SSI
Sustainable
Shipping Initiative

Defining sustainability criteria for marine fuels

Fifteen issues, principles and criteria for zero and low carbon fuels for shipping

SEPTEMBER 2021

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About the authors

The Sustainable Shipping Initiative (SSI)

The SSI is a multi-stakeholder collective of ambitious and like-minded leaders, driving change through cross-sectoral collaboration to contribute to – and thrive in – a more sustainable maritime industry. Spanning the entire shipping value chain, SSI members are shipowners and charterers; shipyards; marine product, equipment and service providers; banks, ship finance and insurance providers; classification societies; and sustainability non-profits.

Guided by the Roadmap to a sustainable shipping industry, SSI works on a range of issues related to enabling and furthering sustainable shipping, including decarbonisation, seafarers' labour and human rights, and responsible ship recycling.

www.sustainableshipping.org
www.shiprecyclingtransparency.org

Copenhagen Business School (CBS) Maritime

CBS Maritime is a research centre at Copenhagen Business School (CBS) focusing on shipping and the broader maritime sector's challenges, particularly decarbonisation and green transition. The centre coordinates across all CBS departments and aims to develop maritime research and teaching at CBS in close association with the business community. CBS Maritime's decarbonisation research develops in collaboration with maritime academies and all the universities in Denmark in the Maritime Research Alliance and internationally through the Green Shipping Project.

www.cbs.dk/en/knowledge-society/interdisciplinary-initiatives/cbs-maritime

PARTNERSHIP UNDER GREEN SHIPPING PROJECT

The collaboration between SSI and CBS Maritime is carried out under the Green Shipping Project, an international research partnership managed jointly by CBS Maritime and the Centre for Transportation Studies at the University of British Columbia's (UBC) Sauder School of Business in Vancouver. With the aim of advancing knowledge and understanding towards the progressive governance of sustainable maritime transport, the Green Shipping Project was launched in 2017 and is a collaboration of 18 universities and 19 government, industry, and NGO partners in Asia, Europe and North America. Funded by the Social Sciences and Humanities Research Council of Canada, the international maritime research network is focused on five areas of research: Trade and Logistics; Green Ports; Innovation; Stakeholders; and Value Chains.

About this report

Sustainability criteria for zero and low carbon marine fuels presents the findings of research undertaken by the Sustainable Shipping Initiative (SSI) and academic partner Copenhagen Business School (CBS) Maritime to identify and provide clarity on sustainability concerns throughout the lifecycle (well-to-wake) of zero and low carbon marine fuels.

This report identifies a set of 15 sustainability issues, principles, and criteria to be considered alongside factors such as price, availability, and technical feasibility of fuels currently being explored for shipping's decarbonisation.

Building on SSI's previous decarbonisation work, this report follows a preliminary white paper published in February 2021, and contributes to work carried out by groups such as the Getting To Zero Coalition (GTZ), as well as discussions happening at the regulatory level such as the International Maritime Organization (IMO).

A contribution to the broader debate surrounding incentivising and enabling the uptake of sustainable zero and low carbon marine fuels, this work is based on multi-stakeholder dialogue between SSI members and stakeholders including academia, NGOs, regulators, fuel producers, ports, as well as shipowners and operators, and supported by academic research conducted by CBS Maritime.

While recognising the importance sustainable fuels and technologies have in the decarbonisation of shipping, this report specifically focuses on marine fuels. This report does not seek to promote a specific type of fuel for decarbonisation, but rather to inform decision-making around the choice of fuel(s) to promote, invest in, procure and use, by providing accurate information around sustainability concerns.

This report is part of SSI's work towards a sustainable shipping industry as presented in the Roadmap to a sustainable shipping industry. Decarbonisation has a critical role to play in shipping's sustainability journey, and ensuring the rapid and sustainable decarbonisation of the industry contributes to all six vision areas

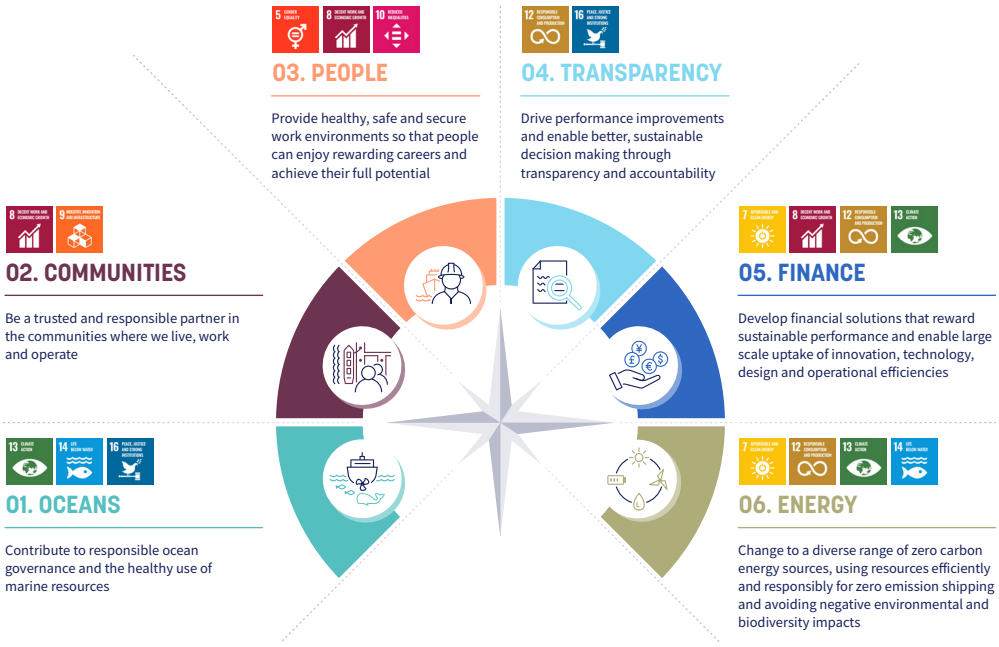


FIGURE 1

Roadmap to a sustainable shipping industry

Acronyms and abbreviations

BC	Black carbon	**NF_3**	Ammonia
CBS	Copenhagen Business School	**NO_x**	Nitrogen oxide
CIMAC	International Council on Combustion Engines	**OC**	Organic carbon
CH_4	Methane	**ODS**	Ozone depleting substances
CO	Carbon monoxide	**PFCs**	Perfluorocarbons
CO_2	Carbon dioxide	**PM**	Particulate matter
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation	**RSB**	Roundtable on Sustainable Biomaterials
EDF	Environmental Defense Fund	**SASB**	Sustainability Accounting Standards Board
EN	European Standard	**SDGs**	Sustainable Development Goals
EU	European Union	**SF_6**	Sulphur hexafluoride
FPIC	Free Prior Informed Consent	**SLCF**	Short-lived climate forcers
GTZ	Getting To Zero Coalition	**SO_2**	Sulphur dioxide
GHG	Greenhouse gas	**SO_x**	Sulphur oxide
HFCs	Hydrofluorocarbons	**SSI**	Sustainable Shipping Initiative
ICCT	International Council on Clean Transportation	**TtW**	Tank-to-wake
IAME	International Association of Maritime Economists	**UBC**	University of British Columbia
IEA	International Energy Agency	**UMAS**	University Maritime Advisory Services
IMO	International Maritime Organization	**UN**	United Nations
IPCC	Intergovernmental Panel on Climate Change	**UNCTAD**	United Nations' Conference on Trade and Development
ISO	International Organization for Standardization	**UNDRIP**	United Nations Declaration on the Rights of Indigenous Peoples
LCA	Lifecycle assessment	**UNFCCC**	United Nations Framework Convention on Climate Change
LNG	Liquified natural gas	**UNGC**	United Nations Global Compact
MARPOL	International Convention for the Prevention of Pollution from Ships	**VOC**	Volatile organic compounds
N_2O	Nitrous oxide	**WtT**	Well-to-tank
NF_3	Nitrogen trifluoride	**WtW**	Well-to-wake

Executive summary

Decarbonising the international shipping sector is a major challenge which is likely to involve a range of solutions including technical and operational energy efficiency measures, improvements to resource use, alternative propulsion methods, and the widespread adoption of sustainable, zero and low carbon marine fuels and technologies.

The marine fuels currently under consideration for shipping's decarbonisation are primarily being evaluated in terms of price, availability and technical feasibility. However, a fourth dimension should be considered, as we must ensure that the fuels we are investing in, purchasing, and using to transport cargo are sustainable across the fuel lifecycle (well-to-wake) and avoid negative impacts across environmental, social, and socio-economic factors.

Defining sustainable marine fuels

Sustainability is generally understood as an integration of three dimensions: **environmental**, **social**, and **economic**. When applied to the fuels used in maritime transport, the following definition (adapted from IMO, 2013 and UNCTAD, 2018) serves as a starting point for identifying the sustainability issues and principles outlined in this report:

"Sustainability in maritime transport entails, among other features, the ability to provide transportation infrastructure and services that are safe, inclusive, accessible, reliable, transparent, affordable, fuel-efficient, environmentally friendly, respectful of land and marine resources, low-carbon and resilient to shocks and disruptions including those caused by climate change and natural disasters."

A lifecycle (well-to-wake) approach

Managing value chain risks for the marine fuels under consideration for shipping's decarbonisation requires an understanding of the sustainability issues across the lifecycle of the fuel. For the purposes of this report, issues are considered on a well-to-wake basis, encompassing well-to-tank and tank-to-wake as illustrated below.

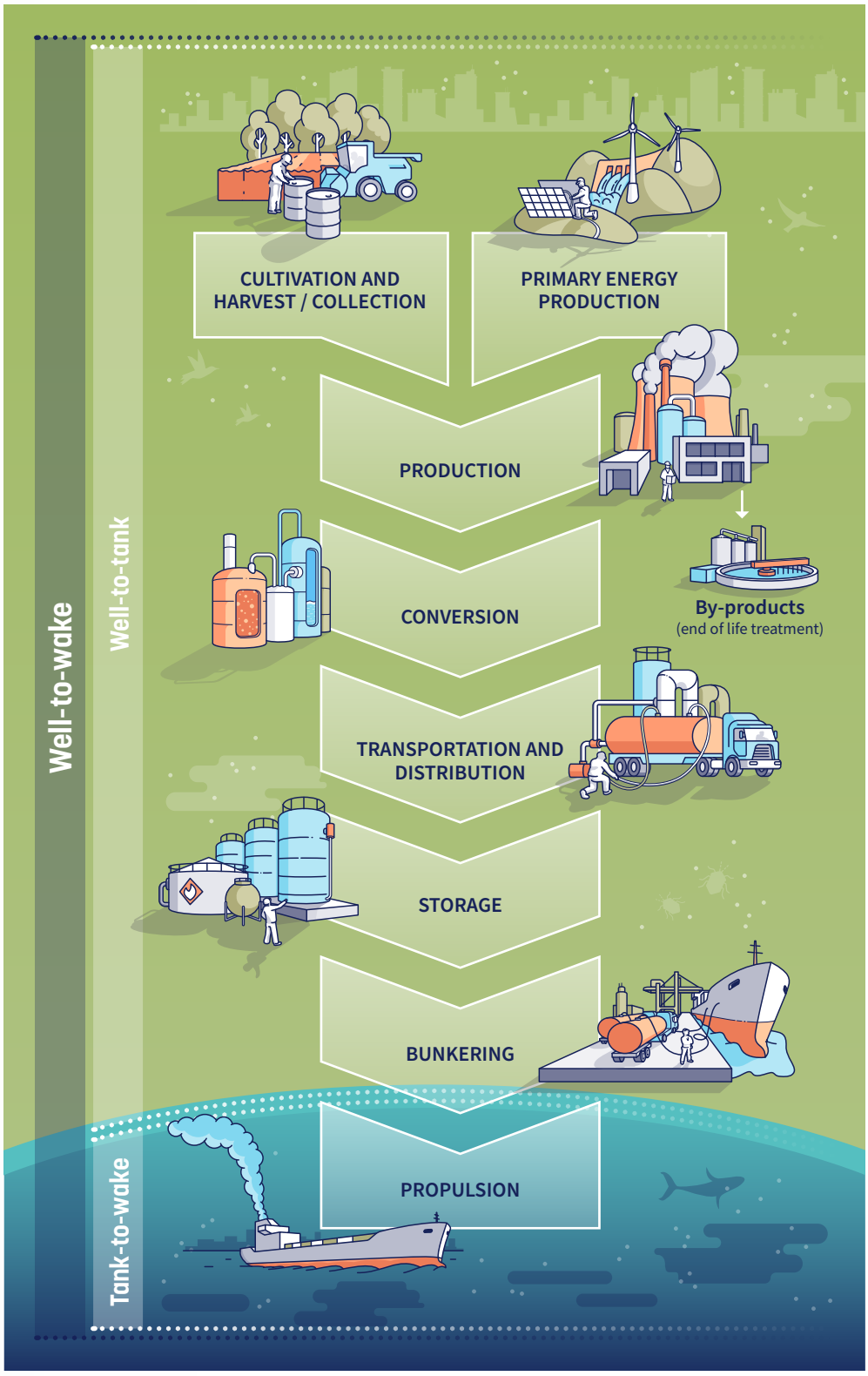


FIGURE 2

Simplified lifecycle of a marine fuel

Sustainability criteria for zero and low carbon marine fuels

The SSI together with academic partner Copenhagen Business School Maritime identified a set of 15 sustainability issues, principles and criteria (Table 1) for zero and low carbon marine fuels that provide clarity on the sustainability concerns over the lifecycle of the fuels currently being explored for shipping's decarbonisation. The figure below displays the 15 sustainability issues for zero and low carbon marine fuels.

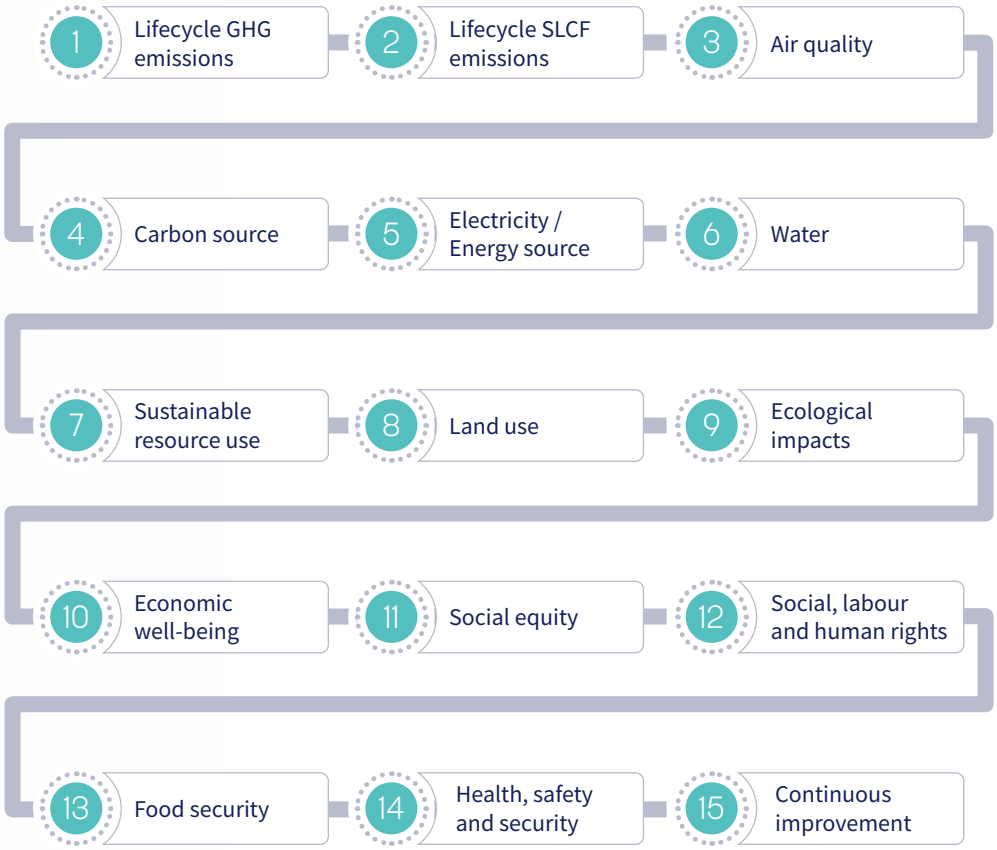


FIGURE 3

Sustainability issues for zero and low carbon marine fuels

Next steps

SSI aims to increase awareness and encourage use of the criteria

Through the development of these principles and criteria, alongside better understanding of the sustainability issues surrounding potential zero and low carbon marine fuels, SSI aims to increase awareness and encourage use of the criteria, as well as further research and innovation focusing on the sustainability of fuels.

The research presented in this report can also contribute to the setting of industry standards and certification programmes to assure the sustainability of marine fuels.

This may aid in the selection of sustainable fuels for shipping, and increase demand across the sector, further increasing trust among key stakeholders and mitigating risk.

Additionally, the criteria can be reviewed at the regulatory level, helping inform discussions around the fuel lifecycle, and incorporation of sustainability criteria in Lifecycle Assessments, which may lead to industry standards against which certification can provide assurance.

Introduction

Under the Paris Agreement, nations have agreed that the global average temperature rise should be limited to 1.5°C or kept well below 2°C compared to pre-industrial levels, to avoid the most severe aspects of climate change (UNFCCC, n.d.).

The Intergovernmental Panel on Climate Change (IPCC, 2018, 2021) has urgently stated the need to achieve net-zero GHG emissions by mid-century in order to limit global warming to 1.5°C, warning that immediate, rapid and large-scale reductions are needed to keep warming close to 1.5°C or even 2°C.

To tackle Greenhouse Gas (GHG) emissions from the maritime sector, the International Maritime Organization (IMO) envisions "a pathway of CO_2 emissions reduction consistent with the Paris Agreement temperature goals" (IMO, n.d.). IMO's 2018 initial GHG strategy aims to reduce total GHG emissions from shipping by at least 50% by 2050 with a vision to phase them out, as soon as possible in this century, and to reduce carbon intensity (CO_2 emissions per transport work) by 70% by 2050 compared to 2008 levels (IMO, 2018). A revised strategy is due to be adopted in 2023 (IMO, n.d.).

Achieving the sector's decarbonisation targets requires an array of solutions that can be developed, adopted and implemented in the short, medium, and long term

The process of reducing carbon intensity and GHG emissions – decarbonisation – is a major challenge for international shipping as the sector has historically been heavily reliant on fossil fuels (World Bank, 2021a). Achieving the sector's decarbonisation targets requires an array of solutions that can be developed, adopted and implemented in the short, medium, and long term.

Decarbonising the shipping sector is likely to involve a range of measures including technical and operational energy efficiency measures, improvements to resource use, alternative propulsion methods, and the widespread adoption of sustainable zero and low carbon marine fuels[1] and technologies.

[1] **THE WORKING DEFINITION FOR ZERO AND LOW CARBON MARINE FUELS** used for this piece of work aligns with terminology used by the Getting to Zero Coalition. It is inclusive of full lifecycle emissions with the "ultimate end objective of 'getting to zero'", while recognising that some fuels currently under consideration are low carbon and may play a role in the transition to the full decarbonisation of shipping. See: Definition for zero carbon energy sources (GTZ, 2019).

Zero and low carbon marine fuels

In order for shipping to decarbonise, the industry must undertake development, testing, scaling and commercialisation of zero and low carbon marine fuels, and through association, zero emissions vessels (GTZ, n.d). As a ship's operational life can be upwards of 30 years, vessels entering the world fleet by 2030 must contribute to significant emissions reduction. To achieve emission reductions, the Getting To Zero Coalition (GTZ) sets out the goal of commercially viable deep sea zero emission vessels ready to be deployed by 2030 (GTZ, n.d.).

In 2020, the Fourth IMO GHG study predicted that over 60% of emissions reduction efforts by 2050 will be achieved by zero and low carbon marine fuels (IMO, 2020). In early 2021, the Race to Zero's Breakthroughs (Race to Zero, 2021), drawing on UNFCCC's Climate Action Pathways (UNFCCC, 2021), suggested that in order to set shipping on course to fully decarbonise by 2050, zero emission fuels need to make up 5% of the international shipping fuel mix by 2030.

A wide range of fuel and technology options are currently under consideration for shipping's decarbonisation[2], highlighting that there is no one-size-fits-all solution and the best option may depend on many factors, such as vessel type and journey length to name a few. Fuels under consideration include biomass-derived fuels (e.g., biodiesel and bio-methane) and electrofuels[3] (e.g., ammonia and hydrogen).

This report will not focus on the merits of each potential option, but rather presents a set of sustainability criteria that can be applied (with potential modifications) to all current and future marine fuels.

[2] e.g. in analyses by Lloyd's Register & UMAS, 2017; Energy Transitions Commission, 2019; World Bank, 2021b; IEA, 2021; UNFCCC, 2021.

[3] Defined here as a group of synthetic fuels derived from hydrogen, adapted from *Electrofuels for shipping: How synthetic fuels from renewable electricity could unlock sustainable investment in countries like Chile* (EDF, 2019).

Context and scene setting

The international shipping industry requires rapid decarbonisation if shipping is to achieve its decarbonisation goals. As stated previously, zero emission vessels must be introduced and net zero emission fuels must make up at least 5% of the international shipping fuel mix by 2030 (GTZ, n.d; Race to Zero, 2021).

This target also needs to take into consideration all dimensions of sustainability across the fuel lifecycle (well-to-wake) in order to avoid negative impacts on the environment, on society, and on socio-economic factors.

Sustainable marine fuels

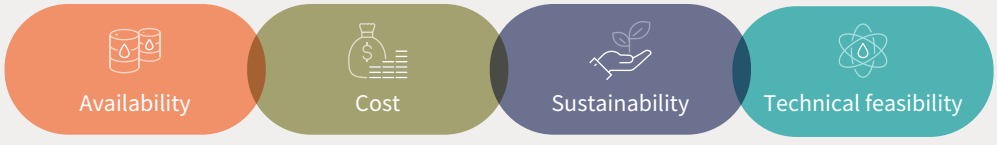
Sustainability is generally understood as an integration of three dimensions: environmental, social, and economic. When applied to the fuels used in maritime transport, the following definition serves as a starting point for identifying the sustainability issues and principles outlined in this report:

> "Sustainability in maritime transport entails, among other features, the ability to provide transportation infrastructure and services that are safe, inclusive, accessible, reliable, transparent, affordable, fuel-efficient, environmentally friendly, respectful of land and marine resources, low-carbon and resilient to shocks and disruptions including those caused by climate change and natural disasters."[4]

When evaluating the zero and low carbon marine fuels that are being invested in, purchased, and used in cargo transport, four factors should be considered on an equal basis: availability, cost, sustainability, and technical feasibility (see Figure 4).

FIGURE 4

Evaluations of zero and low carbons fuels should also consider sustainability, alongside availability, cost, and technical feasibility



[4] Adapted from IMO's definition of the concept of a "sustainable maritime transport system" (IMO, 2013) which was built on and updated by the United Nations' Conference on Trade and Development (UNCTAD) in 2018. As UNCTAD notes, for shipping to do its part in the sustainable development agenda "requires that economic, social and environmental sustainability criteria be fully integrated and mainstreamed into relevant maritime transport planning processes, policies and investment decisions". This report focuses on sustainability criteria for consideration of the sustainability of marine fuels, with commercial questions around price, profitability and competitiveness in the shipping industry covered by techno-economic frameworks in other industry forums. Economic dimensions related to the enhancing material welfare in society – including impacts on economic development – will be explored through research conducted in the context of SSI's collaboration with CBS Maritime. See the 'Academic research' section.

A lifecycle approach

In order to provide a more complete picture of the sustainability of a marine fuel, sustainability concerns should be understood and addressed over the full lifecycle, commonly referred to as “well-to-wake”.

For the purpose of this report, lifecycle refers to all stages in the lifecycle of marine fuels – both **well-to-tank** and **tank-to-wake** (therefore **well-to-wake**).

- **Well-to-tank** includes, but is not limited to, operations leading to the production of the fuel (e.g., cultivation, harvesting, collection and recovery for feedstock-based fuels; or primary energy production for electrofuels), including changes in carbon pools, forgone carbon sequestration and indirect land use change, the production of the fuel, conversion processes (including but not limited to liquefaction, synthesis or compression), end-of-life treatment of by-products and waste streams, transportation and distribution, storage and bunkering.
- **Tank-to-wake** includes, but is not limited to, the application of the fuel on board of the ship (through e.g., combustion in vessel engines or fuel cell propulsion) and, if applicable, end of life treatment (e.g., for batteries and fuel cells).

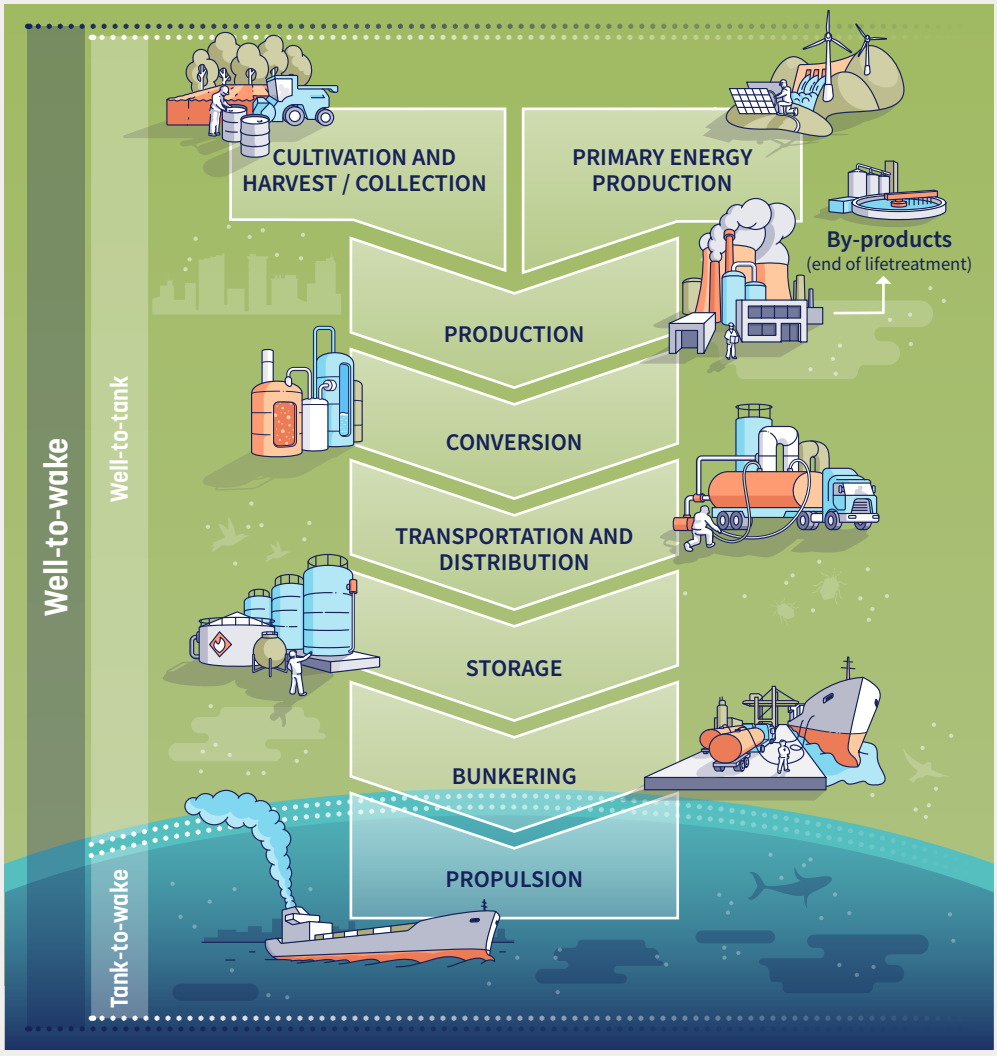


FIGURE 5

Simplified lifecycle of a marine fuel

DEVELOPMENTS ON LIFECYCLE

Approaches to measuring emissions in international shipping tend to concentrate on tank-to-wake and neglect the broader, upstream well-to-tank and thus full lifecycle (well-to-wake) impacts of fuels (Bouman, Lindstad, & Strømman, 2016).

Watch the replay of IMO's Low and Zero-carbon Alternative Fuel Symposium

Nevertheless, a full lifecycle approach is becoming increasingly important to the industry. A candidate measure in the Initial GHG Strategy refers to developing "robust lifecycle GHG/carbon intensity guidelines for all types of fuels, in order to prepare for an implementation programme for effective uptake of alternative low-carbon and zero-carbon fuels" (IMO, n.d.; IMO, 2018). The 2021 Low and Zero-carbon Alternative Fuel Symposium organized by the IMO identified lifecycle assessments[5] as a priority issue for the IMO to further facilitate the development and uptake of alternative marine fuels (IMO, 2021).

Examples of other developments on lifecycle include the International Council on Clean Transportation (ICCT) briefing paper on a methodology for calculating well-to-wake CO_2-equivalent emissions from four fossil marine fuels that could be expanded to new fuels (ICCT, 2021) and the 2020 white paper by the International Council on Combustion Engines (CIMAC) on why a well-to-wake perspective is essential when assessing alternative fuels and respective policies in maritime shipping (CIMAC, 2020). These are a welcome step as they assess GHG emissions and carbon intensity of fuels over their lifecycle.

However, GHG emissions and carbon intensity measures do not take into consideration other dimensions of sustainability such as:

- Social
- Economic
- Other non-GHG environmental factors

In order to ensure a sustainable decarbonisation of the industry, other criteria beyond lifecycle GHG emissions/carbon intensity need to be considered.

[5] A lifecycle assessment (LCA) is a process of evaluating the effects that a product has on the environment over the entire period of its life thereby increasing resource-use efficiency and decreasing liabilities. It can be used to study the environmental impact of either a product or the function the product is designed to perform (United Nations Environment Programme as cited in European Environment Agency , n.d.).

Sustainability criteria for zero and low carbon marine fuels

Stakeholders across the shipping value chain are increasingly aware of the need to better understand sustainability in the context of their activities, including the sustainability issues surrounding the marine fuels under consideration for shipping's decarbonisation, and to ensure negative impacts are not externalised or transferred upstream or downstream to parts of the value chain that the shipping sector does not account for.

Eventual certification of zero and low carbon marine fuels can provide assurance to investors

Understanding sustainability issues from a lifecycle perspective further allows for informed decision-making concerning value chain risks and helps direct choices for investment, purchase and consumption. Eventual certification of zero and low carbon marine fuels based on sustainability criteria can provide assurance to organisations investing in zero and low carbon marine fuel options.

Table 1 (on the following page) seeks to provide clarity on the sustainability issues, principles and criteria surrounding marine fuels.

SUSTAINABILITY ISSUE:

What needs to be considered over the whole lifecycle of marine fuels, ensuring that the needs of current generations are met while not compromising those of future generations.

PRINCIPLE:
Aspirational goal that provides guidance on sustainability issues of relevance.

CRITERIA:
Describes best practice and sets out the condition(s) required to meet the principle.

DISCLAIMER: The Sustainable Shipping Initiative is neither a standard setting nor a certification body. Table 1 outlines sustainability issues, principles and criteria developed according to different feedstocks and primary energy sources for zero and low carbon marine fuels. The issues, principles and criteria cover environmental, social and socio-economic factors in an unranked and fuel agnostic manner intended for application to different production pathways. Standards and certification schemes developed using these criteria may vary depending on production pathways as well as market demand, and may be further elaborated and differentiated according to those, and other, variables.

Table 1: sustainability issues, principles and criteria for zero and low carbon marine fuels

SUSTAINABILITY ISSUE	PRINCIPLE	CRITERIA
1 **Lifecycle[a] Greenhouse Gas (GHG)[b] emissions**	Zero and low carbon marine fuels should generate zero or close to zero GHG emissions on a well-to-wake lifecycle basis over a timescale consistent with achieving the temperature goals of the Paris Agreement.	Zero and low carbon marine fuels shall achieve zero GHG emissions or significant net GHG reductions i.e., total GHG values over the well-to-wake lifecycle of the zero and low carbon marine fuel over a timescale consistent with achieving the temperature goals of the Paris Agreement.
2 **Lifecycle Short-lived Climate Forcers (SLCF)[c] emissions**	Zero and low carbon marine fuels for use in the maritime industry should generate zero or close to zero SLCF[d] emissions on a well-to-wake lifecycle basis over a timescale consistent with achieving the temperature goals of the Paris Agreement.	Zero and low carbon marine fuels shall achieve zero SLCF emissions or significant net SLCF reductions i.e., total SLCF values over the well-to-wake lifecycle for the zero and low carbon marine fuel over a timescale consistent with achieving the temperature goals of the Paris Agreement.
3 **Air quality**	Impacts across the lifecycle of zero and low carbon marine fuels should avoid negative effects on air quality.	Air pollutants[e] across the well-to-wake lifecycle stages of the zero and low carbon marine fuel shall be minimised or eliminated.
4 **Carbon source**	The source(s) of carbon (e.g., feedstock) used in the production of zero and low carbon marine fuels should be disclosed. The feedstock should be derived from a source with the lowest negative impacts according to the best available techniques and eliminate or minimise lifecycle GHG emissions and carbon intensity.	The source of carbon (e.g., the feedstock) used in the production of the zero and low carbon marine fuel shall be fully disclosed. The disclosure shall include, but should not be limited to, origin, production process, quantity and carbon intensity. The source may not be carbon of fossil origin, nor obtained from land with high carbon stock, and should provide a climate benefit compared to fossil fuels.
5 **Electricity/energy source**	The source of renewable electricity/energy consumed in support of producing hydrogen-based zero and low carbon marine fuels should be disclosed. Hydrogen-based zero and low carbon marine fuels should be produced from renewable energy sources and use the best available techniques to eliminate or minimise lifecycle GHG emissions.	The primary source of electricity/energy consumed for the production of hydrogen-based zero and low carbon marine fuel shall be disclosed. The information shall include, but should not be limited to, origin, production process, and quantity. The production of hydrogen should be based on renewable energy sources. Furthermore, there should be an element of additionality, meaning that the fuel producer is adding to the deployment or financing of renewable energy sources.
6 **Water**	Impacts across the lifecycle of zero and low carbon marine fuels should maintain or enhance water quality and availability, and respect water use rights.	Operations in the well-to-tank lifecycle stages of the zero and low carbon marine fuel shall minimise water usage; avoid contamination, pollution and spillage; maintain or enhance the quality, quantity, usage and conservation of water resources; and respect formal or customary water rights.

SUSTAINABILITY ISSUE	PRINCIPLE	CRITERIA
7 **Sustainable resource use**	Impacts across the lifecycle of zero and low carbon marine fuels should avoid resource depletion and ensure the resource potential to meet the needs of present and future generations.	Operations in the well-to-wake lifecycle stages of the zero and low carbon marine fuel shall ensure the sustainable use of, and closed loop approach to, resources (including reuse, recycling, recovery and waste management).
8 **Land use**	Impacts across the lifecycle of zero and low carbon marine fuels should not result in negative land use impacts and shall apply good agricultural practices.	Operations in the well-to-tank lifecycle stages of the zero and low carbon marine fuel shall avoid negative land use impacts (maintain soil health; avoid/reverse soil degradation; maintain carbon stocks; avoid forgone carbon sequestration; enhance biodiversity and ensure no impacts on high biodiversity areas), address the risks related to land use change, leakage, hierarchy and apply good agricultural practices.
9 **Ecological Impacts**	Impacts across the lifecycle of zero and low carbon marine fuels should avoid negative ecological impacts, maintaining or enhancing biodiversity (including rare, threatened or endangered species and high conservation value habitats), ecosystems, soil, ecosystem services and conservation.	Operations in the well-to-wake lifecycle stages (including waste management and use of chemicals) of the zero and low carbon marine fuel shall avoid negative impacts on, and shall maintain or enhance biodiversity (including rare, threatened or endangered species and high conservation value habitats), ecosystems, soil, ecosystem services, conservation values.
10 **Economic well-being**	Impacts across the lifecycle of zero and low carbon marine fuels should contribute to economic well-being of local producers, communities and stakeholders where the operations leading to, and including, the production of low and zero carbon fuel takes place.	Operations in the well-to-tank lifecycle stages of the zero and low carbon marine fuel shall contribute to the economic well-being of local producers, communities and stakeholders where the production of low and zero carbon fuel takes place.
11 **Social equity**	Impacts across the lifecycle of zero and low carbon marine fuels should contribute to social equity in communities where the operations leading to, and including, the production of low and zero carbon fuel takes place.	Operations in the well-to-tank lifecycle stages of the zero and low carbon marine fuel shall contribute to the social equity of local producers, communities and stakeholders.
12 **Social, labour, and human rights**	Impacts across the lifecycle of zero and low carbon marine fuels should respect and uphold the social, labour and human rights of affected populations including indigenous rights and title.	Operations in the well-to-tank lifecycle stages (including operations in the extractive industries) of the zero and low carbon marine fuel shall not violate labour or human rights of the affected populations, shall promote decent work conditions and workforce well-being, and shall not violate land use rights (through e.g., ensuring Free Prior Informed Consent (FPIC) as recognised in the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP)).

SUSTAINABILITY ISSUE	PRINCIPLE	CRITERIA
13 **Food security**	Impacts across the lifecycle of zero and low carbon marine fuels should respect and uphold the right to adequate food and should not disadvantage food security.	Operations in the well-to-tank lifecycle stages of the zero and low carbon marine fuel shall avoid negative impacts on food security (such as the replacement of staple crops, diversion of exports and local food price increases).
14 **Health, safety and security**	Operations in the well-to-tank lifecycle stages of the zero and low carbon marine fuel (including the end-of-life treatment and/or disposal of fuel by-products and waste streams, production plants and equipment) should minimise health, safety and security risks to the workforce, communities and the natural environment.	Health, safety and security risks (including noise, odour and dust) throughout the well-to-wake lifecycle of the zero and low carbon marine fuel shall be addressed by avoidance, mitigation and adaptation through risk assessments, safety management, guidance and training on e.g., accidents, as well as ecological and health impacts of spillage/discharge.
15 **Continuous improvement**	Operations in the well-to-wake lifecycle stages of zero and low carbon marine fuels should continuously improve through innovation[f], adopting a proactive approach to enhancing their sustainability performance.	Innovation in the well-to-wake lifecycle stages of the zero and low carbon marine fuel (explicitly including end-of-life treatment and/or disposal of fuel by-products and waste streams, production plants and equipment) shall contribute to the continuous improvement of the fuel's sustainability performance.

[a] 'Lifecycle' refers to all stages in the lifecycle of marine fuels from well-to-tank and from tank-to-wake (thus well-to-wake). Full definition on page 12.

[b] GHG emissions include all GHGs covered by the UNFCCC/Kyoto Protocol, namely: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6); and nitrogen trifluoride (NF_3) (based on GTZ, 2019).

[c] Short-lived climate forcers (SLCF) are gases and particles that affect the climate. They have lifetimes in the atmosphere of a few days to a decade, and many of them are also air pollutants and greenhouse gases. They include all gases and particles covered by the IPCC: Black Carbon (BC), Organic Carbon (OC), particulate matter 2.5 microns or smaller (PM2.5), nitrogen oxide (NO_x), carbon monoxide (CO), Non-methane volatile organic compounds (NMVOCs) (including biogenic volatile organic compounds (BVOC), sulphur dioxide (SO_2), ammonia (NH_3), methane (CH_4) and halogenated compounds (based on IPCC, 2018)).

[d] There is currently no Intergovernmental Panel on Climate Change (IPCC) Methodology on Short-lived Climate Forcers. The IPCC is undertaking preparatory work for the Methodology Report in the sixth assessment cycle and will continue with further methodological development in the seventh assessment cycle (IPCC, 2020).

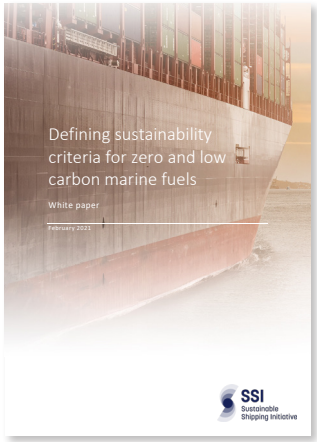
[e] Nitrogen Oxide (NO_x); Sulphur Oxide (SO_x); Ozone Depleting Substances (ODS); Volatile Organic Compounds (VOC); Particulate Matter (PM) (based on MARPOL Annex VI, 1997).

[f] Innovation broadly refers to activities or processes resulting in, or aiming for, a new or changed product, service, process, model, method or a combination thereof (definition inspired by ISO 56000 Innovation management (ISO, 2020)).

Methodology

The sustainability issues, principles and criteria outlined in this report have been developed through multi-stakeholder dialogue.

SSI member Lloyd's Register identified an initial set of sustainability issues for zero and low carbon marine fuels, which were then discussed and refined by members of SSI's decarbonisation working group, academic partner CBS Maritime, and the SSI Secretariat. Early drafts were shared with a group of industry stakeholders including the Getting to Zero Coalition (GTZ), where SSI is a knowledge partner in the Fuels and Technologies Workstream.



Download SSI's white paper: 'Defining sustainability criteria for zero and low carbon marine fuels'

Additional inputs to the sustainability criteria were collected through stakeholder consultations in the form of webinars, online workshops, written feedback and bilateral discussions between November 2020 and January 2021, leading to the launch of a white paper listing a preliminary set of 13 sustainability issues and associated principles for alternative marine fuels. The purpose of the white paper was to provide a starting point for broader stakeholder consultation and debate, feeding into the criteria presented in this report.

The white paper received feedback from a range of stakeholders across fuel producers, international regulators, multi-stakeholder initiatives, NGOs, ports, shipowners and operators, and trade organisations. Based on this feedback, the set of sustainability issues and principles was further expanded to a total of 15, with corresponding criteria defined for each.

Academic research

The process of defining sustainability criteria has evolved in tandem with the work of CBS Maritime on conceptualising sustainability in the context of zero and low carbon marine fuels. CBS Maritime's work (Sornn-Friese et al., 2021[6]) has the aim of providing an appropriate and meaningful foundation for the set of sustainability principles and criteria for alternative marine fuels.

The below text and Figure 6 defining the three interrelated dimensions of sustainability are adapted from Sorrn-Friese et al. (2021)

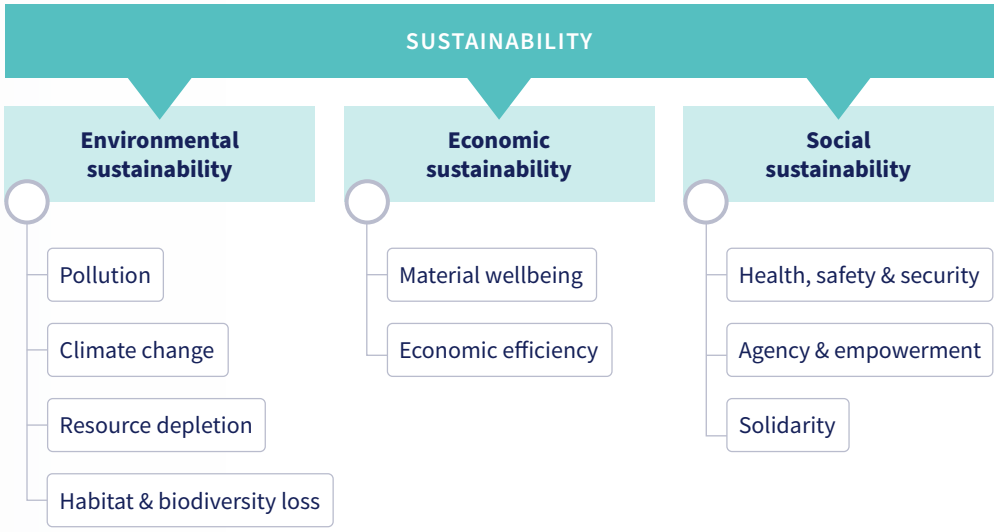


FIGURE 6

Key issues along the three dimensions of sustainability, adapted from Sornn-Friese et al., 2021

ENVIRONMENTAL SUSTAINABILITY

Environmental sustainability is defined as a condition where Earth's natural cycles are not disturbed by human activity beyond their ability to regenerate, and where human activity does not deteriorate the natural capital that must be shared with future generations. For example, it includes a responsibility to minimise ecological impacts, increase resource efficiency, reduce and mitigate the impacts of climate change and preserve the natural environment.

ECONOMIC SUSTAINABILITY

Economic sustainability is defined as improving the material well-being of communities and society through economic development. It also includes the responsibility to distribute wealth so as to not benefit only privileged communities, but to also increase economic opportunities for less privileged ones.

SOCIAL SUSTAINABILITY

Social sustainability is defined as benefiting society and protecting people (UNGC, n.d.) through access to adequate housing, basic services, energy, durable goods, transportation, and education; employment conditions; and other social protections (Lima de Miranda & Snower, 2020). It also includes health, safety and security considerations including protection from noise and visual impacts as well as odour and dust.

[6] The academic paper will be presented at the annual conference of the International Association of Maritime Economists (IAME) in November 2021. The paper will subsequently be submitted for review and publication in an international scientific journal.

Standards and certification schemes for a sustainable shipping industry

The development of these principles and criteria, alongside better understanding of the sustainability issues surrounding potential zero and low carbon marine fuels, can facilitate the setting of industry standards and certification programmes which would assure the sustainability of marine fuels. This can aid in the selection of sustainable marine fuels and increase demand for them across the shipping sector, thus enabling the creation of a more sustainable industry.

The sustainability issues, principles and corresponding criteria defined in this report will provide an informed basis for engagement with standards and certification bodies, facilitating the development of widely accepted standards and associated certification schemes for marine fuels. Standards and certification schemes, developed by both public and private organisations, can target a variety of objectives and cover a number of industrial activities, working in tandem with industry initiatives, regulation, and other forms of guidance and rule-setting.

STANDARD:

- Provides minimum requirements based on the criteria, with which compliance may or may not be mandatory
- Developed by a standard-setting body

CERTIFICATION:

- Assures sustainability by way of thresholds and indicators (which may be all) of the standards
- Conducted by a certification body

Users can begin to evaluate fuels not only on their availability, cost, and technical feasibility, but also on their sustainability credentials

Certification of sustainable zero and low carbon marine fuels has the power to increase demand as users are assured of a fuel's sustainability credentials throughout its lifecycle, thereby making the prospect of selecting sustainable marine fuel options more attractive. Users can then begin to evaluate fuels not only on their availability, cost, and technical feasibility, but also on their sustainability credentials.

Standards and certification schemes therefore have an important role to play in enabling market transformations and improving the sustainability performance of sectors such as shipping.

Certification of sustainable zero and low carbon marine fuels has the power to increase demand as users are assured of a fuel's sustainability credentials throughout its lifecycle, thereby making the prospect of selecting sustainable marine fuel options more attractive. Users can then begin to evaluate fuels not only on their availability, cost, and technical feasibility, but also on their sustainability credentials.

Standards and certification schemes therefore have an important role to play in enabling market transformations and improving the sustainability performance of sectors such as shipping.

Existing standards and certification schemes in shipping

Some sustainability standards and certification schemes currently exist for a limited group of fuels. However, other zero and low carbon marine fuels under consideration remain unaddressed

In shipping, several sustainability standards, certification schemes and criteria exist for e.g., shipping finance, ships and infrastructure, maritime operations, and fuels. Some sustainability standards and certification schemes currently exist for a limited group of fuels (for example, biomass-related standards). However, other zero and low carbon marine fuels under consideration remain unaddressed.

A non-exhaustive selection of standards and certification schemes, adapted from work carried out by CBS Maritime, is presented in Appendix 1 and 2 in order to provide an overview of existing (and some future) schemes relevant to shipping. These tend to vary in reference scheme (i.e., sector focus, fuel focus) and jurisdiction (i.e., local, regional, global), and they are generally developed for one or more sustainability dimensions, but with an emphasis on environmental sustainability.

The sustainability issues, principles and criteria presented in this report endeavour to foster a broader understanding of sustainability that includes environmental, social and economic dimensions along with lifecycle GHG emissions, which can feed into the development of sustainability standards or certification schemes for zero and low carbon marine fuels. Through this work SSI seeks to avoid duplication while ensuring harmonisation with existing sustainability-related standards and certification schemes.

Next steps

Consideration of the proposed sustainability criteria can be used for awareness raising of relevant sustainability issues, for setting or benchmarking standards and certifications for marine fuel, for use at regulatory level, for stakeholder communication, as well as to inspire further research and innovation of sustainability principles across the shipping and marine fuel supply chain.

Going forward, SSI will engage with standards and certification bodies to facilitate the development of one or several sustainability standards and/or certification schemes for zero and low carbon marine fuels.

The standard-setting and certification process will contribute to the identification and mitigation of risks, increase trust and credibility in the sustainability credentials of zero and low carbon marine fuels among key stakeholder groups and reduce reputational risk.

The research presented in this report can also be taken further into fora at the regulatory level

The research presented in this report can also be taken further into fora at the regulatory level, such as the IMO, helping inform discussions around the fuel lifecycle and sustainability criteria to be considered in Lifecycle Assessments, which may in turn lead to the call for industry standards against which certification can provide sustainability assurance.

The SSI will continue to collaborate and partner with potential user groups on the sustainability criteria and other key stakeholder groups across the shipping value chain to further develop and ensure the robustness of the criteria, as well as facilitate its use throughout the industry.

Appendices

Appendix 1: Non-exhaustive selection of standards and certification schemes for fuels

(NB: TtW = tank-to-wake, WtT= well-to-tank, WtW = well-to-wake)

	SCHEME	DESCRIPTION	SCOPE	REGION	SUSTAINABILITY DIMENSION		
					ECONOMIC	SOCIAL	ENVIRONMENTAL
National & regional standards	Renewable Energy Directive II	Overall policy for the promotion and use of energy from renewable sources within the EU	Biofuels and bioliquids	EU			x
	Renewable Transport Fuel Obligation	Detailed regulation for biofuels used for transport and non-road mobile machinery	Biofuels	UK			x
	California Low-Carbon Fuel Standard	Standard designed to decrease the carbon intensity of California's transportation fuel pool and provide an increasing range of low-carbon and renewable alternatives	Fuel-agnostic	US			x
	Renewable Fuel Standard	Standard for refiners or importers of gasoline or diesel fuel. Compliance is achieved by blending renewable fuels into transportation fuel, or by obtaining credits to meet an Environmental Protection Agency - specified Renewable Volume Obligation	Biomass-based diesel, cellulosic biofuel, advanced biofuel, total renewable fuel	US		x	x
	Clean Fuel Standard	Requirements for fuel suppliers (producers and importers) to reduce lifecycle carbon intensity of fuels	Fossil fuels	Canada			x
	British Columbia Low Carbon Fuel Standard	Annual targets for fuel suppliers to reduce average carbon intensity of fossil fuels (diesel and gasoline)	Fossil fuels	British Columbia, Canada			x
	Directive 98/70/EC 'Quality of petrol and diesel fuels' and amending Council Directive 93/12/EEC	Technical specifications on health and environmental grounds for fuels to be used for vehicles equipped with positive-ignition and compression-ignition engines.	Fossil fuels	EU		x	x

	SCHEME	DESCRIPTION	SCOPE	REGION	SUSTAINABILITY DIMENSION		
					ECONOMIC	SOCIAL	ENVIRONMENTAL
ISO & other standards	ISO 13065	Sustainability criteria	Bioenergy	Global	x	x	x
	ISO 20519	Specification for bunkering of LNG fuelled vessels	LNG	Global			x
	ISO 23306; ISO 6583	Specification of individual fuels for marine applications	LNG, methanol	Global			x
	ISO 8216; ISO 8217	Classification and specifications of marine fuels	Fuel-agnostic	Global			x
	ISO/PAS 23263	Technical considerations for fuel suppliers and users regarding marine fuel quality in view of IMO 2020	Fuel-agnostic	Global			x
	ISO 1406x series (ISO 14064-1; ISO 14064-2; ISO 14064-3; ISO 14065; ISO 14066; ISO 14067)	Standards for monitoring, validating and verifying GHG emissions	Fossil fuels	Global			x
	ISO 14040 & ISSO 14044	Environmental management — Lifecycle assessment	N/A	Global			x
	ISO 14083	Quantifying and reporting on GHG emissions from freight transport operations (under development)	N/A	Global			x
	American Society for Testing and Materials (ASTM) D6751	Standard specification for biodiesel fuel blend stock for Middle Distillate Fuels	Biodiesel	Global			x
	European Standard (EN) 16214 series	Sustainability criteria for biofuel production	Biofuels	EU			x

	SCHEME	DESCRIPTION	SCOPE	REGION	SUSTAINABILITY DIMENSION		
					ECONOMIC	SOCIAL	ENVIRONMENTAL
Voluntary standards and certification schemes	Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)	Market-based carbon offsetting scheme for the international aviation sector. Carbon reduction targets will gradually move from a sectoral to an individual approach	Fuel-agnostic	Global			x
	Roundtable on Sustainable Biomaterials (RSB) - Standard	The RSB Standard contributes to food security, rural development and protection of ecosystems. It is a management approach, with a tool-kit and guidance for operators to identify and manage the sustainability issues	Fuels from bio-based and recycled carbon	Global	x	x	x
	RSB - EU RED Fuel Certification	Certification for fuel producers, traders, processors and transporters working within or trading with the EU, proving compliance with requirements in the EU RED as well as with the RSB's stringent sustainability principles	Primary biomass, biomass from end-of-life products and production residues	EU			x
	RSB - Global Fuel Certification	Certification for biomass and fuel producers, traders, processors and transporters	Fuels from biomass and fossil-based waste, and renewable fuels of nonbiological origin	Global	x	x	x
	RSB - CORSIA Certification	Sustainability requirements for operators along the supply chain to produce aviation fuels eligible under CORSIA	Aviation fuels from biomass and solid waste	Global	x	x	x
	Bonsucro Production Standard	Standard for measuring farm productivity and key environmental and social impacts	Sugarcane mills and farms	Global	x	x	x
	Red Tractor Assurance - Combinable Crops & Sugar Beet Scheme	Product quality certification scheme for crops	Wheat, barley, rye, oilseeds, pulses and sugar beet	UK		x	x
	Nederlands Normalisatie Instituut (NEN) Dutch Technical Arrangement (NTA) - 8080	Issues and criteria for sustainably produced biomass for application in bioenergy and bio-based products	All biomass for electricity, heat & cold and transportation fuels	Global	x	x	x
	Round Table on Responsible Soy Association – Standard for Responsible Soy Production	A holistic certification scheme including five principles and 106 mandatory and progressive compliance indicators	Biomass and biofuels	Global		x	x
	U.S. Soybean Sustainability Assurance Protocol EU	A certified aggregate approach audited by third parties that verifies sustainable soybean production at a national scale	Fuels from bio-based and recycled carbon	US	x	x	x
	CertifHy - Guarantees of Origin for Green Hydrogen	Trading standard for renewable hydrogen	Green hydrogen	EU			x

Appendix 2: Non-exhaustive list of other maritime sustainability frameworks

	SCHEME	DESCRIPTION	SCOPE	REGION	SUSTAINABILITY DIMENSION		
					ECONOMIC	SOCIAL	ENVIRONMENTAL
Maritime frameworks	United Nations Global Compact (UNGC) - Sustainable Ocean Principles	Principles for disclosing responsible business practices across relevant sectors and geographies	Ocean health	Global	x	x	x
	Sustainability Accounting Standards Board (SASB) - Marine Transportation Sustainability Accounting Standard	Reporting standard identifying sustainability issues impacting the operating performance or financial condition of the typical company in an industry, regardless of location	General sustainability accounting for shipping	Global		x	x
	Poseidon Principles	Framework for assessing and disclosing the climate alignment of ship finance portfolios	Ships and maritime infrastructure	Global	x	x	x
	Climate Bonds Initiative (CBI) - Shipping Criteria	Technical criteria for shipping assets and programs to certify a green bond under the CBI Certification scheme	Ship owners and operators	Global			x
	Science Based Targets initiative (SBTi) - Maritime Transport	Guidelines on emissions target setting and accounting	Maritime sector	Global		x	x
	Sea Cargo Charter	Framework for aligning chartering activities in bulk shipping with responsible environmental behaviour to promote international shipping's decarbonization	Ships and maritime infrastructure	Global			x
	Green Marine Certificate	Voluntary certification program for key environmental issues	Maritime sector	US and Canada		x	x
	Clean Cargo	Methodology for CO2 emissions calculations and benchmarking	Maritime sector	Global			x
	Clean Shipping Index (CSI)	Independent and holistic labelling system of vessels' environmental performance	Maritime sector	Global			x

References

Bouman, E. A., Lindstad, H. E., & Strømman, A. H. (2016, November 1-6). Life-Cycle Approaches for Bottom-Up Assessment of Environmental Impacts of Shipping. *Proceedings of the SNAME Maritime Convention*. Bellevue, WA, USA.

COP26 Climate Champions & UMAS. (2021). *Shipping needs 5% zero-carbon fuels by 2030 to meet green goal*. Retrieved from Race to Zero: https://racetozero.unfccc.int/shipping-needs-5-zero-carbon-fuels-by-2030-to-meet-green-goal/

EDF. (2019). *Electrofuels for shipping: How synthetic fuels from renewable electricity could unlock sustainable investment in countries like Chile*. https://www.edfeurope.org/news/2019/10/12/electrofuels-shipping : Environmental Defense Fund; Ricardo.

Energy Transitions Commission. (2019). *Mission Possible: Reaching net-zero carbon emissions from harder-to-abate sectors by mid-century. Sectoral focus: shipping*. Energy Transitions Commission.

European Environment Agency. (n.d.). *TERM: life cycle assessment*. Retrieved from European Environment Agency: https://www.eea.europa.eu/help/glossary/eea-glossary/life-cycle-assessment

GTZ. (2019). *Definition of zero carbon energy sources*. Retrieved from Getting to Zero Coalition: https://www.globalmaritimeforum.org/content/2019/09/Getting-to-Zero-Coalition_Zero-carbon-energy-sources.pdf

GTZ. (2021). *Getting to Zero Coalition*. Retrieved from Insight Brief: Five percent zero emission fuels by 2030 needed for Paris-aligned shipping decarbonization: https://www.globalmaritimeforum.org/content/2021/03/Getting-to-Zero-Coalition_Five-percent-zero-emission-fuels-by-2030.pdf

GTZ. (n.d.). *Getting to Zero Coalition*. Retrieved from Ambition Statement: https://www.globalmaritimeforum.org/getting-to-zero-coalition/ambition-statement

ICCT. (2021, March 29). *Accounting for well-to-wake carbon dioxide equivalent emissions in maritime transportation climate policies*. Retrieved from The International Council on Clean Transportation: https://theicct.org/publications/well-to-wake-co2-mar2021

IEA. (2021). *Net Zero by 2050: A Roadmap for the Global Energy Sector*. International Energy Agency.

IMO. (2013). *World Maritime Day: A Concept of a Sustainable Maritime Transportation System*. Retrieved from Sustainable Development: https://sdgs.un.org/publications/concept-sustainable-maritime-transportation-system-17753

IMO. (2018). *Adoption of the Initial IMO Strategy on Reduction of GHG Emissions from Ships and Existing IMO Activity Related to Reducing GHG Emissions in the Shipping Sector*. London: International Maritime Organization.

IMO. (2021, April 19). *Informal discussions focus on lifecycle GHG/carbon intensity of cleaner fuels for shipping*. Retrieved from International Maritime Organization: https://www.imo.org/en/MediaCentre/Pages/WhatsNew-1603.aspx

IMO. (n.d.). *Initial GHG Strategy*. Retrieved from International Maritime Organisation: https://www.imo.org/en/MediaCentre/HotTopics/Pages/Reducing-greenhouse-gas-emissions-from-ships.aspx

IPCC. (2018, 28-31 May). *Expert Meeting on Short-Lived Climate Forcers (SLCF) Meeting Report*. Retrieved from https://www.ipcc.ch/site/assets/uploads/2019/02/1805_Expert_Meeting_on_SLCF_Report.pdf

IPCC. (2018). *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change*. Retrieved from Intergovernmental Panel on Climate Change: https://www.ipcc.ch/sr15/

IPCC. (2020). *Methodology Report on Short-lived Climate Forcers*. Retrieved from The Intergovernmental Panel on Climate Change: https://www.ipcc.ch/report/methodology-report-on-short-lived-climate-forcers/

IPCC. (2021). Summary for Policymakers. In: *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [Masson-Delmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu and B. Zhou (eds.)]. Cambridge University Press. In Press.

ISO. (2020). *ISO 56000:2020(en) Innovation management — Fundamentals and vocabular*. Retrieved from International Organization for Standardization: https://www.iso.org/obp/ui/#iso:std:iso:56000:ed-1:v1:en

Lima de Miranda, K., & Snower, D. J. (2020). Recoupling Economic and Social Prosperity. *Global Perspectives*, 1(1): 11867 (https://doi.org/10.1525/001c.11867).

Lloyd's Register & UMAS. (2017). *Zero-Emission Vessels 2030. How do we get there?* Lloyd's Register.

UN. (n.d.). *Sustainable Development Goals*. Retrieved from The 17 Goals: https://sdgs.un.org/goals

UNCTAD. (2018, November 21-23). *Sustainable freight transport in support of the 2030 Agenda for Sustainable Development. Note by UNCTAD*. Retrieved from United Nations Conference on Trade and Development: https://unctad.org/system/files/official-document/cimem7d17_en.pdf

UNFCCC. (2021). *Climate Action Pathway: Transport: Vision and Summary*. Retrieved from United Nations Framework Convention on Climate Change: https://newsroom.unfccc.int/climate-action/marrakech-partnership/reporting-tracking/pathways/transport-climate-action-pathway#eq-1

UNFCCC. (n.d.). *Action on Climate and SDGs*. Retrieved from United Nations Framework Convention on Climate Change: https://unfccc.int/topics/action-on-climate-and-sdgs/action-on-climate-and-sdgs

UNFCCC. (n.d.). *The Paris Agreement?* Retrieved from United Nations Framework Convention on Climate Change: https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement

UNGC. (n.d.). *Social Sustainability*. Retrieved from United Nations Global Compact: https://www.unglobalcompact.org/what-is-gc/our-work/social

World Bank. (2021a). *Charting a Course for Decarbonizing Maritime Transport*. Retrieved from The World Bank: https://www.worldbank.org/en/news/feature/2021/04/15/charting-a-course-for-decarbonizing-maritime-transport

World Bank. (2021b). *The Potential of Zero-Carbon Bunker Fuels in Developing Countries*. Retrieved from The World Bank: https://openknowledge.worldbank.org/handle/10986/35435.

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Lead Author

Andreea Miu, SSI Secretariat

Contributions from

Henrik Sornn-Friese & Ching Yi Chung, CBS Maritime
Elizabeth Petit González, Andrew Stephens & Rebecca Waterton, SSI Secretariat

Editorial Committee

Ingrid Marie Vincent Andersen, A.P. Moller-Maersk
Katharine Palmer, Lloyd's Register
Simon Bennett, The China Navigation Company
Mark Lutes, WWF Global Climate and Energy Practice

Thank you to the industry stakeholders who provided inputs

E info@sustainableshipping.org

W sustainableshipping.org

@SustShipping

About the Sustainable Shipping Initiative

The Sustainable Shipping Initiative (SSI) is a multi-stakeholder collective of ambitious and like-minded leaders, driving change through cross-sectoral collaboration to contribute to – and thrive in – a more sustainable maritime industry. Spanning the entire shipping value chain, SSI members are shipowners and charterers; shipyards, marine product, equipment and service providers; banks, ship finance and insurance providers; classification societies; and sustainability non-profits.

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