The Role of Sustainable Biofuels in the Decarbonisation of Shipping

The findings of an inquiry into the Sustainability and Availability of Biofuels for Shipping

Report prepared by the Sustainable Shipping Initiative (SSI)
About this report

The Role of Sustainable Biofuels in the Decarbonisation of Shipping: The findings of an inquiry into the sustainability and availability of biofuels for shipping outlines the findings of an inquiry commissioned by the Sustainable Shipping Initiative (SSI), reflecting a stakeholder consultation process facilitated by SSI member Forum for the Future to explore the potential role (if any) of biofuels in the decarbonisation of shipping. Forum for the Future conducted the desktop literature review as well as facilitated stakeholder consultations, and put forward a draft of preliminary key findings on which the conclusions were drawn by the SSI membership.

The process was guided by SSI’s Decarbonisation Working Group, whose members played an integral role throughout the consultations. It also benefited from the active engagement and contributions from speakers and participants of the seminars, webinar and Climate Week NYC event.

This report was launched at the 2019 United Nations Climate Change Conference, COP25 (Madrid, 11 December 2019).

More information on the inquiry is available at www.ssi2040.org

Moderated by Forum for the Future’s Chief Executive, Dr. Sally Uren OBE, SSI’s Climate Week NYC event saw a high level panel offering their views on the role of shipping in the broader energy transition; the risks and opportunities presented by biofuels to shipping; and the question of competition for biofuels with other sectors, such as aviation, among other questions. Panelists were (L-R):

- John Kornerup Bang, Head of Sustainability Strategy & Chief Climate Change Advisor, Maersk
- Lord Adair Turner, Chair, Energy Transitions Commission
- Kirsi Tikka, Independent Non-Executive Director
- Christine Weydig, Director, Office of Environmental and Energy Programs, The Port Authority of New York & New Jersey
- Gerard Ostheimer, Managing Director below50, WBCSD – World Business Council for Sustainable Development
- Manuel Pulgar Vidal, Leader of Climate & Energy Practice, WWF

Photo: Colin Clark Photo
Executive summary

Shipping is currently responsible for around 2 to 3% of global carbon dioxide (CO2) emissions, with virtually all 50,000 or so merchant ships burning heavy fuel oil (HFO) or marine distillate oil (MDO) or liquefied natural gas (LNG).

As the shipping industry explores how to decarbonise by mid-century, and at a minimum meet the level of ambition set out in the Initial IMO Strategy on reduction of GHG (greenhouse gas) emissions from ships (MEPC.304(72)) of reducing absolute GHG emissions by at least 50% from a 2008 baseline by 2050, zero-carbon fuels will need to be commercially available and produced from either renewable electricity, biomass or natural gas with Carbon, Capture and Storage (CCS). It is not yet clear which of the potential zero-carbon alternatives to fossil fuels has the winning combination of availability, sustainability and competitiveness.

Fuels derived from biomass, referred to as biofuels, as the primary energy source may be an attractive option for the shipping sector. Biomass can be used as a feedstock to produce alcohol fuels such as ethanol and methanol, liquified bio-gas (LBG) or bio-diesel. Such fuels could be used as drop-in or blends with minor modifications to existing engines, machinery and storage systems, which simplifies the transition from existing fossil-derived fuels. They can therefore be considered to be the most ‘technologically ready’ of the various zero-carbon alternatives currently under consideration for deep-sea shipping.

However, biofuels have also proven to be highly controversial, with questions raised not only about adverse sustainability impacts arising from their use, but also whether they will be available in sufficient quantities to meet the needs of different sectors.

To understand the role that biofuels could play in the decarbonisation of the maritime industry, the Sustainable Shipping Initiative (SSI) commissioned an inquiry – facilitated by sustainability non-profit Forum for the Future – into the sustainability and availability of biofuels for shipping.

The inquiry methodology (Figure 1) involved a desktop literature review; expert stakeholder interviews; two face-to-face stakeholder roundtables (one on sustainability issues and one on availability considerations) and a webinar; followed by a high-level panel at Climate Week New York. 109 stakeholders were consulted throughout the inquiry (Figure 2), with preliminary findings shared with additional industry stakeholders at the International Maritime Organization (IMO) during the Symposium on IMO 2020 and Alternative Fuels (17-18 October 2019) and the 6th Intersessional Working Group on the Reduction of GHG Emissions (15 November 2019); as well as the annual meeting of the Roundtable on Sustainable Biomaterials (RSB) (5-6 December 2019).

SSI members were engaged and consulted throughout the process. This report outlines the findings of this inquiry.

Figure 1: Approach to the inquiry

Figure 2: Stakeholder consultation

The sustainability issues surrounding biofuels

Biofuels are associated with a wide range of environmental, social and economic impacts. The inquiry revealed that the most contentious of these relate to their full life-cycle carbon credentials and how their use might have indirect impacts across global land management and food production systems.

The indirect impacts of biofuels are difficult to track and measure. This means that estimates of indirect impacts often vary greatly, and that the results of any particular study are typically questioned.

There was broad agreement found in the literature review and the stakeholder roundtables that purpose-grown crops for energy currently pose the most risk of indirect impacts, with palm and soy currently posing the greatest risks of all crops. They are therefore likely to have worse carbon credentials than other biomass feedstocks. Some studies suggest that biofuels produced from palm and soy feedstocks can be far worse in carbon terms than the fossil fuels they seek to replace.

Given these concerns, our inquiry revealed that the significant majority of the stakeholders consulted have a clear preference for any biofuels to be sourced from municipal, agricultural and/or forestry waste streams rather than purpose-grown crops. However, this preference for residues and waste streams was not unanimous: a number of stakeholders proposed that purpose-grown crop feedstocks sourced within regions with strong land governance in addition to clear carbon and biodiversity credentials would be viable to produce biofuels.

Certification schemes exist to evaluate the carbon and other impacts of biofuels, so that buyers and users can have confidence in their ability to provide substantial carbon savings. However, despite ongoing advances in methodologies and with the increasing recognition that bio-feedstocks require evaluation at a landscape scale, no single certification methodology currently addresses the questions and concerns around indirect and systemic impacts.
The potential availability of sustainable biofuels

A number of projections have been made regarding the future availability of sustainable biofuels. The number of variables at play in the models used to make such projections vary significantly and small changes in key assumptions can result in widely different projections. The International Energy Agency (IEA), the UK Climate Change Committee (CCC) and the Energy Transitions Commission (ETC) have all, in recent years, produced forecasts for the future potential availability of sustainable biofuels (see Figure 3).

Data on current production of sustainable biofuels is not comprehensive. The IEA states that two biofuels from waste oils (bio-diesel and hydrotreated vegetable oil (HVO) from waste oil and animal fat feedstocks) produce around 0.25EJ of biofuels, some 6-8% of total production.

In the stakeholder roundtable on availability there was little consensus that feedstock availability would rise to significantly beyond 100EJ per year. Projections well beyond this, including for example the IEA’s High Scenario, were considered to be practically unfeasible. In terms of the minimum amount that could be available, there was fairly broad consensus that at least 50EJ of sustainable biomass feedstock could become available per year by mid-century. Our inquiry therefore has a working assumption of 50-100EJ as the range of available sustainable biomass; while recognising that new data could emerge indicating availability outside of this range.

Other industries are already using or have, to various degrees, stated they intend to use, biomass feedstocks to replace fossil fuels or to reduce carbon emissions in their sectors. The potential for increases in demand from these sectors needs to be considered to understand the level of certainty of estimates of the amount available to the shipping sector in the future.

Different sources of demand will drive competing pressure for the different types of bio-feedstocks, and factors for consideration include:

- whether bioenergy with CCS is scaled;
- whether ground transport decarbonises at all, and the extent it does so from biofuels rather than electrification;
- whether bio-feedstock is used to produce materials rather than fuels;
- whether construction increases the use of wood to replace concrete; and
- how much land is used for natural climate solutions such as afforestation.

It is important to understand that currently not all bio-feedstocks are useful for all these end uses: for example, it is not possible to make buildings out of biogas. There is therefore no direct substitution between all 50-100EJ of supply and all the potential demand uses.

While the details of which feedstocks could go to which industries is beyond the scope of this study, there was general consensus amongst stakeholders that aviation – with its need for kerosene or equivalent quality and energy density liquid fuels – is likely to be the closest competitor for bio-feedstocks to shipping (though existing technologies could lead to this need being fulfilled from a hydrogen feedstock instead). What remains clear is a better understanding of shipping’s potential demand is needed when considering the amount of bio-feedstocks available with little competition from other sectors, and for how long.

Figure 4 compares current forecasts for demand from shipping, aviation, bioplastics as well as other potential end uses, with the working assumption that availability will be between 50-100EJ. This shows that if shipping had no competition, a substantial amount of its energy could come from bio-feedstocks on an enduring basis. However, if aviation was to significantly increase its demand, then supply starts to look like it could be short of both industries’ needs, with the low estimates of demand for both equalling 78EJ and the high 145EJ.

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**Figure 3: Forecasts for the potential future availability of sustainable biofuels by mid-century (data is in EJ per year)**

Source: Figure compiled by Forum for the Future using data from UK CCC, IEA and ETC

**Figure 4: Projected availability of sustainable biofuel (by mid-century) compared to potential demand from a selection of industrial sectors and/or other potential uses of bio-feedstock**

Sources: Figure compiled by Forum for the Future using data from ETC; ICC; ICAO; IPCC; UK CCC; World Energy Council
During the stakeholder roundtables we considered how available bio-feedstock could be distributed across the economy. This could be left to market forces, but as a limited and valuable resource that could contribute in different ways to the decarbonisation of society, certain sectors could be given priority over others.

The following factors need to be considered in answering the question of the availability of bio-feedstock for shipping:

- the consensus on the potential supply of 50-100EJ of energy from bio-feedstocks;
- the forecasted energy need for shipping of 26 to 60EJ of energy in mid-century;
- that not all bio-feedstocks, and therefore not all the potential 50-100EJ are currently feasible for use as inputs for marine fuels;
- that the price which biofuels from each feedstock can be produced is not yet clear;
- that several other sectors are considering substantial increases in their use of bio-feedstocks;
- that allocation by market forces could see sectors with more limited decarbonisation options than shipping prepared to pay more for biofuels; and
- that supply could be allocated by centralised control which could favour other sectors over shipping.

Our research on availability point to a significant – though not currently quantified – probability of supply not meeting shipping’s entire energy demand. However, uncertainty around the supply assumptions, as well as the energy demands of shipping and other sectors could lead to some plausible (though unlikely) scenarios where shipping could have 100% of its energy needs covered by biofuels.

There is also the potential that alternatives for the decarbonisation of shipping – for example fuels produced from renewable electricity or natural gas with CCS – like hydrogen and ammonia could be unfeasible due to their own sustainability, safety, availability and cost considerations. This could result in greater willingness of the shipping sector to pay for an allocation of limited biofuels.

Conclusions

1) The role of biofuels in shipping’s long-term decarbonisation pathway

The supply-demand balance under current expert understanding is tight – even if shipping’s demand remains within the supply range our stakeholders believed reasonable (50-100EJ). When other sectors’ potential demand is factored in, the potential for shipping to meet most or all of its energy needs from biofuels is further constrained.

When asked for their views on the percentage of which shipping’s energy needs would be met by biofuels in 2030 and 2050, the majority of stakeholders agreed this would fall in the 10-30% range (those responding with over 50% were outliers). Further, stakeholders anticipated that biofuel use would be higher in 2030 than 2050, implying this is a short-rather than long-term solution.

Given the ratcheting up of climate ambition across society across all industrial sectors, the pool of available bio-feedstock could be limited. Alongside this, other supply constraints raised by stakeholders were that end uses of bio-feedstocks that result in carbon being stored – i.e. in materials opposed to being released through combustion – could further limit the long-term role of biofuels in the shipping sector.

2) The potential use of biofuels to accelerate early decarbonisation

Industry stakeholders consulted in this inquiry suggested that in the short-term, biofuels could have a significant role to play to accelerate early decarbonisation action. The low end of the supply working assumption of 50EJ could more than meet all of shipping’s current energy needs, and currently only 0.25EJ of advanced biofuels are used globally. There is therefore, a potential window of opportunity for shipping to use sustainable biofuels whilst sustainable bio-feedstocks are underutilised. However, depending on the supply-demand factors, there is uncertainty on the duration of this supply, with some stakeholders suggesting it could last through much of the 2020s.

3) Scaling of sustainable biofuels

To scale the production of sustainable biofuels, market incentives are needed to provide a signal to encourage investment in the bio-economy, putting sustainability and carbon benefits front and centre. Such a signal could come in the form of IMO short-term policy measures and/or customers demanding and paying a premium for lower carbon supply chains.

Many of the stakeholders we consulted considered sustainability certification to be a pre-requisite in order to give the market confidence in biofuel use. However, not all were convinced that certification could ensure sustainability.

4) Supply-demand balance

There remains no clear consensus on whether there is sufficient sustainable biomass for shipping as well as other sectors. Current understanding suggests that a biomass-based decarbonisation pathway for shipping comes with considerable supply risks and as a consequence also poses risks related to their price.

However, there are scenarios within the working assumption range of 50-100EJ where there would be sufficient supply for shipping. The key assumptions needed to arrive at this, relate to high projections for purpose-grown energy crop use; high recovery of agriculture waste residues; road transport to electrify; and a lower to medium demand from biomaterial.

5) Risk associated with the use of biofuels

Irrespective of potential supply-demand constraints, the use of biofuel carries the additional risk of good intentions resulting in perverse outcomes, for example, increasing carbon emissions. All stakeholders who supported the use of biofuels considered certification to be a prerequisite.
to ensuring the transparency and sustainability of biofuel supply chains. However, others considered current use of sustainability certification schemes to be insufficient.

One potential option for the introduction of biofuels into the shipping sector is to use bio-feedstocks from waste and residue rather than from purpose-grown energy crops, which our stakeholders deemed a lower sustainability risk.

However, if purpose-grown crops are certified using leading sustainability standards and are sourced within regions with strong land governance, carbon and biodiversity credentials, some stakeholders deemed this to have low sustainability risk while others believed it remained high.

6) The role of biofuels and innovation in the shipping industry

There is potential for the maritime industry to play a constructive role in establishing a sustainable bio-economy. Through this proactive engagement, the market for sustainable biofuels could develop to facilitate their role in the decarbonisation of shipping and in doing so, it could also support decarbonisation in other sectors. In parallel, managing the risks of a sustainable supply means continuing to innovate in zero-carbon solutions from all primary energy sources to provide a clearer picture of which options may emerge to contribute to a longer-term solution that is both available, sustainable – and competitive.

7) The need to cooperate with other sectors and players

Shipping cannot solve or manage these risks and uncertainties alone. In order to ensure that a functioning and sustainable bio-economy emerges, coordination and engagement across all interested sectors and the entire shipping value chain (ports, cargo owners, fuel producers, investors, insurers, regulators, etc) is essential. Aviation and shipping alongside other sectors all have a role to play in providing clear market signals and in ensuring that sustainability is central to the production and sourcing of biomass feedstocks.

Recommendations for further work

From this review of sustainability and availability of biofuels for shipping a clearer picture of the uncertainties and risks has emerged. This work has also illuminated key questions where additional work is needed that will advance understanding for the best routes for decarbonisation of the shipping sector:

- As Lord Adair Turner concluded at the panel event during Climate Week in New York: “A key question for shipping is how to balance the long-term decarbonisation which may well be ammonia-based with short term options such as biofuels. We need to understand better whether biofuels could be a transitional bridge to ammonia, or whether this would result in wasted investment.”
- Whether a near term scaling up of sustainable biofuels use makes the pursuit of other technologies easier or harder?
- What the level of risk is from the different crop-based feedstocks for reputational costs for the industry and unintended social, environmental and climate impacts given the various concerns over these sources of biofuels?
- Whether the use of biofuels, even those sourced from only wastes and residues, present a risk given the opposition of some stakeholders?
- When and at what scale and price could other zero-carbon alternatives become available?
- How can the shipping industry and wider value chain act to scale up the supply of sustainable biofuels?
- A deeper understanding of the likelihood around the assumptions needed to ensure enough sustainable biomass for shipping, notably the feasibility of governing purpose-grown energy crops, the feasibility of recovering substantial portions of agricultural waste residues and the likelihood of road transport to electrify.
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; ports; shipyards, marine product, equipment and service providers; banks, ship finance and insurance providers; classification societies; and sustainability non-profits.

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