Moving Forward Network

# Maritime Freight: Local and Global Impacts, Technologies and Considerations

A STUDY BY

Aoife O'Leary

Opportunity Green

JUNE 2022

# About the Study

**The Maritime Freight: Local and Global Impacts, Technologies and Considerations** study has been written by Aoife O'Leary, Opportunity Green on behalf of and for the Moving Forward Network (MFN). The purpose of the study is to inform the MFN members as they participate in the advancement of the MFN Zero-Emission Freight: Community Voices for Equity and Environmental Justice campaign. With the exception of the MFN campaign goals and objective laid out in the October 26th, 2021, MFN letter to US-EPA, the information in this study is not intended to indicate support or agreement from MFN and its membership related to policy approaches, technologies, fuels, legal or any other opinion. Rather, it is intended to provide data, information and considerations that will support and inform MFN and its members advocacy.

# About the Moving Forward Network

The Moving Forward Network (MFN) is a U.S. based nation-wide network of over 55 member organizations in 20 cities. The MFN centers grassroots, frontline-community knowledge, expertise, and engagement from communities across the US that bear the negative impacts of the global freight transportation system. MFN builds partnerships between these community leaders, academia, labor, big green organizations, and others to protect communities from the impacts of freight. Its diverse membership facilitates an integrated and geographically dispersed advocacy strategy that incorporates organizing, communications, research, legal and technical assistance, leadership development and movement building. This strategy respects multiple forms of expertise and builds collective power. In October of 2021, MFN launched its Zero-Emission Freight: Community Voices for Equity and Environmental Justice campaign. This campaign is calling on US-EPA to prioritize environmental justice in freight impacted communities by aggressively advancing zero-emission technology and solutions across the freight sector, including specific requests for maritime freight.

# About Opportunity Green

Opportunity Green is an NGO working to unlock the opportunities from tackling climate change using law, economics and policy. Opportunity Green helps countries, civil society and business access the solutions that reduce emissions and bring enormous opportunities for economic development, improved health and increased democracy. At Opportunity Green we believe lawyers are obligated to analyze the existing legal systems and regulations to stop climate change. We use legal innovation to forge new pathways on climate action or, where that is not possible, find pathways within the present legal structure to facilitate the legislation needed to slash carbon pollution.

# Acknowledgements

This paper was written by Aoife O'Leary from Opportunity Green. It was commissioned by the Moving Forward Network and the author is grateful for the input of Angelo Logan through the course of its production.
The author would also like to thank and acknowledge the input of Dan Hubbell and Delaine McCullough of Ocean Conservancy and Bryan Comer of the International Council on Clean Transportation. This report is an initial assessment of maritime freight, commissioned by the Moving Forward Network on the local and global impacts, technologies and considerations to advance zero emissions shipping. Any errors remain the author's own. The contents of the report are solely produced for the purpose of better understanding the policy, technology and options for zero emission maritime freight; nothing in the report represents the position or opinion of the Moving Forward Network.

# Further Information

**Aoife O'Leary**

*CEO*

Opportunity Green

aoife@opportunitygreen.org

opportunitygreen.org

**Molly Greenberg MSW, MPhil**

*Campaign Manager*

Moving Forward Network

greenbergm@oxy.edu

movingforwardnetwork.com


# Maritime Freight: Local and Global Impacts, Technologies and Considerations

## Introduction

There are about 50,000 ships hauling 80% of the world's cargo around the world every year. Ports are hubs of world trade, but also centers of concentrated pollution from ships. The 2020s are the critical decade for climate action, but there is little to no regulation anywhere in the world, other than the European Union, to reduce the climate impact of maritime freight. The decarbonisation of all maritime freight needs to begin in earnest immediately. This paper will set out the impacts of international shipping on local communities in the U.S. and on the global climate system, and then consider the potential technologies and legal pathways to a reduction of those impacts. It will conclude with considerations for regulation to drive zero emission vessels. While the paper will focus on the U.S. impacts, it is important to note that the impacts come not just from U.S.-flagged ships but also from international ships stopping at U.S. ports, and that the U.S. can regulate these international ships when they call at U.S. ports (see the legal section below for the full discussion).

# Impact

## LOCAL AIR POLLUTION

Most U.S. ports are located in urban areas (e.g. Los Angeles and New York) which are often surrounded by low-income, minority communities.[1] One study found that "around 40% of zip codes within a 25-mile radius of the major ports in California are designated as 'disadvantaged' communities, with concentrations of people that are of low income, color, high unemployment, and/or low levels of educational attainment." The study further found that just one additional vessel in port leads to an additional 3.1 hospital visits per thousand Black residents within 25 miles of a port and 1.1 hospital visits for white residents.[2] Meanwhile, the California Ocean-Going Vessel At-Berth Regulation[3] which reduces diesel particulate matter (PM) and oxides of nitrogen (NOx) from ocean-going vessels auxiliary engines while they are docked at California ports reduces hospital visits by 5.5 per thousand Blacks per year and 2.1 per thousand whites.[4]

There is a similar global pattern with shipping being historically responsible for approximately 266,000 premature deaths per year worldwide from shipping's air pollution impact alone.[5]

## GLOBAL CLIMATE

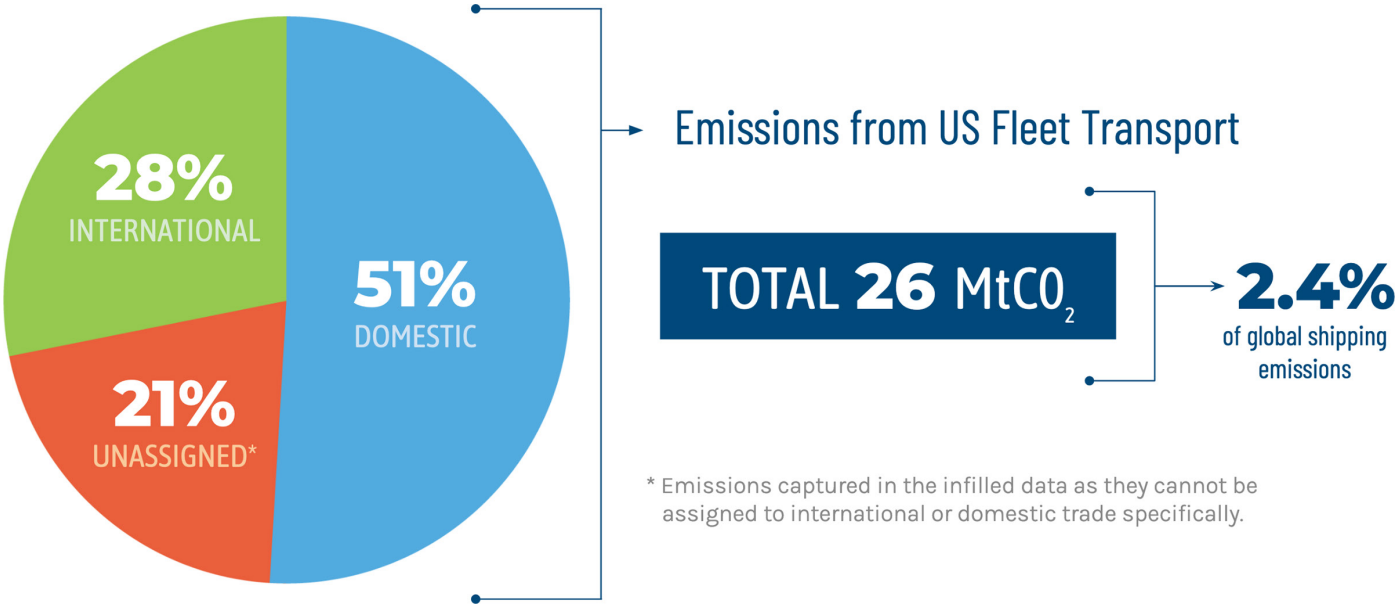
Maritime shipping is responsible for about 3% of all carbon dioxide ($CO_2$) worldwide every year.[6] If it was ranked as a country, it would be the sixth-largest emitter in the world, with more emissions than Germany. In addition, the sector contributes significantly to air pollution and other environmental problems such as invasive species, whale strikes, ocean noise pollution, and pollution discharges at sea and in delicate marine ecosystems.

The sector is regulated on multiple levels with the broadest being the International Maritime Organization, which is based in London, UK, with a membership of 175 countries. The legal section of this briefing will detail how and where shipping can be tackled in the U.S. and internationally.

The main climate emissions from shipping are $CO_2$, methane, black carbon and nitrogen oxide (NOx). The estimation of shipping's climate-relevant emissions at 3% excludes black carbon which adds significantly to shipping's climate impact. Of particular concern in polar regions, black carbon is a powerful climate forcer as it absorbs solar radiation.[7] There are clearly significant environmental and health benefits of decarbonising shipping, but tackling shipping's pollution will also create large numbers of jobs and employment opportunities.[8]

# U.S. Emissions

U.S. international shipping (based on U.S. international trade by mass) $CO_2$, methane and nitrogen oxide emissions in 2018 totalled 143 million tons of carbon dioxide equivalent ($MtCO_2$ eq), or 13% of all global shipping emissions.[9] Emissions from U.S. flagged ships were 26 $MtCO_2$ eq, some of which are included in the international emissions, but not all—and none of these figures include black carbon emissions. It is hard to estimate exactly how much of the black carbon emissions from shipping are attributable to the U.S., but it could be assumed that it is 13% of all black carbon emissions on the same basis that carbon dioxide equivalent emissions are distributed.




*Source:* UMAS, "Understanding the U.S. Flagged Fleet" https://www.u-mas.co.uk/wp-content/uploads/2022/04/UMAS_OC_infographics_Understanding-the-US-flagged-fleetTypes.pdf The 21% unassigned emissions are emissions where we don't know whether they relate to domestic or international journeys. Further, these are just U.S.-flagged ships, emissions from all ships calling at U.S. ports is much greater. $MtCO_2$ is million tons of carbon dioxide equivalent.

A 2022 report by the shipping research consultancy University Maritime Advisory Services (UMAS) found that the U.S. shipping fleet "has vast untapped potential for becoming a leader

in the decarbonisation of shipping" and that "combined with programmes focusing on energy efficiency, large near-term greenhouse gas reductions are possible this decade".[10] The report further found that the U.S. fleet is older than the global average, and more than 40% of energy used by the U.S. fleet could be replaced by zero emission solutions this decade. This is because more than 17% of the current fleet's demand for energy from fossil fuels could be substituted with electrification (direct electrification when in harbor, or battery electrification for shorter voyages). A further 24% of the energy demand of the fleet represents a strong case for being early adopters of sustainable zero emission fuels, because the operating profiles of these vessels mean they should require minimal infrastructure investment to make this transition.

Solutions aimed at decarbonization/zero emission solutions should consider a lifecycle perspective as to ensure that throughout the creation, deployment, use, and end of life these technologies will not further harm already overburdened environmental justice communities.

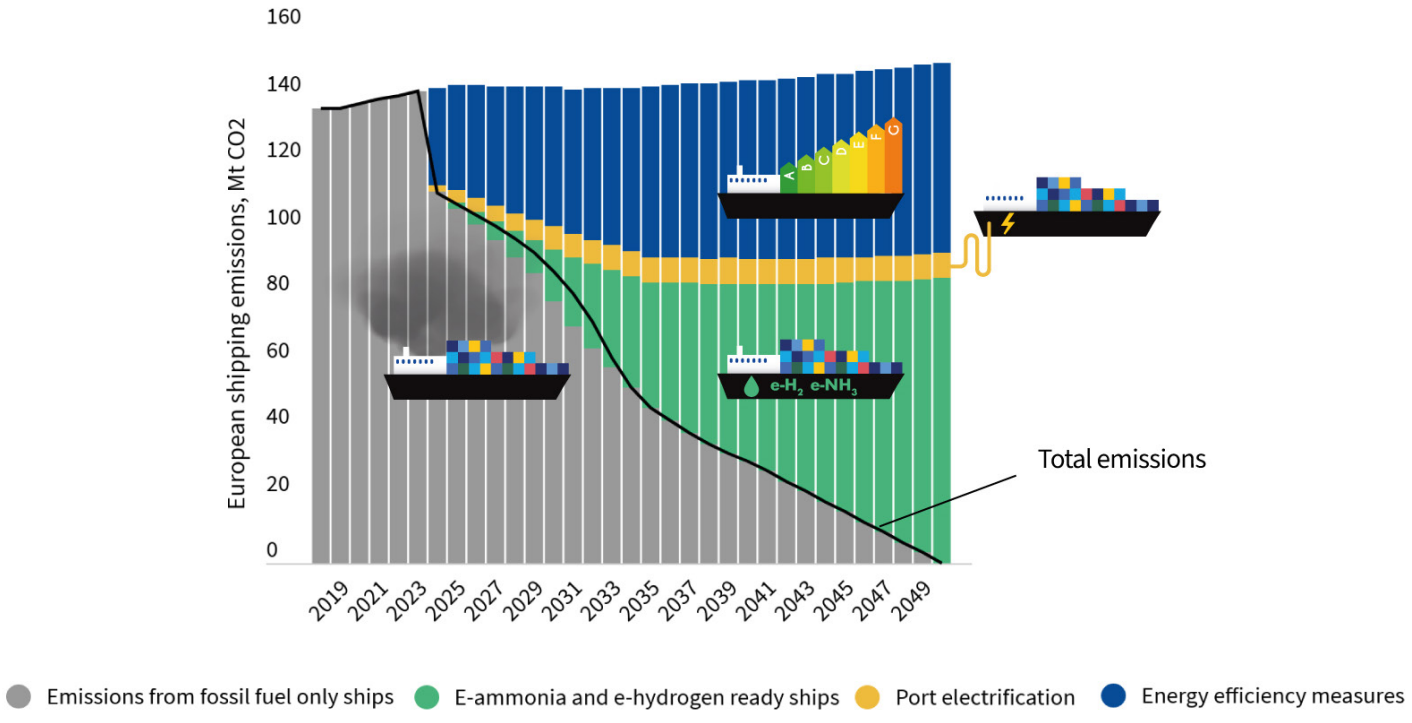
The report, *The Maritime Fleet of the USA*, identified the different types of ships within the U.S. fleet,[11] i.e. the ships that are U.S.-flagged and their corresponding emissions, and found that fishing, container, tug and offshore ships account for the majority of the fleet and the emissions. It shows that although container ships are only 1% of the U.S. flagged ships, in 2018 they were responsible for 19% of all emissions from the U.S.-flagged fleet. There are many more ships calling at U.S. ports that are not U.S.-flagged, and these are not contained in this graph. Therefore, addressing the international fleet of ships that call at U.S. ports is an important consideration that needs to be addressed.

# Technologies

There are many proven solutions that could reduce the impact of shipping on human health and the environment, many of which can be implemented quickly and have a corresponding immediate reduction in emissions (e.g. via changes in operation or efficiency improvements). It is estimated that one third of emissions can be reduced worldwide just from efficiency measures alone (see below).[12] Ultimately shipping will have to move away from fossil fuels, and while there are scalable zero emissions fuels for shipping, they will require new technologies and infrastructure for fuel production, delivery, and use on vessels. The best fuel for human health and the environment is the fuel that is not used at all. About 40% of all shipping journeys currently transport fossil fuels, so these journeys should be eliminated as the world decarbonizes.

Solutions aimed at decarbonization/zero emission solutions should consider a lifecycle perspective as to ensure that throughout the creation, deployment, use, and end of life these technologies will not further harm already overburdened environmental justice communities. This section will outline the various potential climate solutions for shipping, including future fuels.

## 7% e-fuels by 2030 Would Kickstart the Decarbonisation of Shipping




*Source:* Transport & Environment

## SLOW STEAMING

This is the reduction in the speed of the vessel. The seminal study on slow steaming found that reducing ship speed by 10% would lead to a 13% reduction in ship emissions, even when accounting for the additional ships required to carry the same amount of goods under slow steaming scenarios.[13] In addition to the reduction in emissions, slow steaming also reduces whale strikes and ocean noise, which causes stress to marine life. There are a number of 'Vessel Slow Down' programs worldwide, including along North America's western and eastern seaboards, in the Gulf of Panama and in Spain. However, participation in these programs is voluntary for the shipping companies involved and it is unclear what the impact of them is.

## WIND

Wind energy can be used in a number of ways on modern ships: soft sails, fixed wings, rotors, kites and conventional wind turbines. However, wind energy has not seen significant uptake to date. The ability of wind technologies to reduce emissions varies by ship type and route but a 2019 study showed reductions in emissions of almost 50% with the addition of wind technology to a ship.[14]

## ELECTRIFICATION

Smaller vessels operating locally with voyage ranges of less than 200 nautical miles can use current batteries and associated onshore infrastructure.[15] There are substantial opportunities to use direct electrification for routes that are close to shore and often close to communities.[16] But ultimately the vast bulk of climate emissions from shipping comes from ships on ocean-going voyages, requiring alternative fuel sources.

Larger vessels will need what researchers are calling scalable zero emissions fuels (SZEFs) powering internal combustion engines or fuel cell technologies. A 2022 study by UMAS for Ocean Conservancy, Future Maritime Fuels in the USA – the options and potential pathways[17] gives an in-depth analysis of the potential future maritime fuels for the U.S. fleet. One of the central conclusions of the report is that the U.S. "has several natural advantages, in the form of technology expertise and existing energy infrastructure that make it well suited to early use of the leading candidate SZEFs".

When considering SZEFs it is important to look at the emissions from the production of the fuel, including indirect land use change – especially for biofuels - as well as the use of the fuel. Below the potential fuels

are enlisted, followed by a short explanation of fuels that are not part of the solution.[18] It is important to note though that there is no 'perfect' future shipping fuel, there is a trade-off to be made between climate impact, toxicity, infrastructure to be built and other impacts - see Figure X for an overview comparison of these impacts between fuels.

## HYDROGEN/AMMONIA


These are alternative fuels[19] that can be produced in a number of different ways.[20] One type of production 'green' hydrogen or ammonia uses water, electricity and ammonia, while another 'blue' hydrogen or ammonia uses natural gas plus carbon capture.[21] There is a debate about the environmental impact of using natural gas plus carbon capture (due to varying issues including but not limited to capture rates and methane leakage throughout the natural gas supply chain) but ultimately, studies show that producing these fuels from renewable energy will be the cheapest pathway.[22]

Both hydrogen and ammonia can fuel internal combustion engines or fuel cells (in the future). Ammonia is effectively a hydrogen carrier. Hydrogen needs to be transported at such a low temperature that it requires expensive storage, making it cheaper to transport and use ammonia rather than hydrogen directly. When either hydrogen or ammonia are burned in internal combustion engines there are some emissions of nitrous oxide and there would need to be safety and handling protocols established and followed.

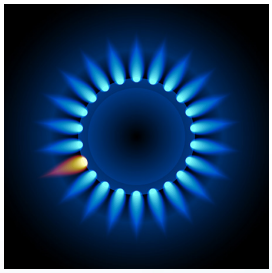
### A NOTE ABOUT ALTERNATIVE FUELS

Renewable energy may have many definitions based on the source of energy. MFN considers solar and wind to be renewable energy. However, there are important Environmental Justice (EJ) and equity implications that come from these "cleaner" energy sources (i.e siting, manufacturing, shipping, etc). All of these must be considered with EJ leadership before endorsing specific renewable energy recommendations

## METHANOL

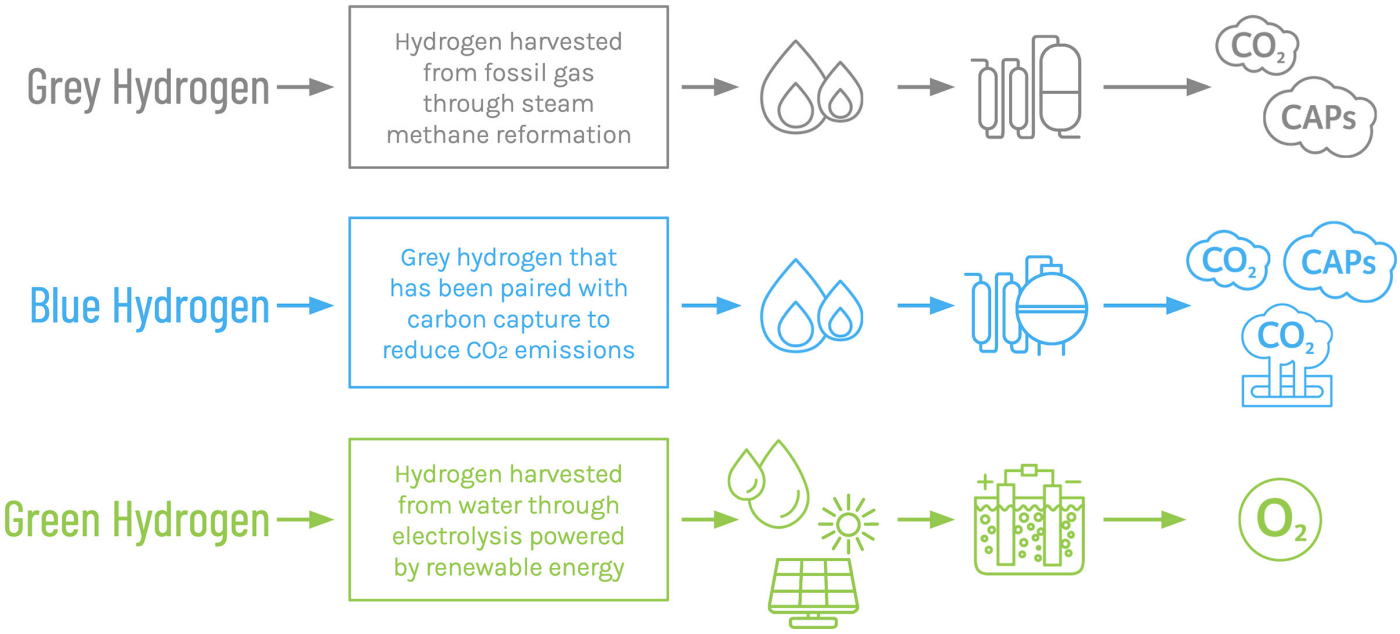

Presently, this is produced from natural gas.[51] And while it could be produced by renewable energy plus direct air capture or carbon capture in the future, that pathway is more expensive than the hydrogen/ammonia options.[52]

### A NOTE ABOUT NATURAL GAS



It is important to note with regards to natural gas, the MFN network is not in support of this "false solution" because of the cumulative impacts from the production, use, and disposal of natural gas the waste products. Presently, MFN frames false solutions as technologies that rely on; carbon trading and/or "greenwashed" energy that comes from non-renewable and heavy-polluting sources such as natural gas, biomass, etc.

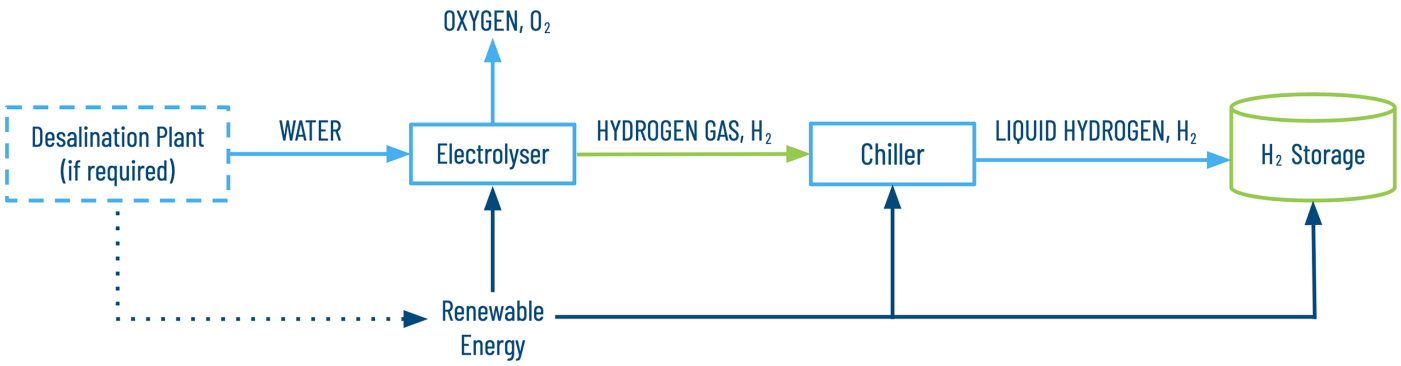
# Types of Hydrogen




## CAPS = CRITERIA AIR POLLUTANTS

*Source:* Earthjustice, Reclaiming Hydrogen for a Renewable Future: Distinguishing Oil & Gas Industry Spin from Zero-Emission Solutions, August 2021 https://earthjustice.org/sites/default/files/files/hydrogen_earthjustice_2021.pdf

# Production Process for Green Hydrogen




**Ammonia:** Add Nitrogen capture and Haber-Bosch process
**Methanol:** Add Carbon capture and Methanol synthesis

*Source:* Ash, N., Sikora, I. and Richelle, B., 'Electrofuels for shipping: How synthetic fuels from renewable electricity could unlock sustainable investment in countries like Chile', Environmental Defense Fund, London, 2019.

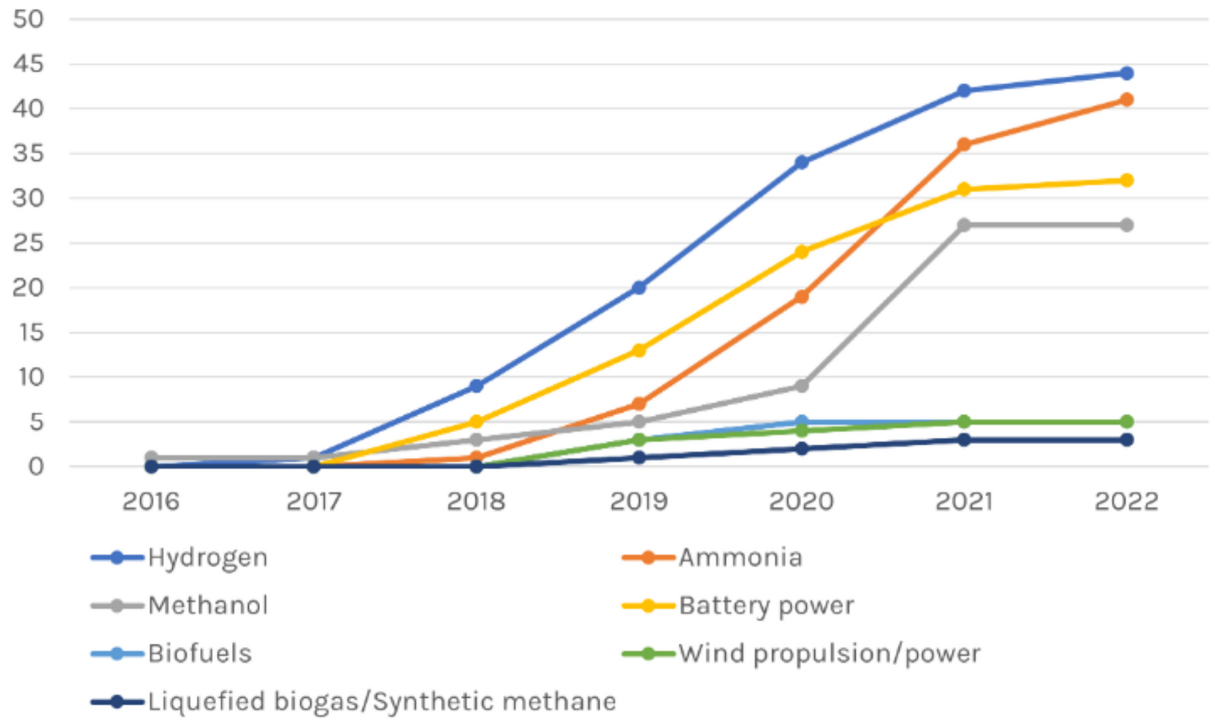
# **Fuels:** Comparison of the Characteristics of Hydrogen, Ammonia, and Methanol as Electrofuels for Shipping

| | HYDROGEN | AMMONIA | METHANOL |
|---|---|---|---|
| Temperature for liquid storage | -253 °C | -34 °C | AMBIENT |
| Compatibility with existing bunkering infrastructure | LOW<br>Requires Refrigerated Tanks | LOW<br>Requires Refrigerated Tanks | HIGH |
| Storage volume compared to marine gas oil for a fixed energy content | x7.6 | x4.1 | x2.3 |
| Electricity required to produce enough fuel for one day's sailing of a Panamax container vessel | 1.2 GWh | 1.4 GWh | 1.6 GWh<br>1.7 GWh<br>1.8 GWh<br>2.0 GWh |
| Requires co-firing with another fuel in compression ignition engines | YES<br>Carbon-based fuel | YES<br>Carbon-based fuel | YES<br>Carbon-based fuel |
| Requires co-firing with another fuel in spark ignition engines | NO | YES<br>Hydrogen or Carbon-based fuel | NO |
| Toxic to humans | NO | YES But well understood mitigation measures | YES But well understood mitigation measures |
| Toxic to aquatic life | NO | YES | NO |
| Flammability | VERY HIGH | LOW | HIGH |

BEST PERFORMING ACCEPTABLE BEST PERFORMING

*Source:* Ash, N., Sikora, I. and Richelle, B., 'Electrofuels for shipping: How synthetic fuels from renewable electricity could unlock sustainable investment in countries like Chile', Environmental Defense Fund, London, 2019.

# Total Number of Ship Projects by Fuel Focus
## 2016 to Q1 2022




*Source:* Global Maritime Forum, Mapping of Zero Emission Pilots and Demonstration Projects, Third Edition, March 2022

### METHANOL

Presently, this is produced from natural gas.[23] And while it could be produced by renewable energy plus direct air capture or carbon capture in the future, that pathway is more expensive than the hydrogen/ammonia options.[24]

Regardless of the fuel type, there are very few projects around the world testing scalable zero emission fuels. The above figure from the Global Maritime Forum shows that even hydrogen, with the most projects, has only 45 projects worldwide as of March 2022.

## NON-SOLUTIONS: BIOFUELS AND LNG

Other fuels that are promoted by the oil and gas industry but are not a suitable solution for shipping include Liquefied Natural Gas (LNG) and biofuels. LNG is a fossil fuel and is composed primarily of methane, which is 81 times more powerful than $CO_2$ over a 20-year time period. Ships that use LNG in engines leak unburned methane into the atmosphere on top of the emissions from the fuel actually used, making them even more problematic.[25] Biofuels can bring emissions reductions if carefully sourced and produced, but there is a limited supply worldwide and there are other sectors (e.g. aviation) which have fewer potential solutions for decarbonisation and thus may have to use biofuels. As such, it does not make sense to use biofuels for shipping.

## AIR POLLUTION CONTROL TECHNOLOGIES

In addition to technologies that could reduce shipping's climate impact, there are technologies that can reduce air pollution from shipping and these technologies can sometimes also reduce the climate impact of shipping. Most of the United States (apart from Alaska) and Canada form the North American Emissions Control Area[26] which requires all ships sailing within 200 nautical miles of shore to use fuels or technologies that will limit sulfur and NOx emissions. California further has regulations on vessel emissions while they are in port that reduce air pollution emissions.[27] The technologies that can be used to reduce air pollution from shipping include switching to low-sulfur fuel oil, scrubbers (these are after-treatment devices which remove sulfur from the emissions of ships, but often create water pollution which is later dumped), and selective catalytic reduction technologies which can reduce NOx emissions by up to 75%.

## AVAILABILITY

Engines in the largest ships today can burn almost anything and "with modifications to the injection and fuelling supply systems and the addition of extra fuel tanks, a ship can be transitioned relatively easily to a dual

fuel engine operating on a conventional fuel along with a zero-carbon fuel."[28]

In addition to the availability of the engines, the production of the fuels needs to be rolled out, along with associated safety and handling guidelines. 95% of hydrogen produced today is from natural gas or coal sources, and vastly more hydrogen will be required to meet shipping demand than is currently being produced. The U.S. has vast potential to ramp up the production of sustainable shipping fuels produced from renewable energy. However, it is important to note that only 12% of domestic energy production in the U.S. is from wind or solar energy currently and it is almost always more efficient, and thus saves more Greenhouse Gases (GHGs) to use additional renewable energy to decarbonise domestic production before using it to produce shipping fuel (though using electricity directly for ships in port or for short sea electrification is quite efficient). However, all sectors need

All sectors need to decarbonise immediately, the luxury of decarbonising only the most urgent sectors has passed.

to decarbonise immediately, the luxury of decarbonising only the most urgent sectors has passed. The U.S. has committed to fully decarbonising its power sector by 2035 and adding additional renewable energy alongside this to produce shipping fuels is possible, especially if additional funding is generated from the shipping sector which is currently undertaxed.[29]

# Legal Options to Regulate Shipping

Regulating shipping throws up a number of jurisdictional questions and a full discussion of U.S. authority to regulate shipping, both domestic and international, can be found in the Shipping chapter of the book Legal Pathways to Deep Decarbonization in the United States.[30] There are three types of authority that countries can exercise over ships: flag (regulating ships that fly the country's flag), coastal (regulating the ships that pass through a country's coastal waters) and port (regulating ships that dock in that country's ports). Regulating only U.S. flagged ships would only capture a small portion of the emissions for which the U.S. is responsible. As discussed above, the U.S. flagged ships are responsible for only 2.4% of worldwide shipping emissions but 13% of worldwide emissions are attributable to the U.S. if ships flying the flag of other countries are taken into account. Regulating ships that pass through the coastal waters of the U.S. is problematic due to restrictions under international law on what avenues can be used to enforce coastal rules.[31] Regulating ships that dock in U.S. ports (referred to as port state jurisdiction under international law) is the most appropriate for tackling the environmental impact of shipping. Ports are part of the domestic jurisdiction of the U.S. and all ships stopping in U.S. ports must comply with any U.S. regulations.

## THE INTERNATIONAL MARITIME ORGANIZATION (IMO)

The IMO has authority over international shipping. It has been discussing what to do about shipping's climate impact for almost three decades and various other environmental impacts (notably oil spills) for even longer. The IMO has agreed various policies that are supposed to reduce shipping's emissions but unfortunately do little other than continue business as usual emissions.[32]

The IMO's headline climate goal is to reduce emissions by at least 50% compared to 2008, by 2050 but this is less than the reductions required by the Paris Agreement.[33] This goal is under discussion for revision,

and should be finalized in 2023. The IMO is also discussing additional measures such as a carbon levy or fuel standard to reduce emissions.

The U.S. has supported an IMO goal of zero emissions from shipping by 2050 and, while it recently increased the federal funding available for decarbonizing shipping and ports through the Infrastructure Investment and Jobs Act, the administration has yet to support any concrete regulatory policies that would ensure that goal is met. The U.S. has been historically quite ambitious on reducing air pollution from shipping in the IMO but, until the Biden administration took office, the U.S. was not ambitious on climate measures.

The U.S. delegation to the IMO is headed by the U.S. Coast Guard and the State Department, the Environmental Protection Agency (EPA) and the National Oceanic and Atmospheric Administration (NOAA) are also part of the delegation. The most concrete and ambitious proposal on the table at the IMO is a proposal from the climate vulnerable countries of the Marshall Islands and the Solomon Islands for a GHG levy in line with the Paris Agreement goal of limiting temperature rise to 1.5 degrees, with funds used to support the equitable transition to 1.5°C-aligned decarbonisation of international shipping.[34] The U.S. delegation has not explicitly supported the proposal due to the political difficulty of implementing such a regulation in U.S. domestic law, nor has the U.S. proposed any alternative proposal(s) that would be as ambitious or put equity at the heart of the measure.

Importantly, any additional measures will almost certainly be implemented as an amendment to the existing MARPOL Convention.[35] This is important for the U.S. as the EPA has authority under the Clean Air Act and the Act to Prevent Pollution from Ships to implement any amendments to MARPOL as administrative measures.[36] The U.S. can use this route to enact any further amendments to MARPOL into U.S. law without requiring congressional approval. In 2022, the U.S. Coast Guard announced a rulemaking process to close some of the gaps between the MARPOL Convention and its implementation under U.S. law.[37]

## THE UNITED NATIONS CONVENTION ON THE LAW OF THE SEA

The Law of the Sea sets out the extent of jurisdiction for countries to regulate shipping on the basis of flag, coast and port. The U.S. has not signed nor ratified the Law of the Sea and there is debate about whether and how much the Law of the Sea is customary international law. In general,

the U.S. acts in accordance with the Law of the Sea when conducting international relations and this report assumes the U.S. would want to do so when regulating international shipping as well. A full discussion of the different types of jurisdiction detailed in the Law of the Sea is beyond the scope of this paper.[38] However, as stated, the U.S. can regulate all ships that call at U.S. ports as ports are part of the sovereign territory of the U.S. If a ship voluntarily calls at a U.S. port, that ship is subjecting itself to any and all U.S. regulation.

## THE JONES ACT

The Merchant Marine Act of 1920, better known as the "Jones Act" requires the use of U.S. built and flagged ships with U.S. crews and U.S. ownership on domestic routes.[39] It was designed to protect U.S. crew and ship production, and for national security reasons. Essentially the Jones Act has meant that more short-sea shipping in the U.S. is carried out by U.S. flagged vessels than would otherwise be the case. The Jones Act does not regulate ship emissions but as these ships are purely U.S. flagged, the U.S. could tackle this section of shipping first, without any international concern, but it would require congressional action to amend the Jones Act to insert emissions requirements into it.

## CLEAN AIR ACT AUTHORITY

The Clean Air Act (CAA) gives the EPA authority to promulgate standards for emissions from "nonroad engines and vehicles", which includes marine vessels. The EPA must find that emissions of ships "significantly contribute" to air pollution that may reasonably be anticipated to endanger public health or welfare (an "endangerment finding") with regard to the emissions of carbon monoxide, NOx, and volatile organic compounds. To regulate other pollutants (such as $CO_2$) the EPA would need to make an endangerment finding specifically related to those pollutants but, to date, the EPA has declined to make an endangerment finding for GHGs from shipping.[40] It is also important to note that even if the EPA did issue an endangerment finding, the language in the CAA for shipping states that EPA "may" act once a finding is made, thus allowing EPA discretion whether to regulate. Finally, the standards would only apply to "new" vessels, leaving a significant portion of the problem unaddressed.

On the whole, the authority of the EPA is not particularly useful with regard to regulating shipping GHGs. However, if getting new legislation through Congress is deemed as too difficult, the EPA authority could immediately require all new built ships to be the most efficient

possible and/or use particular types of fuels (importantly taking into account the full upstream production process) or ban the sale/use of fossil fuel engines for ships from a particular date. The EPA would just not be able to address existing ships. An interesting idea is to investigate whether requiring one of the pollutants the EPA has already found to significantly contribute (carbon monoxide, NOx and volatile organic compounds) to be zero, would have the same effect as a strict climate standard. The EPA could impose such a rule relatively quickly (i.e. bypassing the requirement for a new endangerment finding). However, such a rule would preclude the use of any synthetic fuels that emit carbon monoxide such as methanol or biofuels, so the EPA would need to be comfortable excluding these fuels as possibilities.

## STATE AUTHORITY

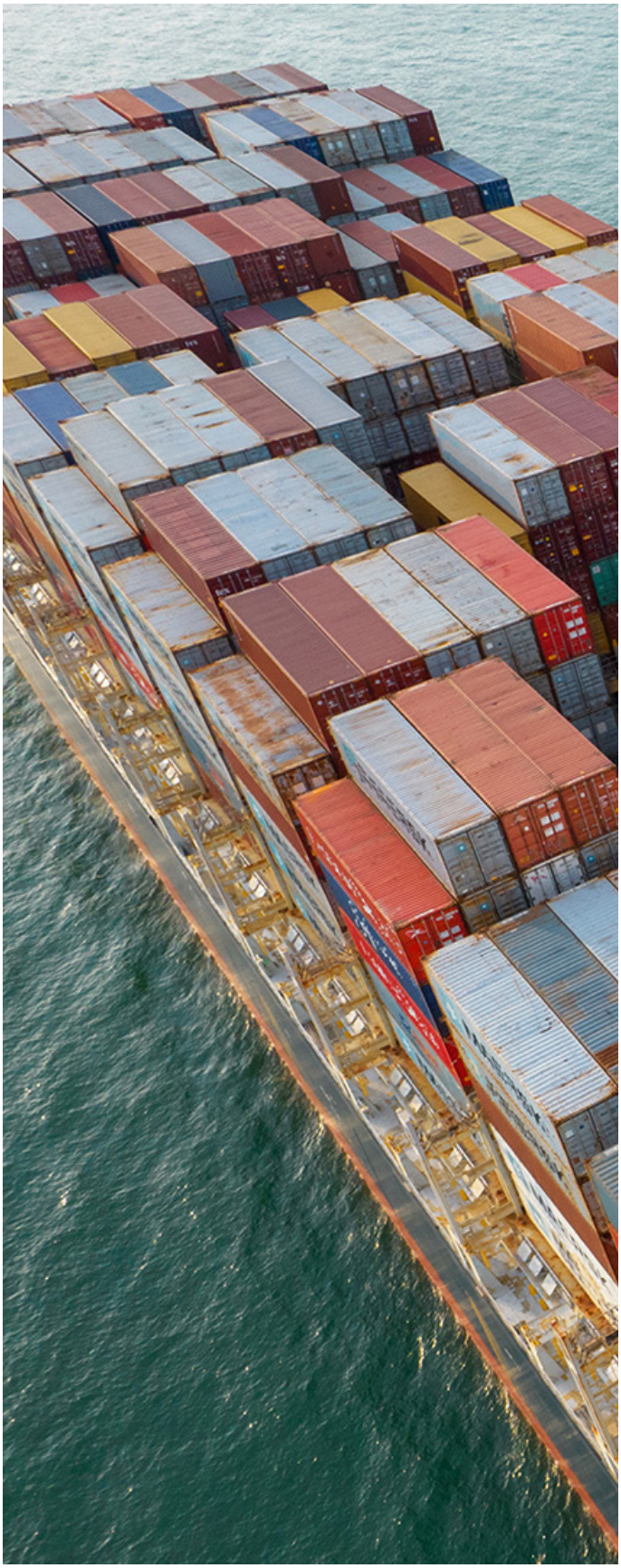
The CAA gives U.S. States the right to draw up their own rules on reducing GHGs from international shipping for approval by the EPA. States may also set "in-use" requirements for shipping that do not require EPA approval.[41] Such "in-use" requirements "merely regulate how vehicles may be used"[42] such as requiring the use of particular low carbon types of fuels, renewable sources or slow steaming. California has used this authority with regard to the sulfur content of fuels in the past and as long as the rules set requirements in terms of fuel use or other use of the ship, they should be upheld as valid in-use rules.[43] States could use this precedent to act on climate emissions from shipping. As was the case with California, such a requirement would then apply to all ships that call at the ports of the state. One caveat is that it is not clear what distance out to sea any in-use standard could apply to, as such rules are supposed to be formulated to deal with local concerns. The California fuel requirement applies for 24 nautical miles from the California border. However, if a state required an in-use standard of zero emission fuels for the 24 nautical miles coming in and out of port, that would at least mean that all ships would have to have zero emission or dual-fuel capabilities. This would create a demand for zero emissions technology and speed up the transition to zero emissions shipping.

A number of Californian ports have voluntary speed reduction measures. These grant ships reduced port fees on the basis of voluntarily slow steaming within (at most) 40 nautical miles of port. However, these are not "in-use" requirements because they

are not mandatory Californian rules but rather initiatives of the ports themselves which if followed grant the relevant ships reduced port fees (though the initiatives are supported by the California Air Resources Board).

## Jurisdictional Choice

Like many other industries, the maritime industry is very resistant to change. Indeed, the maritime industry has been accustomed to little or no regulation as it is international, and so labor and safety standards especially are not well enforced at sea. The industry will almost always suggest that any regulation that would really have an impact to reduce emissions, would also destroy the industry and the jobs the industry supports. The truth is that shipping is a very profitable business, especially with the increase in freight rates over the past year due to supply chain congestion.[44] A 2021 study estimated that infrastructure spending in the immediate and short term on projects to reduce air pollution and GHGs from major maritime port operations in the U.S. could create 316,700 jobs.[45] Of that, more than 80,000 jobs come from construction of new power and communications structures from decarbonization activities such as shoreside power.



For any regulator considering a strict emission standard, the largest possible jurisdictional basis would be best, whether that is city, region, state, national or international. The only real regulation that could easily be avoided by international shipping is a fuel tax, as ships can travel long distances without needing to take on extra fuel. Further, extra fuel does not create an efficiency penalty, the way it does for other modes of transport. Therefore, it is always important to ensure the regulation is imposed based on emissions, rather than fuel. In 1991 California briefly imposed a tax on shipping fuels but due to a falloff in sales of bunker fuels, the tax was abolished in 1992.

To date the shipping industry has been very successful at ensuring no effective climate regulations have made it through the IMO. However, in the EU regulations are currently under consideration which will require shipping to pay for its pollution and use specific fuels.[46] These regulations are not fully in line with the Paris Agreement requirements but are the most impactful regulations proposed on shipping's climate impact anywhere in the world. Several studies have been done on the cost to the shipping industry of avoiding those regulations and it has been found that those regulations would need to be much more restrictive before it

would make sense for ships to make additional port calls in order to avoid the regulations or switch to increased use of land transport (which would usually increase emissions).[47]

# Conclusion: Considerations

Maritime freight makes a significant contribution to local air pollution impacts and the global climate crisis. International law does not provide any material restrictions on the measures the U.S. can directly implement on ships calling at its ports. There is some existing EPA and state authority that can be used without requiring congressional action as discussed above. There are many policy options for reducing emissions from shipping, both domestic and international, that the U.S. could enact, mainly because there are very few regulations existing so almost any regulation would be an improvement on the current lack of regulation. A 2021 report by Pacific Environment and Ocean Conservancy sets out the regulatory options the U.S. should take to regulate emissions[48] and a 2021 report by UMAS for the Getting to Zero Coalition has detailed all the regulatory options on an international level.[49]

The Moving Forward Network wrote letter on October 26th 2021, to the EPA calling for the Agency to prioritize environmental justice in freight impacted communities by aggressively advancing zero-emission technology and solutions across the freight sector, including the follow requests on shipping:

- **EPA adopt rulemaking by the end of 2022 that will maximize zero-emission requirements.**
- **Tier 5 zero-emission standard that will require 100% of new marine engines to be zero-emission by 2035.**
- **Tier 4 standard by 2025 and the retirement of any marine engines that do not meet the zero-emission standard by no later than 2045.**
- **EPA should provide grants for the installation of shore power infrastructure and ship emission capture systems to reduce at-berth emissions.**
- **EPA to require all ships at-berth in U.S. ports emit zero emissions under the United States' port state control authority.**

- **EPA to push its federal colleagues to push for strong international standards and other strategies at the International Maritime Organization.[50]**

In conjunction with what was submitted to the EPA from MFN, further considerations that would advance zero emissions shipping include the following:

- **The EPA could adopt rulemaking by the end of 2022 that will maximize zero-emissions requirements via existing authority or issue an endangerment finding for GHGs from marine vessels (this would require an endangerment finding).**
- **The EPA could require all new marine engines to be zero-emission by 2030, including via the use of maximum wind on ships.**
- **States could exercise their in-use fuel authority to require all ships to use zero-emission fuels in waters close to port and as far away from port as possible. This could also include slow steaming and the maximum use of wind. This requirement should be designed in a way that all non-zero emission ships must retire no later than 2045.**
- **Congress could introduce a pollution charge on all ships that stop at U.S. ports.**
- **Congress could require all ships calling at U.S. ports to be zero-emission by 2045 and introduce standards starting 2025 that begin to require the use of zero-emissions fuels on a lifecycle basis (i.e. taking into account upstream emissions).**
- **Congress could impose slow steaming requirements and rules that require a maximum use of wind on ships.**
- **The U.S. delegation to the IMO could support and develop as quickly as possible, a fuel standard in line with 1.5 degrees and a GHG levy as suggested by several Pacific Island delegations to support an equitable transition.**

# Endnotes

[1] Gillingham, K. and Huang, P. (2021). Racial Disparities in the Health Effects from Air Pollution: Evidence from Ports. [online] Air Pollution: Evidence from Ports. NBER Working Paper No. w29108. Available at: https://ssrn.com/abstract=3897544 [Accessed 23 May 2022].

[2] Ibid.

[3] See the California Air Resources Board for full description of the rule and all updates: California Air Resources Board (n.d.). Ocean-Going Vessels At Berth Regulation | California Air Resources Board. [online] California Air Resources Board. Available at: https://ww2.arb.ca.gov/our-work/programs/ocean-going-vessels-berth-regulation [Accessed 23 May 2022].

[4] Gillingham, K. and Huang, P. (2021). Racial Disparities in the Health Effects from Air Pollution: Evidence from Ports. [online] Air Pollution: Evidence from Ports. NBER Working Paper No. w29108. Available at: https://ssrn.com/abstract=3897544 [Accessed 23 May 2022].

[5] Sofiev, M., Winebrake, J.J., Johansson, L. et al. Cleaner fuels for ships provide public health benefits with climate tradeoffs. Nat Commun 9, 406 (2018). https://doi.org/10.1038/s41467-017-02774-9

[6] Fabel, J. et al. (2020). Fourth IMO Greenhouse Gas Study. International Maritime Organization.

[7] Bryan, C. (2019). Black Carbon and Maritime Shipping: The Long Road to Regulating a Short-Lived Climate Pollutant. [online] Climate & Clean Air Coalition. Available at: https://www.ccacoalition.org/en/blog/black-carbon-and-maritime-shipping-long-road-regulating-short-lived-climate-pollutant [Accessed 23 May 2022].

[8] For an overview of the potential economic opportunities, see: Englert, D., Losos, A., Raucci, C. and Smith, T. (2021). The Potential of Zero-Carbon Bunker Fuels in Developing Countries. [online] World Bank Group Open Knowledge Depository. Washington DC: World Bank. Available at: https://openknowledge.worldbank.org/handle/10986/35435 [Accessed 23 May 2022].

[9] Principles and pathways for achieving zero-emission vessels Bryan Comer, PhD, Marine Program Lead, ICCT March 10, 2021 U.S. Maritime Decarbonization Working Group

[10] Bonello, D.J.-M., Velandia Perico, C., Taylor, J. and Smith, D.T. (2022). The Maritime Fleet of the USA – the current status and potential for the future. University Maritime Advisory Services (UMAS).

[11] However, this excludes Great Lakes US flagged bulk carriers. A separate analysis by the International Council on Clean Transportation found that US flagged GL bulk carriers emitted about 500,000 tonnes of $CO_2$ in 2019: Comer, Ph.D., B. and Meng, Z. (2022). Great Lakes – St Lawrence Seaway Ship Emissions Inventory, 2019. [online] ICCT The International Council on Clean Transport. The International Council on Clean Transportation. Available at: https://theicct.org/publication/ships-great-lakes-emissions-mar22/ [Accessed 23 May 2022].

[12] Faber, J. et al. (2020). Fourth IMO Greenhouse Gas Study. International Maritime Organization.

[13] Jasper, F., Nelissen, D., Hon, G. and Tsimplis, M. (2012). Regulated Slow Steaming in Maritime Transport: An Assessment of Options, Costs and Benefits. [online] CE Delft. CE Delft. Available at: https://cedelft.eu/publications/regulated-slow-steaming-in-maritime-transport/ [Accessed 23 May 2022].

[14] Bryan, C., Chen, C., Stolz, D. and Rutherford, D. (2019). Rotors and Bubbles: Route-Based Assessment of Innovative

Technologies To Reduce Ship Fuel Consumption And Emissions. [online] ICCT International Council on Clean Transportation. ICCT International Council on Clean Transportation. Available at: https://theicct.org/publication/rotors-and-bubbles-route-based-assessment-of-innovative-technologies-to-reduce-ship-fuel-consumption-and-emissions/ [Accessed 23 May 2022].

[15] Mao, X., Georgeff, E., Rutherford, D. and Osipova, L. (2021). REPOWERING CHINESE COASTAL FERRIES WITH BATTERY-ELECTRIC TECHNOLOGY. [online] ICCT International Council on Clean Transport. ICCT International Council for Clean Transport. Available at: https://theicct.org/publication/repowering-chinese-coastal-ferries-with-battery-electric-technology/ [Accessed 23 May 2022].

[16] Vanderbilt School of Engineering (2021). Decarbonization of U.S. waterways poses unique challenges. [online] Vanderbilt University. Available at: https://engineering.vanderbilt.edu/news/2021/decarbonization-of-u-s-waterways-poses-unique-challenges-2/#:~:text=A%20landmark%20new%20report%20by [Accessed 23 May 2022].

[17] Taylor, J et al. (2022). Future Maritime Fuels in the USA – the options and their potential pathways. [online] UMAS. UMAS. Available at: https://oceanconservancy.org/wp-content/uploads/2022/04/oc_fuels_final_report_20220117.pdf.

[18] There is a growing literature on the various future fuels for shipping and the author would recommend Environmental Defense Fund (n.d.). Alternative Fuels for Shipping. [online] Environmental Defense Fund. Available at: https://www.edfeurope.org/alternative-fuels-shipping [Accessed 23 May 2022]. as a good starting point to go more in-depth.

[19] Renewable energy may have many definitions based on the source of energy. MFN considers solar and wind to be renewable energy. However, there are important Environmental Justice (EJ) and equity implications that come from these “cleaner” energy sources (i.e siting, manufacturing, shipping, etc). All of these must be considered with EJ leadership before endorsing specific renewable energy recommendations.

[20] For a full discussion see Saadat, S. and Gersen, S. (2021). Reclaiming Hydrogen for a Renewable Future. [online] EarthJustice. EarthJustice. Available at: https://earthjustice.org/sites/default/files/files/hydrogen_earthjustice_2021.pdf [Accessed 23 May 2022].

[21] There are other production pathways for these fuels but a full discussion of all possible pathways is beyond the scope of this report.

[22] Taylor, J et al. (2022). Future Maritime Fuels in the USA – the options and their potential pathways. [online] UMAS. UMAS. Available at: https://oceanconservancy.org/wp-content/uploads/2022/04/oc_fuels_final_report_20220117.pdf.

[23] It is important to note with regards to natural gas, the MFN network is not in support of this “false solution” because of the cumulative impacts from the production, use, and disposal of natural gas the waste products. Presently, MFN frames false solutions as technologies that rely on; carbon trading and/or “greenwashed” energy that comes from non-renewable and heavy-polluting sources such as natural gas, biomass, etc.

[24] Ibid.

[25] Taylor, J et al. (2022). Future Maritime Fuels in the USA – the options and their potential pathways. [online] UMAS. UMAS. Available at: https://oceanconservancy.org/wp-content/uploads/2022/04/oc_fuels_final_report_20220117.pdf.

[26] Designation of the North American Emission Control Area for Marine Vessels | US EPA

[27] Ocean-Going Vessels At Berth Regulation | California Air Resources Board

[28] Taylor, J et al. (2022). Future Maritime Fuels in the USA – the options and their potential pathways. [online] UMAS. UMAS. Available at: https://oceanconservancy.org/wp-content/uploads/2022/04/oc_fuels_final_report_20220117.pdf.

[29] See International Transport Forum (2019). Maritime Subsidies Do They Provide Value for Money? [online] ITF. International Transport Forum. Available at: https://www.itf-oecd.org/sites/default/files/docs/maritime-subsidies-value-for-money.pdf [Accessed 23 May 2022].

[30] O'Leary, A. (2019). Shipping. In: J. Dernbach and M. Gerrard, eds., Legal Pathways to Deep Decarbonization in the United States. Environmental Law Institute.

[31] For a full discussion of coastal state jurisdiction see: O'Leary, A. (2022). Freedom to Regulate the High Seas. [online] Transport and Environment. Available at: https://www.transportenvironment.org/discover/freedom-to-regulate-the-high-seas/ [Accessed 23 May 2022].

[32] See Comer, B. (2021). Zero-Emission Shipping and The Paris Agreement: Why The Imo Needs To Pick A Zero Date And Set Interim Targets In Its Revised GHG Strategy. International Council On Clean Transportation. Available at: https://theicct.org/zero-emission-shipping-and-the-paris-agreement-why-the-imo-needs-to-pick-a-zero-date-and-set-interim-targets-in-its-revised-ghg-strategy/ [Accessed 23 May 2022].

[33] Ibid.

[34] Proposal for Universal Greenhouse Gas levy on all International Shipping by Pacific Island States presented at UN Global Sustainable Transport Conference - University of the South Pacific (usp.ac.fj)

[35] International Convention for the Prevention of Pollution from Ships, adopted November 2, 1973, as modified by the Protocol of 1978, adopted on February 17.1978, entered into force in 1983, 1340 U.N.T.S. 61, 17 I.L.M. 546.

[36] O'Leary, A. (2019). Shipping. In: J. Dernbach and M. Gerrard, eds., Legal Pathways to Deep Decarbonization in the United States. Environmental Law Institute.

[37] Department of Homeland Security, Rulemaking notification, MARPOL Annex VI; Prevention of Air Pollution from Ships, Fall 2021.

[38] For a full discussion see For a full discussion of coastal state jurisdiction see: O'Leary, A. (2022). Freedom to Regulate the High Seas. [online] Transport and Environment. Available at: https://www.transportenvironment.org/discover/freedom-to-regulate-the-high-seas/ [Accessed 23 May 2022].

[39] This is a simplification of the Jones Act which is a complex piece of legislation that has a number of exemptions and conditions depending on the particular ship, route and cargo.

[40] EPA (2012). Memorandum in Response to Petitions Regarding Greenhouse Gas and Other Emissions from Marine Vessels and Nonroad Engines and Vehicles.

[41] 42 U.S.C. §7543(e)(2)(B)

[42] PMSA v Goldstene (2008)

[43] Pacific Merchant Shipping Association v. Goldstene [2008] 517 F.3d 1108 (9th Cir.).

[44] Wackett, M. (2022). Containership earnings bonanza continues in the red hot charter market. [online] The Loadstar. Available at: https://theloadstar.com/containership-earnings-bonanza-continues-in-the-red-hot-charter-market/ [Accessed 23 May 2022].

[45] Wooley, D., Jones, B., Cheung, A. and Brito, J. (2021). Maritime Port Clean Energy Infrastructure Jobs Study. [online] Berkeley Public Policy. Centre for Environmental Public Policy. Available at: https://oceanconservancy.org/wp-content/uploads/2021/09/Maritime-Port-Clean-Energy-Infrastructure-Jobs-Study.pdf [Accessed 23 May 2022].

[46] Gozillon, D. (2022). FuelEU Maritime: T&E Analysis and Recommendations: How to drive the uptake of sustainable fuels in European Shipping. [online] Transport & Environment. Available at: https://www.transportenvironment.org/wp-content/uploads/2022/02/TE-Report-FuelEU-Maritime-1.pdf [Accessed 23 May 2022].

[47] See Defour, S. and Afonso, F. (2020). All Aboard! Too expensive for ships to avoid EU carbon market. [online] Transport and Environment. Available at: https://www.transportenvironment.org/wp-content/uploads/2021/07/ETS_shipping_study.pdf [Accessed 23 May 2022].

[48] Barry, J., Hubbell, D. and Rose, M. (2021). ALL ABOARD: How the Biden-Harris Administration Can Help Ships Kick Fossil Fuels. [online] Ocean Conservancy. Available at: https://oceanconservancy.org/wp-content/uploads/2021/04/All-Aboard-US-Policy-Zero-Emissions-Report_FINAL.pdf [Accessed 23 May 2022].

[49] Rojon, I., Shaw, A., Blaxekjær, L. and Kulaksiz, A. (2021). Policy Options for Closing the Competitiveness Gap Between Fossil and Zero-Emission Fuels in Shipping. [online] www.globalmaritimeforum.org. Available at: https://www.globalmaritimeforum.org/news/policy-options-for-closing-the-competitiveness-gap-between-fossil-and-zero-emission-fuels-in-shipping [Accessed 23 May 2022].

[50] https://www.movingforwardnetwork.com/wp-content/uploads/2021/11/MFN-Zero-Emission-in-Freight-Letter-to-EPA-10_26_21.pdf

[51] It is important to note with regards to natural gas, the MFN network is not in support of this “false solution” because of the cumulative impacts from the production, use, and disposal of natural gas the waste products. Presently, MFN frames false solutions as technologies that rely on; carbon trading and/or “greenwashed” energy that comes from non-renewable and heavy-polluting sources such as natural gas, biomass, etc.

[52] Ibid.