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SHIPS, PORTS & EV'S

THE IMPACT OF ALTERNATIVE FUELS

THE CHANGING TRANSPORTATION LANDSCAPE

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With the passage of the Inflation Reduction Act (IRA), companies and the general public are actively discussing renewable energy. Solar, wind, geothermal, and other unconventional sources of energy are popular topics.[1] Tax credits, in particular, attract attention.[2] Although the IRA contains provisions that offer incentives to parts of the hydrocarbon industry,[3] most coverage emphasizes the need to build utility-scale solar farms, expand the transmission line network to deliver electricity from solar and wind facilities to both urban centers and underserved rural communities, or conversely, develop distributed generation resources featuring self-sustaining microgrids.[4] Overlooked in many cases are developments in the alternative fuels sector that predate the IRA, and that leads us to ships, ports, and electric vehicles (EVs).[5] Florida, which has an extensive cruise and marine industry,[6] as well as numerous tourist and cargo ports, is directly impacted not only by IMO 2020 and its updates, but also by additional regulations from the EU coming into effect in 2023 and later years.

The International Maritime Organization

Many governments throughout the world are focused on climate change and its impacts on the environment.[7] International organizations have taken steps to reduce the carbon footprint across many industries. One such industry is shipping. The international shipping industry is viewed as a major contributor to certain types of pollution.[8] Of particular concern are sulfur emissions. In response, the United Nations, through the International Maritime Organization (IMO), created IMO 2020.[9] Beginning 1 January 2020, this rule imposed a new limit on the sulfur content in fuel oil used on board ships, drastically reducing the earlier 3.5% m/m limit for sulfur in fuel oil operating outside designated emission control areas (ECAs) to 0.50% m/m.[10] Following an amendment to Annex VI of the International Convention for the Prevention of Pollution from Ships (MARPOL), IMO 2020 became compulsory.[11]

Despite varying enforcement abilities, to comply with the new regulations, cruise lines and cargo lines had to change their energy technology. The IMO has taken a technology-neutral approach to IMO 2020, leaving controversial emission abatement systems like scrubbers[12] for heavy fuel oil, as well as liquified natural gas (LNG) and other low sulfur fuels as contenders.[13] The other alternative fuel options include Bio-LNG, which is different in origin than fossil-based LNG,[14] synthetic LNG,[15] bio-diesel, which is derived from waste oil feedstocks,[16] ammonia, a zero-carbon fuel,[17] "blue" and "green" methanol, with an aggregate installed capacity in the EU projected to triple to three million tons per year by 2023,[18] and the oft-discussed hydrogen, which can be extracted from fossil fuels and biomass or from water, or a combination of the two.[19] Each cruise and shipping line has taken its own path toward compliance, with Carnival Corporation leaning toward LNG on one end and Maersk exploring methanol on the other.[20]

Flag States and Port States

One of the challenges in recent years is that many international organizations that establish these rules have little or no power to enforce them.[21] That task falls to each ship's flag state where it is registered and port state when jurisdiction shifts from the flag state to the national territory the ships are in.[22] Many of these states, in anticipation of IMO 2020, adopted guidelines, laws, and regulations that implement, complement, or supplement IMO 2020. But in each case, each local jurisdiction offered its own variation on local requirements, thus impacting the international shipping industry.

Flag States

Floridians are familiar with several flag states such as Bermuda and the Bahamas.[23] Bermuda's legislation relates back to IMO 2020. The Merchant Shipping (Prevention of Air Pollution from Ships) Regulations 2019 limits the sulfur content to the requirements of MARPOL Annex VI.[24] Subsequent Amendment Regulations expressly specified the appropriate sulfur content as 0.50% by mass generally by 1 January 2020, and 0.10% by mass in sulfur oxide ECAs.[25]

Many of these jurisdictions share common elements when it comes to regulating vessels and require ships flying their flags to comply with their regulations. By way of example, and for discussion purposes, The Bahamas' treatment is illustrative. The Bahamas is one of the world's largest ship registers with approximately 1,500 commercial ships totaling over 50 million gross tons flying the Bahamian flag.[26] Gearing up toward IMO 2020, on 30 August 2019, The Bahamas Maritime Authority (BMA) released Informational Bulletin No. 183, which provided initial guidance on the regulation and how to comply in Bahamian waters. [27] The Bulletin emphasized that

the new global sulfur limit would be mandatory and applicable to all fuel for all ships on all voyages, including fuel oil used in emergency systems like rescue boats.[28] Ship and machinery safety concerns would not exempt ships.[29] Departing from the technology-neutral stance of the IMO, the BMA warned that open-loop scrubbers were not permitted,[30] forcing ships to use compliant fuel oil or switch to closed-loop mode in Bahamian waters.[31]

Port States

Port states have also adopted regulations impacting the shipping industry by imposing requirements for vessels that use their ports. They have similar characteristics in that they limit sulfur emissions, mandate inspections, impose restrictions, and require reporting.

Norway, the fourth-largest shipping nation in the world measured by market value,[32] requires the reporting of alternative means to comply with the emission requirements to the Norwegian Maritime Authority[33] and even with reporting, does not allow the use of open-loop scrubbers in its heritage fjords.[34]

Singapore, ranked the fifth-largest register of ships in the world, has a fleet of almost 5,000 ships totaling over 96 million gross tons.[35] Since 2018, Singapore's Maritime & Port Authority (SMPA) has engaged stakeholders to prepare for the new sulfur regulations, working closely with them to develop and publish guides to comply with IMO 2020.[36] Singapore's Prevention of Pollution of the Sea (Air) Regulations 2022 includes the entire MARPOL Annex VI in the first schedule of the Regulations.[37]

The United States is the fifth-largest shipping nation in the world measured by market value.[38] In total, there are 587 ports across the country.[39] The majority of the United States is part of the North American and U.S. Caribbean Sea ECAs.[40] Since 1 January 2015, both ECAs have had a fuel oil sulfur cap that is lower than that imposed by IMO 2020.[41] In 2021, the U.S. Environmental Protection Agency (EPA) published MARPOL Annex VI and the Act to Prevent Pollution from Ships (APPS) (33 U.S.C. §§ 1905-1915) under its enforcement page.[42] There, the EPA explains that there is a memorandum of understanding (MOU) between the EPA and the U.S. Coast Guard (USCG) to enforce MARPOL Annex VI.[43] Efforts that fall under this MOU include oversight of marine fueling facilities, onboard compliance inspections, and record reviews.[44] More recently, the USCG Office of Commercial Vessel Compliance came out with a guidance dated 13 January 2020 covering the implementation of compliance and enforcement policy for IMO 2020.[45] In that guidance, the USCG reasserts that pursuant to APPS, it has the authority and responsibility to conduct ship inspections, examinations, and investigations, and can undertake enforcement action.[46] Although only the EPA can issue Engine International Air Pollution Prevention (EIAPP) certificates, both the EPA and the USCG are authorized to issue regulations to carry out Annex VI.[47]

IMO 2023

November 2022 amendments to MARPOL Annex VI required short-term improvements to the energy efficiency of ships.[48] Subsequently, IMO 2023 entered into force on 1 January 2023.[49] This new IMO regulation focuses on two carbon intensity measures—the Energy Efficiency Existing Ship Index (EEXI) and the Carbon Intensity Indicator (CII).[50] The first annual reporting for EEXI and CII requirements must be completed in 2023.[51]

Under the EEXI requirement, ships of 400 gross tonnage and above are compared to a required baseline relative to the ships' type and size.[52] Each ship's attained EEXI value must be below the required EEXI to meet the minimum energy efficiency standard.[53] Similarly, under the CII requirement, ships' actual annual operational CII will be verified against a required annual operational CII.[54] The CII measure determines the appropriate reduction factor for each ship to continue to improve its operational carbon intensity.[55] Initial ratings generated from these metrics will apply in 2024.[56] The IMO encourages providing incentives for ships with A or B ratings, while ships rated D for three consecutive years, or E for one year, will have to submit corrective action plans.[57]

EU Fit for 55 Updates

About 75% of the EU's external trade, along with 31% of its internal trade in terms of volume, comes from maritime transport.[58] Approximately 400 million passengers embark or disembark in EU member state ports annually, creating ship traffic that accounts for around 11% of all EU carbon dioxide emissions from transport and 3-4% of total EU carbon dioxide emissions.[59]

1.

EU Emissions Trading Scheme and Regulation 2015/757

As part of recommended updates to the European Union's Fit for 55 package, the EU Emissions Trading Scheme (EU ETS) will expand to cover maritime transport.[60] In parallel, Regulation (EU) 2015/757 on the monitoring, reporting, and verification of carbon dioxide emissions from maritime transport will provide for monitoring, reporting, and verification rules that are necessary for the extension of the EU ETS to maritime transport activities.[61] This includes monitoring and reporting aggregated emissions data from maritime transport activities at the company level.[62] The Regulation's title will be amended to replace "carbon dioxide" with "greenhouse gas,"[63] which represents the proposed inclusion of methane and nitrous oxide in the Regulation as of January 2024.[64] Inclusion of methane and nitrous oxide in the EU ETS is recommended to follow in 2026.[65]

Subject to limited exceptions,[66] under the EU ETS amendments, ships of 5,000 gross tonnage or more will have to comply with emission allowances beginning in 2024.[67] Because emissions from ships below 5,000 gross tonnage amounts to less than 15% of emissions from ships, their inclusion will be assessed at a later date.[68] For applicable ships, 100% of the emissions from voyages between two member states and emissions within a port under the jurisdiction of a member state are included.[69] Meanwhile, 50% of the emissions from voyages between a port under the jurisdiction of a member state and a port outside the jurisdiction of a member state will be subject to the EU ETS.[70] To combat the risk of evasive port calls and the risk of delocalization, incoming and outgoing voyages are covered,[71] certain stops at non-Union ports will be excluded,[72] and a limit of 300 nautical miles from a port of jurisdiction of a member state will be implemented.[73]

Shipping companies, defined as the ship owners, will be responsible for compliance with the EU ETS.[74] Each shipping company will be assigned to one member state, but all member states will act in solidarity when a shipping company fails to comply with requirements or enforcement measures.[75] To reduce administrative costs, member states will not take into account contractual agreements that vary from ship to ship;[76] however, a shipping company will be entitled under statute to claim reimbursement from another entity if they are directly responsible for decisions affecting the greenhouse gas (GHG) emissions of the ship.[77]

FuelEU Maritime

Also applying to ships of over 5,000 gross tons, FuelEU Maritime (FuelEU) will join the Fit for 55 package in January 2025.[78] The regulation was proposed, in part, to prevent the diversion of traffic and market distortion that would occur between competing ports of member states if obligations for renewable and low-carbon fuels were established at a national level.[79] It establishes rules that reduce the carbon dioxide, methane, and nitrous oxides (GHG)[80] of energy used on board ships arriving at, within, or departing from ports under the jurisdiction of a EU member state,[81] including while a ship is at berth.[82] Shipping companies will be responsible for compliance[83] and will have to submit monitoring plans and information for the amount, type, and emission factor of energy used on board their ships.[84] Any entities directly responsible for decisions affecting GHG intensity—like fuel, route, and speed of ships—should be held contractually accountable by the shipping company.[85]

The European Commission will create an electronic database that houses compliance data for each ship's GHG emissions per unit of energy used on board.[86] To alleviate administrative burdens, the regulation also proposes certifications of fuels.[87] Similarly, shipping companies have some flexibility with options to roll over compliance surpluses and pool compliance performance.[88] FuelEU certificates of compliance will be issued by verifiers and kept on board each ship to be inspected by ports as evidence of compliance.[89] Penalties will be assessed for each quantum of energy used above the requisite reference value,[90] which will drop by 2% in 2025, 6% in 2030, 13% in 2035, 26% in 2040, 59% in 2045, and 75% in 2050.[91]

The reference value will be calculated in accordance with fleet averages using methodologies and default values in Annex 1 to Regulation (EU) 2015/757.[92] To assess a fuel's emissions factor, FuelEU will employ a well-to-wake approach, which takes into account the entire process of fuel production, delivery, and use.[93] Stakeholders advocated for use of this approach,[94] expressing concerns that the alternative "tank-to-wake" option creates a false impression of GHG reduction—burdening fuels with low emissions derived from upstream processes, like LNG,[95] while promoting fuels with zero operational emissions, like hydrogen and ammonia.[96]

Carbon Border Adjustment Mechanism

Taking effect in October 2023, the Carbon Border Adjustment Mechanism (CBAM) will place a "carbon price" on certain goods imported into the EU[97] based on GHG emissions regulated by the EU ETS and a timeline that spans the production of applicable goods to the time of import.[98] For now, covered goods include cement, iron and steel, aluminum, fertilizers, electricity, and hydrogen.[99] The introduction of CBAM will work alongside the phaseout of free allowances under the ETS system.[100] In turn, the free allocation no longer provided to the CBAM sectors will be added to the EU's Innovation Fund to support innovation in climate-change mitigation technologies.[101]

Under CBAM, EU importers of goods register with national authorities and buy CBAM certificates priced according to weekly ETS allowances.[102] Importers then declare the emissions embedded in their goods and surrender the corresponding number of certificates yearly.[103] If importers have already paid a carbon price, that amount can be deducted from certificates due.[104] Two kinds of emissions can be monitored—direct and indirect emissions.[105] Direct emissions are embedded emissions that occur during the production process.[106] Indirect emissions are attributed to the production of electricity needed for manufacturing.[107]

Customs authorities can conduct searches that include inspecting the goods and checking the goods' quantity and country of origin.[108] Additionally, customs authorities can verify identification of the authorized CBAM declarant, the eight-digit combined nomenclature (CN) code, and the date of declaration of the customs procedure.[109] During the transitional phase, customs authorities should also inform customs declarants of reporting requirements.[110] The Commission will maintain a CBAM registry.[111]

Countries and territories with (i) an emission trading system that fully links to the EU ETS and (ii) carbon pricing that is charged on the emission embedded in goods without any rebate beyond those also applied in the EU ETS will be exempt from CBAM.[112] Currently, that list includes the countries of Iceland, Liechtenstein, Norway, and Switzerland, along with five other territories.[113]

Global Arrangement on Sustainable Steel and Aluminium

While the United States is not exempted from CBAM, as it does not have a domestic carbon pricing system equivalent to the EU ETS, the European Commission President Ursula von der Leyen is working with the United States to bring a Global Arrangement on Sustainable Steel and Aluminium (GASSA) to fruition.[114]

Despite GASSA's possible market-stabilization and decarbonization benefits, there is concern over the arrangement interfering with the CBAM, and GASSA and CBAM violating World Trade Organization (WTO) rules such as the most-favored nation rule prohibiting discrimination among WTO members.[115] President von der Leyen has historically expressed similar discrimination concerns with the United States' IRA.[116] The WTO, however, has a series of exceptions for environmental protection, public health, national security, and measures taken under an international commodities agreement that likely make the CBAM, IRA, GASSA, and similar regulations WTO-compatible.[117]

Port Infrastructure

In a recent survey among 130 public port authorities in the United States, Canada, the Caribbean, and Latin America, 58% of respondents have begun studying projects to serve vessels with alternative fuels, including hydrogen, LNG, and ammonia.[118] Three key elements of port infrastructure are storage facilities, bunkering vessels, and transfer systems.[119] Ports may face delays with hydrogen production and storage facilities due to significant technical and safety concerns;[120] however, if those challenges are overcome, ports may be well-positioned to become hydrogen production hubs.[121] LNG, on the other hand, has more developed infrastructure and transfer systems, which certain biofuels can share.[122] Meanwhile, transfer systems are in place for ammonia, but storage facilities are more infrequent in ports, and ammonia bunkering vessels need to be developed.[123] Likewise, methanol and ethanol port infrastructure and bunkering vessels are sparse and need to be developed, with fuel currently transported by trucks.[124]

With a projected US$1.2 to US$1.6 trillion price tag for onshore infrastructure and production facilities needed to decarbonize the shipping industry by 2050, stakeholder collaboration

and major investment is key for ports.[125] Taking into account the wide array of fuel types used to meet technology- and fuel-neutral regulations, ports must consider how long each transitional fuel will be used, the stakeholder demand for each fuel type, and the price of setting up the fuel supply's corresponding infrastructure.

Shore Operations of Ports

Ports are faced with the challenge of not only complying with the existing and upcoming fuel regulations (and building the necessary infrastructure to handle it) but also taking measures to reduce their carbon footprint while catering to a changing client base that both demands and requires such a reduction. The Port of Corpus Christi, for example, recently revised its environmental policy to include a new objective: reduction of greenhouse gases per cargo ton handled by 7.5% annually.[126] Ports across the country are considering how to achieve similarly ambitious goals.

Electrification of Port Facilities

While the focus on short-term returns in certain industries has had the effect of stalling advancements in energy policy and management, a focus on long-term returns, coupled with the unquantifiable benefits related to improving local economies and protecting the surrounding marine environment, is spurring the advancement of clean energy strategies at seaports and container terminals. A similar movement in trucking logistics[127] means pronounced port efforts toward replacing gas- or diesel-engine fleets and equipment with electric and battery-run fleets, equipment, and infrastructure in the effort to reduce the carbon footprint.[128]

The success and profitability of seaports and terminal ports have historically turned on three elements: efficiency of operations, resilience of systems, and productivity.[129] For long-term survival in a globally competitive marketplace, seaport and container ports have, for some time, acknowledged and actively evaluated the impact of electrification in these three areas;[130] however, electrification is expensive and complex.[131]

Container port infrastructure is already an entangled, interconnected system of intermodal equipment (e.g., cargo handling equipment, containers, trailers, forklifts, cranes, and carriers) and cargo handling processes.[132] The electrification of such infrastructure and processes creates additional complexity around design, the capacity and adequacy of power sources and distribution, and new and evolving regulatory frameworks.[133] This is because existing infrastructure, equipment, methods, and labor must be evaluated for capacity, connectivity, scale, and sufficiency of assets.[134] Any incompatibility or obsoleteness in any of those areas or elements would equate to a need for significant capital expenditures and investments. For example, the Port of Long Beach and the Port of Los Angeles are estimating costs in the range of US$8.5 billion to US$14 billion to support new technologies and modernized infrastructure to support the San Pedro Bay Clean Air Action Plan.[135]

Because of the significant investment associated with electrification, ports are also evaluating alternative power generation sources that reduce the dependency on the power grid as part of their electrification strategy. Powering electric equipment and fleet charging with solar photovoltaic energy and battery energy storage systems (BESS) increases sources of available power without producing additional drain and stress on the capacity of existing electric grids.[136] Ports are taking advantage of owned but unproductive land and strategic investments to fund the development and construction of solar photovoltaic and battery farms[137] or, in some cases, energy islands.[138] In addition, existing infrastructure such as carport canopies are being repurposed into productive energy generating assets,[139] onshore power systems are being installed, and structures like warehouses are being retrofitted to provide heavy power capabilities that go beyond grid capacity.

Alternative sources of power and electrification are the future and "net zero" is a requirement to protect against changes in the environment and reductions in global trade.[140] By taking a long-term view and forging collaborative efforts with public and private stakeholders, sea and container ports have demanded and are aggressively leading advancements in the decarbonization of supply chain and logistics through implementation of green infrastructure, alternative fuels, and electrification of port infrastructure.[141]

Robert J. Downing

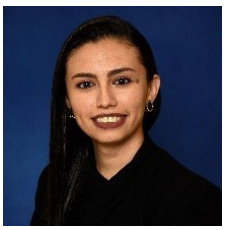
Robert J. Downing has more than 35 years' experience in domestic and international business transactions. He focuses on corporate, mergers and acquisitions and finance matters, with an emphasis on energy, infrastructure and project development. He served as Associate General Counsel at Duke Energy International, a subsidiary of Duke Energy, the largest electric utility in the United States. He holds an LL.M. in Energy, Environmental and Natural Resources Law and is Board Certified in International Law by The Florida Bar.

Robert is currently lead counsel for a multinational company that is designing, engineering, and constructing a green methanol production facility with capabilities to produce more than 6,000 MTPD and valued at over USD $2.6 billion. The project involves drafting and negotiating multiple EPC and FEED contracts with several EPC contractors from Texas, Asia and Europe. He was the lead in-house counsel and Board Member of Ibn Sina (National Methanol), a major Saudi Arabia petrochemical company based in Al-Jubail, Saudi Arabia, with responsibilities for drafting, negotiating and advising on EPC contracts and shared facility agreements. The project involved the addition of polyoxymethylene (POM) and polymethyl methacrylate (PMMA) chemical plants to the existing methanol operations. Robert was also lead EPC contract counsel for the construction of an electrical substation to provide electricity to the expanded plant.

Robert represented Kiewit Construction in drafting and negotiating the EPC contract and ancillary agreements for a petrochemical fluids storage facility in the Port of Progreso, Yucatan, Mexico. He also represents several affiliates of Petrobras on their floating production storage and offloading (FPSO) EPC contracts. In this capacity he has analyzed more than a dozen EPC contracts with values ranging from USD $850 million to USD $1.4 billion. Legal work includes advising on EPC contracts terms and conditions, drafting and negotiating change orders and contract amendments, and providing interpretations of New York law pertaining to the EPC contracts, as amended.

Geiza Vargas-Vargas

Geiza Vargas-Vargas focuses her practice on mergers and acquisitions, joint ventures and capital raises for clients in the United States and Latin America. She has closed transactions in a wide variety of sectors, including digital infrastructure, renewable energy, technology, and industrials. She has advised investment funds and strategic investors in aerospace, telecommunications and Section 363 acquisitions and has represented clean technology companies, including in the electric vehicle charging space, and their investors and lenders in various financings, recaps and buyouts. She also advises her clients on general corporate matters.



Adrienne Kanter

Adrienne Kanter is a soon-to-be graduate from Florida International University College of Law (FIU), where she has a full-tuition merit scholarship. She worked on this article as a continuation of her research for Mr. Downing's energy law seminar class at FIU and received the CALI Excellence for the Future Award for that class. She is also interested in litigation and has won the 2023 American Association for Justice National Student Trial Advocacy Competition (AAJ STAC) Regional Championship as well as the 2022 E. Earle Zehmer National Worker's Compensation Moot Court Competition Best Written Brief Award.

Endnotes

1. The IRA was signed into law on 22 August 2022. It contains, among other things, tax credits and incentives that extend up to ten years, thereby providing a higher level of certainty for the renewable energy industry and entities, such as hedge funds, private equity, and strategic players looking to invest.

2. *See, e.g.*, United States Internal Revenue Service, *Credits and Deductions Under the Inflation Reduction Act of 2022*, https://www.irs.gov/credits-and-deductions-under-the-inflation-reduction-act-of-2022 (last visited 27 Apr. 2023).

3. *See, e.g.*, Brad Handler & Morgan Bazilian, *The Inflation Reduction Act's modest impact on oil and gas*, The Hill (22 Aug. 2022, 4:00 PM ET), https://thehill.com/opinion/energy-environment/3611212-the-inflation-reduction-acts-modest-impact-on-oil-and-gas/.

4. *See, e.g.*, Thomas Leffler, *Solar-powered Fla. town survived Hurricane Ian -- with lights on*, United Press International, Inc. (3 Nov. 2022, 10:55 AM), https://www.upi.com/Top_News/US/2022/11/03/Hurricane-Ian-solar-power-Florida-Babcock-Ranch/5921667486567/. One of the on-going debates within the renewables community is whether to encourage discussion of "long distance" transmission lines or instead incentivize the development of microgrids to serve local communities. *See, e.g.*, Steve Hanley, *Macrogrids Or Microgrids: Which Is The Key To The Renewable Energy Revolution?*, CleanTechnica (19 June 2020), https://cleantechnica.com/2020/06/19/macrogrids-or-microgrids-which-is-the-key-to-the-renewable-energy-revolution/.

5. As discussed below, the IRA contains numerous incentives for the development of electric vehicles (EVs) and EV charging stations. Those incentives should accelerate the adoption of the use of EVs and installation of EV charging stations, particularly in commercial and industrial facilities, such as ports.

6. Florida's ports generate an economic impact of $117.6 billion and support 900,000 jobs. *See* Governor's Press Office, *Governor DeSantis Announces $250 Million to Support Economic Recovery for Florida Ports*, Florida Department of Transportation (29 Jul. 2021), https://www.fdot.gov/info/co/news/2021/07292021-gov.

7. The concept of "climate change" is highly politicized as are the words themselves. This article does not address the continuing debate regarding the causes and consequences of climate change but instead addresses steps being taken by government and industry, both in a legal and commercial context, related to climate change.

8. The World Bank in 2022 contended that the shipping industry was the sixth-largest contributor to greenhouse gas emissions (GHGs) between Japan and Germany. Tell Me How, *Decarbonized Shipping: Reducing the Dependence on Fossil Fuels*, The World Bank (16 March 2022), https://www.worldbank.org/en/news/podcast/2022/03/16/decarbonized-shipping-reducing-the-dependence-on-fossil-fuels.

9. International Maritime Organization, *IMO 2020 – cutting sulphur oxide emissions*, https://www.imo.org/en/MediaCentre/HotTopics/Pages/Sulphur-2020.aspx (last visited 7 Nov. 2022).

10. I*d.*

11. *Id.*

12. Exhaust gas cleaning systems, commonly referred to as scrubbers, take three forms: open-loop, closed-loop, and hybrid. *See* LiqTech, *Open-Loop vs. Closed-Loop Scrubbers*, https://liqtech.com/water-treatment-solutions/marine-filtration/marine-scrubber-water-treatment-system/open-loop-vs-closed-loop-scrubbers/ (last visited 22 Nov. 2022).

13. LNG, sometimes referred to as a transition fuel, is typically discussed as a leading contender to reduce emissions and as a less polluting alternative to coal, heavy fuel oil, and diesel.

14. Prapisala Thepsithar et al., *Singapore study highlights role and challenges of bio-LNG as future bunker fuel for shipping sector*, Manifold Times (7 June 2021), https://www.manifoldtimes.com/news/singapore-study-highlights-role-and-challenges-of-bio-lng-as-future-bunker-fuel-for-shipping-sector/#:~:text=Bio-LNG%20can%20be%20used%20as%20an%20alternative%20marine,fuel%20to%20facilitate%20further%20reduction%20of%20GHG%20emissions.

15. *Id.*

16. Tim Wilson, *Does biodiesel have a place in the marine fuel purchasing portfolio?*, Lloyd's Register (4 Jan. 2021), https://www.lr.org/en/insights/articles/biodiesel-marine-fuel-purchasing-portfolio/.

17. Bureau Veritas, *Developing Ammonia: The Marine Approach to a Zero-Carbon Fuel*, https://marine-offshore.bureauveritas.com/developing-ammonia-marine-approach-zero-carbon-fuel (last visited 11 Nov. 2022).

18. *Marine Fuel*, Methanol Institute, https://www.methanol.org/marine-fuel/ (last visited 11 Nov. 2022).

19. The Editorial Team, *Understanding the potential of Hydrogen as a marine fuel*, SAFETY4SEA (4 Feb. 2021), https://safety4sea.com/understanding-the-potential-of-hydrogen-as-a-marine-fuel/.

20. *2021 Sustainability Report*, Carnival Corporation & PLC, https://carnival-sustainability-2022.nyc3.digitaloceanspaces.com/assets/content/pdf/FY-2021-Sustainability-Report_Carnival-Corporation-and-plc.pdf (last visited 11 Nov. 2022); *2021 Sustainability Report*, MSC Mediterranean Shipping Company, S.A., https://www.msccargo.cn/en/sustainability (last visited 11 Nov. 2022). In 2021, Maersk invested in 13 green methanol-enabled ships. *See 2021 Sustainability Report*, Maersk, https://www.maersk.com/sustainability/reports-and-resources (click "Sustainability Report 2021" hyperlink) (last visited 11 Nov. 2022). In the same report, Maersk also stated that it prefers not to invest in transitional fuels, including LNG, and instead plans to "leapfrog" directly to fuels that have significantly larger greenhouse gas reduction potential.

21. Rosie Spinks, *The Cruise Industry Will Soon Face Its Strictest Pollution Standard Yet: Can Anyone Enforce It?*, Skift (31 Oct. 2019, 2:30 AM EDT), https://skift.com/2019/10/31/the-cruise-industry-will-soon-face-its-strictest-pollution-standard-yet-can-anyone-enforce-it/.

22. *Id.*

23. In the Mediterranean, Malta is a prominent hub for the shipping industry. Malta's Subsidiary Legislation 545.18, last amended in 2022, governs the quality of fuels. Leġiżlazzjoni Malta [Maltese Legislation] S.L. 545.18 (Malta).

24. Bermuda Merchant Shipping (Prevention of Air Pollution From Ships) Regulations, 2019 (BR 106/2019) (Berm.).

25. Bermuda Merchant Shipping (Prevention of Air Pollution From Ships) Amendment Regulations, 2019 (BR 15/2019) (Berm.).

26. Raunek, *Top 10 Largest Flag States in the Shipping Industry*, Marine Insight (6 Apr. 2022), https://www.marineinsight.com/maritime-law/top-10-largest-flag-states-in-the-shipping-industry/.

27. The Bahamas Mar. Auth., Information Bulletin No. 183 (7 Nov. 2022), https://www.bahamasmaritime.com/wp-content/uploads/2020/10/BMA-Bulletin-183-Marpol-Annex-VI-%E2%80%93-Global-Fuel-Oil-Sulphur-Limit.pdf.

28. *Id.*

29. *Id.*

30. At least 30 countries, including Bermuda, Norway, Singapore, and the United States, have prohibited open-loop scrubbers. *See* LiqTech, *Where Are Open-Loop Scrubbers Banned?*, https://liqtech.com/water-treatment-solutions/marine-filtration/marine-scrubber-water-treatment-system/where-are-open-loop-scrubbers-banned/ (last visited 22 Nov. 2022). Wash water from open-loop scrubbers is more acidic than natural seawater and contains gaseous and particulate emissions. This water is discharged into the ocean. *See* LiqTech, *Open-Loop vs. Closed-Loop Scrubbers*, https://liqtech.com/water-treatment-solutions/marine-filtration/marine-scrubber-water-treatment-system/open-loop-vs-closed-loop-scrubbers/ (last visited 22 Nov. 2022).

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