THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION

Practical Steps Toward a Carbon-Free Maritime Industry: Updates on Fuels, Ports, and Technology

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Written testimony

My name is Dan Rutherford. I'm the program director for shipping and aviation at the International Council on Clean Transportation. The ICCT is an independent, non-profit research organization headquartered in Washington DC, with offices in San Francisco, Berlin, Beijing, and São Paulo. ICCT employs a team of over one hundred transportation experts that advise policymakers on how to improve the environmental performance of the transport sector.

I appreciate the opportunity to testify today on behalf of the ICCT. Maritime shipping is a cornerstone of our modern economy, but it comes with impacts. Air pollution from shipping is linked to at least 64,000 premature deaths per year globally[1], with underprivileged and minority communities living near ports feeling the brunt of that impact. In 2018, global shipping emitting about a gigatonne of carbon dioxide (CO_2), or more than the German and Dutch economies combined.[2] Much work lies ahead if the sector is to meet the United Nations' goal of cutting GHG emissions from international shipping by at least 50% from 2008 levels by 2050.[3]

To meet this goal, we'll need zero emission deep sea ships on the water by no later than 2030. Key technologies include battery electric ships for near-port operations and short sea shipping; hydrogen, which in pressured or cryogenic form can power fuel cells that are already available and scalable; and ammonia, which is gaining attention as an easy-to-store hydrogen carrier. These fuels can be generated from abundant renewable electricity with a negligible climate footprint.

Today, we're already seeing fully battery electric and fuel cell zero-emission vessels, especially ferries and barges on short, dedicated routes (Figure 1). Infrastructure investments for fast charging for battery electric ships can also support shore power to reduce at-port air pollution. We expect full-sized, deep-sea zero-emission vessels running on hydrogen fuel cells or burning renewable ammonia to be possible as soon as 2030. Hybrid or fully zero-emission regional cargo ships will be available even sooner.

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[1] Sofiev et al., 2018.
[2] Faber et al., 2020; Crippa et al., 2019.
[3] Rutherford & Comer, 2018.

Technologies like wind-assisted propulsion and hull air lubrication will help reduce energy use and make zero carbon fuels more competitive.[4]

A word of caution: biofuels and liquefied natural gas (LNG) are being used now, but neither is a reliable bridge to zero-emission vessels. Sustainable biofuel supply is limited, in demand by a variety of sectors, must be generated from waste, and not result in deforestation in order to be sustainable.[5] LNG produces about 25% less CO_2 when combusted but, due to methane leaks upstream during the production of LNG and downstream from the engine itself, LNG is often worse for the climate than conventional fuels after accounting for its full life-cycle emissions (Figure 2).[6]

The coming transition to zero emission shipping can be a win for the US economy, the environment, and human health. Zero-emission vessels (ZEVs) eliminate air pollution from the ships themselves, easing the health burdens of coastal and near-port communities. ZEVs avoid the water pollution generated by ships that use sulfur scrubbers. They're also quieter. And zero-emission vessels will unlock new careers to develop advanced engines, fuel cells, batteries, and fuels.

The production and sale of zero emission marine fuels in particular is a major opportunity for US businesses. Today, the largest vessels visiting US ports are often fuelled abroad, not here at home (Figure 3). Producing zero emission marine fuels like electricity, hydrogen, and ammonia domestically will provide new economic opportunities for Americans (Figure 4) while protecting vulnerable near-port communities.

So, what actions can the US government take to support the ZEV transition? First, we need substantial investments to develop and deploy zero-emission vessels and fuels, along with supporting port electrification and infrastructure. US flagged "Jones Act" vessels, which operate shorter routes between regular ports, can be used to demonstrate and mature the technologies we'll need for deep sea ZEVs.

Second, the US should work with key trading partners, including Canada, Mexico, the EU, and China, to establish zero-emission vessel corridors and the associated infrastructure. Finally, the US should lead in negotiating ambitious international standards for larger ships at the International Maritime Organization. These actions can reduce climate and air pollution from shipping, improve the health and well-being of port communities, and help unlock new markets for zero-emission vessels and fuels.

Thank you for the opportunity to present today. I look forward to answering any questions the honorable members have for me.

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[4] Comer et al., 2019.
[5] Zhou et al., 2020.
[6] Pavlenko et al., 2020.

Supplemental information

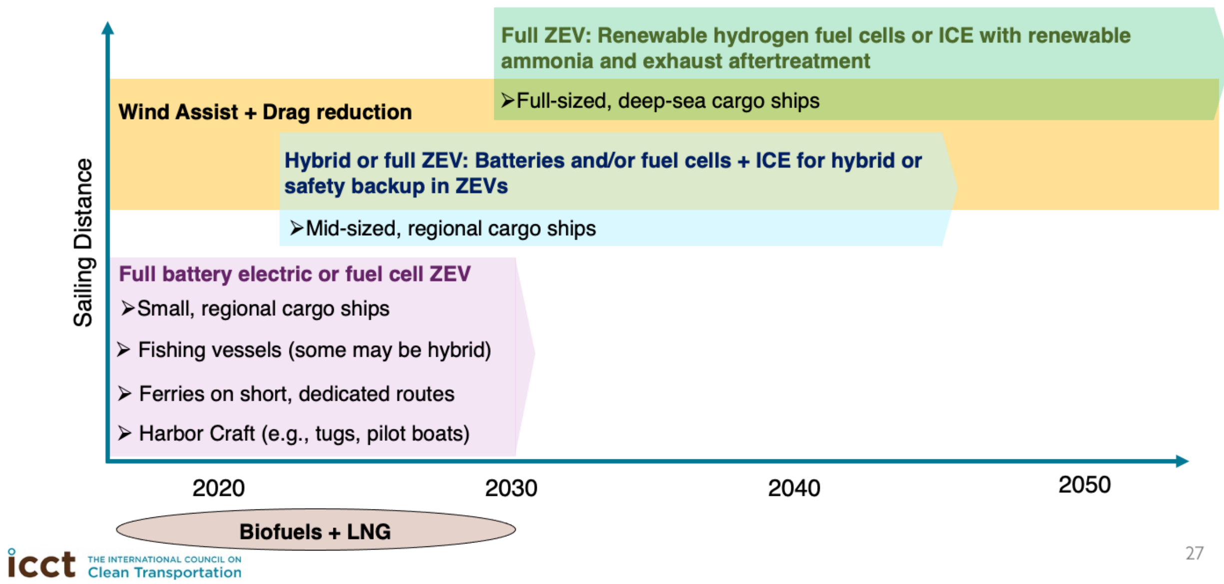

Figure 1: Technologies for zero emission shipping through 2050.

Principles for assessing alternative marine fuels

Flexible, technology-neutral standards set a level playing field for innovation and enable industry to find least-cost ways to reduce emissions. ICCT research has identified three key principles when evaluating fuels to support zero emission shipping:

1. **CO_2e not CO_2:** Some fuels and energy sources are zero-CO_2, but not zero CO_2 equivalents (CO_2e). For example, burning ammonia (NH_3) in a marine engine will emit zero CO_2, but could emit nitrous oxide (N_2O), which has a global warming potential about 300 times that of CO_2.

2. **GWP20 not solely GWP100:** Reducing pollutants with high 20-year global warming potential (GWP20), such as black carbon and methane, helps avoid additional near-term warming, which is essential for limiting warming to 1.5°C or well-below 2°C. GWP20 is a particularly useful metric for evaluating "bridge" fuels.

3. **Well-to-wake not tank-to-wake:** Consider the full life-cycle impacts of marine fuels and energy sources. Some fuels, such as hydrogen, are zero-emission when they are used, but they must be sourced from renewable energy, not fossil fuels, to be truly zero-emission.

Collectively, these three principles highlight that LNG is unlikely to be a suitable future fuel for shipping. LNG is mostly methane, a potent GHG that traps 86 to 87 times more heat in the atmosphere than the same amount of CO_2 over a 20-year time period. Methane leakage during extraction, processing and transport, and methane slip when burned, means that using LNG is often worse for the climate than conventional fuels, particularly over shorter timescales. For example, the most popular LNG engine technology today emits up to 70% more lifecycle GHGs (20-year GWP) than the cleanest oil-based fuel (marine gas oil, MGO), as shown in Figure 2.[7]

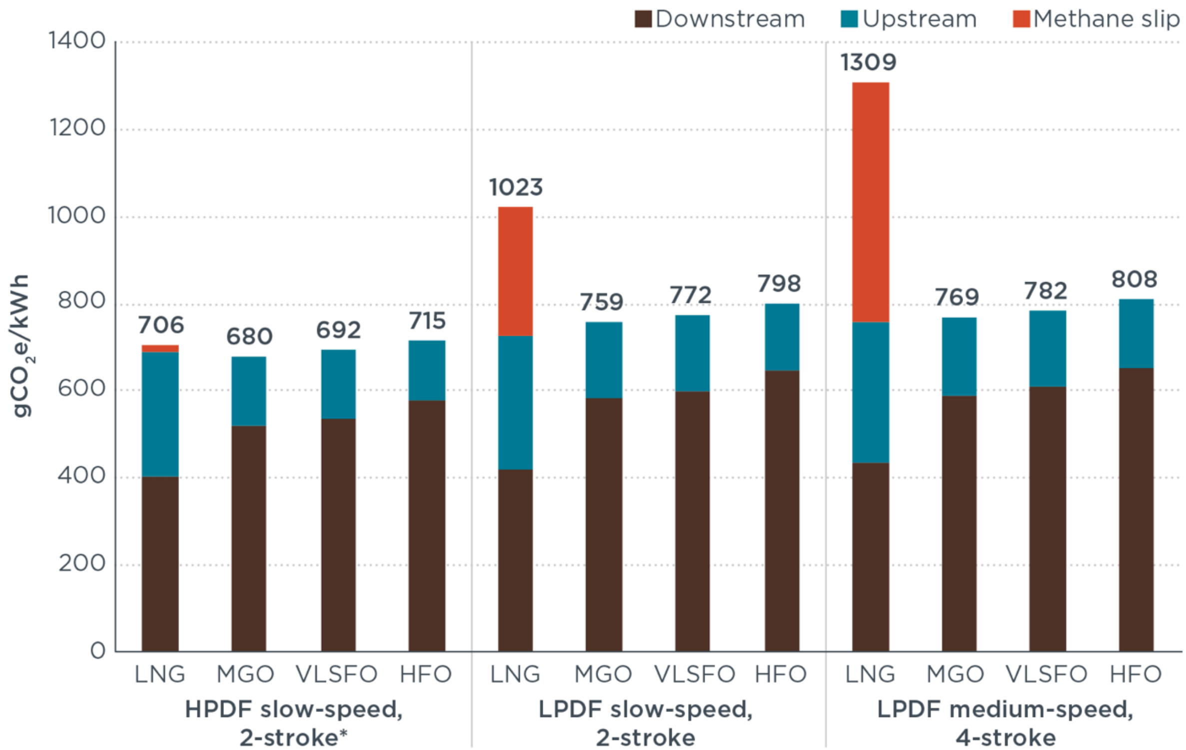

Figure 2: Lifecycle GHG emissions by engine and fuel type, 20-year GWP

Centralized vs. distributed marine fuel production

The largest oceangoing vessels can operate up to 50,000 miles, enough to circumnavigate the Earth twice, before refueling. As a result, the current centralized fossil fuel bunkering system means that a relatively small number of ports, mostly foreign, dominate global marine bunker fuel sales (Figure 3). This is particularly true for Pacific bunker fuel sales, which are dominated by Asian ports.

[7] Pavlenko et al., 2020.

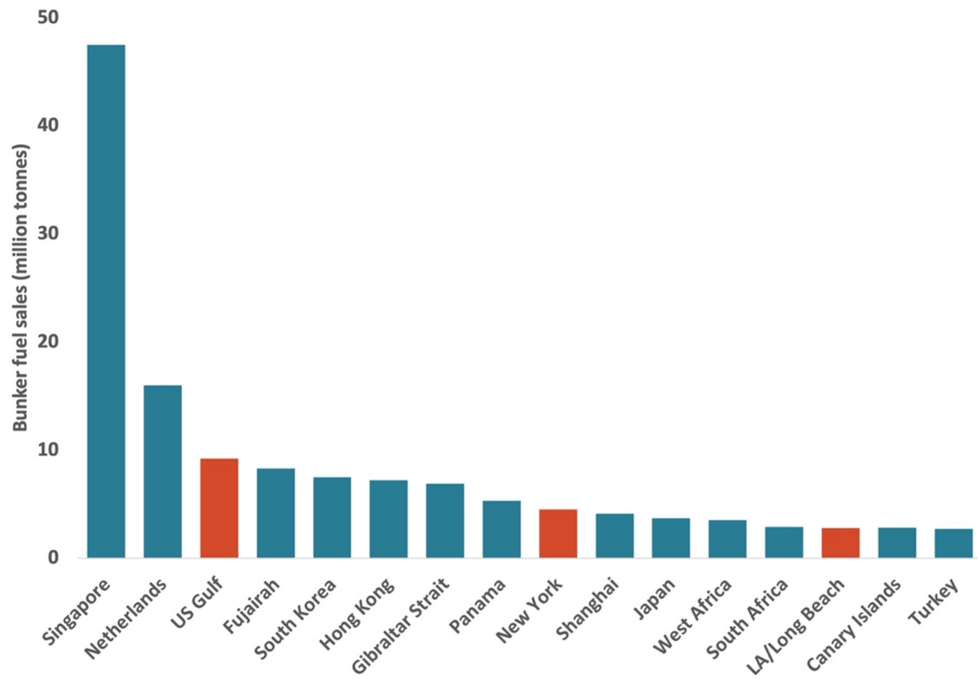

Figure 3: Marine bunker fuel sales in 16 busiest ports, 2019 (Source: Ship & Bunker)

In contrast, zero emission marine fuels like hydrogen and ammonia can be generated widely and, because of their lower energy density, are more likely to be sold and used near where they are produced. This is particularly true of renewable hydrogen. When my colleagues and I analyzed the potential for zero emission transpacific container shipping, we found that shifting to liquid hydrogen could generate substantial new refueling demand at U.S. ports, particularly in Southern California. Furthermore, our work highlighted the potential for Aleutian Islands ports to serve as a new refueling stop between Asia and the West Coast of the United States if hydrogen refueling infrastructure is built there (Figure 4).[8]

[8] Georgeff et al., 2020.

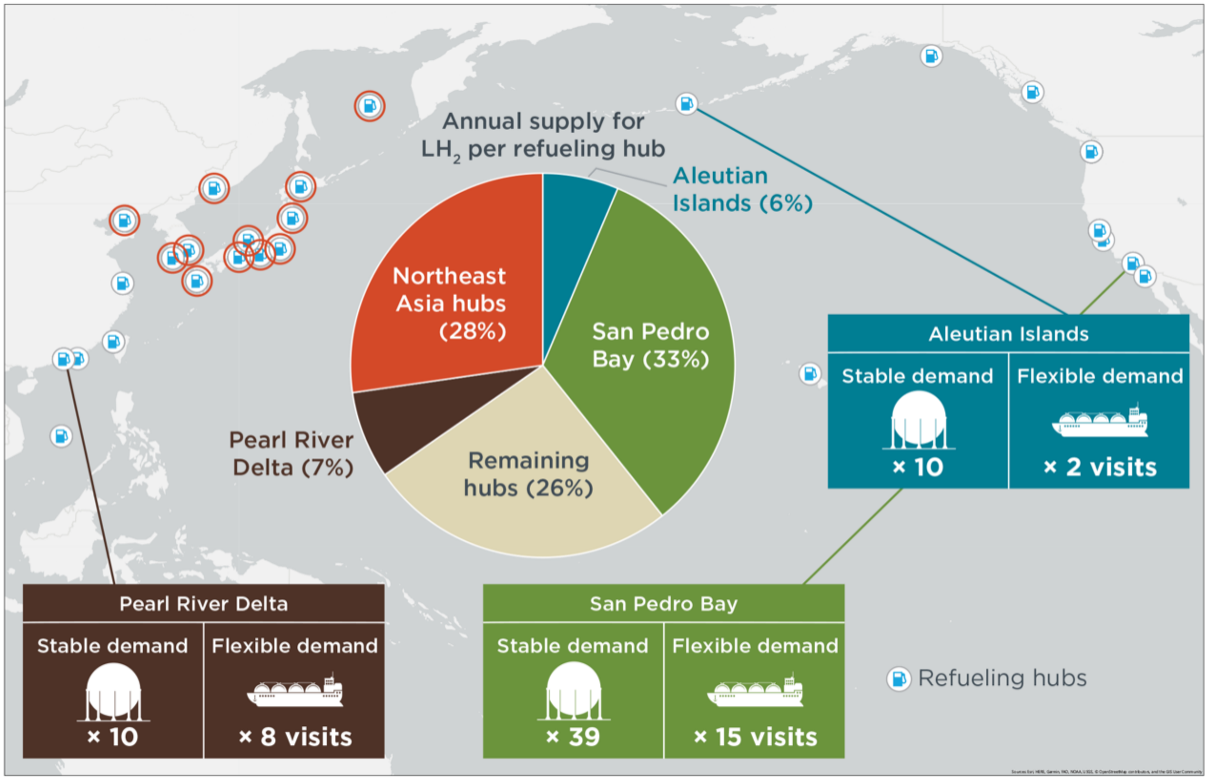

Figure 4: Hydrogen demand and refueling infrastructure for transpacific container ships.

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