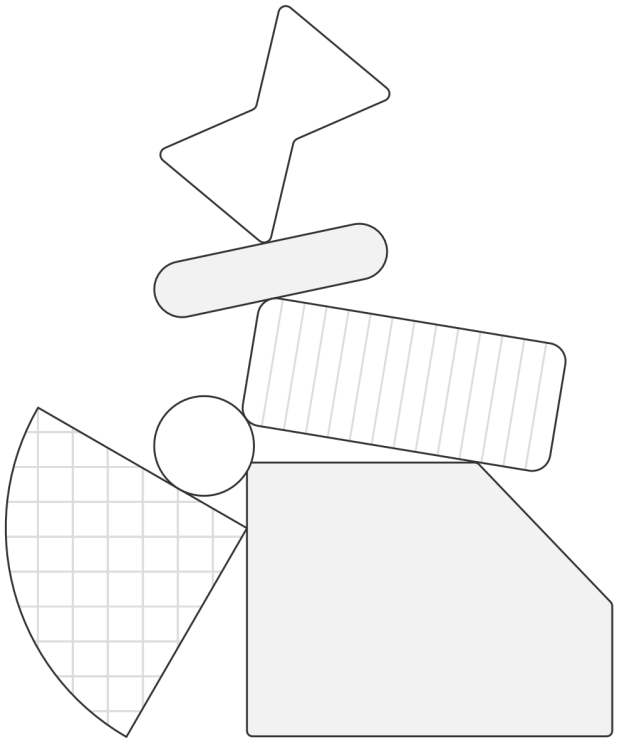
Showing the world it is possible

Impact Report 2023/2024

Mærsk Mc-Kinney Møller Center
for Zero Carbon Shipping

Success stories



Showing the world it's possible

By Bo Cerup-Simonsen, CEO

Shipping is a testament to human ingenuity – it's a global system of over 100,000 commercial vessels that embodies effective, reliable, global collaboration.[1] The global maritime industry is the backbone of over 80% of international trade and we will continue to depend on shipping for a connected world and future growth. [2] However, something must change to take shipping more sustainably into the next centuries of trade.

The global commercial fleet consumes around 300 million tonnes of fossil fuels every year, making the shipping sector account for around 3% of global greenhouse gas emissions. Curtailing maritime emissions requires a transition to more sustainable practices – including adoption of new technologies, unprecedented investments, and firm regulatory support across multiple industries in the maritime ecosystem. The industry is already taking important early steps. However, keeping the well-to-wake net-zero target within reach by 2050 requires further maturation, scaling, and acceleration of transformation activities.

> "Something must change to take shipping more sustainably into the next centuries of trade."

The Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping (MMMCZCS) was established in 2020 with a mission to be an independent and significant not-for-profit driver of sustainable maritime decarbonization. With our extensive partner network, and in coordination with other leading stakeholders

[1] https://www.weforum.org/stories/2021/10/global-shortagof-shipping-containers/
[2] https://unctad.org/publication/review-maritime-transport-2021

in the maritime ecosystem, we generate and freely disseminate knowledge and encourage public and private sectors to act.

Our unique capacity for generating impact within the maritime sector rests on our credibility as a source of decarbonization knowledge, insights, and guidance. Our unique features include:

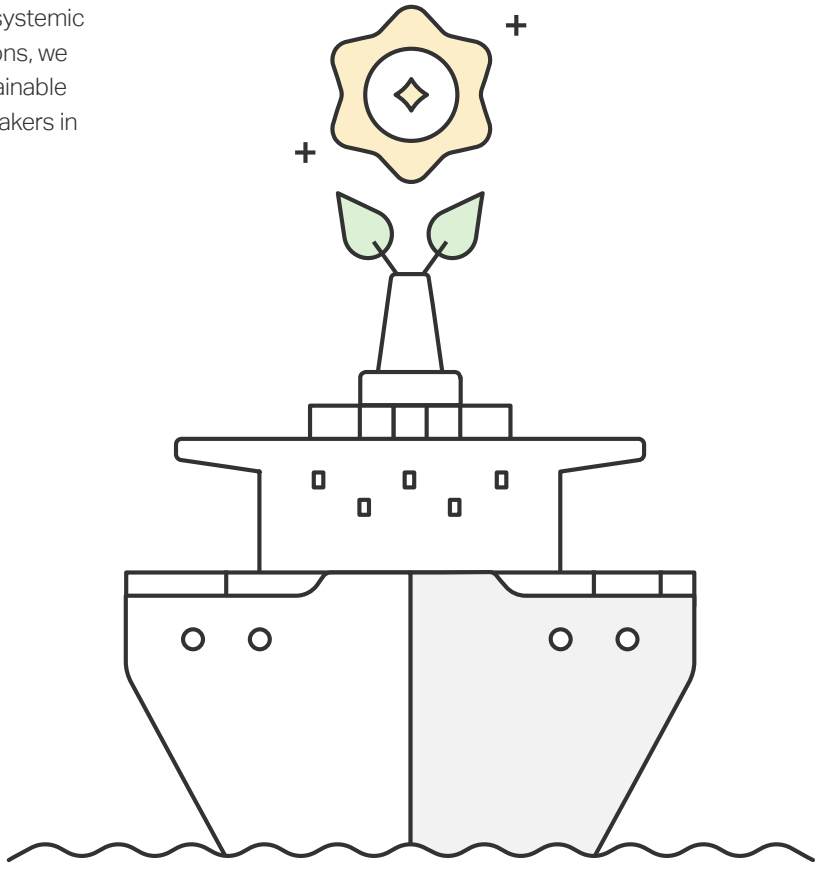
- Expertise: We apply multi-disciplinarity and develop science-based evidence and methods when building the case for decarbonization action.
- Objectivity: We operate independently of any government or industry interests and provide unbiased recommendations for decarbonization for the greater good.
- Reputation: Our independence, the quality of our work, and our strong partnerships with respected entities position us as a valued and trusted advisor to key stakeholders.

The Center has achieved support from partners across the ecosystem and has become a collaboration platform for the needed industry transition. We apply our deep technical knowledge to cross-disciplinary development of policies, business frameworks, concrete concepts and standards, and other necessary building blocks for decarbonization. By combining an overarching systemic view on transition pathways with tangible solutions, we enable industry-wide adoption of scalable, sustainable solutions in close collaboration with decision-makers in public and private sectors.

This report provides examples of the Center's impact and progress over the past two years. Key activity data provides a transparent view of Center performance, while a set of case success stories showcases our approach and ways of working. It is not easy to capture and describe the full depth and complexity of everything we have accomplished in one report, but we hope it will inspire readers to visit our website www.zerocarbonshipping.com for more information, or to reach out to us on info@zeroarbonshipping.com to engage a conversation on the topic of relevance.

We look forward to hearing from you,

Bo Cerup-Simonsen.



What will it take to decarbonize the maritime industry?

Mærsk Mc-Kinney Møller Center
for Zero Carbon Shipping

The global maritime industry's goal to reach net-zero GHG emissions by or before 2050 is an ambitious yet necessary goal to avoid a global temperature increase beyond 1.5°C above pre-industrial levels.[3] The details and precise timing of this transition, however, could follow several different scenarios. In the Center's annual Maritime Transition Compass analysis (Figure 1), we examine the present status of specific transition drivers and the relationships among them. In this way, the Maritime Transition Compass highlights the short and long-term gaps to show what is needed to progress maritime decarbonization.

From where we stand today, maritime stakeholders need to act now to ensure that the following target outcomes across four key drivers are in place by the mid-2030s:

Regulation and policy

Enforceable regulations and policies adequately incentivize the transition from economic, technical, and safety perspectives.

Technology & infrastructure

Vessel and engine technologies are compatible with decarbonization solutions – including energy efficiency levers – and available at scale. Sufficient port and fuel bunker infrastructure is available to support the use of sustainable maritime fuels and sustainable energy, and alternative fuels are available in sufficient quantities.

Market

A strong end-customer pull exists for green/decarbonized offerings, and funding and financing mechanisms exist to drive development and uptake of decarbonization solutions.

Adoption

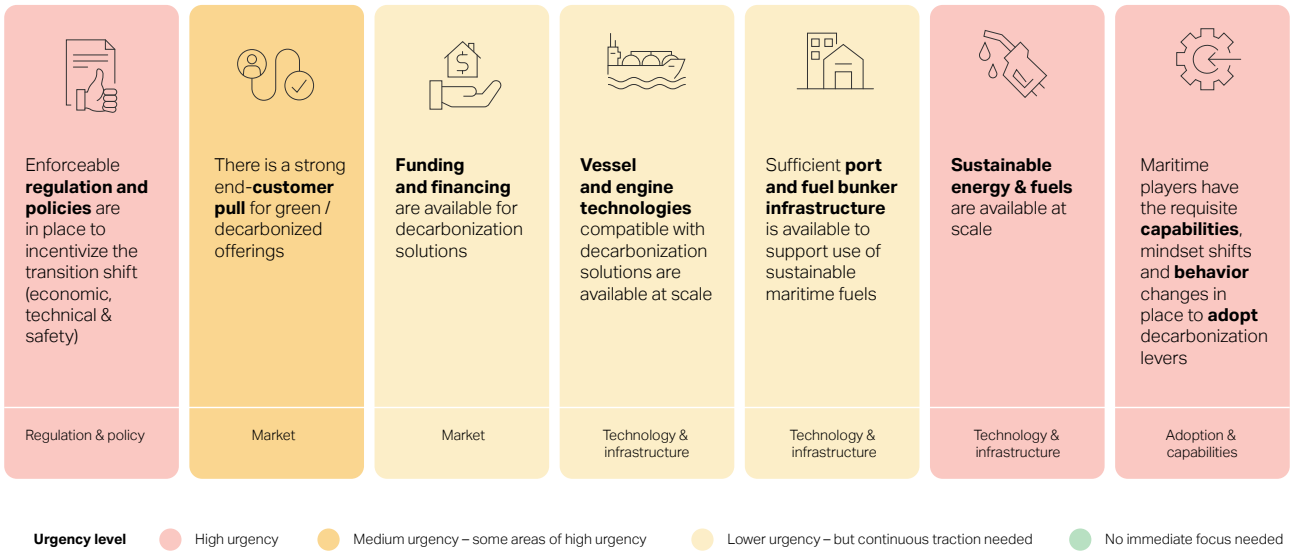
Maritime players have the capabilities and mindset needed to adopt decarbonization solutions at scale.

Results from the Maritime Transition Compass and input from partners and key industry stakeholders inform our work programs to ensure we always address the most urgent challenges, and leverage the Center's unique capabilities for maximum impact and acceleration of the transition.

During 2025, the Maritime Transition Compass will be made available to the public on the Center's website, allowing everyone to obtain guidance from the Center's assessment of transition progress and relevant next steps.

[3] https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/annex/MEPC%2080/Annex%2015.pdf

Figure 1: Transition drivers and urgency according to the Center's 2024 Maritime Transition Compass analysis.



Our work programs

The Center's four multi-disciplinary work programs aim to accelerate progress across a strategic selection of the transition drivers.

Reduce Fleet Energy Demand

It will be challenging to achieve zero-carbon shipping if the industry's energy demand continues to grow. Building on the technical knowledge base of the Center and our partners, projects within the "Reduce Fleet Energy Demand" program develop operational, commercial, and regulatory measures to reduce energy consumption in shipping. We focus on aligning industry incentives to reduce energy demand, helping stakeholders to realize available financial savings and creating favorable conditions for the necessary behavior changes.

Transform the Energy System

The energy that drives maritime transportation is currently supplied largely by burning conventional fossil-based fuels. To reach net-zero emissions, industry needs to replace these fuels with sustainable forms of energy. To support this transition, our "Transform the Energy System" program focuses on producing and activating knowledge to address energy production roadblocks and opportunities, and to build confidence in both the operational and technological fleet solutions needed for decarbonization at scale.

Catalyze Ecosystem Transition

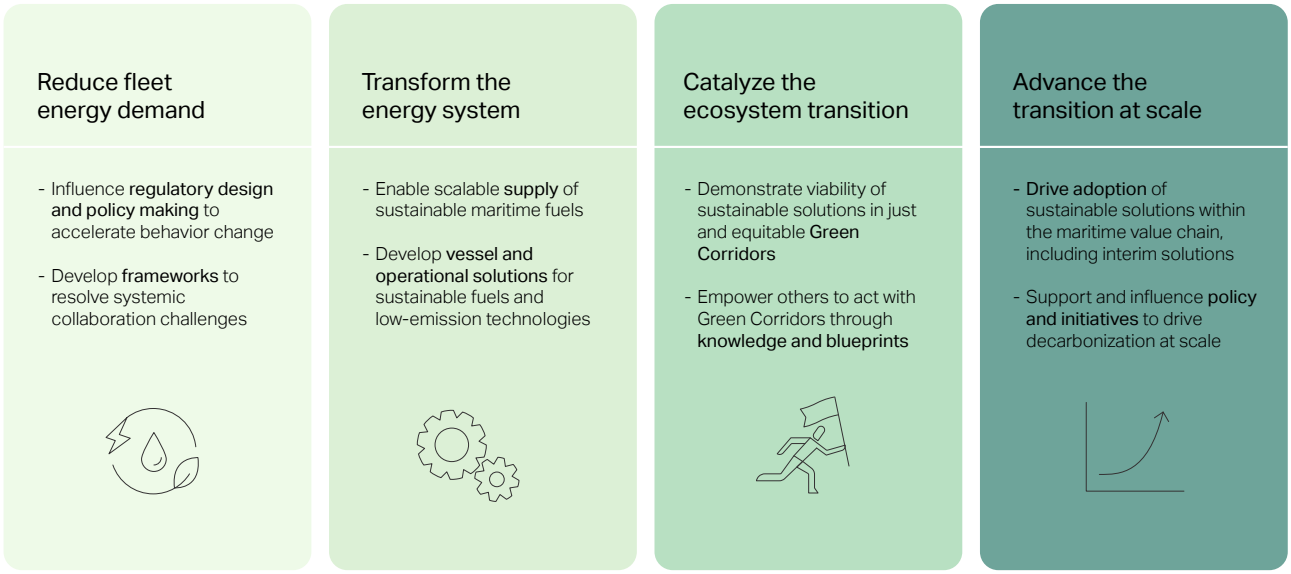
We use green shipping corridors as a demonstration concept to accelerate sustainable deployment of alternative fuels by first movers. Green corridor projects provide the knowledge needed for replication elsewhere in the ecosystem. While each green corridor represents a fraction of global emissions, the overall goal of this program is to demonstrate feasibility and best practices in zero-carbon shipping. In doing so, we inspire an increasing number of actors to establish their own green corridors together with relevant stakeholders.

Advance the Transition at Scale

Demonstration projects can help get the ball rolling, but we also need to ensure that decarbonization scales across the maritime sector. Our "Advance the Transition at Scale" program targets solutions that will drive widespread adoption of decarbonization initiatives by identifying the most impactful global initiatives and by influencing authorities and commercial stakeholders. This program works to jump-start an industry paradigm shift and pave the way to a sustainable maritime value chain.

It's important to note that the Center itself does not develop new technologies, build vessels, produce any fuels, or enforce regulations. Instead, we work as an accelerator of a maritime green transition that heavily depends on the actions of the thousands of stakeholders involved. In everything we do, therefore, we seek to inform and mobilize those who hold the mandate to act, invest, adopt, and demonstrate real climate action.

Figure 2: Center work programs.



Our Partners

A systemic transition requires collective action – no single player can do this alone. At the Center, we acknowledge that new alliances and cross-sectoral collaboration will be fundamental to the successful decarbonization of the maritime industry.

Our partners number over 100 companies and organizations from across the maritime value chain. Collectively, they represent the enablers of the maritime transition needed to holistically address drivers and gaps highlighted by our Maritime Transition Compass.

Figure 3: Center partners are divided into four categories: Strategic, Knowledge, Academic Partners, and Mission Ambassadors.

23 Strategic Partners

ABS, Maersk, Cargill, CF, Mitsui & Co., bp, Mitsubishi Heavy Industries, Ltd., DP World, Siemens Energy, Norden, John Swire & Sons, TotalEnergies, MAN Energy Solutions Future in the making, Sumitomo Corporation, NYK Line, seaspan, Rio Tinto, Hapag-Lloyd, Royal Caribbean Group, Alfa Laval, Stolt Tankers, equinor

17 Knowledge Partners

RystadEnergy, Danish Maritime Authority, sea, Maritime and Coastguard Agency, HUR Ocean Centre for the Fourth Industrial Revolution, A&O Shearman, McKinsey & Company, Breakthrough Energy, DanishShipping, The Royal Institution of Naval Architects, Global Maritime Forum, ecoinvent, BCG Boston Consulting Group, Global Centre for Maritime Decarbonisation, Environmental Defense Fund, Gorrissen Federspiel, SSI Sustainable Shipping Initiative

4 Academic Partners

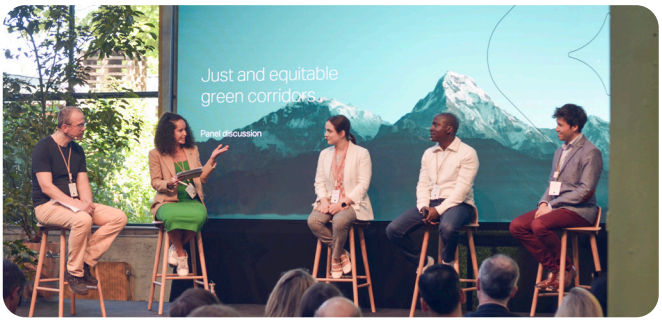
University of Michigan
Maritime Research Alliance
NTNU Norwegian University of Science and Technology
WMU World Maritime University

66 Mission Ambassadors

GSBN
CIP Copenhagen Infrastructure Partners
Carnival Corporation & PLC
Bernhard Schulte
TEN Technip Energies
msc
NavigareCapital
TOPSOE
Woodside Energy
MONJASA
Swire Shipping
MPC Container Ships
Bibby Marine Services
FEDNAV
FUGRO
HD
BELLONA
TORM
TUFTON
novonesis
KONGSBERG
OLDENDORFF
Ultranav
Bunker Holding Group
Ørsted
Höegh Autoliners
Meyer Werft Papenburg 1795
vtti
TSUNEISHI
Blue Sky Maritime Coalition
ABB
STX
Minerva Gas Inc.
Zero North
Wallenius Wilhelmsen
Eagle Bulk
GTT Technology for a sustainable world
Navigator Gas
gard
X-Press Feeders
Wärtsilä
IMCA
A.P. Møller Capital
Anglo-Eastern
S&P Global
Port of Gothenburg
methanex the power of agility
Daihatsu
HIF
World Shipping Council
Oshima
Dorian LPG
Norwegian Hydrogen
Intermar In the Shipping Business since 1960
Skuld
Jotun
Hero Future Energies planet positive power
ClassNK
subsea 7
E&S Tankers
Canal de Panamá
DFDS
Vopak
Hempel
IWSA International Windship Association
Acceleron

The Center's collaborative nature is clearly reflected in an open-sharing partner model, where partner companies second employees to the Center's office in Copenhagen. Here, the secondees work side by side across companies to develop solutions that will benefit the entire industry. This model is unique to the Center and truly shows each partner's dedication and desire to make a difference, not only to their own company but to the entire industry.

Four years after establishing the Center, we have a strong network of dedicated partners spanning geographies, competencies, sectors, and segments that all share the same mission: to show the world that it really is possible to decarbonize the maritime industry by 2050.



How we select projects

Strategic fit: Everything we do aims to close an identified transition gap or accelerate the pace of transition

Center uniqueness: We focus our work where we can leverage our credibility, expertise, and objectivity

Advocacy effect: Our work seeks to inform and inspire influential decision-makers with the power to act to accelerate the transition

Figure 4: Maritime ecosystem.

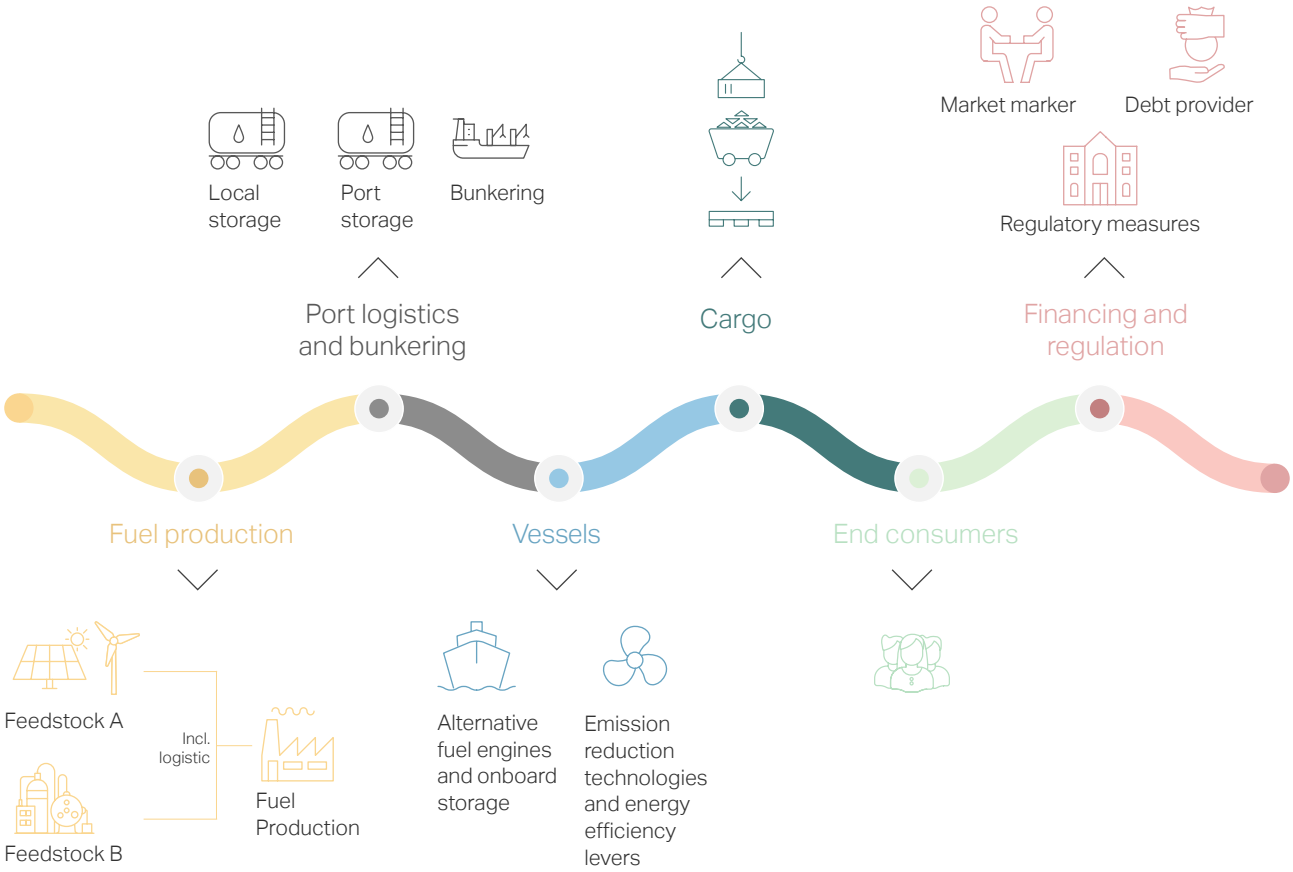


Figure 5: Center impact is exemplified in seven case stories covering all selected, strategic areas in our work programs.

Turning new technologies into reality
The Center contributes to fleet renewal by proposing novel vessel designs and retrofitting guidance that integrate innovative solutions and new technologies.

Reduce Fleet Energy Demand

Demonstrating what the maritime future could look like
The Center has developed a framework that provides a systematic, structured, and phased approach to establishing green shipping corridors around the world

Catalyze Ecosystem Transition

Fueling the transition with trustworthy data and insights
The Center's work rests on a solid foundation of industry data and knowledge provided by our partners, our subject matter experts, and other credible sources

Science-driven and data-based approach

Transform the Energy System

Enabling ammonia as a marine fuel
The Center works across disciplines to address critical safety risks and support the qualification of low-carbon ammonia as an alternative maritime fuel.

Enabling an alternative fuel market
The Center has developed a methodology for making lifecycle assessments (LCA) of marine fuels.

Advance Transition at Scale

"No transition without regulation"
The Center actively participates in the processes of shaping new regulation and policies.

Offering the willing an opportunity to move faster
The Center and US-based thinktank RMI have launched Katalist, a book and claim platform for shipping.

Ship design

Turning new technologies into reality

Mærsk Mc-Kinney Møller Center
for Zero Carbon Shipping

Figure 6: NoGAPS – Nordic Green Ammonia Powered Ships (gas carrier/illustrative).

The average life span of a commercial vessel is between 25 and 30 years, meaning that ships built today will still be sailing in 2050, when we need the fleet to be fully decarbonized. Yet, the current newbuilding order book indicates that 49% of the vessels on order will be built with engines that run solely on conventional fossil fuels.[4]

This calls for:

1. New ship designs that are energy efficient and ready to adopt alternative marine fuels as they mature and become more widely accepted and available.
2. Retrofitting fossil-fueled vessels so they can run on alternative marine fuels.

The Center contributes to fleet renewal by proposing novel vessel designs and retrofitting guidance that integrate innovative solutions and new technologies. The knowledge obtained helps build confidence in new, alternative fuel types. It strengthens investment cases. It builds baselines for safety acceptance when considering new power sources. And it outlines the requirements for robust regulation.

During 2023 and 2024, we were involved in several exciting vessel design projects with a wide selection of partners. Most of these ship designs have received approval in principle (AiP) – the first approval step provided by shipping class societies.

All ship designs created by the Center are made publicly available to inform the dialogue between shipowners and shipyards looking to retrofit or build new ships. This is particularly helpful for small and mid-sized shipowners without the in-house expertise to develop such designs themselves.

Specific examples of Center ship design projects:

Overview of **concept designs** that have received AiP:

- NoGAPS – Nordic Green Ammonia Powered Ships (gas carrier)
- 15,000 TEU ammonia-fueled container vessel
- Ammonia-fueled container feeder vessel
- Preparation design of conversion of a tanker vessel to green fuels

[4] https://www.dnv.com/maritime/publications/maritime-forecast/

Recommended reading on this topic:

1

Emerging Ship Design Principles for Ammonia-Fueled Vessels

Critical component in enabling an ammonia fuel pathway. Informed the creation of interim guidelines for ammonia ship design in the International Maritime Organization (IMO).

2

Tackling Methane Slip in Shipping

Increasing awareness around important requirements with equipment manufacturers and regulatory bodies to prevent methane slips onboard vessels

3

Nordic Green Ammonia Powered Ships (NoGAPS)

The NoGAPS project involves producing an initial ship design that will lay the foundation for a shipyard tender and the potential construction of the vessel.

Ammonia safety

Enabling the use of ammonia as a marine fuel

Mærsk Mc-Kinney Møller Center
for Zero Carbon Shipping

Center analysis confirms ammonia as a central part of the future alternative fuel mix for maritime. Ammonia is already one of the most produced chemicals in the world and widely transported as a commodity (fertilizer). However, the shift to using ammonia as a fuel aboard vessels introduces new challenges. Ammonia is highly toxic, and leaks are potentially lethal.[5] Addressing the safety challenges of ammonia as a marine fuel is, therefore, critical to realizing its potential to decarbonize shipping at scale.

The Center works across disciplines to address critical safety risks and support the qualification of ammonia as an alternative maritime fuel. Together with multiple partners, we have published designs for safe storage and usage of ammonia onboard vessels, as well as guidelines for bunkering of ammonia in ports, where the risk of leaks is substantial. Finally, we have addressed human factors related to safe operations aboard the vessel.

> "Addressing the safety challenges of ammonia as a marine fuel is, therefore, critical to realizing its potential to decarbonize shipping at scale."

Building on this work, the Center has contributed to the IMO's interim guidelines for the safety of ships using ammonia as fuel, which were approved by the IMO bodies in 2024.

In addition to publishing insights and guidance, the Center also gathers key enablers (ammonia producers, shipping companies, class societies, and other relevant players) for an annual ammonia safety roundtable. At the roundtable, stakeholders exchange the latest learnings, identify the challenges ahead, and initiate joint projects to further pave the way for the safe deployment of ammonia as fuel.

Finally, the Center also drives key industry projects that aim to demonstrate the safe use of ammonia as a marine fuel both on board vessels and when bunkering.

Areas where the Center contributes to enabling ammonia as a fuel:

- → Inherently safer design of ammonia-fueled vessels
- → Bunkering operations and demonstrators
- → Safe onboard operations
- → Competence and training of seafarer and shore personnel
- → Industry acceptance of ammonia fuel
- → Facilitating dialogue among leading enablers of ammonia as a fuel

[5] https://www.emsa.europa.eu/publications/item/5264-study-investigating-the-safety-of-ammonia-as-fuel-on-ships.html

Recommended reading on this topic:

1

Ammonia as a fuel – Competencies and training

Implementation of ammonia as a maritime fuel presents hazards such as toxicity, material incompatibility, and fire/explosion risks. Seafarers and others across the shipping industry will require new skills, competencies and training to manage the safety risks associated with ammonia as fuel.

2

Investigating Maritime Community Perceptions of Ammonia as a Marine Fuel

The survey covers responses from over 2,000 respondents across the maritime community who share their opinions, concerns, and suggested ways forward using ammonia as a marine fuel.

3

Recommendations for Design and Operation of Ammonia-Fueled Vessels Based on Multi-Disciplinary Risk Analysis

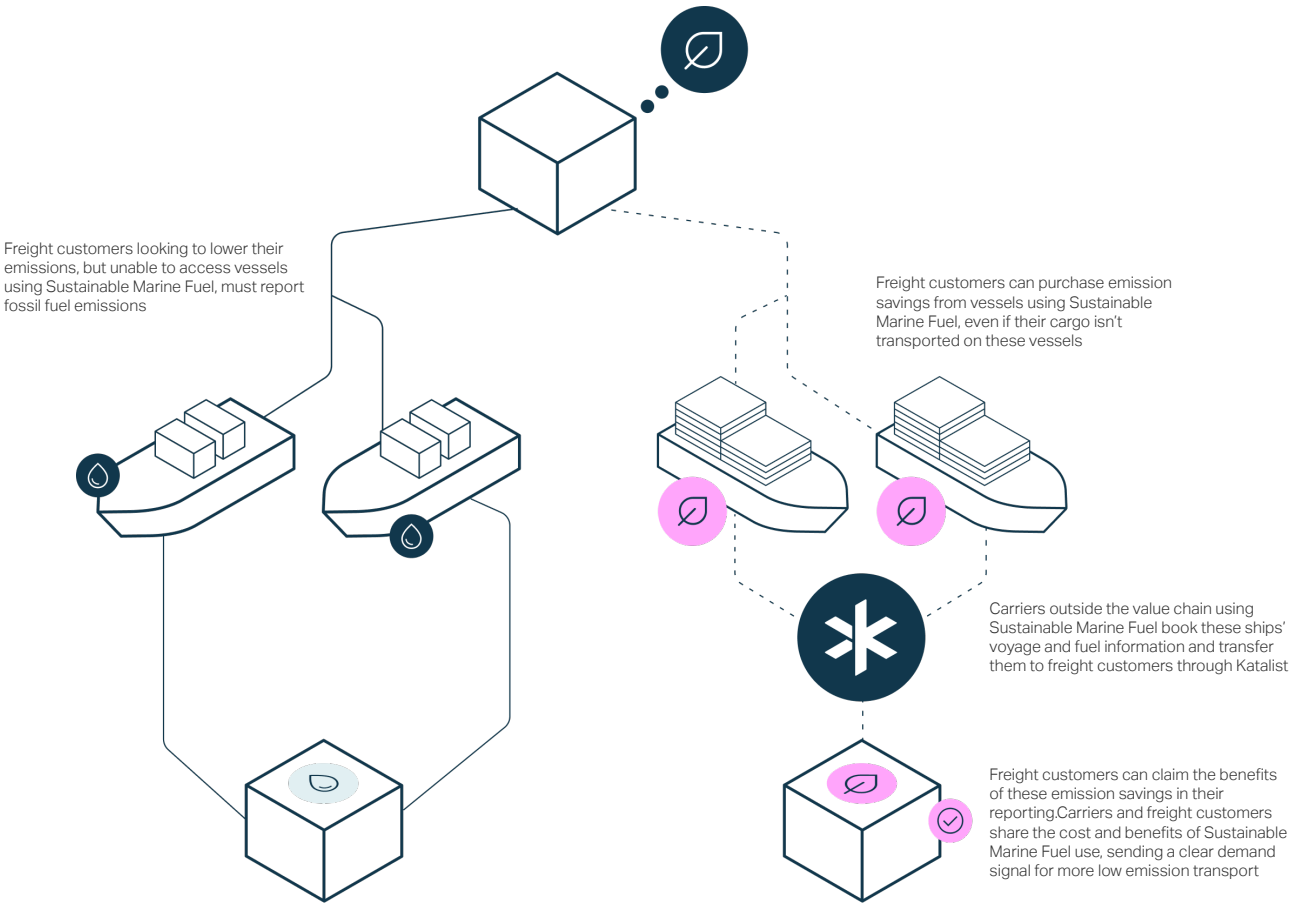
Mitigating risks to crew safety related to handling ammonia as fuel onboard is a key enabler of the ammonia fuel pathway.

Katalist – a book and claim platform for maritime

Offering the willing an opportunity to move faster

Mærsk Mc-Kinney Møller Center
for Zero Carbon Shipping

Figure 7: Katalist – a Maritime Book and Claim system.



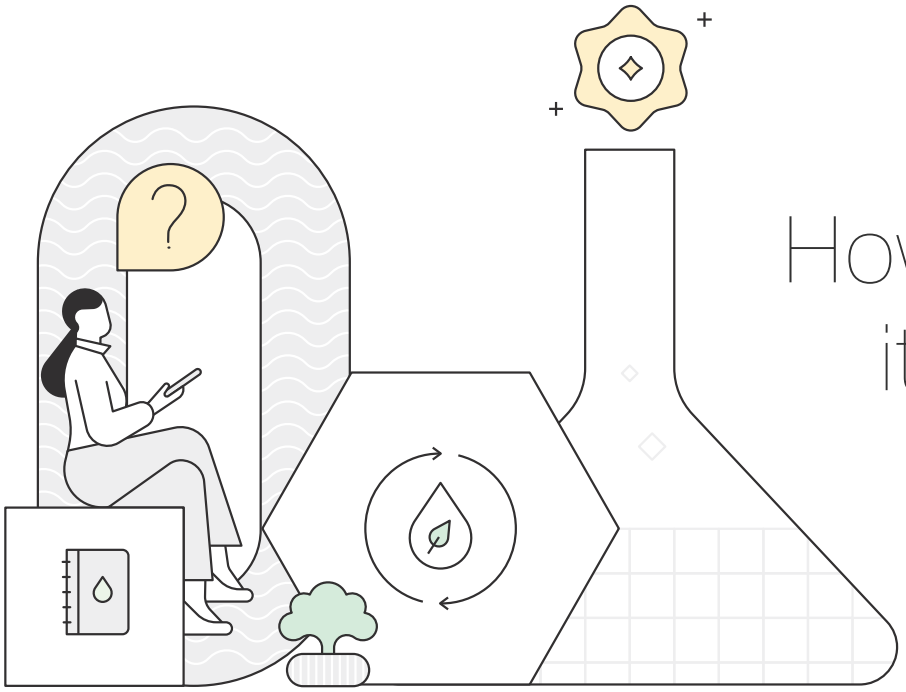
While regulations that will drive decarbonization in the maritime industry are maturing, the pace of progress is a challenge for the many companies aiming to move faster than these regulations to meet their 2030 and 2040 decarbonization targets. In 2024, to support such early movers, the MMMCZCS and US-based thinktank RMI launched Katalist, a book and claim platform for shipping.[6]

Katalist bridges the gap between shipping companies using low-emissions fuels today and freight customers who want to reduce emissions in their value chain.

For example, the ship could be a tanker vessel sailing on biofuels between the Gulf of Mexico and Rotterdam, where the fuel is available, but customers might not be ready to pay the premium for low-emissions transport. Meanwhile, the cargo owner could be a shoe manufacturer exporting goods from Southeast Asia to Los Angeles on board hundreds of different vessels, with no guarantee that alternative fuels will be used.

Katalist can connect these parties through an online registry, enabling customers to claim the environmental benefits of low-emissions transport without physically receiving them, while stimulating overall use of low-emissions fuels.

[6] Book and claim refers to a system where the buyer 'books' a specific quantity of verified sustainable transportation and then 'claims' the emissions reduction toward their sustainability targets.



How does it work?

This allows freight customers to take back control of their emissions, as they get credible, auditable, and aligned documentation for sustainable transportation through a transparent single platform. They no longer need to navigate different sustainable shipping offerings from individual shipping companies. Instead, customers now have a one-stop shop where all types of low-emissions shipping are translated into the same units of guaranteed emissions reduction.

Throughout 2023 and 2024, we partnered with RMI to educate the industry on the concept of book and claim, which is novel to shipping. In November 2024, we launched the Katalist platform. The Katalist software and rules of engagement have been developed and tested with 29 companies to ensure robust and relevant solutions. The Zero Emission Maritime Buyers Alliance (ZEMBA) has chosen Katalist as the platform of choice for its request for tenders on decarbonized transportation, demonstrating industry confidence in this solution.

Would you like to know more?

1 Get more information and the latest news about maritime book and claim at www.katalist.eco

2 Read the Center's publication on Maritime Book and Claim

Techno-economic modeling

Fueling decision-makers with trustworthy transition analytics and insights

Mærsk Mc-Kinney Møller Center
for Zero Carbon Shipping

The Center's work rests on a solid foundation of industry data and knowledge provided by our partners, our subject matter experts, and other credible sources. This data allows us to model future decarbonization scenarios in detail and derive valuable and credible transition insights. We openly share our models, results, and insights via Center publications, at conferences, and on our website.

Figure 8: Fuel Maturity Pathways.

	Feedstock availability	Fuel production	Fuel storage, logistics & bunkering	Onboard energy storage & fuel conversion	Onboard safety & operations	Vessel emissions	Regulation & certification
e-ammonia							
Blue ammonia							
e-methanol							
Bio-methanol							
e-methane							
Bio-methane							
Bio-oils							
e-diesel							
Bio-diesel							

Solutions are enabled and ready to scale

Solutions exist, but further development is needed

Solutions are not fully developed or lack specification

Key examples of data-driven tools created by the Center include:

Fuel Pathway Maturity Map – unbiased readiness assessments

Decarbonization requires multiple sustainable fuel pathways, and enabling these new pathways relies on developments throughout the value chain. With the Fuel Pathway Maturity Map, the Center offers an interactive overview of the current value chain readiness for those sustainable fuels that we expect to be most important in decarbonizing the maritime sector by 2050.

The map provides an assessment of key parameters such as scalability, sustainability, technology development, and regulatory acceptance. Assessments are regularly updated by Center experts. The Fuel Pathway Maturity Map offers intuitive, unbiased, and clear information on a complex topic, and is used by a wide range of stakeholders.

Would you like to know more?

→ Link to Fuel Maturity Map

NavigaTE – the backbone of Center analyses

NavigaTE is a simulation model that projects how the global fleet and shipping operations may evolve under various conditions. We developed NavigaTE, which informs most of the Center's analyses, to provide insights into shipping's transition towards net-zero emissions.

The NavigaTE model simulates the development of the global fleet and operations by imitating the industry's decision-making on newbuilding, retrofitting, fueling, and the operation of vessels. By tracking these decisions, the model can estimate whether and how decarbonization is likely to play out under a given set of economic, technological, and regulatory conditions. Furthermore, the model can be used to quantify the transition impact of, for example, novel technologies, regulatory levers, fuel availability constraints, and associated timing.

The NavigaTE model covers shipping's entire value chain, from fuel feedstocks to vessel operations. This end-to-end view allows the model to indicate which parts of the value chain may be bottlenecks and, therefore, are likely to determine the pace of transition.

NavigaTE is shared openly with Center partners and for academic purposes, and is being used, for example, in a research project by the Massachusetts Institute of Technology (MIT). We are currently maturing the model's structure and documentation to make it openly available to a wider public audience.

Would you like to know more?

→ Read the Center's publication on NAvigaTE here

Fuel Cost Calculator

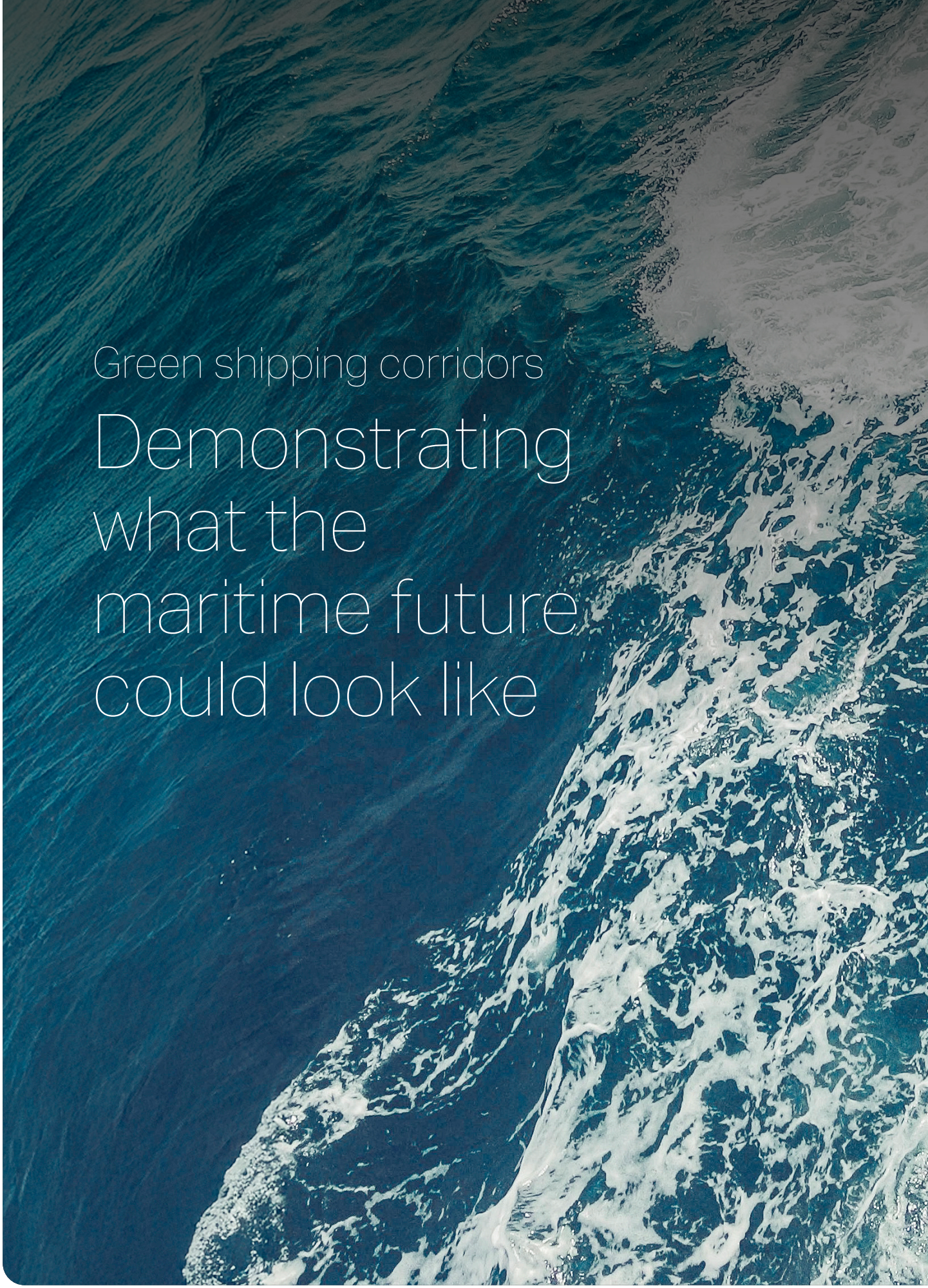
All shipping companies face bespoke transition journeys. The right fleet transition strategy depends on the type, size, and age of the fleet, as well as numerous other parameters. The common denominator, however, is cost. In fact, one of the major challenges the maritime industry faces is the absence of reliable third-party fuel cost estimates.

To help mitigate this challenge, the Center has developed the Fuel Cost Calculator, an interactive tool available for free on our website. The tool allows users to calculate the bottom-up production costs of sustainable maritime fuels and benchmark these against fossil fuels. These unbiased insights enable fuel producers, financiers, and off-takers to assess fuel options on a like-for-like basis.

The Fuel Cost Calculator is built on the Center's set of assumptions provided by our in-house experts and derived from a blend of public literature, extensive industry knowledge, and expert insights.

Would you like to know more?

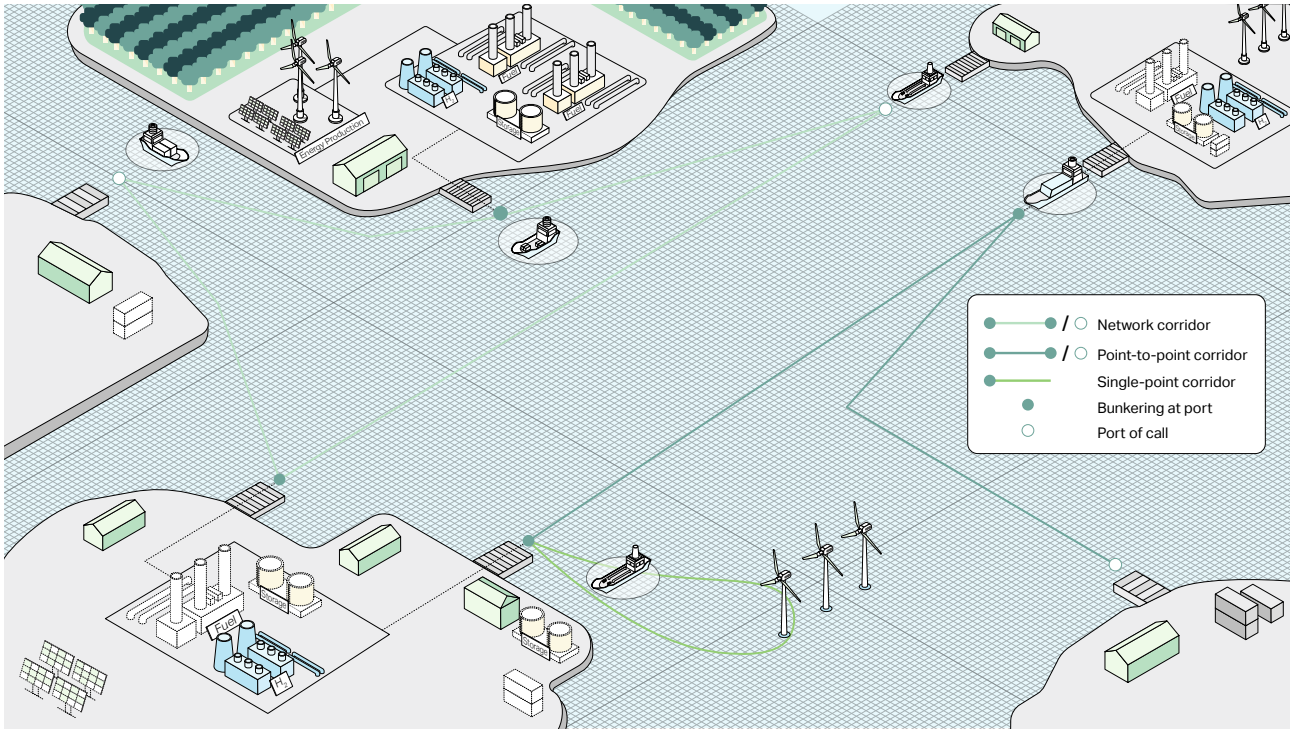
→ Visit the Fuel Cost Calculator on the Center's website



Green shipping corridors

Demonstrating what the maritime future could look like

Mærsk Mc-Kinney Møller Center
for Zero Carbon Shipping



Changing an entire industry requires someone to be willing to lead the way, acting before it makes sense from a commercial or market-driven perspective. In the maritime industry, some of these forward-looking first movers from across the entire value chain come together in green shipping corridor projects to demonstrate what decarbonized shipping looks like in reality. These projects aim to deliver real decarbonized transportation between selected ports or in a network of ports. In the process, green corridor projects help to test new solutions and prototype the collaboration and financing required to make decarbonized shipping happen.

A key challenge in this early stage of the transition is funding the cost gap between conventional fossil fuels and sustainable alternatives in a premature market, where regulation has not evened out the cost difference. Two of the most advanced green corridor projects in the world are led by the Center. Both focus on solving this systemic funding issue by developing models that leverage both public and private funding solutions.

We have developed and published a green corridors maturation methodology based on learnings from the projects we run. This framework provides a phased approach to establishing green corridors around the world. Projects using the methodology can be initiated by a fuel producer, a port, a shipowner, a government, or a cargo owner.

> "From the earliest phase, the Center's green corridors methodology has focused on driving a just and equitable transition."

Funding green shipping corridors remains a key challenge, as these demonstration projects take place in a premature market with no immediate return on investment. The Center is leading two of the most advanced green corridor projects in the world, and both focus on solving this systemic funding issue by developing models that leverage both public and private funding solutions.

From the earliest phase, the Center's green corridors methodology has focused on driving a just and equitable transition. The methodology is widely applicable to all regions around the world. Green corridor projects are possible in all economies, thanks to the methodology's focus on both public

and private funding solutions, which can be combined with the potential benefits derived from contributing to alternative fuel supply chains, independent of the current fossil grid.

Eventually, green corridors will be replaced by appropriate regulations that will incentivize the use of alternative fuels. Until these regulations are in place, the corridors provide accelerated development of the solutions and models required for the industry to move ahead.

Green corridor highlights from the Center 2023 to 2024

Chile
One of the most advanced green corridor projects in the world. Pre-feasibility and feasibility studies are complete, and the next stage is maturing towards financing and implementation. Includes several projects, from decarbonized salmon production to the export of copper and ammonia from Chile.

South Korea to US West Coast
Fast-maturing feasibility study looking to provide zero-emissions transportation for the South Korean auto industry.

Namibia
Pre-feasibility study is complete. Exploring options for alternative fuel production (ammonia) and mapping relevant ports.

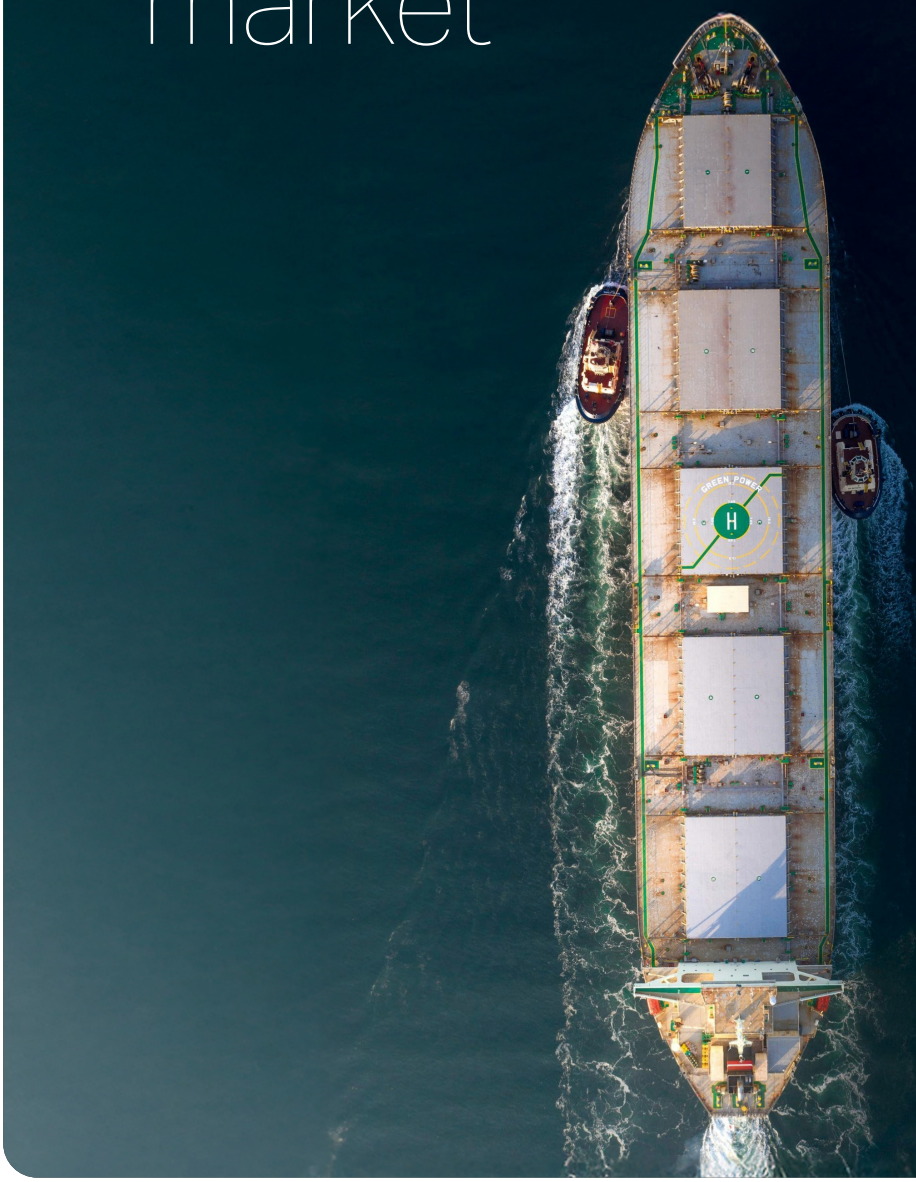
Americas
Several projects including export of dry-bulk cargo to South Korea and Japan from the Gulf of Mexico, assessing development of a fuel hub in Tacoma/Seattle/Vancouver, and decarbonizing cruise lines in Alaska to enable compliance with the Federal Clean Air Act.

1 QR code to Methodologies on Center website

2 QR code to publication on Just and Equitable Green Corridors

Life cycle assessments

Enabling an alternative fuel market



Mærsk Mc-Kinney Møller Center
for Zero Carbon Shipping

Ninety-three percent of the global fleet currently runs on traditional fossil-based fuel oils.[7] To successfully decarbonize shipping, the future fuel mix will depend on the maturation of several low- or zero-emissions fuel pathways to cover the demand.[8] However, fuels can vary widely in the level of greenhouse gas savings they can deliver, and so shipowners or operators can find it very difficult to select a fuel for their future fleet. As a result, the industry needs a consistent and transparent method for comparing greenhouse gas emissions from each alternative fuel type.

To meet this need, the Center has developed a methodology for making lifecycle assessments (LCA) of marine fuels. This methodology enables harmonized, end-to-end analysis of emissions from 'well to wake' – meaning from the initial feedstock source through fuel production, fuel distribution, bunkering of the fuel onto the vessels, and ultimately to fuel combustion on board the vessel.

With our LCA methodology, users can assess the energy and consumables that the fuel value chain requires, helping fuel producers to document their fuel's emissions profile in a maritime context. Center experts estimate that fuel producers can fast track their LCA analysis by up to a year through using the Center's methodology instead of creating their own.

> "Because we do not incentivize a particular fuel or technology, we can create a level playing field for maritime decision-makers to take guidance from."

Our independent status means that the Center is uniquely positioned to build such a methodology. Because we do not incentivize a particular fuel or technology, we can create a level playing field for maritime decision-makers to take guidance from. The Center's wide network also ensures robust assumptions across all relevant parts of the value chain – something that can be difficult for the individual fuel producers to obtain.

The Center is currently implementing our LCA methodology, confirming that LCA can be applied in a shipping context – a task that, for many, had previously seemed too complex or academic. By applying LCA, the industry can reap the benefits of increased transparency of emissions across fuel production and onboard consumption.

A number of fuel producers have now integrated our methodology into its project development process, enabling the company to serve the maritime industry with its fuels.

The Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping has developed a Life Cycle Assessment (LCA) methodology that:

- ✓ Enables end-to-end assessment of greenhouse gas emissions from alternative marine fuels
- ✓ Harmonizes the landscape of future marine fuels by making their performance comparable
- ✓ Enables fuel producers to future-proof their alternative marine fuel supply chain by indicating areas for targeted mitigation of emissions
- ✓ Reduces decision-making risks for fuel producers and regulators wanting to stimulate the establishment of an alternative maritime fuel market

Would you like to know more?

→ QR code to LCA Methodology on Center website

[7] "Energy Efficiency of Ships - Report of fuel oil consumption data submitted to the IMO Ship Fuel Oil Consumption Database in GISIS (Reporting year: 2023)" (MEPC 82/6/38).

[8] https://www.zerocarbonshipping.com/fuel-pathways/

Regulations and policies

No transition without regulation

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Unlike other global industries, the maritime industry has the advantage of being regulated centrally in the IMO, a specialized agency of the United Nations. Centralized regulation is an advantage when you want to incentivize new ways of operating under equal terms across the entire sector. The IMO is responsible for measures to improve the safety and security of international shipping and to prevent pollution from ships.[9] In July 2023, the IMO adopted the 2023 IMO Strategy on Reduction of Greenhouse Gas Emissions from Ships (the IMO GHG Strategy). The IMO GHG Strategy represents a framework for the 176 IMO member states, setting out the future vision for international shipping and including further candidate mid- and long-term measures with possible timelines.[10]

The IMO GHG Strategy includes:

- an enhanced common ambition to reach net-zero GHG emissions from international shipping by or around 2050;
- a commitment to ensure uptake of alternative zero- and near-zero-GHG fuels by 2030;
- indicative checkpoints for international shipping to reduce total annual GHG emissions compared to 2008 levels for 2030 (by at least 20%, striving for 30%) and 2040 (by at least 70%, striving for 80%).

The IMO GHG Strategy also aims to see the carbon intensity of international shipping reduced by at least 40% compared to 2008 levels by 2030. The new level of ambition is linked to the industry's uptake of zero or near-zero-GHG emission technologies, fuels, and/or energy sources. These solutions should represent at least 5% (striving for 10%) of the energy used by international shipping by 2030.[11]

The Center actively participates in the processes of shaping new regulations and policies. Our independent status and subject matter expertise across multiple techno-economic areas, as well as world-class techno-economic analysis capabilities, make us trusted advisors to regulators and policymakers. Our research results have directly impacted relevant global regulations with the IMO, as well as regionally (especially in the EU and the US), and at national levels with governments around the world.

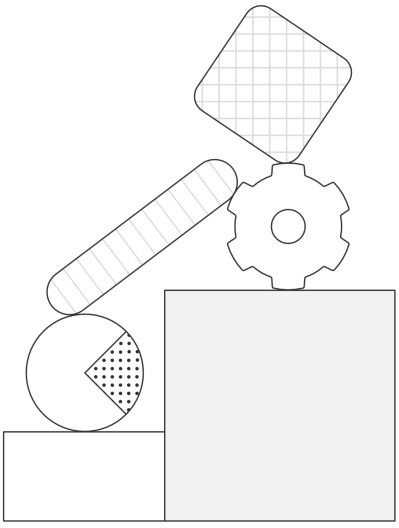
Examples of how the Center has contributed to developing regulations and policies during 2023 and 2024 include:

Globally: International Maritime Organization (IMO)

- Presentations at the IMO supporting the creation of a robust 2023 IMO GHG Strategy.
- Extensive support to regions and countries on shaping their position for the IMO GHG Strategy.
- Guidance on data collection and reporting – helping to ensure that over 30,000 ships now report fuel consumption data at the highest level of granularity.
- Papers submitted to propose the development of a sustainable marine fuel certification framework (the IMO Certification Framework) at the IMO, which will be crucial to the implementation of the IMO net-zero framework.
- Expert advice on energy efficiency topics that has been largely adopted by the IMO. This strengthens new and existing regulations that accelerate the uptake of energy efficiency technologies across the global fleet.
- Advice to the IMO on safe ship design, safe onboard handling, and related training needs for seafarers on ammonia-fueled vessels – addressing safety as one of the major barriers for the ammonia fuel pathway.
- Participation in workshops at the IMO on redistribution of the revenue of a potential CO_2 tax, LCA, and fuel certification.

Regionally

- Industry guidance on maximizing opportunities from FuelEU Maritime (an EU regulation limiting the GHG intensity of energy used aboard vessels that call into the EU) in collaboration with the European Commission's Directorate-General for Mobility and Transport (DG MOVE) and the European Maritime Safety Agency (EMSA).
- Dialogue with the European Commission to advise on the technical implementation of FuelEU Maritime.

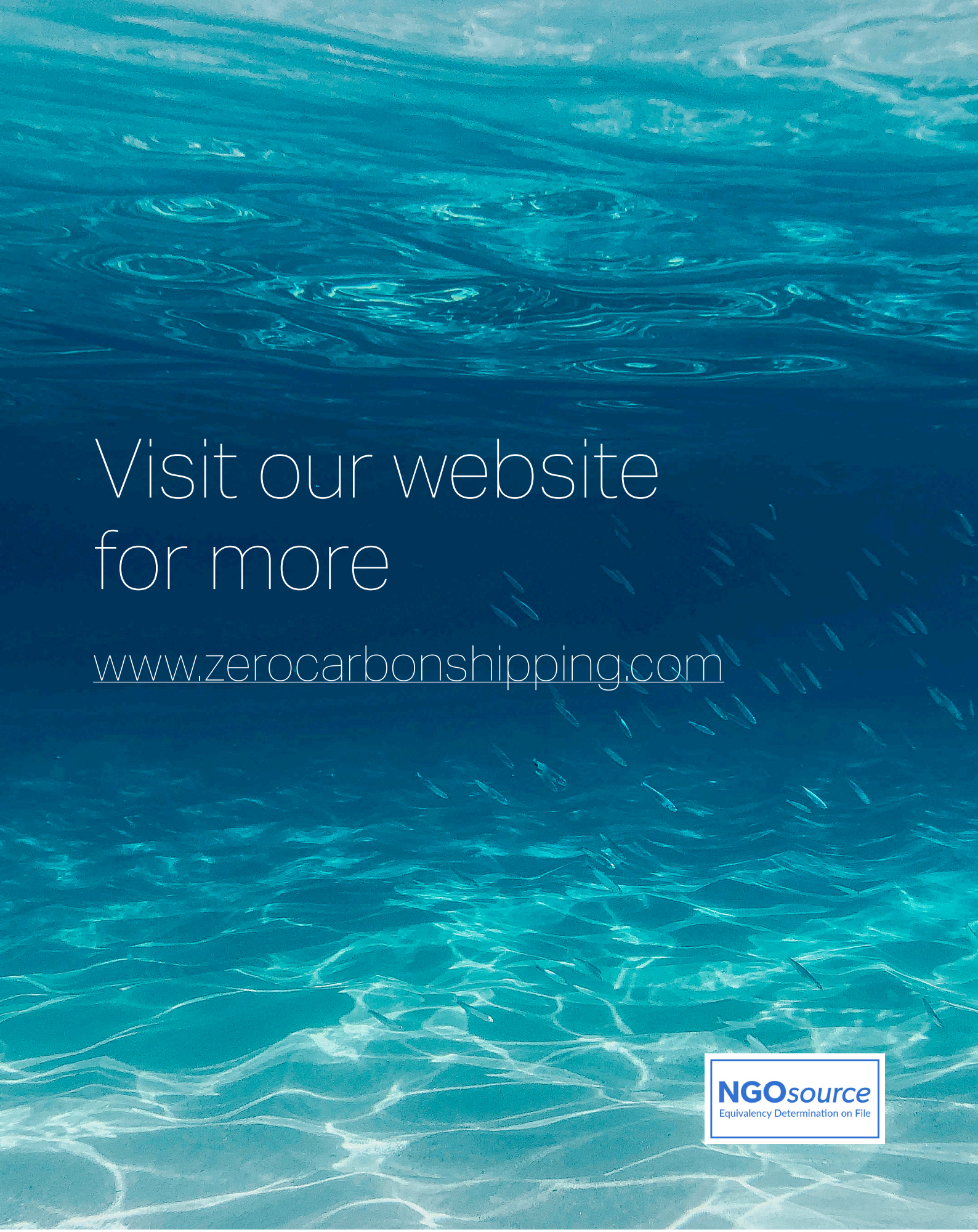


Impact stats

Funding		
USD raised for maritime decarbonization through Center lifetime	Founder: USD 106,000,000 Strategic partner in-kind: USD 24,000,000 Strategic partner cash: USD 10,000,000 Mission ambassadors: USD 1,000,000	
USD projects funded by external partners through lifetime	USD 3,000,000	
% of raised USD re-invested in maritime decarbonization	100%	
Projects funded by external partners	8	
Total funding raised for the decarbonization of shipping	USD 144,000,000	
Productivity		
Hours spent on research and development projects in 2023 and 2024 by employees and secondees	2023: 71,005 hours	2024: 94,793 hours
Projects completed	77	
Projects ongoing	77	

Publications	**2023:** 20	**2024:** 16
Unique visitors viewing publications	**2023:** 25,443	**2024:** 34,671
Publication downloads	**2023:** 4,479	**2024:** 9,793
Newsletters	**Countdown to FuelEU** Receivers: 9,015 Avg. open rate: 57% **Mid-Term Measures** Receivers: 9,511 Avg. open rate: 69%	
Webinars held	**2023:** 8 **Registrations:** 2,997	**2024:** 6 **Registrations:** 3,685
Webinar participants	**2023:** 1,898	**2024:** 2,361
Webinar attendance rate	**2023:** 63%	**2024:** 64%
Papers submitted to IMO	13	
Center green corridors	**Pre-feasibility:** Finalized: 6 Ongoing/planned: 5 **Feasibility:** 13	
Center deliverables to the ecosystem – ship design and functions	Ship designs: 3 Ship design functions: 4	
Partners		
Partner satisfaction survey results	7,5 out of 10	
Partner coverage of world fleet	5,000 commercial vessels (5%)	

Partner coverage of world tonnage	300 million gross tonnage (gt) 360 million deadweight tonnage (dwt)	
Partner coverage of world energy production	2.5%	
Presentations at external conferences and events	2023: 100+	2024: 100+
Events participated in	2023: 87	2024: 70
External participants at Partner Accelerate Summit	588	
Presentations at Partner Accelerate Summit	41	
Walking the talk		
Center GHG emissions, Scope 1 and 2	2023: 8.8 tons	2024: 5,8 tons
Center GHG emissions, Scope 3	2023: 124.5 tons	2024: 298,3 tonnes
Center employees and secondees	159	
Nationalities at the Center	33	
Gender diversity at the Center	Employees: Female: 47% Male: 53%	Secondees: Female: 32% Male: 68%
Transparency on funding allocation and sourcing	100%	



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