



**Catalyzing Demand for
Decarbonized Shipping Solutions:
Reflections and Insights from the
Zero Emission Maritime Buyers Alliance's
Inaugural Tender**
June 2024

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LIST OF ABBREVIATIONS

CO ₂ e	Carbon Dioxide Equivalent
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
coZEV	Cargo Owners for Zero Emission Vessels
EAC	Environmental Attribute Certificates
EU	European Union
EU MRV	European Union Monitoring Reporting and Verification
EU RED	European Union Renewable Energy Directive
GHG	Greenhouse Gas
HFO	Heavy Fuel Oil
ICAO	International Civil Aviation Organization
ICCT	International Council on Clean Transportation
ILUC	Induced Land Use Change
IMO	International Maritime Organization
IMO LCA Guidelines	International Maritime Organization Life Cycle Assessment Guidelines
ISCC	International Sustainability and Carbon Certification
ISO	International Organization for Standardization
LCA	Life Cycle Assessment
LFO	Light Fuel Oil
LNG	Liquefied Natural Gas
LSFO	Low Sulfur Fuel Oil
LSFO-R	Low Sulfur Fuel Oil of Pure Residual Type
MRV	Monitoring, Reporting, and Verification
RFI	Request for Information
RINA	Royal Institute of Naval Architects
RSB	Roundtable on Sustainable Biomaterials
SABA	Sustainable Aviation Buyers Alliance
SBTi	Science Based Targets Initiative
TEU	Twenty-foot Equivalent Unit
TEU-nm	Twenty-foot Equivalent Unit per Nautical Mile
TtW	Tank-to-Wake
WtT	Well-to-Tank
WtW	Well-to-Wake
ZEMBA	Zero Emission Maritime Buyers Alliance
ZLCA Guidelines	ZEMBA Life Cycle Assessment Guidelines

EXECUTIVE SUMMARY

The Aspen Institute¹ worked with companies to launch Cargo Owners for Zero Emission Vessels (coZEV) in 2021, a platform for cargo owners to work collaboratively to accelerate the transition to zero- and near-zero emission maritime shipping. Subsequently, in March 2023, recognizing the need to aggregate demand to stimulate the marketplace for zero-emission shipping, the Aspen Institute, Amazon, Patagonia, and Tchibo launched the Zero Emission Maritime Buyers Alliance (ZEMBA), a first-of-its-kind buyers group within the maritime sector. Following the addition of over 20 multinational companies to its membership, ZEMBA released its inaugural tender² in September 2023, seeking bids for the environmental attributes³ associated with zero-emission shipping services beginning in 2025.

This tender involved the development of a definition for zero-emission fuels and complete life cycle assessment (LCA) guidelines, as well as the construction of a framework to certify the greenhouse gas (GHG) intensity, *i.e.*, the Carbon Dioxide Equivalent (CO_{2e})⁴ intensity of the winning bid and the emissions avoided. For purposes of the inaugural ZEMBA tender, a zero-emission fuel is one with a 90% or greater reduction in CO_{2e} intensity over conventional shipping fuels on a full life cycle basis. The remainder of the report uses the phrase ‘zero- and near-zero’ in reference to fuels, vessels, and shipping services to better align with the International Maritime Organization’s (IMO) “2023 Strategy on Reduction of GHG Emissions from Ships”.⁵ We do not suggest that a reduction of CO_{2e} intensity in fuel of 90% or greater should constitute the formal definition of a zero- or near- zero fuel. This definition was created by ZEMBA for the purposes of the inaugural tender and may be subject to change in future tenders.

The successful conclusion of ZEMBA's first tender was announced on 17 April 2024. The winner of the tender is Hapag-Lloyd, which committed to using exclusively waste-based biomethane to satisfy the tender requirements for final contracted volumes. The service is expected to achieve a well-to-wake (WtW) CO_{2e} emissions reduction greater than 90% (excluding pilot fuel) compared to Low Sulfur Fuel Oil (LSFO), and avoid at least 82,000 metric tonnes of CO_{2e} emissions cumulatively in 2025 and 2026.

ZEMBA evaluated the outcome of its first tender and is designing the second tender, which is expected to launch in late 2024. Additional efforts are being undertaken to determine how ZEMBA can best support the nascent e-fuel market through its subsequent tenders, given the need to increase production and availability of such fuels for use in shipping’s energy transition. An important first step in this next phase was to conduct an information-gathering exercise by issuing a Request for Information (RFI) to examine the potential availability of e-fuels for maritime offtake in the years ahead; responses will be used to inform the parameters of ZEMBA’s second tender. ZEMBA will also use this information, as well as

¹ Aspen Institute, a non-profit organization based in Washington, D.C., facilitates the Cargo Owners for Zero Emission Vessels initiative and serves as the secretariat for the Zero Emission Maritime Buyers Alliance.

² As used in this context, “tender” means an invitation for carriers to submit bids for zero-emission shipping services that meet ZEMBA’s zero-emission fuels definition and criteria through an open, competitive process.

³ In this context, environmental attributes refer to the emissions reductions associated with the movement of a particular volume of freight over a specific distance using a zero-emission fuel (*i.e.*, CO_{2e} reduced per TEU-nm).

⁴ Within the ZEMBA zero-emission fuels definition, CO_{2e} covers CO₂, CH₄ and N₂O.

⁵ International Maritime Organization (2023). “2023 IMO Strategy on Reduction of GHG Emissions from Ships”. Available at:

<https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/annex/MEPC%2080/Annex%2015.pdf> (Accessed: 5 June 2024).

feedback from the inaugural tender, to consider possible changes to several design elements, including its zero-emission fuels definition and LCA guidelines.

ZEMBA was the first collective procurement effort to go to market in search of zero-emission shipping solutions at commercial scale. Through this inaugural tender process, ZEMBA gained a number of key insights, which are summarized in the box below:

Reflections and Insights

- **ZEMBA member companies are eager to purchase zero- and near-zero emission maritime shipping services.** ZEMBA has proven to be an effective mechanism to aggregate their demand to spur markets for new fuel and technology solutions.
- **ZEMBA enables significant life cycle emissions reductions for its members starting in 2025.** It also sends a critical demand signal to the fuels sector to further invest in zero- and near-zero solutions for the maritime industry.
- **The first tender offers a real-time view into the current market conditions for competitive zero-emission fuel procurement.** This was the first time a commercial request for deployment of zero-emission maritime fuels was taken to the container shipping market at this scale.
- **No bids were received for either e-fuels that could meet ZEMBA's requirements or that used carbon capture and storage technology.** All bids received that were capable of meeting ZEMBA's criteria relied on biogenic feedstocks, which face scalability challenges.
- **E-fuels and some zero-emission technologies are nascent and needed a longer lead time between confirmed offtake and production than ZEMBA initially anticipated.** The ZEMBA tender process revealed that the market is currently incentivized to produce bio-based fuels, which are available for near-term deployment. To fully decarbonize the sector, strong policy support and additional voluntary first-mover actions are needed, and there must be a transition plan that both secures near-term emissions reductions and also catalyzes immediate investment in long-term scalable solutions.
- **International and domestic policy are urgently needed to create global market confidence for scalable e-fuels that will be necessary to achieve decarbonization goals.** It is unlikely to be sufficient to merely reduce the cost gap through policy intervention – comprehensive measures that create cost parity for their use within the shipping sector will be critical.
- **Both private sector initiatives and global policy need to account for emissions over the full life cycle of fuels to avoid displacing emissions from sea to shore.** Life cycle WtW emissions accounting was crucial to provide ZEMBA's cargo owners assurances about avoided GHG emissions achieved through the tender.
- **ZEMBA's tender process highlighted gaps in the current IMO LCA Guidelines and the need for certification systems for maritime fuels.** Development of

comprehensive, science-based IMO LCA Guidelines, including transparent and credible independent certification requirements, are needed to ensure success of the sector's transition and support future voluntary initiatives.

- **Using widely accepted international certification standards was more efficient and acceptable to bidders and fuel providers than creating a unique ZEMBA certification standard.** Ensuring that these standards are robust, trusted throughout the value chain, and striving for continuous improvement is essential to fulfilling their critical function in enabling confidence in fuel supply chains and the emissions reductions associated with the fuel use.

1. Cargo Owners for Zero Emission Vessels (coZEV) Initiative and the Zero Emission Maritime Buyers Alliance (ZEMBA)

Since 2020, the Aspen Institute Energy & Environment Program has focused on catalyzing private sector leadership to drive the policy and market changes needed to enable decarbonization of the entire maritime sector no later than 2050. Recognizing that corporate customers of the shipping industry have a significant stake in this transition but lacked an outlet to channel this collective interest, the Aspen Institute worked with cargo owner companies to launch coZEV in 2021. Through engagement in coZEV, cargo owners can demonstrate concrete action to lower their supply chain (Scope 3) emissions while helping to shape the zero-emission⁶ shipping transition to achieve their climate goals and meet the logistical needs of their global businesses.

Initially released in October 2021, the coZEV 2040 Ambition Statement⁷ is a collective signal of cargo owner support for transitioning to zero-emission maritime shipping solutions on a trajectory aligned with a 1.5°C limit on climate change. With 27 current signatories,⁸ the 2040 Ambition Statement affirms these companies' intentions to only use maritime shipping services powered by zero-emission fuels and technologies by 2040. The statement also includes the first call for policy action by a group of cargo owners, acknowledging that decarbonization of this sector requires strong public sector action across multiple jurisdictions.

Recognizing the need to demonstrate customer demand to foster an economically viable marketplace for zero-emission shipping, the Aspen Institute, Amazon, Patagonia, and Tchibo launched ZEMBA, a first-of-its-kind buyers group within the maritime sector, in March 2023. An initiative of coZEV, ZEMBA's mission is to accelerate commercial deployment of

⁶ coZEV defines zero-emission fuels as those that have zero GHG emissions on a life cycle basis, are sufficiently scalable to decarbonize the entire shipping industry, and for which safety and land use concerns have been addressed. ZEMBA used a more specific definition of zero-emission for its inaugural tender, which is discussed in Section 2.1 of this paper.

⁷ Cargo Owners for Zero Emission Vessels (2021). "coZEV Ambition Statement". Available at: https://www.cozev.org/img/050124_Ambition-Statement_4C5.pdf (Accessed: 5 June 2024).

⁸ Cargo Owners for Zero Emission Vessels (2024). "coZEV Ambition Statement Signatories". Available at: <https://www.cozev.org/initiativesfeed/send-demand-signals-for-zero-emission-shipping> (Accessed: 5 June 2024).

zero-emission shipping solutions, enable economies of scale for freight buyers and suppliers, and help cargo owners maximize emissions reduction potential beyond what any one freight buyer could accomplish alone. By working together, ZEMBA members are offering committed demand to build confidence among investors, carriers, ship owners, and producers of zero-emission fuels and renewable energy to invest in these solutions.

Following its launch, and the addition of over 20 multinational companies to its membership, in September 2023, ZEMBA released its inaugural tender for zero-emission shipping services to be deployed beginning in 2025.⁹ The successful conclusion of ZEMBA's first tender was announced on 17 April 2024, at Singapore Maritime Week. ZEMBA is now in the process of evaluating the outcome and designing the second tender, expected to launch in late 2024. Additional information about the first tender, the design process, including the formulation of a definition of zero-emission fuels and LCA guidelines, and the winning bid can be found in Sections 2 and 3. Section 4 provides reflection and insights from the inaugural tender process, Section 5 discusses ZEMBA's next steps, and Section 6 offers concluding remarks.

2. Designing the Inaugural ZEMBA Tender

ZEMBA was the first collective procurement effort to go to market in search of zero-emission shipping solutions at commercial scale. In September 2023, ZEMBA launched its inaugural tender for the environmental attributes associated with 3.45 billion Twenty-foot Equivalent Unit (TEU)-nautical miles (nm) of zero-emission container shipping services over a three-year period (2025-2027) on a deep-sea route.¹⁰ ZEMBA sought bids that would meet the following criteria¹¹:

- Sufficient capacity to move 1.15 billion TEU-nm/year on a transoceanic route starting in 2025.
- Fuels that could achieve a 90% or greater GHG emissions reduction compared to LSFO on a life cycle basis.
- Transparent fuel life cycle emissions and certification to validate emissions reduction claims.

A critical dimension of the design of ZEMBA's tender was its reliance on a book and claim system. Book and claim is a chain of custody¹² model in which “the administrative record

⁹ Cargo Owners for Zero Emission Vessels (2023). Press Release. “Amazon, Electrolux, Philips, and Over 20 Other Major Global Companies Launch Historic Tender to Accelerate Deployment of Zero-Emission Shipping”. Available at:

<https://www.cozev.org/thelatest/amazon-electrolux-philips-and-over-20-other-major-global-companies-launch-historic-tender-to-accelerate-deployment-of-zero-emission-shipping> (Accessed: 5 June 2024).

¹⁰ ZEMBA initially announced its volume target in TEU units, seeking 600,000 TEU over 3 years benchmarked on the transpacific route of Shanghai to Los Angeles, which is just over 5,700 nautical miles. This translates to 3.45 billion TEU-nm from 2025-2027, or 1.15 billion TEU-nm per year. Since the first tender was route-neutral, it became necessary to use a unit that includes both containers carried and distance travelled. The unit may be refined in subsequent tenders.

¹¹ In the first tender, ZEMBA was focused on facilitating the deployment of zero-emission fuels and receiving competitive bids for emissions reductions associated with those services. ZEMBA assumed the use of efficiency measures is naturally incentivized with the adoption of zero-emission fuels as vessel operators seek to minimize the usage of this more expensive fuel to reduce costs and seek competitive advantage. ZEMBA is a strong supporter of technology innovation and maximum use of efficiency measures.

¹² Chain of custody refers to the sequence of ownership or control of a material as it is transferred to different members of a supply chain. As a system, a chain of custody includes complete documentation to verify a unit of production and a claim about the final product. Chain of custody systems generally include elements such as an

flow does not necessarily connect to the physical flow of material or product throughout the supply chain.”¹³ Within a book and claim system, environmental attributes (CO₂e emissions reductions in the case of the ZEMBA tender) are decoupled from the physical service or product and are sold, tracked and claimed separately through the issuance of certificates.

For ZEMBA, adopting a book and claim system was necessary due to the global and diversified logistical needs of freight buyers. The cargo flows of freight buyers may not always align with each other, temporally or geographically. Nor do the cargo flows necessarily align with the locations where zero-emission fuels and technologies are available, or could be deployed, particularly in the early years of the transition. As such, it would have been logistically infeasible to aggregate the physical cargo of all ZEMBA’s members to be shipped via a zero- or near-zero emission vessel from one specific location to another. Instead, ZEMBA’s book and claim approach allows for geographic neutrality so that bidders can focus their bids on maximizing emissions reduction at the lowest feasible cost for ZEMBA members. It is a key tool that ZEMBA believes is essential to facilitate the transition by tapping customers’ demand across the globe, derisking investment in new supply chains by enabling commercially-relevant volumes of committed offtake, and tracking the appropriate allocation of emissions reduction credits to the actors who enabled those reductions to take place through voluntary investment.

Given its geographic neutrality, ZEMBA’s tender sought proposals for purchase of environmental attribute certificates (EACs) for the GHG emissions reductions associated with the use of zero-emission fuels. The EACs will represent the decoupled environmental attributes associated with zero-emission shipping services, including life cycle emissions reductions, for a specific volume of cargo over a particular distance using fuel that is compliant with ZEMBA’s criteria. Functionally, ZEMBA members and the winning bidder will each bilaterally contract for a certain number of EACs. The winning bidder will issue EACs using a credible book and claim system, from which ZEMBA member companies can claim and retire those certificates. This ensures members receive appropriate credit for their investment in the decarbonized freight service and gives confidence that those specific credits are neither sold multiple times nor otherwise inappropriately allocated. See section 2.3 for more information about this system.

To support the requirements of the tender process, the ZEMBA team, expert consultants, and legal counsel developed several technical resources.¹⁴ These resources served to address informational and regulatory gaps discovered during the design of the ZEMBA tender in an effort to provide interested suppliers with requisite details for their submission of bids. The resources also sought to equip cargo owner members with the information and decision-making tools required to support investment in the tender. Key activities included developing a zero-emission fuels definition, in-depth LCA Guidelines, a holistic framework to

applied standard, monitoring mechanism, and a reporting system. For more information, see ISEAL Alliance (2016). “Chain of custody models and definitions; A reference document for sustainability standards systems, and to complement ISEAL’s Sustainability Claims Good Practice Guide”. Available at:

<https://www.isealalliance.org/get-involved/resources/iseal-guidance-chain-custody-models-and-definitions> (Accessed: 5 June 2024).

¹³ “Book and Claim Model”. International Organization for Standardization (ISO) 22095:2020, *Chain of custody – General terminology and models*, section 3.3.5. Available at:

<https://www.iso.org/obp/ui/en/#iso:std:iso:22095:ed-1:v1:en> (Accessed: 5 June 2024).

¹⁴ Aspen Institute’s collaborators and advisors in the development of these products included Neoteric Energy & Climate (now the Center for Green Market Activation), Lloyd’s Register, Lloyd’s Register Maritime Decarbonisation Hub, and Pillsbury Winthrop Shaw Pittman LLP.

enable robust and transparent validation, certification, verification, and reporting of the environmental attributes required by the tender, and actively engaging in the development of a book and claim registry to issue EACs. Much of this technical detail is now reflected in the contractual arrangements between ZEMBA members and the winning carrier. The following sections detail the design of the zero-emission fuels definition and ZEMBA LCA Guidelines (hereafter ZLCA Guidelines).

2.1 Zero-Emission Fuels Definition

At the time of designing the inaugural tender, there was no formally accepted definition by the shipping sector or by the IMO of what qualifies as a zero- or near-zero emission fuel. As such, the ZEMBA initiative developed a definition of zero-emission fuel that sought to send a signal of its highest ambition while balancing commercial maturity and feasibility for deployment in 2025. The full definition is provided in Annex 1 with some key details offered below.

“Zero-emission” was defined for ZEMBA’s inaugural tender as fuels that have the potential to achieve GHG (CO₂, CH₄ and N₂O) emissions reductions equal to, or greater than, 90% when compared to a commonly used reference fuel: Low Sulfur Fuel Oil of pure residual type (LSFO-R) such as Heavy Fuel Oil (HFO) or Light Fuel Oil (LFO).¹⁵ The full life cycle, or WtW emission factor,¹⁶ for this baseline corresponds to the IMO LCA Guidelines: 92.36 g CO₂e / MJ (LCV = 40,200 kJ / kg).¹⁷

For bids, LCA values were required to reflect 100-year Global Warming Potential (GWP100),¹⁸ expressed in CO₂e, in accordance with the 5th Assessment Report of the Intergovernmental Panel on Climate Change and the IMO LCA Guidelines. Further requirements included that “zero-emission” fuels be:

- Derived from sustainable and/or waste, residual, or byproduct feedstock sources including hydrogen and captured CO₂.
- Supplied by a vendor certified to a relevant sustainability standard by an independent certification body accredited to one of the following sustainability standard holders: Roundtable on Sustainable Biomaterials (RSB), the International Sustainability and Carbon Certification (ISCC), or another standard holder recognized by the European Commission.¹⁹

¹⁵ Residual marine grades based on ISO 8217:2017 with sulfur levels S>0.5%.

¹⁶ This is a fuel-specific multiplier used to calculate GHG emissions based on the amount of that fuel consumed.

¹⁷ International Maritime Organization (2023). Resolution MEPC.376(80). “Guidelines on Life Cycle GHG Intensity of Marine Fuels (LCA Guidelines)”. Available at: [https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/MEPCDocuments/MEPC.376\(80\).pdf](https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/MEPCDocuments/MEPC.376(80).pdf) (Accessed: 15 May 2024).

¹⁸ GWP values assess the relative potency of GHGs, on a molecular basis, taking account of how long they remain active in the atmosphere. European Environment Agency (2023). “Eurostat Glossary”. Available at: [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Global_warming_potential_\(GWP\)](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Global_warming_potential_(GWP)) (Accessed: 28 May 2024).

¹⁹ ZEMBA chose the ISCC and RSB standards as the fuel certifications, as well as their voluntary certifications, ISCC Plus and RSB Global, because their WtW LCA evaluations are widely recognized and used in the fuels sector, including for the European Union Renewable Energy Directive (EU RED II).

- Produced using renewable energy or another non-fossil, low-carbon energy source²⁰ (including any relevant feedstocks, e.g., hydrogen).
- Sufficiently scalable to make a meaningful contribution to the decarbonization of the maritime shipping sector as determined by ZEMBA's criteria, and with any safety concerns addressed.

In this inaugural tender, the focus was on fuels associated with the primary propulsion of oceangoing vessels and therefore excluded pilot fuels.²¹

The LCA values, or WtW CO₂e emissions, of the bidders' fuel services were calculated according to the ZLCA Guidelines, a link to these guidelines is included in Annex 2, the design of which is discussed in the following section.

2.2 ZEMBA Life Cycle Assessment Guidelines

LCA Guidelines are necessary to calculate the emissions associated with a fuel on a WtW basis, *i.e.*, over the full life cycle of a fuel from production to transportation and combustion. This involves combining well-to-tank (WtT) and tank-to-wake (TtW) assessments. During the design of the inaugural tender, the IMO LCA Guidelines, adopted in IMO Resolution MEPC.376(80), were incomplete; they provided a methodology and framework but not the detailed technical guidance needed to evaluate the WtW CO₂e intensity of bids (the LCA value). To ensure that bids would meet the tender's emissions reduction criteria, ZEMBA needed to create guidelines that would produce science-based, technically robust, WtW CO₂e intensity values and provide enough detail to allow for the third-party certification of the fuel used by the winning bidder. Third-party certification creates an additional level of assurance for the ultimate emissions reductions calculations by requiring verification that the LCA methodology has been applied correctly and is supported by accurate data.

ZEMBA's ZLCA Guidelines are a comprehensive evaluation framework used for the tender process. To develop these guidelines, ZEMBA drew upon the supporting technical analysis and detailed LCA calculation methodologies in the existing regulatory standards for the EU RED II and the International Civil Aviation Organization's (ICAO) Carbon Offsetting and Reduction Scheme for International Aviation (CORSA), as well as the voluntary standards put forward by RSB Global and ISCC Plus. Relevant methodologies from each of these standards were applied to the framework provided by the IMO LCA Guidelines in order to develop ZLCA Guidelines that were as closely aligned to internationally-recognized policy as possible, but that were comprehensive and could meet the ZEMBA tendering requirements. This also created cohesion between the calculation and verification of the LCA values in the bids. Further discussion of the need for certification and verification is in Section 2.6.

²⁰ The rationale for this requirement was to keep the tender fuel/energy agnostic and open to a variety of bids. While some sectors associated with feedstocks may be carbon intensive sectors themselves (e.g., the electricity production and agriculture sectors), there are low-carbon fuel products like renewable electricity or waste feedstocks that are produced in association with these sectors. These products are viewed as low-carbon options compatible with the ZEMBA zero-emission fuel requirements.

²¹ Pilot fuels are those fuels used for ignition before the main propulsion fuel is injected. Although ZEMBA excluded the emissions associated with the use of pilot fuels from its zero-emission fuels definition for the inaugural tender, the template contract did set an upper limit on the total amount of fuel that can be claimed as pilot fuel.

As highlighted above, the IMO LCA Guidelines did not provide the detailed technical documentation and guidance necessary to consistently evaluate the life cycle CO₂e intensity of most fuels or to verify those evaluations through a third-party certification. For example, the IMO’s LCA Guidelines at the time of the inaugural tender did not prescribe the waste feedstock classifications and upstream emissions allocations for zero-emission fuels, or the emissions credits allowable for carbon-sequestering production pathways. To eliminate potential ambiguities around LCA calculations resulting from this lack of detailed guidance, the ZLCA Guidelines required fuel suppliers to calculate their emissions using a life cycle CO₂e intensity value that has been certified by an independent body accredited by RSB, ISCC, or another such standard holder recognized by the European Commission.

Although the certification standards eligible under the ZLCA Guidelines all calculate WtW LCA values, ZEMBA required additional disclosure of specific calculations and variables used to arrive at the fuel vendor's LCA value, and imposed adjustments to the certified life cycle CO₂e intensity values to produce a final WtW LCA value. These components are further described in this section and summarized in the table below:

LCA Component	Required Certification, Methodology, or Default Values
Direct WtW Emissions Calculation	EU RED II (e.g., ISCC EU or RSB EU certification), ISCC Plus certification, or RSB Global certification
Methane Slip	IMO or FuelEU Maritime default values
Feedstock Classification ²²	ICAO CORSIA classification of wastes, residues, byproducts, and co-products, EU RED II Annex IX
ILUC ²³	ICAO CORSIA default values
Out-of-Sector Emissions Crediting ²⁴	Science Based Targets Initiative (SBTi) Corporate Net Zero Standard, SBTi Aviation Sector Guidance

Table 1: Required LCA components for the ZEMBA inaugural tender

²² Feedstock classification is important because upstream emissions such as induced land use change (ILUC)—also referred to as indirect land use change—and direct land use change are not allocated to waste, residue, or by-product feedstocks.

²³ILUC refers to emissions related to land use change due to “the displacement of crops or animals for which the land was previously used. ILUC emissions assessment accounts for these different effects, by evaluating greenhouse gas released from conversion of natural vegetation (forest, other natural land), soil organic carbon, oxidation of peatlands, and sequestered biomass.” ICAO. Available at: https://www.icao.int/environmental-protection/pages/SAF_LifeCycle.aspx (Accessed: 5 June 2024).

²⁴ Used here, out-of-sector emissions crediting refers to carbon credits that reduce GHG emissions or remove carbon from the atmosphere, but occur outside of the maritime fuel’s value chain. ZEMBA does not consider out-of-sector offsets as suitable to meet sector-specific climate targets.

As ILUC default values were not quantified under either EU RED II or FuelEU Maritime, ZEMBA required the use of ICAO CORSIA default values for ILUC, and considered the CORSIA technical analysis behind default ILUC values as representative of international ILUC impacts, and thus adequate for ZEMBA's application to the maritime sector. Feedstock classification from CORSIA or EU RED II was used to determine eligibility of feedstocks to be treated as waste feedstocks, which would result in an ILUC value of zero gCO₂e/MJ. Additionally, the ZLCA Guidelines restricted the use of net negative carbon intensity values for out-of-sector emissions crediting such as soil carbon sequestration to align with current best practices in the voluntary market and SBTi.²⁵

Neither existing fuel certification standards nor the IMO LCA Guidelines incorporated monitoring and verification of fuel deployment at the time that ZEMBA was designing the inaugural tender. As a result, the ZLCA Guidelines expanded on the scope of existing fuel certification schemes to include fuel deployment information, including how far the vessel traveled and how much cargo the vessel carried while using zero-emission fuels.^[REDACTED]

2.3 Book and Claim

Book and claim is emerging as a useful tool for the private sector to accelerate decarbonization and appropriately claim emissions reductions across a range of hard-to-abate sectors, including the maritime sector. Book and claim systems can also facilitate greater confidence in zero-emission markets when properly implemented in a credible, transparent system.²⁶

Because the decoupling of environmental attributes from the zero-emission fuel service was integral to the design of ZEMBA's inaugural tender as discussed above, ZEMBA is supporting the creation of a first-of-its-kind non-profit²⁷ maritime book and claim mechanism to allow value chain actors to book and credibly claim emissions reductions associated with transactions for environmental attributes, including those facilitated through the inaugural ZEMBA tender. Several ZEMBA member companies, Aspen Institute staff, and consultants, as well as other actors across the maritime value chain, are working with the Maersk Mc-Kinney Møller Center for Zero Carbon Shipping, and RMI²⁸ on the development of this system with the intention to verify, account for, and credibly claim emissions reductions from the deployment of zero-emission shipping services from the maritime sector. Ultimately, ZEMBA will facilitate the usage of a specific book and claim system that follows best practices and is able to deliver the necessary functionality to execute the ZEMBA-related transactions.

²⁵ Science Based Targets Initiative. Available at: <https://sciencebasedtargets.org/> (Accessed: 5 June 2024).

²⁶ Getting to Zero Coalition (2023). "Accelerating Maritime Decarbonisation: A Book and Claim Chain of Custody System for the early transition to Zero-emission fuels in Shipping". Available at https://www.globalmaritimeforum.org/content/2023/03/Insight-brief_Accelerating-Maritime-Decarbonisation-A-Book-and-Claim-Chain-of-Custody-System.pdf (Accessed: 5 June 2024).

²⁷ It was important to ZEMBA to identify a book and claim system that is set up as a nonprofit, meaning that fees charged to use the system are intended only to cover costs. This will mitigate any potential profit-seeking practices that could risk incentivizing increasing units in the system and possibly decreasing integrity of the system.

²⁸ RMI, a non-profit organization formerly known as the Rocky Mountain Institute. For more information, visit <https://www.rmi.org>.

2.4 Aggregated Volume and Pricing

Through this inaugural tender, ZEMBA initially sought bids for 3.45 billion TEU-nm of zero-emission shipping services to be deployed over three years (2025-2027), or 1.15 billion TEU-nm per year. The ZEMBA team and its expert advisors conducted techno-economic modelling to identify the cost difference to carriers on a total cost of ownership basis for a vessel operating on a variety of potentially qualifying zero-emission fuels. This analysis was used to develop optional decision-making tools for ZEMBA member companies to use, as they deemed helpful, in determining their individual volume nominations. Individual volume nominations were later aggregated with the clear understanding that these were projected ranges and that the first commercial price for zero-emission shipping services would be the product of an open and competitive go-to-market exercise. This approach enabled ZEMBA to understand what available options could meet ZEMBA's ambitious 90% life cycle reduction threshold and then evaluate those options based on factors such as feedstock sustainability certification, confidence in bidder delivery, and economic efficiency.

Final confirmation of ZEMBA member volumes was an important step in the process designed to follow the conclusion of commercial negotiations and clarification of commercial details, including information about how the fuel would be deployed and what the "green premium" would be. The "green premium" is the additional amount cargo owners pay for environmental attributes of zero-emission shipping services through ZEMBA, relative to the baseline price for their normal maritime shipping services. To ensure that members would only cover the green premium associated with a fuel switch, and not any additional fees or charges associated with the use of fossil fuels or regulatory compliance, ZEMBA developed a bespoke pricing mechanism.

The ZEMBA tender required bidders to identify a price per TEU-nm. This price was considered along with a set of other factors in the bid evaluation process, and finalized through a commercial negotiation undertaken by a team composed of Aspen Institute staff and neutral technical experts. The criteria used in ZEMBA's evaluation of bids received were: compliance with ZEMBA's zero-emission fuels definition and ZLCA Guidelines, ability to meet ZEMBA's target volume, deployment timeline, a preference for deepwater transport, and economic efficiency. The evaluation of bids and negotiation of the final aggregated deal strictly did not include any ZEMBA member companies or members of the ZEMBA Board of Directors appointed by ZEMBA member companies. At the conclusion of negotiations by this team, Aspen Institute staff recommended the anonymized winner, as well as other leading bids, to the ZEMBA Board of Directors based on clear and neutral criteria. Once the Board of Directors decided on the winning bid, the team revealed the name of the winning carrier to the Board of Directors and ZEMBA member companies.

The winning bidder and final deal, announced in April 2024, represented 1.2 billion TEU-nm over two years, or 600 million TEU-nm per year. See Section 3 for more information about the winning bid and the reduction in contract length.

2.5 Contracting

ZEMBA's inaugural tender process will conclude with contractual commitments made bilaterally between ZEMBA member companies and the winning bidder. Given the novelty of this approach, the ZEMBA team and legal counsel prepared a template contract which

outlined certain technical terms that had been negotiated by the ZEMBA team and the winning bidder. The ZEMBA team then shared this template with each participating cargo owner, which they were not required to use, to expedite the individual cargo owners' final bilateral negotiations with the winning bidder and enable consistency, while still giving each ZEMBA member and the winning carrier the opportunity to tailor the contract to their needs.

The creation and use of a contract template was a key tool in managing the legal and logistical burden for the winning bidder and ZEMBA member companies, as well as facilitating bilateral contracting for a first-of-its-kind purchase in a nascent market. Additionally, ZEMBA's template contract provided assurances for any cargo owners less experienced in the maritime fuels market that the zero-emission services purchased through ZEMBA would be in line with the tendered specifications, delivered through a robust book and claim system, in fulfillment of ZEMBA's sustainability criteria, and be assured through third-party certification and verification processes.

2.6 Assurance Requirements: Certification, Monitoring, Reporting, and Verification

ZEMBA has developed a multi-layered approach to assure that the environmental attributes purchased through the ZEMBA tender meet its emissions reduction requirements and other criteria. ZEMBA's assurance approach relies on a combination of existing, best-in-class sustainability certifications, and an additional module ZEMBA created for verification of fuel deployment information. See Annex 4 for a chart that provides additional details about ZEMBA's assurance approach.

First, to comply with ZLCA Guidelines, all qualifying bids were required to procure fuel from a fuel supplier certified by an independent, third-party body. The certification body was required to be accredited by RSB, ISCC, or another accreditation body recognized by the European Commission,²⁹ and must apply an existing, stringent fuel certification scheme to verify a fuel's LCA value. Requiring this kind of third-party certification ensures that the bidder's fuel provider submits accurate information on an ongoing basis to meet the certification bodies' widely accepted and standardized parameters, which increases credibility and is a key component of ZEMBA's verification process.

Existing fuel certification standards accepted for ZEMBA's inaugural tender included RSB EU, RSB Global, ISCC EU, and ISCC Plus. All bidders were required to disclose which of these standards they would use to certify their fuel. In the process of evaluating and conferring this certification, a third-party sustainability certifier will ensure that all monitoring procedures, assumptions, calculations, and data associated with the bidder's final CO₂e intensity determination are compliant with the standards of the sustainability certification applicable to that fuel. In other words, the calculation of the final CO₂e intensity value of the fuel, which includes inputs from the entire chain of custody, from the point of feedstock collection to the point of fuel combustion, will be audited for data accuracy and adherence to the calculation methodology prescribed by the certification standard.

²⁹ Recognition by the European Commission signifies that a certification body is widely acceptable within this context. Including this requirement also streamlined the ZEMBA process, which otherwise would have been dramatically slower if a process of selectively vetting certification bodies had been taken.

Second, in order to calculate and confirm resulting emissions reductions, ZEMBA required bidders to provide information about fuel use.³⁰ This requirement reflects an understanding that the same fuel used in different vessels operated or deployed under different conditions can lead to wide variations in the actual CO₂e intensity. To address this, ZEMBA's template contract requires third-party verification of the carrier's fuel deployment, which is guided by a ZEMBA-built, bespoke assurance framework.³¹ ZEMBA's fuel deployment assurance framework, which draws on the standards of the EU Monitoring Reporting Verification (EU MRV) program,³² will require the reporting and verification of zero-emission fuel delivery and consumption, as well as distance traveled and cargo carried using zero-emission fuels. This third-party verification of the fuel deployment information is separate, and in addition to, the fuel LCA value certification, but prescribes a similar process in the absence of established and internationally recognized standard holders for this scope of verification.

Finally, the winning bidder is required to contract separately with a ZEMBA-approved classification society to monitor, report, and audit implementation of the final deal to ensure that the emissions reductions facilitated through this tender are in fact achieved. Under the ZEMBA framework, the classification society will consider information regarding fuel consumption, distance traveled, and cargo transported during the contract period.

3. ZEMBA Inaugural Tender Winning Bid

On 17 April 2024 at Singapore Maritime Week, ZEMBA announced Hapag-Lloyd, one of the world's leading container shipping companies, as the winning bidder of the inaugural tender. At the time of the announcement, more than a dozen ZEMBA members including Amazon, Patagonia, Tchibo, Bauhaus, Brooks Running, DB Journey, Green Worldwide Shipping, Meta, New Balance, lululemon, Nike, REI Co-op, and Sport-Thieme collectively committed to purchase the environmental attributes associated with nearly 1.2 billion TEU-nm of Hapag-Lloyd's exclusively waste-based biomethane service, which, at the conclusion of contracting, is expected to result in at least 82,000 metric tonnes CO₂e emissions avoided.³³

The tender initially sought bids for the environmental attributes of zero-emission shipping services over three years from 2025-2027. In light of the winning bid's reliance on biogenic feedstocks for the zero-emission service, ZEMBA's Board of Directors chose to reduce the length of the contract for the inaugural tender from three to two years (2025-2026). This

³⁰ While the CO₂e intensity of a zero-emission fuel in gCO₂e/MJ can be used to calculate the emissions associated with the fuel consumption, in order to calculate the emissions in gCO₂e/TEU-nm, distance traveled in nm, and cargo carried in TEU are required values.

³¹ Existing fuel certifications verify the life cycle CO₂e intensity of a fuel but not the transportation service provided using that fuel (e.g., cargo quantity carried and distance traveled). ZEMBA's template contract requires fuel deployment information because operational variables such as vessel utilization percentage, weather patterns, and speed can vary significantly and subsequently impact the fuel efficiency of a container vessel. Due to these operational variances, two units of fuel with the same life cycle CO₂e intensity may produce different emissions reductions depending on how they are used. Thus, the ZEMBA template contract requires an additional module of verification for these data.

³² The EU MRV Program was chosen as the most suitable reference for the ZEMBA assurance framework because it is an international regulation that outlines monitoring, reporting, and verification criteria specific to operational emissions in the maritime sector.

³³ Cargo Owners for Zero Emission Vessels (2024). Press Release. "Zero Emission Maritime Buyers Alliance (ZEMBA) Announces Successful Completion of Inaugural Collective Tender". Available at: <https://www.cozev.org/thelatest/zero-emission-maritime-buyers-alliance-zemba-announces-successful-completion-of-inaugural-collective-tender> (Accessed: 5 June 2024).

change reflected the ZEMBA Board of Directors' perspective that all fuels that rely heavily on biogenic feedstocks have scalability challenges that limit their viability as a long-term fuel solution for the maritime sector. This scalability challenge is especially acute for the most advanced, waste-based biofuels that avoid both land degradation and competition with human food supply. Reducing the length of the contract allows ZEMBA member companies the opportunity to leverage new technologies and e-fuels with more long-term scalability potential through ZEMBA's next tender, for which the contract term will likely begin in 2027.

Due to the commercially sensitive nature of the ZEMBA tender process, neither the pricing information for the winning bid nor the total monetary value of the cargo owners' collective ZEMBA commitment are available for disclosure. ZEMBA is confident that economies of scale, as well as investor interest, market development, and real emissions reduction were achieved beyond what any one cargo owner could have accomplished by acting alone.

3.1 Fuel and Technology Details

The winning bid of the inaugural tender demonstrated full compliance with ZEMBA's zero-emission fuel definition and ZLCA Guidelines. Compared to LSFO, the certified, exclusively waste-based biomethane service is expected to achieve a WtW CO₂e emissions reduction of greater than 90%, excluding pilot fuel. No new liquified natural gas (LNG)-related infrastructure or vessel reconstruction is needed to deploy the services associated with this bid.

The biomethane used in this deal will be sourced from a mix of waste feedstocks including landfill waste, dairy and swine manure, and organic waste, which will be blended to meet the specific CO₂e intensity threshold required by ZEMBA's zero-emission fuels definition. This fuel complies with the EU RED II standard, which outlines several sustainability criteria, and effectively mitigates the risks of competing with food supplies, contributing to forest degradation, and compounding other negative land use impacts. Avoided methane emissions associated with the use of manure as a feedstock for biomethane production are incorporated within the fuel's CO₂e intensity score and contribute to the fuel's ability to meet ZEMBA's emissions reduction threshold. This approach is acceptable under both the EU RED II standard and the ZLCA Guidelines and will be audited for compliance with the EU RED II requirements under the ISCC EU certification to be held by the fuel provider.

The biomethane will be delivered through the European gas grid using a mass balance chain of custody³⁴ approach compliant with EU RED II standards. ZEMBA considered alternative chain of custody options, such as physically segregating and delivering the fuel directly to the vessel, but doing so would have incurred higher costs and greater emissions to transport the fuel. Mass balance, when properly implemented, can be a high-integrity mechanism for tracking environmental attributes and is widely accepted in broader contexts (e.g., EU RED II).

³⁴ For more information on different chain of custody approaches, see ISEAL Alliance (2016). "Chain of custody models and definitions: A reference document for sustainability standards systems, and to complement ISEAL's Sustainability Claims Good Practice Guide". Available at: <https://www.isealalliance.org/get-involved/resources/iseal-guidance-chain-custody-models-and-definitions> (Accessed: 5 June 2024).

When using methane or methane-derived fuels, fugitive methane emissions must be considered. The ZLCA Guidelines required the use of FuelEU's³⁵ EU RED II or IMO's draft methane slip factors in the CO₂e intensity calculation. To evaluate the potential impacts of methane slip, ZEMBA conducted a sensitivity analysis on the CO₂e intensity impacts of varying methane slip assumptions with both the Fuel EU's EU RED II and the IMO's draft methane slip factors. An additional analysis was run using the methane slip factors recommended by the International Council on Clean Transportation (ICCT) in their "Fugitive and Unburned Methane Emissions from Ships (FUMES)" report.³⁶ The resulting analyses showed that the winning bid is in compliance with the 90% CO₂e intensity threshold required by ZEMBA's zero-emission fuels definition using any of the three organizational methane slip factors.

4. Reflections and Insights from ZEMBA's Inaugural Tender

ZEMBA's inaugural tender was designed to be an innovative, first-of-its-kind process for aggregating demand for zero- and near-zero emission shipping services from climate-leading multinational companies. The outcomes of this tender provide the first, real-time window into the readiness of the container shipping sector to provide these solutions through a competitive process and the near-term availability of fuels that can offer a 90% or greater reduction in WtW CO₂e emissions. Moreover, developing a new commercial process and required supporting guidance materials illuminated technical and regulatory gaps, and highlighted elements that are essential for creating an efficient and verifiable process to decarbonize the sector.

Through this process, ZEMBA sought, among other things, to maximize its emissions reduction impact through economies of scale, send signals about what customers of the shipping industry expect in terms of the pace and ambition of the sector's transition, and build confidence among fuel producers and policymakers to support the production and deployment of zero-emission maritime solutions. Additional key insights from ZEMBA's tender process follow.

There is strong interest and willingness among cargo customers, the container shipping sector, and fuel suppliers to reduce emissions quickly and adjust business models for longer-term impact.

Maritime decarbonization will require innovation and engagement across the shipping sector and supply chain. ZEMBA's tender attracted interest from carriers representing over 80% of container shipping worldwide, and multiple bids met ZEMBA's zero-emission definition using

³⁵ FuelEU Maritime is part of the EU's Fit for 55 package. Applying to ships of 5000 gross tonnage and above, the regulation enters into force on 1 January 2025 and will reduce the allowable GHG intensity of marine fuels from 2% in 2025 to 80% by 2050 (compared to a reference value of 91.16 gCO₂e/MJ). FuelEU Maritime covers 100% of energy used on voyages and port calls within the EU European Economic Area, and 50% of energy used on voyages into or out of the EU European Economic Area. EU (2023). Available at: <https://data.consilium.europa.eu/doc/document/PE-26-2023-INIT/en/pdf> (Accessed: 5 June 2024).

³⁶ Comer, et al. (2024). "Fugitive and Unburned Methane Emissions from Ships (FUMES): Characterizing Methane Emissions from LNG-Fueled Ships Using Drones, Helicopters, and On-Board Measurements". Available at: <https://theicct.org/publication/fumes-characterizing-methane-emissions-from-lng-fueled-ships-using-drones-helicopters-and-on-board-measurements-jan24/> (Accessed: 5 June 2024).

the ZLCA Guidelines. This outcome demonstrates that the market can deliver aggressive WtW CO₂e emissions reduction in the near-term. It also shows ZEMBA cargo owners' willingness to work in partnership across the supply chain. Moreover, the tender process showed that some maritime stakeholders are willing to innovate on elements of the maritime business model, like commercial and contractual arrangements, offtake agreements, and risk sharing.

Creating a viable pathway to maritime decarbonization requires both near-term emissions reductions and catalyzing investment in long-term scalable solutions.

A transition plan that fully decarbonizes the sector will be one that both secures near-term emissions reductions to address the accelerating severity of climate change and also immediately catalyzes investment in long-term scalable solutions. The winning waste-based biofuel bid enables ZEMBA members to realize significant scope 3 life cycle emissions reductions, starting in 2025. Moving forward, ZEMBA will strive to ensure that subsequent tender processes accommodate member needs for near-term emissions reduction, while also building the business case for long-term solutions that are not overly reliant on supply-constrained biogenic inputs.

This need for balance is also mirrored in the policy context. The results of ZEMBA's inaugural tender process underscore the urgency for international and domestic policy support as essential complements to propel the market past only bio-based fuels and close the zero-emission fuels price gap in the long term. Without first-mover investment and an ambitious policy landscape, the higher cost and lower availability of e-fuels will limit their production and deployment in the maritime sector, thereby risking a delayed and potentially disruptive transition that many cargo owners and other stakeholders would find unacceptable.

Current lack of market readiness for long-term scalable e-fuels and other technology solutions indicates an essential role for policy to address this barrier.

ZEMBA received no bids for e-fuels that could meet its criteria and no bids that used carbon capture and storage technology. The tender criteria, particularly its rapid deployment timeline, large aggregated volume target, and focus on deep sea transport, limited the viability of proposals supporting less mature and emerging technologies that were not yet at a point of operational maturity for commercial deployment. As noted, all bids that did meet ZEMBA's criteria relied on biogenic feedstocks, which have scalability limitations.

The outcome suggests that the link between demand signals for zero-emission solutions and the production and use of e-fuels, for example, is not a linear relationship. A key lesson learned through this process was that if carriers and fuel suppliers are to more effectively leverage the aggregated demand from cargo owners to invest in production of e-fuels, cargo owners may need to allow more time between finalizing their advanced market commitments and expected deployment, as well as considering longer-term offtake to enable e-fuel projects to reach final investment decisions.

ZEMBA's result further indicates that much stronger signals and efforts to de-risk investments are also needed from the public sector to build investor confidence in a broader base of future demand for zero-emission solutions and provide a credible pathway for the production, use, and scaling of e-fuels. It is unlikely to be sufficient to merely reduce the cost gap through policy intervention – comprehensive measures that achieve cost parity between conventional fuels and zero-emission fuels will be critical to the transition.

In the interest of ensuring ZEMBA's ability to support longer term scalable solutions such as e-fuels in the second tender, ZEMBA conducted a rigorous information-gathering exercise in summer 2024 to better understand the availability of e-fuels for maritime offtake starting in 2027 (see Section 5 for additional information). The responses to this information gathering exercise will help ZEMBA better understand the opportunities and limitations around the development of the e-fuel market over the next 3-5 years. Once available, the ZEMBA team hopes to share aggregated conclusions about market readiness.

The IMO has a key role to play in the development of robust, science-based LCA Guidelines and transparent certification requirements that provide market confidence for the transition to e-fuels.

During the tender process, the limitations of the existing IMO LCA Guidelines became apparent. These limitations required ZEMBA to develop the ZLCA Guidelines based on other existing regulatory standards, including EU RED II and ICAO CORSIA, and voluntary standards like RSB Global and ISCC Plus.

Robust LCA guidelines, and the resulting certification standards, must clearly prescribe treatment of ILUC, waste feedstock classifications and their upstream emissions calculations, allowable emissions credits, and any other input to an LCA calculation that could be open to interpretation under a WtW LCA approach. As one example relevant to ZEMBA, avoided emissions from capturing methane as a fuel feedstock were not addressed in the IMO LCA Guidelines at the time of the inaugural tender design. Furthermore, methane slip default factors are treated differently under the IMO draft Guidelines and the EU RED II, and new studies, such as the ICCT FUMES report, have shown that both sets of default factors may underestimate methane slip from certain engine technologies. Though this potential discrepancy was minimized in the ZEMBA deal by the specific engine type that will be used in deployment, the difference between established default values and emerging research illustrates that accurate accounting for methane slip is a key gap that the IMO will need to address.

Although ZEMBA was able to design and implement a comprehensive assurance process in its first tender, the lack of an existing assurance process specific to the maritime sector required ZEMBA to lean on the fuel certification standards developed in other policy frameworks like EU RED II and ICAO CORSIA. These policy frameworks have developed guidance which can be applied by accredited certification bodies using existing fuel certification standards.

Sustainability certifications like RSB EU and ISCC EU are generally familiar to carriers and fuel producers, and the existing framework of certification standard holders and their

accredited third-party certification bodies could be used to develop a global standard specific to the maritime sector. As suggested by a recent submission to the IMO by the Royal Institute of Naval Architects (RINA) (ISWG-GHG 16/3/1), drawing on the existing expertise and framework approaches of other regulating bodies such as ICAO and EU, may be a useful starting point in expediting the IMO's development of a certification scheme for the maritime sector and help to avoid duplicative efforts. Ultimately, ensuring that certification standards are robust, trusted throughout the value chain, and evaluated for continuous improvement will be essential to fulfilling their critical function in shipping's energy transition.

The role of voluntary private sector initiatives and regulation.

While voluntary initiatives alone cannot complete shipping's transition, they are critical for stimulating market change, creating innovative investment opportunities, and demonstrating that near-term emissions reductions from the maritime sector are possible. International and domestic policy is key to creating frameworks that drive the transition overall and support future voluntary initiatives. ZEMBA's first tender occurred prior to the adoption and implementation of the forthcoming IMO GHG reduction measures, due to enter into force in 2027, and before completion of the IMO LCA Guidelines. The lack of a formally accepted zero-emission definition, complete IMO LCA guidelines, and guidance on certification presented a number of challenges for ZEMBA's tendering process. In contrast, a similar voluntary initiative in the aviation sector by the Sustainable Aviation Buyers Alliance³⁷ was able to leverage their sector's international regulations and guidance. As the maritime sector's regulatory landscape evolves, it will inform future voluntary initiatives that can continue to provide an outlet for climate-leading maritime stakeholders to act. International policy can be facilitative of such initiatives and, in particular, further development of the IMO LCA guidelines and the definition of zero- and near-zero fuels, as well as guidance on certification will better enable the design of voluntary initiatives like ZEMBA.

Over the course of the Aspen team's work with cargo owners, some companies have expressed concern about their ability to count avoided emissions from book and claim approaches toward their corporate climate targets set through SBTi, a major voluntary corporate climate standing-setting organization. As of 9 April 2024 the Board of Trustees of the SBTi announced its intention to allow certain categories of EACs for emissions abatement purposes to count toward companies' Scope 3 emissions targets. This announcement provides a good indication to cargo owners who seek to be first movers in investing in zero-emission shipping services that their investments in zero-emission shipping through ZEMBA will count toward their science-based targets. ZEMBA looks forward to summer 2024 when SBTi is expected to issue an initial set of rules and implementation guidance for the use of EACs. Before and after the implementation of global GHG regulatory measures, GHG accounting for shipping's emissions will likely remain linked, at least in part, to the guidance and methodology of SBTi, indicating that this is an important arena for policymakers to track.

³⁷ The Sustainable Aviation Buyers Alliance (SABA) is an initiative similar to coZEV and ZEMBA working in the aviation sector and "is accelerating the path to net-zero aviation by driving investment in, and adoption of, high-integrity sustainable aviation fuel and supporting companies, airlines and freight customers in achieving their climate goals." Sustainable Aviation Buyers Alliance. Available at: <https://flysaba.org/about-saba/> (Accessed: 5 June 2024).

5. Next Steps for ZEMBA

By going to market with the first-ever collective procurement exercise for zero-emission shipping services, ZEMBA's inaugural tender revealed valuable insights about the maturity of the market for zero-emission maritime fuels. ZEMBA is carefully considering these lessons to inform its approach to future tenders. While the winning biomethane bid met ZEMBA's decision-making criteria as specified in the first tender, showing that immediate life cycle emissions reductions above 90% are possible now, the maritime sector will need to quickly accelerate a transition to additional fuels and technologies that no longer rely on biogenic feedstocks in order to ensure a smooth and scalable decarbonization trajectory. Catalyzing uptake of these fuels for maritime decarbonization is a key motivator for ZEMBA to adjust its next tender specifications to focus on e-fuels.

ZEMBA is working to determine how it can best support the nascent e-fuel market through its subsequent tenders. An important first step in this process was to conduct a robust information-gathering exercise, issuing an RFI to more deeply examine the potential availability of e-fuels for maritime offtake. This effort included seeking information from fuel producers about the total volume of e-fuels anticipated to be available for maritime offtake starting in 2027, including e-methanol, e-ammonia, e-methane, and e-hydrogen. The RFI asked about project status, fuel volumes available, emissions reduction potential, and geography. The RFI also sought key information from carriers about e-fuel capable vessels expected to be ready for service in and around 2027, including where they will be deployed, and which fuels they will use. Ultimately, the RFI was intended to provide a core set of data and enable a better understanding of the barriers e-fuel production projects currently face in initiating and scaling production. Responses will also inform what roles ZEMBA could play, if any, to address these issues.

To ensure it is achieving its goal of catalyzing the market for long-term zero-emission solutions, ZEMBA will revisit design decisions based on the RFI results and feedback from the first-round results, including the zero-emission fuels definition and ZLCA Guidelines. For example, ZEMBA may consider establishing a minimum percentage of e-fuels to more directly stimulate uptake, using both GWP20 and GWP100 values when assessing fuels' life cycle emissions,³⁸ and including pilot fuels in a revised zero-emission fuels definition.³⁹ Other design options that ZEMBA will consider in the next tender include lengthening the contract duration, awarding multiple winners, redefining qualifying consortium bids, revisiting the preference for deep sea routes, incentivizing the development of e-fuel infrastructure in the maritime sector, and supporting geographically-specific fuel development.

An additional and overarching goal of this next tender is to increase the initiative's impact by expanding cargo owner participation. ZEMBA will also explore the feasibility of expanding to

³⁸ While GWP100 was chosen for the inaugural tender, there is a possibility of assessing fuels against a shorter Global Warming Potential time horizon of 20 years. ZEMBA will consider this in its design of the second tender.

³⁹ While pilot fuels were not included in the zero-emission fuels definition for the first tender, ZEMBA will consider their inclusion in the second tender.

other segments of the shipping industry, like bulk shipping or car carriers, on the buyer and/or supplier side of the commercial relationship.⁴⁰

6. Conclusion

With the launch of its inaugural tender in 2023, ZEMBA set a high bar for procurement of zero- and near-zero deep-sea transport and will continue to increase its ambition over time. In doing so, ZEMBA is demonstrating to all actors in the shipping value chain that best-in-class standards for fuel certification, service verification, and high-integrity processes to ensure credibility of claims are attainable now in container shipping. ZEMBA's collective procurement provides important evidence of demand and allows cargo owners that are newer to maritime decarbonization to confidently invest in a robust and verified shipping decarbonization service, which helps amplify this demand signal.

Importantly, ZEMBA has demonstrated that the process of aggregating cargo owner demand and going to market through an open competitive process works. This initial success sets the stage for continuous refinement in subsequent tenders so that ZEMBA can continue to support the nascent market for zero-emission solutions and push the boundaries of what is technically and economically possible in maritime decarbonization over time.

The bids that ZEMBA received through its inaugural tender suggest that the current policy landscape and market conditions favor fuels with biogenic feedstocks. Based on this tender, a combination of refining ZEMBA's procurement approach, enhancing its role as a market catalyst, and securing robust policy support is needed to expand the fuels options available to the maritime sector beyond only bio-based fuels and incentivize the production and commercial deployment of e-fuels.

In addition to demonstrating the utility of demand aggregation to accelerate maritime decarbonization, the outcomes of the inaugural ZEMBA tender process highlights two essential points:

1. The private sector can exceed current regulatory requirements, provide confidence for businesses and policymakers to act ambitiously, and break new ground, but the voluntary market alone cannot prompt a sustained industry-wide transition. The transition's success is reliant on the development of global and domestic policy measures to create a credible, comprehensive framework that builds on private sector momentum, incentivizes early investments in long-term solutions, and supports systems-wide transitions.
2. The policy measures that will drive the transition are dependent on a robust methodology to calculate the full life cycle emissions from new, cleaner fuels and a system capable of certifying and verifying these reductions.

We are at a pivotal moment in shipping's energy transition, whereby the actions taken by policymakers and the shipping sector will have an impact on how close the international shipping community is to fulfilling its decarbonization goals. ZEMBA has shown that it is

⁴⁰ The design options and inclusion of sectors beyond container shipping for future tenders will be a function of practical constraints on the initiative. The main aim is to continue to learn from this experience and improve the initiative within the mission of helping to accelerate maritime decarbonization.

possible to forge a transition pathway that is ambitious and feasible, and looks forward to continuing to work with stakeholders and policymakers to positively shape the next era of maritime shipping.

ANNEXES

ANNEX 1: ZEMBA Zero-Emission Fuels Definition

Available at: <https://www.cozev.org/pdfs/ZEMBA-Fuel-Definition.pdf> (Accessed: 5 June 2024).

Context

The RFP includes ZEMBA's definition of Zero Emissions Fuels. To support Respondents in identifying compliant fuels, please also see the additional details below the main definition, which is copied again here in bold for ease of reference. Please note that ZEMBA may adjust this definition under future RFPs as the market for alternative maritime fuels grows and more options become available.

Definition

“Zero Emission” fuels have the potential to achieve GHG (CO₂, CH₄ and N₂O) emission reductions equal to or greater than 90% when compared to the reference fuel (LSFO-R). The methodology for the calculation of the Well-to Wake “WtW” GHG emissions life-cycle assessment (LCA) value will be based on the IMO LCA Guidelines^[1] and is further explained in ZEMBA RFP Attachment B. The units will be gCO₂(eq)/MJ of fuel.

- Reference fuel:
 - Low Sulfur Fuel Oil of pure residual type (LSFO-R) such as Heavy Fuel Oil (HFO) or Light Fuel Oil (LFO) (RM grades based on ISO 8217:2017) with sulfur levels S>0.5%
 - The Well-to-Wake (WtW) baseline emission factor is 92.36 g CO₂(eq) / MJ (LCV = 40200 kJ / kg)^[2]
- LCA values must reflect 100-year Global Warming Potential (GWP 100) and be expressed in CO₂ equivalent units in accordance with the 5th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC).
- Geological sequestration of CO₂ captured at a processing unit in the supply chain processing the fuel's raw materials and finished fuel products can be deducted from the LCA value of the fuel up to a value of zero, as long as all other fuel requirements are met.
- GHG emissions from Pilot fuel in Main Engines and Diesel Generators will not be included in the LCA value.
- Emissions from onboard electricity generation and transportation and distribution must be included in the submitted total LCA value as well as submitted in disaggregated form. Given challenges in securing zero emission fuel at this time, the treatment of these emissions will be considered after proposals have been received and evaluated.

“Zero Emission” fuels shall be derived from sustainable and/or waste, residual, or byproduct feedstock sources including hydrogen and captured CO₂. Fuel suppliers must be certified to a relevant sustainability standard by an independent certification body accredited to one of the following sustainability standard holders: the Roundtable on Sustainable Biomaterials (RSB), the International Sustainability and Carbon Certification (ISCC) or another standard holder recognized by the European Commission.

- CO₂ used as a feedstock may be sourced from direct air capture (DAC), biogenic sources, or industrial sources. If sourced from industrial or biogenic sources, the source facility may not also claim the CO₂ as reductions. In a future RFP, ZEMBA may elect to disallow industrially sourced CO₂.
- Example standards include RSB Global and ISCC Plus. If in doubt, please contact ZEMBA to confirm whether a fuel sustainability certification meets this criterion.

“Zero Emission” fuels, including any relevant feedstocks (e.g. hydrogen), shall be produced using renewable energy or another non-fossil, low-carbon energy source.

- Renewable energy may be obtained via Virtual Power Purchase Agreements (VPPAs) or Renewable Energy Certificates (RECs). ZEMBA does not require assessment of the “additionality” of the energy sources used pursuant to this RFP. In a future RFP, however, ZEMBA may elect to place additional restrictions on the sourcing of renewable energy and its attributes.
- Some sustainability certification standards may place additional sourcing requirements on renewable energy, which must be followed in order to achieve those certifications.

“Zero Emission” fuels must be sufficiently scalable to make a meaningful contribution to the decarbonization of the maritime shipping industry as determined by ZEMBA and must have safety concerns addressed.

- No clarifications required.

^[1] Contained in IMO Resolution MEPC376(80) and further explained in ZEMBA RFP Attachment B

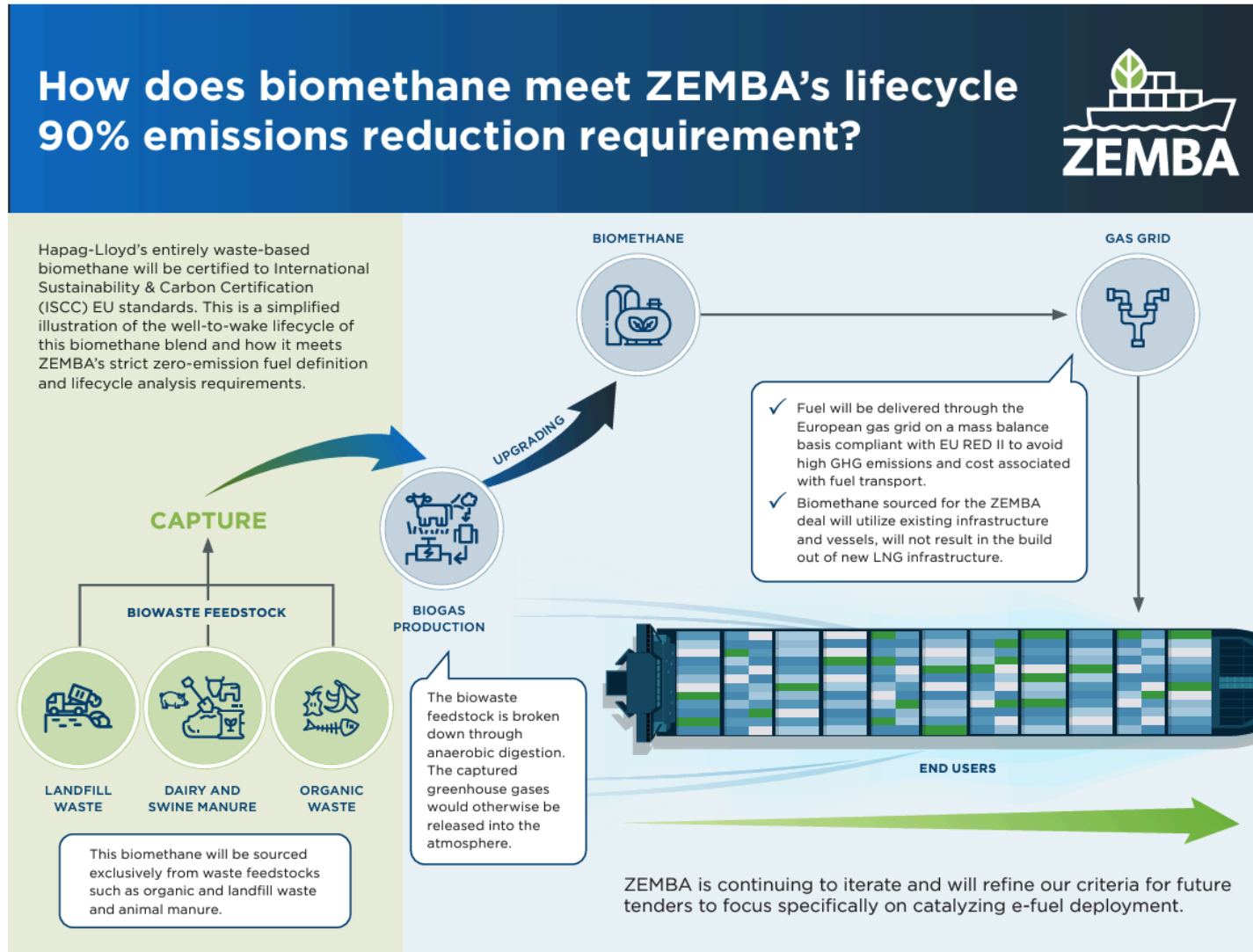
^[2] **Reference:** document *IMO MEPC 80/7/4, Annex I* with title “*Draft guidelines on lifecycle intensity of marine fuels*” – upcoming *Resolution MEPC 376(80)*.

ANNEX 2: Link to ZEMBA LCA Guidelines and Proposal Requirements

Available at:

<https://www.cozev.org/img/3.-Attachment-B-ZEMBA-LCA-Guidelines-and-Proposal-Requirements.pdf> (Accessed: 5 June 2024).

ANNEX 3: ZEMBA Biomethane Graphic



ANNEX 4: ZEMBA Bid Verification: CO₂e Intensity Validation and Verification, Assurance Structure, and Diversified Roles and Responsibilities

