

E-diesel

Alternative maritime fuel information sheets
Document 7 of 8



Mærsk Mc-Kinney Møller Center
for Zero Carbon Shipping

About this document

Shipowners, managers, and operators face considerable uncertainty when selecting low-emissions fuels and technologies to meet decarbonization targets and comply with regulations. Transitioning from fossil-based fuels to low-emissions alternatives is essential for shipping's decarbonization. While several fuel options can reduce greenhouse gas (GHG) emissions, each has distinct strengths and limitations in terms of emissions, scalability, technological maturity, and cost — there is no silver bullet solution.

To navigate the uncertainty around fuel selection, the Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping (MMMCZCS) has developed a set of information summaries on eight alternative maritime fuels. These summaries provide a snapshot overview of the risks and opportunities associated with e-ammonia, blue ammonia, e-methanol, bio-methanol, e-methane, bio-methane, e-diesel, and biodiesel. The shared information is based on a collation of analysis and insights from several sources, including previous MMMCZCS research projects and insights from interviews we conducted with industry experts at our partner organizations.

Readers can use these fuel snapshots to identify key aspects that deserve close attention when evaluating and comparing alternative fuels for future fleet fueling strategies.

Each information summary is organized into four main subject areas that support evaluation across the eight fuel pathways:

- [Sustainability considerations](#)
- [Fuel availability potential](#)
- [Maritime uptake](#)
- [Commercial considerations](#)

This document focuses on [e-diesel](#). For additional insights into alternative maritime fuels towards 2050, we encourage readers to take a look at the [MMMCZCS fuel pathway maturity map](#) on our website.

Nothing in these information sheets shall be taken as advice, predictions, or recommendations, and readers should read the disclaimer before using the information sheets.

Acknowledgements

This information sheet was prepared by the Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping (MMMCZCS) with assistance from our partners. Contributors marked with an asterisk (*) were seconded to the MMMCZCS from their home organization and contributed in a research capacity under the supervision and direction of MMMCZCS.

Writing led by Annalicia Poehler and Nikolaj Enevoldsen (both MMMCZCS); editorial review by Matilda Handsley-Davis and Jazelyn Rivas Rosende (both MMMCZCS); layout and design by Julia Garbowska (MMMCZCS); project steering by Estela Vazquez Esmerode and Christoffer Lythcke-Elberling (both MMMCZCS). Thanks to Maria Grammatikou (MMMCZCS) and Tobias Kleinke* (Hapag-Lloyd) for assistance with preparing the publications and to all colleagues at the MMMCZCS and partner organizations who contributed expert knowledge to the project.

Disclaimer

This publication has been prepared by Fonden Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping ("Center") for informational purposes only. The Center acts as a neutral facilitator. This material presents non-confidential, public-source and/or modeled information for general understanding. Nothing herein constitutes advice, a recommendation, or guidance on individual commercial strategy. The content herein is based on studies, research, and analyses conducted by the Center, as well as publicly available information as of the date of publication. While the Center has made every effort to ensure the accuracy and reliability of the information presented, it does not guarantee or warrant, either expressly or impliedly, the completeness, accuracy, or suitability of this information for any specific purpose.

This publication is not intended to serve as technical, regulatory, commercial, legal or other advice. Readers are encouraged to consult with their advisors before making any decisions or taking actions based on the information contained herein. Compliance with applicable laws, regulations, and standards, including but not limited to those related to safety, environmental protection, and design requirements, remains the sole responsibility of the reader. The Center disclaims all liability, whether in contract, tort (including negligence), or otherwise, for any damages, losses, errors, or injuries, whether direct, indirect, incidental, or consequential, arising from the use of, or reliance on, the information contained in this publication. By accessing this publication, readers acknowledge and agree to the terms of this disclaimer and release the Center from any liability associated with the use of the information provided herein.



Sustainability considerations

- Similar to other alternative fuels, e-diesel is expected to be subject to sustainability compliance. However, the industry currently lacks mandatory and harmonized criteria – particularly regarding life-cycle assessment (LCA) methodologies for emerging options, including e-diesel.
- Besides climate impact, notably based on electricity and carbon sources, (see 'Life cycle GHG emissions,' below), the main sustainability risks from this fuel include:
 - Risks including land use change, biodiversity losses, and increased emissions can arise if carbon dioxide (CO₂) used for e-diesel production is not sustainably sourced.¹ Examples of alternative (sustainable) CO₂ sources include direct air capture (DAC) and direct ocean capture (DOC).
 - Moreover, e-diesel production requires significant resources, including land, water, and low-emissions electricity (see 'Fuel availability potential'). Depending on the production method and location, this resource demand can also lead to sustainability risks associated with land use changes, freshwater change, biodiversity loss, and conflicts surrounding land and water use rights, especially in water-scarce regions or during water-scarce seasons.^{2,3,4}
- Since e-methanol can be a feedstock for e-diesel, the sustainability considerations in our accompanying alternative maritime fuel information sheet on e-methanol are also relevant to e-diesel.⁵

Life cycle GHG emissions

- Life cycle emissions include all GHGs released across the full value chain – from feedstock and resource extraction, to transportation of the fuel to market, and final use on board the vessel.
- For e-diesel, life cycle GHG emission intensity is typically in the range of 1-10 g CO₂eq/MJ,^a depending on the carbon source, electricity mix, and production efficiency.^{6,7} Publicly available reported data remains limited, as e-diesel production pathways are still in the early stages of development.
- The main drivers of life cycle emissions are associated with electricity used for hydrogen production through electrolysis and the capture and processing of CO₂ to synthesize hydrocarbons. The overall emissions profile is therefore strongly influenced by the GHG intensity of the power supply and whether the CO₂ source is biogenic, captured, or derived from industrial processes.⁸
 - Like other carbon-containing e-fuels, e-diesel can achieve near-zero life cycle GHG emissions when produced using renewable electricity and biogenic or captured CO₂. Conversely, use of high-GHG-intensity electricity or industrial CO₂ substantially increases the fuel's GHG intensity, reducing the climate benefit.
 - E-diesel combustion produces CO₂. These emissions are considered carbon-neutral provided that the carbon originates from biogenic or atmospheric sources, as the CO₂ released during combustion roughly corresponds to carbon previously removed from the atmosphere.
- LCA is essential for evidence-based decision making, as it provides transparency on a fuel's full emissions profile of a fuel. Results can vary depending on methodological choices and data sources. Accurate descriptions of the system boundaries and assumptions are necessary for comparisons.

^a g CO₂eq/MJ = grams of carbon dioxide-equivalent per megajoule of energy



Fuel availability potential

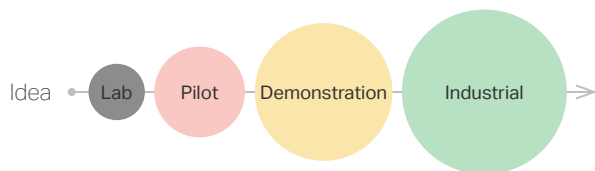
- Feedstock availability

E-diesel can be produced via two pathways:

- The main feedstocks for the Fischer-Tropsch pathway are low-emissions electricity, water, and biogenic CO₂ (typically a waste stream generated by combustion of biomass).
- The main feedstocks for the e-methanol pathway are e-methanol and e-hydrogen.

The availability of low-emissions electricity and renewably sourced (biogenic) CO₂ at the required scale are key challenges for both e-diesel pathways. CO₂ removal techniques such as DAC and DOC can offer an alternative source of carbon feedstock – however, we do not consider these options extensively here, as the technologies are still in the demonstration phase (see 'Industrial maturity').

- Industrial maturity



- Carbon capture system for biogenic CO₂: industrial⁹
- Carbon removal systems (DAC and DOC): demonstration¹⁰
- Electrolysis technologies: demonstration to industrial^{11,12}
- E-diesel synthesis from e-methanol: demonstration¹³
- Fischer-Tropsch synthesis: industrial¹³

- Infrastructure requirements

Renewable electricity generation; electrolyzer capacity; biogenic CO₂ capture and transport infrastructure; and synthesis, upgrading, and refining facilities for e-diesel.

- To support industrial-scale e-diesel production, the manufacturing rate for electrolyzers needs to be optimized and scaled up.¹⁴ Doing so will reduce costs and ensure the production of sufficient quantities of e-hydrogen.
- Development for most catalytic synthesis plants requires 5-6 years. This timeline includes permitting as well as engineering, procurement, and construction activities for both the catalytic facilities and the associated supporting infrastructure. However, development timelines for e-diesel pathways may be longer due to the limited experience and application of these technologies at industrial scale.^{15,16}
- Biogenic CO₂ feedstock is available from existing industries, but e-fuel production would additionally require capture, storage, and transport of this CO₂.⁹ Biogenic CO₂ transport can be through either pipeline (limited infrastructure) or truck (limited capacities).
- Producing e-diesel fuel at scale will also require significant expansion of renewable electricity supply, electrical balancing, and transmission lines.
- E-diesel can utilize existing infrastructure and facilities for diesel transport, storage, bunkering, and onboard use.¹⁷



Maritime uptake

Safety

- E-diesel's properties closely resemble those of conventional maritime fuels.
- Technology and safe operations are mature and not considered a challenge.¹⁸

Vessel technology

- As much of the existing fleet can already use diesel, we do not expect e-diesel to present new challenges or requirements for shipyards.¹⁹

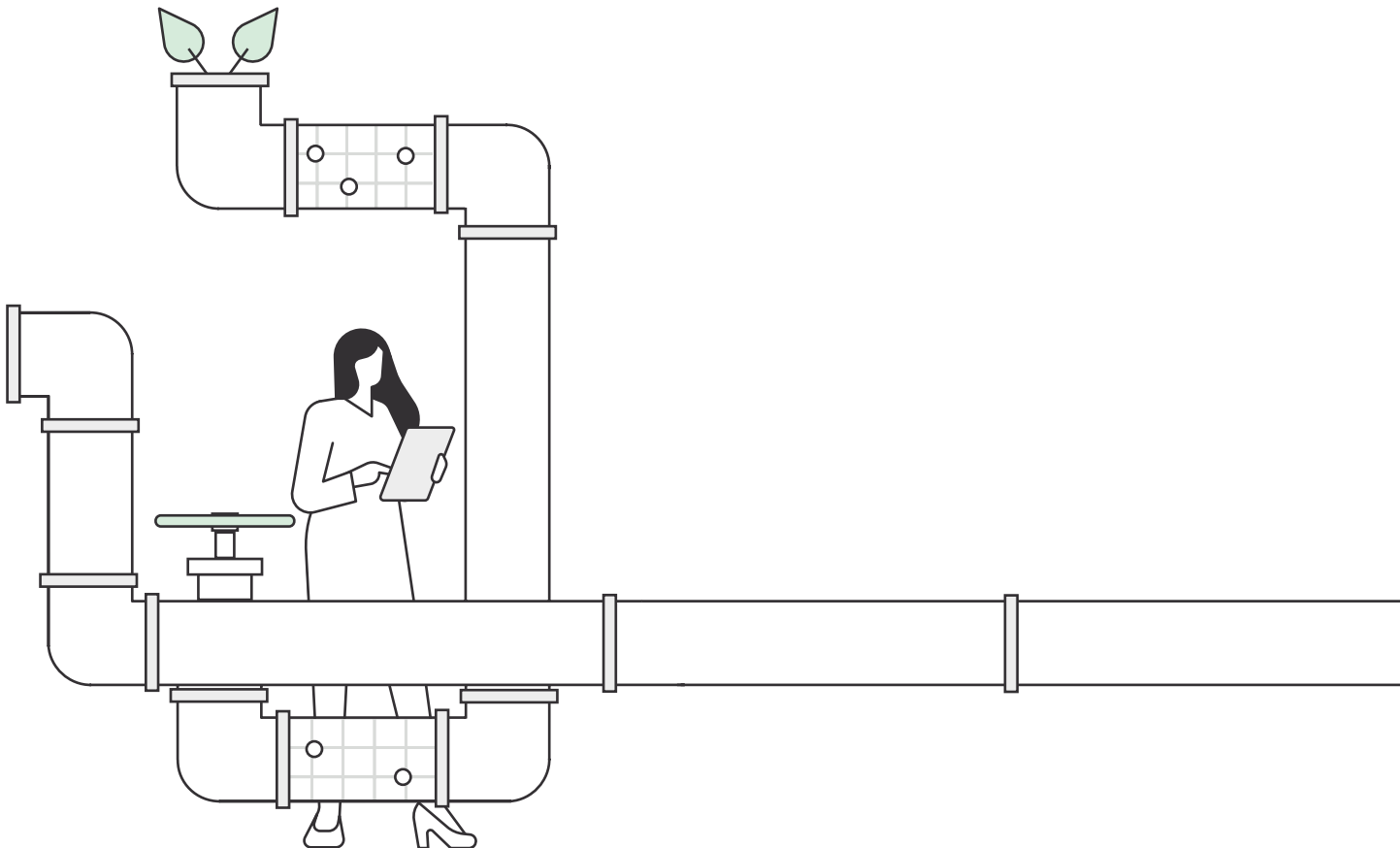
Logistics, storage, and bunkering

- We expect that e-diesel will be able to use the same equipment as conventional diesel for storage, bunkering, and onboard use. Bunkering guidelines need to be defined and demonstrated.

Commercial considerations

Regulatory and certification

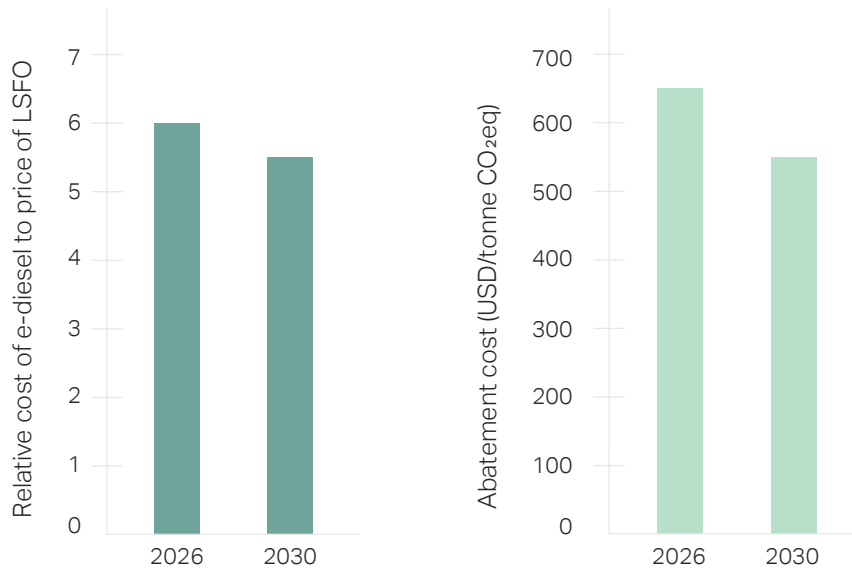
- The IMO Net-Zero Framework is a set of technical and economic measures aimed at delivering emissions reductions according to the IMO's 2023 GHG Strategy. The timeline for the framework's adoption and implementation remains to be finalized.²⁰
- Final guidance on quantification of well-to-wake GHG emissions from fuels and the sustainability criteria are still under development by the IMO.²¹ These guidelines will be combined with the development of certification schemes to ensure that the utilized alternative fuels are produced according to a set of sustainability requirements and reduce GHG emissions.
- As e-diesel has the same composition as conventional diesel, it should comply with the same standards and procedures for use on board ships.



Cost and market development

- Production costs for e-diesel are estimated to be 6 times the price of LSFO per unit energy in 2026 and 5.5 times the price of LSFO per unit energy in 2030.^b
- The estimated abatement cost is around 650 USD/tonne CO₂eq avoided emissions in 2026 and 550 USD/tonne CO₂eq avoided emissions in 2030, excluding vessel cost.^b
- We expect the chemicals industry to be the main competitor for e-diesel and for methanol as a possible feedstock.²²
- Biogenic CO₂ can also be permanently stored or used to produce e-SAF.^c We expect these applications to compete with e-methanol and e-diesel production for access to biogenic CO₂.^{9, 23, 24}

Figure 1: Modeled cost (left) and abatement cost (right) for e-diesel in 2026 and 2030. Values are illustrative outputs from analytical modeling using an assumed levelized cost of electricity of 30-40 USD/MWh. Values do not represent market prices or forecasts.



^b These figures are model-based estimates provided for analytical context only and do not represent market prices or forecasts.

^c SAF = sustainable aviation fuel



References

- ¹ [Souissi, N. E-diesel in the shipping sector: Prospects and challenges. Oxford Institute for Energy Studies \(2024\).](#)
- ² [Grahn, M., Malmgren, E., Korberg, A. D., Taljegard, M., Anderson, J. E., Brynolf, S., Hansson, J., Iva Ridjan Skov, I. R. & Wallington, T. J. Review of electrofuel feasibility—cost and environmental impact. *Progress in Energy* 4 \(2022\).](#)
- ³ [Grubert, E. Water consumption from electrolytic hydrogen in a carbon-neutral US energy system. *Cleaner Production Letters* 4 \(2023\).](#)
- ⁴ [The Oxford Institute for Energy Studies. Fueling the future: A techno-economic evaluation of e-ammonia production for marine applications \(2024\).](#)
- ⁵ [Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping. Alternative maritime fuel information sheets: e-methanol \(2026\).](#)
- ⁶ [Singh, H. et al. A critical review of technologies, costs, and projects for production of carbon-neutral liquid e-fuels from hydrogen and captured CO₂. *Energy Advances* 1: 580 \(2022\).](#)
- ⁷ [Ellis, T. E-fuels: A Challenging Journey To A Low-Carbon Future. S&P Global \(2024\).](#)
- ⁸ [Edwards, R. et al. JEC well-to-wheels analysis: well-to-wheels analysis of future automotive fuels and powertrains in the European context \(version 4.1\). JEC Consortium \(2014\).](#)
- ⁹ [Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping. Global Availability of Biogenic CO₂ and Implications for Maritime Decarbonization \(2024\).](#)
- ¹⁰ [International Energy Agency. Direct Air Capture: A Key Technology for Net Zero \(2022\).](#)
- ¹¹ [International Energy Agency. Electrolysers - Energy System - IEA \(2025\).](#)
- ¹² [National Renewable Energy Laboratory. H2A: Hydrogen Analysis Production Models | Hydrogen and Fuel Cells \(2020\).](#)
- ¹³ [Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping. Internal interview with industrial partner \(2023\).](#)
- ¹⁴ [Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping. Fuel Pathway Maturity Map: e-diesel – fuel production \(2024\).](#)
- ¹⁵ [Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping. Biogas as a Source of Biofuels for Shipping \(2024\); reference to catalytic plants on page 28 and 29.](#)
- ¹⁶ [Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping. Fuel Pathways Maturity Map: e-diesel – feedstock availability \(2024\).](#)
- ¹⁷ [Scarborough, T. & Longva, T. Study on the Readiness and Availability of Low- and zero-Carbon Technology and Marine Fuels: Update and Preliminary Outputs \(2023\).](#)
- ¹⁸ [Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping. Fuel Pathway Maturity Map: e-diesel – onboard safety and operations \(2024\).](#)
- ¹⁹ [Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping. Internal interviews with shipbrokers and ship manufacturers \(2024\).](#)
- ²⁰ [International Maritime Organization. IMO net-zero shipping talks to resume in 2026 \(2025\).](#)
- ²¹ [International Maritime Organization. 2023 IMO Strategy on Reduction of GHG Emissions from Ships \(2023\).](#)
- ²² [IRENA & Methanol Institute. Innovation Outlook: Renewable Methanol. International Renewable Energy Agency \(2021\).](#)
- ²³ [Søren Mikkelsen. e-SAF offers much promise within Sustainable Aviation Fuels | TOPSOE blog \(2024\).](#)
- ²⁴ [Skov, I. R. & Abid, H. Renewable Aviation E-SAF Catalogue and System Impacts \(2024\).](#)



Go to these links to learn about other alternative maritime fuels.

Document 1: [E-ammonia](#).



Document 5: [E-methane](#).



Document 2: [Blue ammonia](#).



Document 6: [Bio-methane](#).



Document 3: [E-methanol](#).



Document 8: [Biodiesel](#).



Document 4: [Bio-methanol](#).



For more, visit
www.zerocarbonshipping.com



Mærsk Mc-Kinney Møller Center
for Zero Carbon Shipping

Copyright Notice: ©2026 Fonden Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping. All Rights Reserved. Any publication, display or reference (in whole or in part) of or to this report, shall be made conditional on inclusion of a reference to the Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping.