

High science on the high seas

Advancing new technologies for lower-emission fuels



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This document includes forward looking statements. Actual future conditions and results (including but not limited to energy demand, energy supply, the relative mix of energy across sources, sectors of the economy and geographic regions) could differ materially from the statements provided herein. In addition, the full Advancing Climate Solutions 2022 Progress Report can be found [here](#), including important cautionary statements. Exxon Mobil Corporation has numerous affiliates, many with names that include ExxonMobil, Exxon, Mobil, Esso, and XTO. For convenience and simplicity, those terms and terms such as Corporation, company, our, we, and its are sometimes used as abbreviated references to specific affiliates or affiliate groups. Abbreviated references describing global or regional operational organizations, and global or regional business lines are also sometimes used for convenience and simplicity. Nothing contained herein is intended to override the corporate separateness of affiliated companies.



“We’ll continue to innovate and provide solutions that meet the growing needs of society, including its net-zero emissions ambitions, by fully leveraging our competitive advantages of scale, integration, technology, functional excellence, and our highly skilled people.”

Darren W. Woods
ExxonMobil Chairman & CEO

The energy transition

ExxonMobil's commitment to driving emission reductions in support of a net-zero future.

ExxonMobil is committed to helping society reduce overall greenhouse gas emissions by decreasing our emissions and by developing and deploying emission-reducing technologies and products. We have been a leader in innovation for more than 130 years, supplying products that people need to live healthy, prosperous lives in an ever-changing world.

As a major marine fuel supplier, ExxonMobil supports the International Maritime Organization (IMO) with a plan to be part of the solution. Our commitment to driving emission reductions in support of a net-zero future is outlined in our [Advancing Climate Solutions – 2022 Progress Report](#).

We plan to invest more than \$15 billion on initiatives to reduce greenhouse gas emissions, with a significant share focused on biofuels, carbon capture storage, and hydrogen by 2027.

Our objective is to provide more than 40,000 barrels per day (2.3 million metric tons p.a.) of lower-emission fuels by 2025 and have a further goal of 200,000 barrels per day (11.3 million metric tons p.a.) by 2030.

Through the development of new projects, repurposing refinery infrastructure, co-processing bio-feeds, executing purchase agreements, utilizing existing and exploring new CCS technologies, we are advancing a number of options for producing lower-emission solutions.

Commercially viable alternatives along with energy-efficient process technology, will play an essential role in helping achieve the transition to a net-zero future.

Components of a path to net-zero include:

- | | |
|---|---|
|  Equipment upgrades |  Renewable power agreements |
|  Technology improvements & development |  Supportive government policy |
|  Electrification |  2030 emission-reduction plans |

The need for lower-emission solutions

A path to greenhouse gas emissions reduction



The International Maritime Organization (IMO) aims to reduce the carbon intensity of international shipping by at least 40% by 2030, moving to 70% by 2050, compared with 2008¹.

While the shipping industry is under increasing pressure to reduce greenhouse gas (GHG) emissions, substantial emission reductions in the coming decades are likely to require additional technology development and the introduction of lower carbon fuels.

Ship owners will select fuel based on individual circumstances such as their routes, vessel sizes and geographical location.

Increased cooperation, communication and consultation among various stakeholders, will likely be necessary to fulfill the IMO's ambitions. While some emerging technologies have matured in the interim, we will continue to work closely with customers to help determine their best route towards meeting the IMO's ambitious goals.

ExxonMobil marine

Planning to play a leading role in the energy transition

ExxonMobil has supplied high-quality fuels, provided technical expertise and supported regulatory compliance to the marine industry for more than 50 years.

Quality, reliability and innovation are the three values that continue to define ExxonMobil's global commitment to our customers. The Company is committed to providing and improving critical products while working toward IMO targets, and creating greater value for all its stakeholders.

To date, our recent marine innovations include pioneering the use of third-party accredited Mass Flow Metering systems (MFMS) and

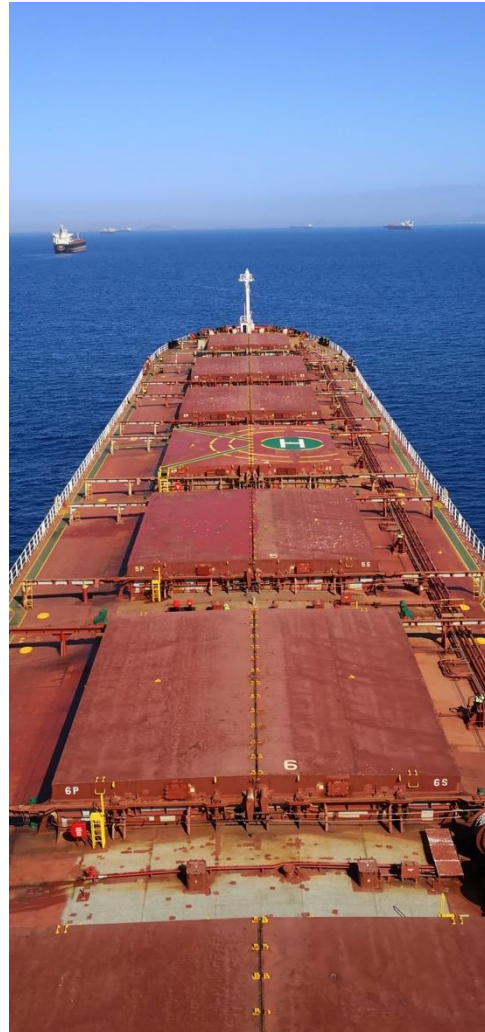
the development of branded fuels such as **Premium HDME 50™**, a fuel that complies with ECA 0.10% sulfur limits; **EMF.5™**, which can safeguard engines running on 0.50% sulfur fuels; and **BMF.5™**, our fuel oil and biodiesel blend, which is a 0.50% sulfur residual-based fuel (VLSFO), processed with a second generation waste-based FAME component and has the potential of up to 34% reduction in Well-to-Wake GHG emissions*.

A successful sea trial of **BMF.5™** took place with shipping company Stena Bulk bunkered in the port of Rotterdam. The trial demonstrated that **BMF.5™** can be used in a relevant marine application without

*Benefit is up to 34 percent compared with conventional petroleum-based HFO/VLSFO, calculated on an energy basis. Well-to-Wake GHG emissions reduction calculated using the rules as published in the Directive 2009/30/EC of the European Parliament and of the Council Annex IV A and EN 16258. Actual values are reported from purchases of Annex IX part A feedstock as supplied to ExxonMobil in Europe in 2020.

engine modification. The sea trial was designed and completed as part of ExxonMobil's assessment and trial protocol to demonstrate no adverse equipment effects when operating with higher levels of bio components. ExxonMobil's new marine biofuel oil meets the need for quality fuels that are both reliable and ISO compliant and can help operators reduce their GHG emissions.

There are few challenges more important than meeting the world's growing demands for energy while reducing environmental impacts. ExxonMobil is committed to doing its part across the industries and sectors we serve, including marine. Our sustained investment in R&D plays an important role in helping to develop breakthrough solutions.



Emerging technologies

A future of energy alternatives

ExxonMobil is investigating several potentially viable alternatives to conventional fuel formulations including biofuels, hydrogen, methanol and ammonia. Lower-emission biofuels are a “drop-in” alternative that can be used in existing engines without the need for extensive modifications. These biofuels have the potential to reduce GHG emissions by at least one-third compared with conventional marine fuel oil.

On a Well-to-Wake basis, methanol, ammonia and hydrogen have the potential to reduce the carbon footprint of shipping. However, one of their challenges is their lower energy content and the comparatively lower amount of energy they can store in the tanks of a ship. Ship designs would require changes to accommodate fuel-containment and gas-supply systems or frequent bunkering.

ExxonMobil wants to be part of the solution while responsibly providing affordable energy required to power the economy. We have the experience, capabilities, capacity and commitment to help meet this critical need.

Carbon capture and storage

ExxonMobil’s efforts are reinforced by the establishment of ExxonMobil Low Carbon Solutions, a business that is working to commercialize and broadly deploy emission-reduction technologies. This business is initially focusing on carbon capture and storage (CCS) and is already advancing plans for several new CCS opportunities worldwide. We are also leveraging our experience in producing hydrogen which, when coupled with CCS, is likely to play a critical role in a lower-carbon energy system.

Hydrogen

ExxonMobil is evaluating strategic investments in hydrogen to increase the use of this important lower-emissions energy technology. The Company has extensive experience with hydrogen and produces about 1.3 million metric tons annually. Hydrogen is a zero-carbon energy carrier that could serve as an affordable and reliable energy source for hard-to-decarbonize transportation such as aviation, marine, and heavy-duty trucking, as well as energy-intensive industrial processes in the steel, refining, and chemical sectors. ExxonMobil can produce low-carbon hydrogen from low-carbon electricity via electrolysis of water, natural gas reforming coupled with carbon capture and storage, and other processes. Low-carbon hydrogen from natural gas with carbon capture and storage is called blue hydrogen, and is available for deployment at scale today.

ExxonMobil is a member of the U.S. HyBlend consortium, a collaborative research and development project designed to address the technical barriers of blending hydrogen into natural gas pipeline streams.



We have also signed a memorandum of understanding with SGN and Macquarie's Green Investment Group to explore the use of hydrogen and carbon capture to reduce emissions in England's Southampton industrial cluster. In addition, the Company is studying large-scale production of hydrogen for the Rotterdam industrial complex and has provided funding to Hydrogen4EU, a cross-sectoral research project confirming that hydrogen is essential to help meet the EU Green Deal's 2050 net-zero targets. Additional ongoing projects include:

- Blue Hydrogen in Baytown, Texas along with associated CO₂ storage
- Acorn Hydrogen/CCS in Scotland, UK leverages existing O&G infrastructure and well-understood offshore CO₂ storage
- Hydrogen Hub in Southampton, UK lowering industrial emissions, including EM Fawley complex potentially using blue H₂

- Air Liquide Normand'Hy to construct a 200 MW capacity electrolyzer in the industrial zone of Port-Jerome, France for the production of green hydrogen

Methanol

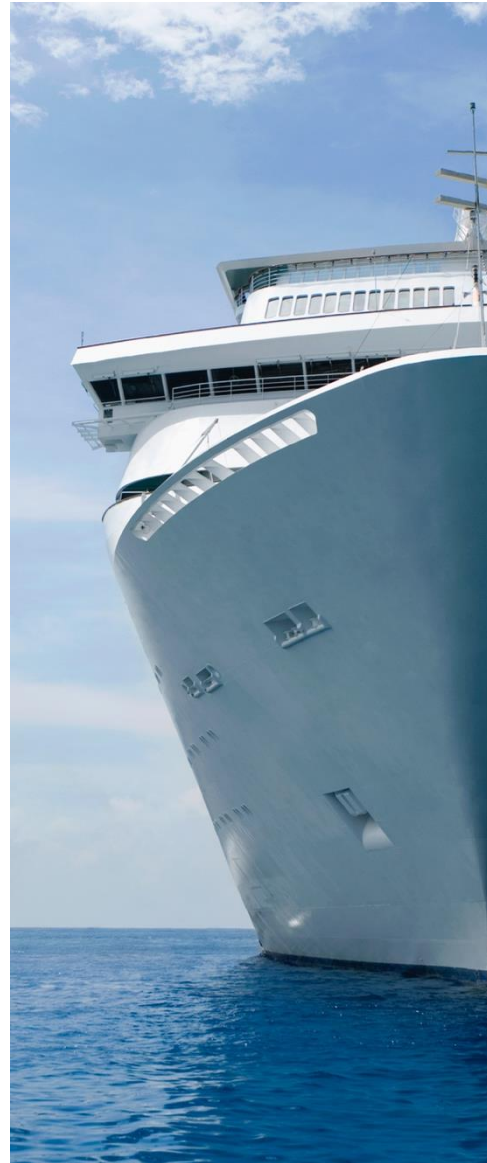
ExxonMobil is exploring a mosaic of lower-emission fuel options, including second-generation or advanced biofuels and synthetic fuels created by using hydrogen and captured CO₂ to form methanol. Methanol can be used for a fuel as-is in Marine and other applications, or further converted to fuels for hard to de-carbonize sectors like aviation.



Ammonia

ExxonMobil has signed a memorandum of understanding along with Grieg Edge, North Ammonia, and GreenH to study the potential production and distribution of green hydrogen and ammonia for lower-emission marine fuels at the ExxonMobil Slagen terminal in Norway. The study would explore the potential for the terminal, powered by hydroelectricity, to produce up to 20,000 metric tons of green hydrogen per year and distribute up to 100,000 metric tons of green ammonia per year. The hydrogen would be produced from hydro-powered electrolysis.

ExxonMobil is also investigating the potential role of ammonia as a marine fuel by participating with partners in Singapore to assess safety protocols and potential gaps in the supply chain and are also participating in a HAZID to inform ship designs operating on ammonia as a fuel.



Market motivation

The demand for growth

Today's transportation fuel demand growth is driven by increased commercial activity - moving more people and products by bus, rail, plane, truck, and marine vessel. Shipping plays an indispensable role in the global economy, transporting more than 80% of total trade volume and generating 3% of global GHG emissions. Among several modes of cargo transportation, it enables the regional and intercontinental movement of large quantities of cargo in the most fuel-efficient way at a lower cost. Based on the projected growth of the shipping industry using various future scenarios (IMO, 2014), the

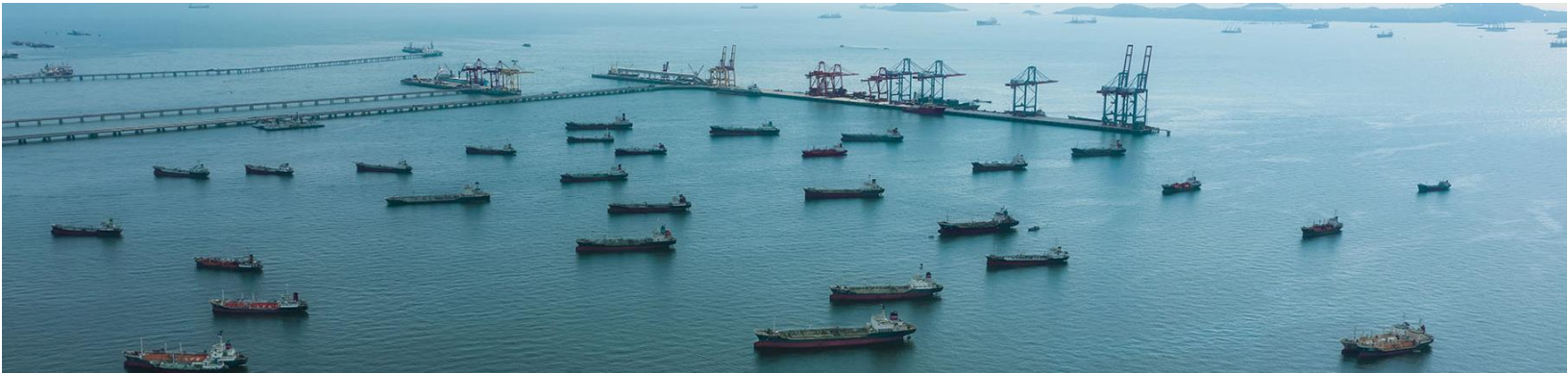
energy consumption is estimated to be around 12-14 EJ in 2030 and about 15-36 EJ in 2050.**

In designing for the future, the advent of modern dual-fuel engine technology will likely make the transition to lower- and zero-carbon fuels easier to achieve than in the recent past. The transition to alternative fuels can be made much more attractive if it is planned at the new building design stage. In particular, the design of the fuel tank should be specified based on all the fuels planned to be used throughout the life of the vessel.²



Regulatory policy

Advancing the energy transition



ExxonMobil advocates for a low carbon fuel standard (LCFS) to provide a predictable long-term pathway of reductions in carbon intensity (CI) of the fuel pool to support the IMO's ambition of reducing GHG emissions from shipping. To enable this, policy should include the following attributes:

- Set declining annual targets for the Well-to-Wake CI of the consumed marine fuels expressed in gCO₂equivalent/MJ
- Be technology neutral to encourage multiple pathways and innovation
- Provide flexibility to manage investments in the fleets and the growth of lower GHG emission emerging technologies and energy
- Support lower-carbon fuels, as the life cycle assessment approach helps to provide an effective tool for comparing alternative fuels
- Include reporting of the fuel CI on the Bunker Delivery Notes
- In case of non-compliance, a pre-determined buy-out could provide revenues to a global fund dedicated to the marine sector

ExxonMobil is active in industry committees, standards committees, and trade associations and encourages policies and standards to support the production of transport fuels with lower life-cycle greenhouse emissions.

“ExxonMobil is doing exciting work in lower-emissions fuels to create products that will directly advance our customer’s transition to a net-zero future.”

Russ Green, Low Emissions Fuels Venture Executive

Learn more about our commitment to climate solutions in the ExxonMobil Advancing Climate Solution Progress Report and Marine Fuels site on www.exxonmobil.com.