

**THE ROUTE TO NET ZERO.
TOGETHER TO DECARBONISE
THE MARITIME SECTOR.**

EXECUTIVE SUMMARY

The maritime sector, which has experienced considerable growth over the years, is the backbone of the global economy, considering that 90% of goods are transported by water, and it generates about 3% of the world's total climate-changing emissions.

Eni together with the shipowners' associations (Assarmatori and Confitarma) promoted the project "The route towards net zero. Together to decarbonise the maritime sector". This project involved participation from the three largest marine engine manufacturing companies, namely Wärtsilä, Man Energy Solutions, and WinGD, as well as Federchimica/Assogasliquidi, Unem, and Assocostieri. The supervision of the document was carried out by RINA.

The Kick off Meeting took place on March 16th, 2023 and, after 4 months, the decarbonisation roadmap was presented, optimizing the cost curves, with short and medium-term objectives to allow shipowners to respond to the targets of the FuelEU Maritime Regulation, International Maritime Organization (IMO), the Emission Trading System (ETS) and other further obligations.

To respect the EU and IMO targets, a strong acceleration and, at the same time, far-sightedness in adopting the most suitable choices, are required. The solutions will be determined by investments in technologies and infrastructures, as well as by the opportunities of the regional areas linked to the types of transport and the different acceptability of the risk. The great potential of the maritime sector finds a concrete answer in the principle of technological neutrality, highlighting that there is no effective competition between the various energy vectors, but that they can all contribute to replace the fossil bunker that powers 99% of marine vessels (and the 95% of the tonnage) of the world fleet, respecting the type of traffic, the characteristics of the engines, the refitting, etc.

In order to respond to this demand for decarbonisation in the short term, biofuels (particularly liquid) will make a substantial contribution. In the medium and long-term it will be necessary to enhance the production of other fuels as well.

The regulatory interventions of the European Commission enable the competitiveness of low carbon energy carriers and the effectiveness of these interventions will be guaranteed by the harmonization of the internal EU market and by creating the conditions to be competitive in non-EU areas.

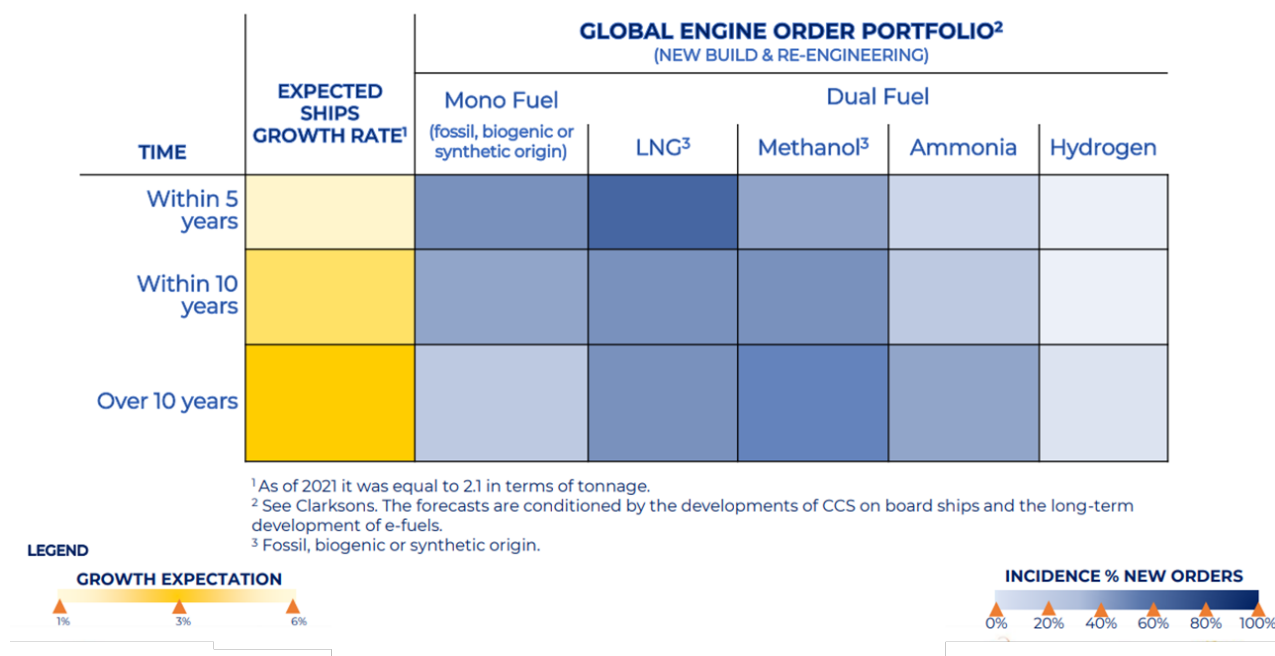
The maturity of marine engine technologies has shown an immediate response capacity towards shipowners' needs. In particular, ship on order is oriented towards the solution of dual fuel engines which make refuelling and adaptation to market dynamics more flexible.

Mono Fuel engines, assisted by Carbon Capture & Storage (CCS), could also play an important role in the medium/long term. The incremental solution is the Dual Fuel LNG which will see a gradual integration of methanol and ammonia. The latter two are favoured alternatives in geographical areas other than Europe where some aspects of safety and environmental compatibility are considered less critical (technological acceptability).

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The most plausible scenarios foresee a substantial growth in fleets equipped with both methanol and ammonia engines, once the obstacles pertaining to the availability of these fuels in «green» form and the creation of the necessary infrastructure are successfully overcome.

Graph: Evolution of the marine sector (in operation – on order)



Developed by the "The route towards net zero. Together to decarbonize the maritime sector" working group. For details on the methodology used, please consult the Methodological Note at the bottom of the document.

In the decarbonisation processes, it is essential to account for the fleet's characteristics, and it is necessary to consider a two-track process:

- guaranteeing the refuelling of the existing fleet with low carbon fuels (drop-in) as it is progressively replaced (currently the replacement rate of the fleets can be estimated in the order of 2% per year)
- supporting new marine vessels with dual fuel or dual fuel ready engines with logistics that satisfies their refuelling needs along the routes.

The AS IS scenario highlights the fundamental role of both liquid and gaseous biofuels, each characterized by varying levels of availability; HVO and FAME with more consistent productions, however, have different performances with a consequent propensity of the shipping world to adopt hydrogenated biofuels.

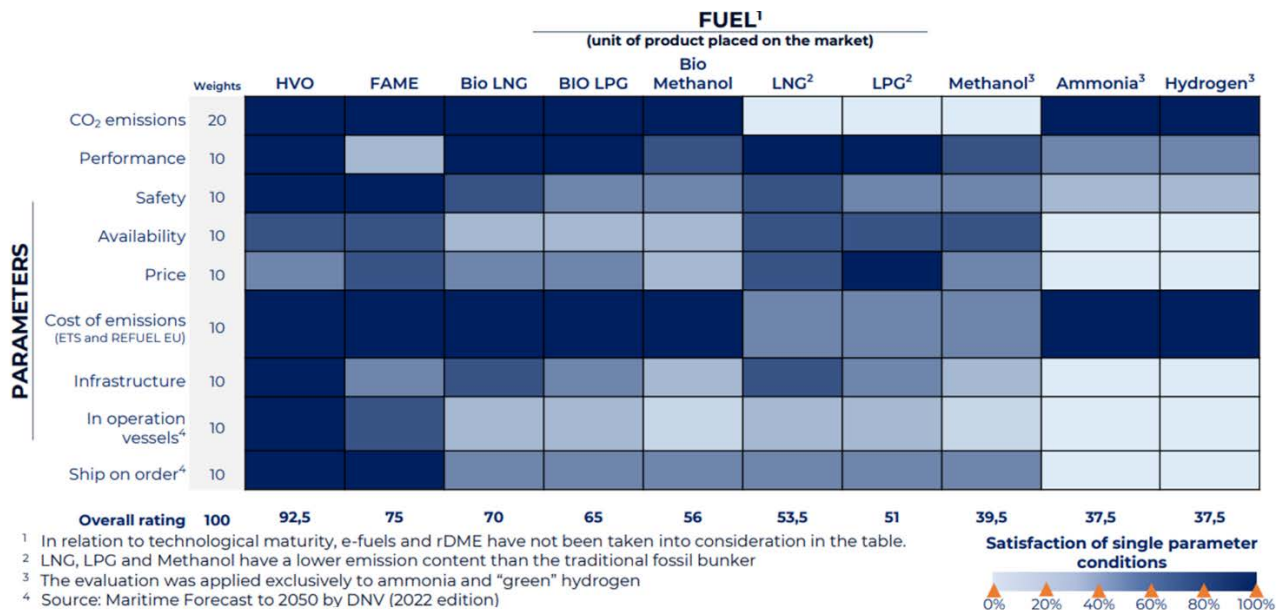
In the short term, the development of LNG infrastructure would favor its penetration; the lack of infrastructure and investments penalizes the competitiveness of methanol, hydrogen and ammonia.

In this scenario, the distribution of "ships in operation" influences the choice of energy carriers that can be used to achieve the decarbonisation targets, guaranteeing technological continuity and reducing any refitting costs. The trend of the "ship on order" parameter has made it possible to enhance the positioning of new energy carriers (for example, from the Maritime Forecast to 2050 study by the

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DNV, it emerges that in 2022, compared to 11 methanol ships in operation, 35 are in order).

Graph: Availability and Performance – AS IS



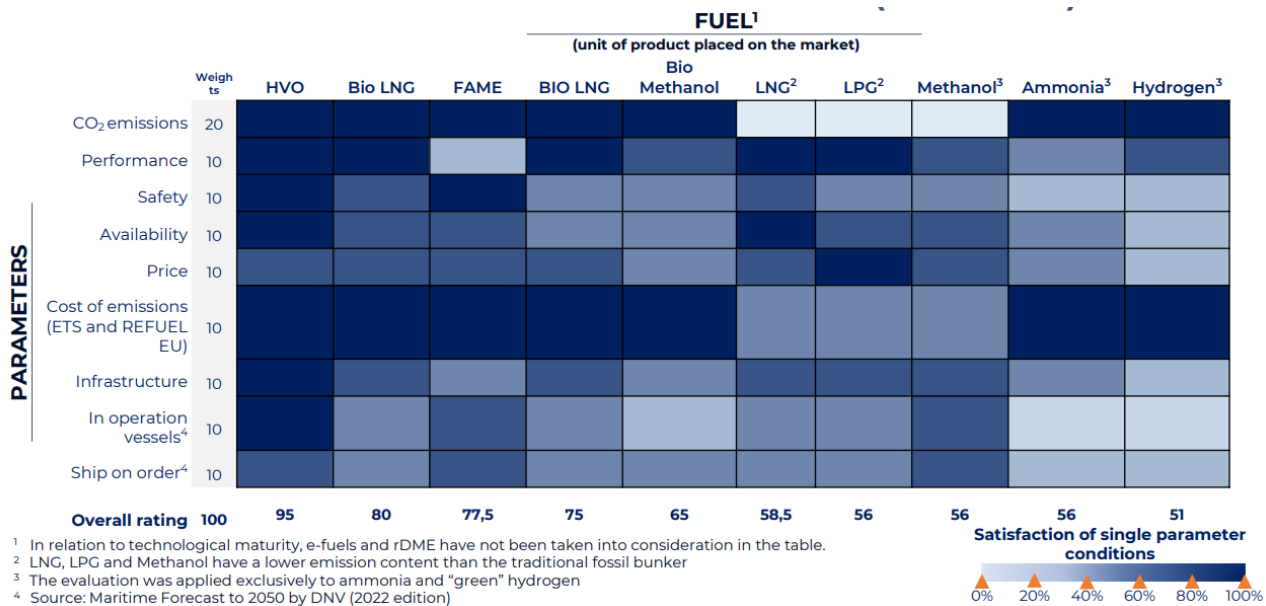
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For the definition of the TO BE scenario, the working group has identified key enabling criteria that could influence the marine engines and fuel market, namely:

- fleet replacement trends in alignment with current patterns;
- implementation of EU and IMO regulatory provisions;
- costs for adaptation interventions to meet EU and IMO targets; progressive increase in Dual Fuel engines
- impact of the cost of CO₂ quotas within the European Union Emissions Trading System and of the sanctions identified in the Marine Regulation for any economic advantage of non-compliance;
- acceleration of investments by producers of bio, green and synthetic energy carriers;
- implementation of CCS on board technology with positive effect on fossil bunkers;
- the supply/demand market dynamics of bio, green and synthetic fuels;
- creation of infrastructures and strengthening of logistics to support the routes.

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Graph: Availability and Performance – TO BE (10 years)



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The TO BE scenario highlights trend lines from which it emerges that biofuels, in all its vectorial specificities, continue to represent the most advantageous solution for decarbonisation, provided that the distribution of costs occurs equitably and does not penalize the most fragile segments.

To complete the analysis in terms of national competitiveness, it is essential to have an energy strategy that makes Italian ports energy hubs capable of supplying ships with the different types of fuel available in the future.

The national logistics system, adequately strengthened, could make Italy attractive and strategic thanks to the synergy between national ports and hydrogenated biofuel production sites, which can offer a distinct competitive advantage for the efficient distribution of this energy source.

The volumes of bunkers handled in Italy are not commensurate with the maritime traffic of its ports which would therefore have great potential to further develop this sector by recovering market shares, also given the geographical centrality of our country in the Mediterranean.

It is also important to remember that biofuels can offer the possibility of reducing CO₂ emissions not only during navigation but also while vessels are moored in ports, at least until the cold ironing infrastructure powered by renewable sources becomes available.

The rapidly growing demand for new carriers, spurred by policy and regulatory initiatives, along with the maturity level of the motor sector (a strong element also emerging from this study) will dictate the pace at which the new carriers will spread. This dynamic, as we have seen, will be conditioned by a series of factors, such as:

- the expected cost of reducing greenhouse gases (€/tCO₂_saved);

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- the level of sustainability of the production chains;
- the availability of raw materials (feedstock);
- the technological and commercial maturity of the alternatives;
- the need to adapt/build new marine vessels in a very diversified sector where economic resources are also differently distributed;
- the development of technologies capable of increasing energy efficiency;
- training of operators in the sector especially with regards to safety;
- competitiveness with other sectors (e.g. aviation);
- the development of intermodal synergy, one of the main ways to contribute to the ecological transition of transport

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