"Methanol production generates growing interest in Spain as a low-carbon fuel"[1]

By the third quarter of 2025, HyFive, a subsidiary of White Summit Capital, will start the construction of a hydrogen and green methanol plant in Asturias, with an investment of 250 million euros, capable of producing up to 100 thousand tons of e-methanol. In addition, the Danish company European Energy is planning an investment of up to 1 billion euros per project for the production of e-methanol in Andalucía, Galicia, Cataluña and Aragón. This growing interest in this alternative fuel has led the country's main ports, such as Barcelona, to initiate an analysis of the risks involved in the implementation of methanol, marking a milestone in the energy transition of Spanish ports towards low carbon fuels.

Analysis of the Fundación Valenciaport

According to the International Energy Agency, about 11% of the CO2 generated globally by the transport industry corresponds to maritime traffic, contributing about 0.89 Gt of total emissions by 2022. One of the main sources contributing pollution in the maritime sector is the burning of fuels to generate power in the engines that power ships, generating pollutants such as **nitrogen oxides** (NOx), **sulfur oxides** (SOx) and particulate matter.

In this sense, the different entities involved in the maritime sector are joining efforts to reduce polluting emissions through different strategies, with the operation of ship engines being one of the protagonists. This is how the International Maritime Organization (IMO) in its regular effort has approved in 2023 a new strategy for the **reduction of polluting gases** where a cut of 30% and 80% is foreseen for the years 2030 and 2050 respectively (taking 2008 as a reference), even seeking to reach zero emissions by 2050.

Among the actions proposed in this framework, there is the safe and efficient implementation of alternative low-carbon fuels, which play an important role in decarbonization in situations where the application of other measures such as direct electrification is usually more complex or costly, as can be the case of long-distance transportation.

[1] Original news published by "El periódico de la energía" and available at: *https://elperiodicodelaenergia.com/european-energy-prepara-una-inversion-milmillonaria-en-e-metanol-en-espana/*

In this order of ideas, one of the low-carbon fuels that has attracted attention in recent years has been **methanol**. Methanol is a one-carbon alcohol, being the simplest in this family of substances. It is found in a liquid state at ambient temperature and pressure conditions, so it can be stored in fuel tanks installed in existing ships, with only minor adjustments being necessary.

Likewise, it is a substance that is widely available industrially due to its common use. Additionally, methanol dissolves easily in water, which is beneficial in the event of a spill or leak. Similarly, methanol is a fuel whose composition allows it to reduce CO2 emissions generated by combustion compared to conventional fuels. It also has a high-octane **number**, which means it is less likely to explode uncontrollably, thus improving engine efficiency.

During methanol combustion, relatively low temperatures are produced, which results in lower NOx emissions compared to conventional fuels. In addition, methanol used in marine applications contains very low levels of sulfur, so SOx generation is significantly reduced. Table 1 shows average emission reduction values for different alternative fuels, where it can be seen that methanol has competitive values compared to other fuels.

Table 1. Emissions comparison between alternative fuels.

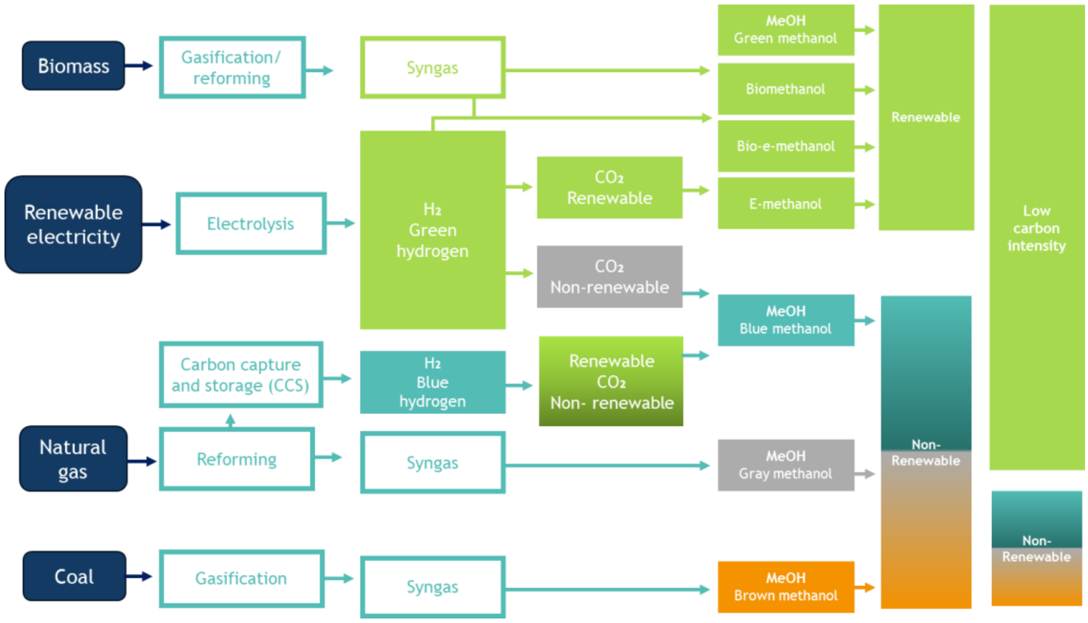
Energy storage type / chemical structure	**Emission reduction compared to HFO (%)**			
	SOx	**NOx**	**CO_2**	**PM**
Ammonia (NH_3)(liquid, -33°C)	100	Compliant with regulation	~90	~90
Methanol (CH_3OH)(65°C)	90-97	30-50	11	90
LPG (liquid, -42°C)	90-100	10-15	13-18	90
LNG (liquid, -162°C)	90-99	20-30	24	90

Source: MAN, The methanol-fuelled MAN B&W LGIM engine.

However, it should be noted that low methanol-related emissions require that its **production sources** are of **renewable origin**. Although the use of methanol as a fuel can be beneficial from the point of view of its use, the processes involved in its production can be highly polluting. Currently, most methanol is produced from fossil fuels, with natural gas being the most common feedstock used for its production.

In this order of ideas, Figure 1 shows the different methanol production routes that are currently being used or studied, where methanol has been assigned a color to differentiate its origin. Thus, brown methanol comes from coal gasification, whose products (carbon monoxide, carbon dioxide and hydrogen) react to produce methanol. On the other hand, gray methanol is produced from the steam reforming of natural gas, obtaining carbon monoxide and hydrogen monoxide necessary for the production of methanol. Thus, methanol production by these means is highly carbon dioxide-intensive due to the by-products generated, in addition to the high energy consumption required. Even so, these two types of methanol production are predominant on an industrial scale, so the transition to cleaner production methods is indispensable.

Ilustration 1. Different routes of methanol production



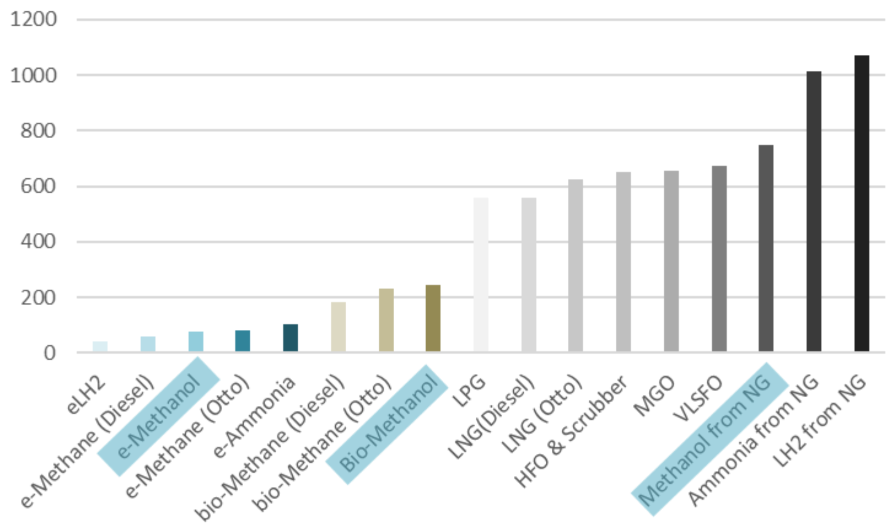
Source: IRENA, 2021

Therefore, there is the production of **blue methanol**, which is produced from **blue hydrogen**. Blue hydrogen originates from the natural gas reforming process, to which carbon capture processes are applied, allowing for a reduction in emissions by up to 95%. Finally, there is the production of **green methanol**, which is produced using only renewable energy sources, ensuring that no pollutants are emitted into the atmosphere.

Green methanol can be obtained from the gasification of sustainable biomass sources, which produce synthesis gases that are then used to produce methanol, known as **biomethanol**. On the other hand, methanol can also be produced from **green hydrogen**, generated through electrolysis that uses renewable energy sources. This green hydrogen reacts with captured carbon dioxide to produce what is known as e-**methanol**.

Considering the above, Illustration 2 shows the emissions in grams of CO2 equivalent per unit of energy produced for different marine fuels. It is observed that, depending on the origin of the methanol, it could generate more emissions compared to conventional fuels like MGO or VLSFO, or other alternative fossil fuels such as natural gas (NG) or liquefied petroleum gases (LPG). On the other hand, it is observed that the options of biomethanol and e-methanol significantly reduce carbon dioxide emissions compared to other fuels, highlighting their relevance in reducing emissions in the maritime sector.

Ilustration 2. Emissions from production to use of marine fuels (in gCO2/kWh)



Source: Bureau Veritas, 2022

Still, it is estimated that the production of methanol is about **100 million tons**, with only 0.2% coming from **renewable sources**. It is expected that the production of this fuel will reach **500 million tons per year** by 2050, presenting a challenge for the growth of green methanol production facilities to reduce emissions.

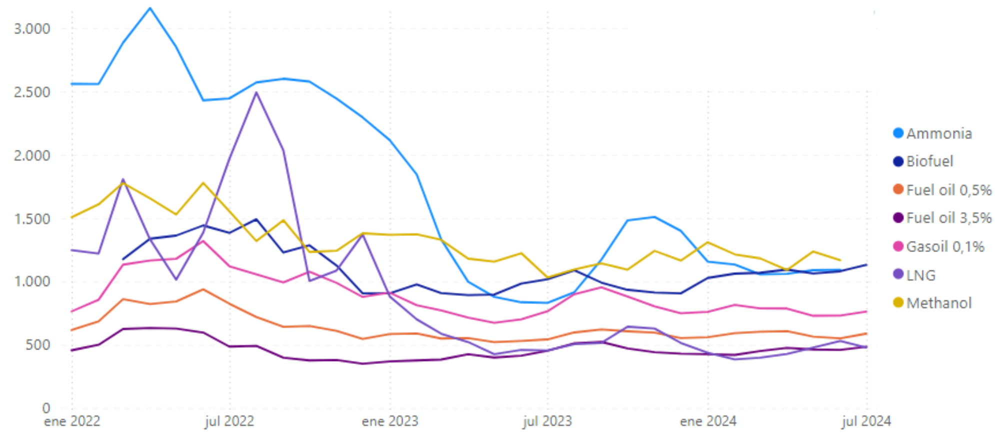
Among the challenges faced by the sector in implementing methanol are the current **high production costs**, which raise its prices and make it less competitive compared to conventional fuels and other alternative fuels. Illustration 3 shows the price evolution of different fuels in dollars per ton of MDO equivalent, both conventional and alternative, over the past two years, with the methanol used in the image considered to be of green origin.

While **conventional fuels** range between **500-700 USD** per ton of MDO equivalent, the price of **green methanol** is estimated at around **1250 USD**. On the other hand, although the price of gray methanol is around **700 USD**, making it competitive, it is certainly derived from polluting sources.

In this regard, the current production costs of green methanol are uncertain. While the number of production plants under construction is increasing, very few are in operation producing significant quantities of methanol. With users of fossil-derived methanol **seeking cleaner production alternatives**, market pressures on cost and availability will remain uncertain until some of these green methanol projects reach significant production levels.

However, IRENA estimates an annual production of green methanol of about **385 million tons** per year by **2050**, which translates into the **construction** of various **high-capacity** methanol plants. Considering this increase in production, a price of around **500 USD** per ton of MDO equivalent is projected. In this context, different measures such as emission taxes should be considered when estimating these values.

| Illustration 3. Evolution of prices of conventional and alternative fuels between 2022-2024



Source: DNV

Another challenge to consider is **adaptation** due to the implementation of methanol, given its physicochemical characteristics that necessitate changes in **ship engine design**. Additionally, there are changes required in **fuel storage** and **supply systems** that comply with current regulations regarding the use of fuels with methanol's specific characteristics.

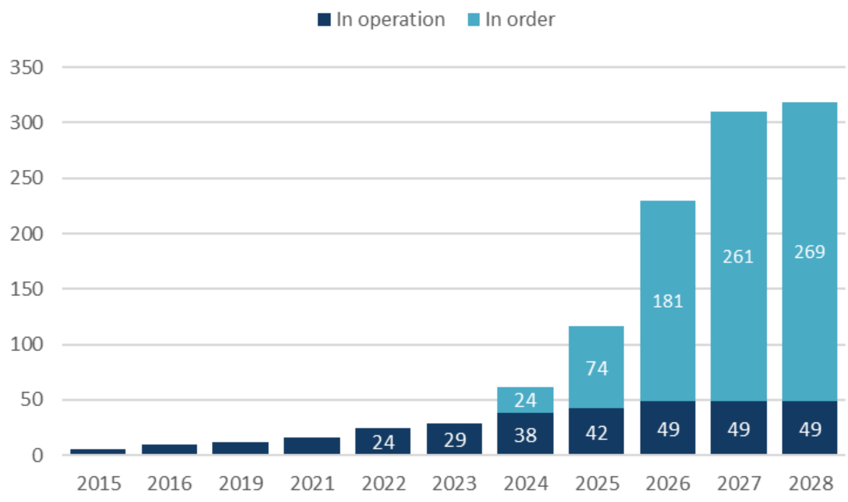
Thus, manufacturers such as MAN, Hyundai, or Wartsila have adapted or manufactured new engines for methanol use with changes in fuel injection and lubrication systems, ensuring low emissions and adequate system performance.

On the other hand, following **current regulations**, additional changes in fuel supply systems related to safety requirements in fuel handling rooms (ventilation, air locks, fire and explosion protection equipment) are necessary for safe operation. Additionally, the implementation of **double-walled piping** is required. Furthermore, there is an increase in the size of methanol tanks due to its low energy density, which also requires additional **safety barriers**, adding complexity compared to conventional fuel tanks. Finally, the addition of additional systems such as nitrogen inerting systems may increase adaptation efforts.

Considering the above, according to DNV, there is expected to be a 10% increase in initial capital investment for ships powered by methanol compared to ships using additional fuels. However, despite this, methanol is a manageable fuel, and there is a growing number of ships powered by it. With increasing experience in methanol usage and the adaptations made in various ships, it is expected that construction costs will decrease in the future, bringing them closer to conventional ships.

Following this trend, there is currently an **increase in demand** for ships adapted for methanol use. Illustration 4 depicts the growth of methanol-powered ships, including those currently in operation and those on order. There is a notable growth projected for the coming years, with an expected 11-fold increase in methanol-powered ships from 2024 to 2028.

| Illustration 4. Growth of methanol-powered ships



Source: Alternative Fuels Insight - DNV

Providing perspective on the aforementioned, according to DNV, 8% of all ships currently on order are methanol-powered, with the **container ship** sector showing the greatest adoption.

An example of this is Maersk's inclusion of its fifth methanol-powered container ship, scheduled for unveiling at the end of August this year. The vessel has a capacity to carry 16,000 TEUs and is expected to use green methanol on its maiden voyage. Similarly, the company has commissioned an additional 20 ships designed to utilize methanol as fuel.

In summary, the analysis shows that methanol offers **significant advantages** in **reducing emissions** of polluting gases compared to conventional fossil fuels. This reduction is even more significant when considering the origin of methanol, which ideally should be generated from **renewable energy sources with carbon capture**, resulting in green methanol. On the other hand, methanol can also be derived from fossil sources such as coal, resulting in what is known as brown methanol.

Among the challenges related to the use and production of methanol, particularly green methanol, are its limited and costly production, which affects its current competitiveness. Additionally, it requires various adaptations in ship infrastructure to comply with regulations, as well as in engines to ensure optimal energy performance and emissions control. However, despite these challenges, there is a significant increase in demand for methanol-powered ships.

Taking the above into account, it is recommended to promote policies that encourage **investment** in green methanol plants to increase **availability** and thereby lower costs. Considering the implementation of emissions taxes is crucial for enhancing competitiveness. Furthermore, increased investment in research and development is highly desirable to improve methanol production efficiency, including advancements in carbon capture technologies, optimization of green hydrogen production processes, and biomass gasification processes. These efforts can contribute to further cost reduction. Finally, a proper adaptation of **port infrastructure** would ensure the safe and efficient handling of methanol, ensuring that Spanish ports can support the **energy transition** using fuels like methanol.