Gas Strategies

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Viewpoint

Sink or float?

How to make methanol work for a low-carbon shipping future

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The shipping industry needs to decarbonise, but options are limited

A major contributor to global greenhouse gas (GHG) emissions, the shipping industry is responsible for approximately 2% of global energy-related CO_2 emissions, or 706Mt in 2022[1]. Historically, shipping emissions have grown as demand for international trade has increased. With no slowdown in long-term international trade forecasted (despite recent tariff uncertainties which may have short-term impact), emissions are projected to continue increasing unless alternative fuels and energy efficiency measures are adopted in the sector.

To address these concerns, the International Maritime Organisation (IMO) has set ambitious decarbonisation targets for shipping companies[2], which are laid out in short, medium, and long-term phases. See *Figure 1*.

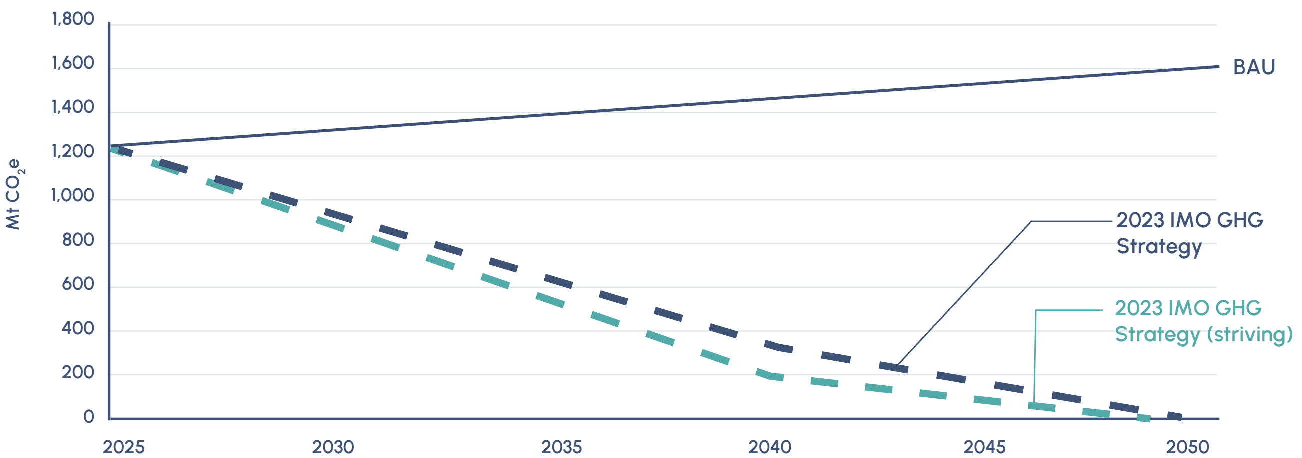
In the short-term (present to 2030), the IMO has stated that shipping companies must reduce their carbon intensity by at least 40% in comparison to 2008 levels and increase the uptake of zero or near-zero GHG fuels to at least 5% of their fuel supply on a calorific equivalent basis.

By 2040, the IMO is striving to reduce GHG emissions in the entire sector by at least 70% against 2008 levels, and by 2050 the goal is for the industry to be net zero.

Executive summary

- Despite limited current uptake, shipping companies are expected to rely on low-carbon fuels to aid decarbonisation
- Methanol is gaining traction as a bunkering fuel due to its low-carbon footprint and ease of transportation and storage
- Based on Gas Strategies' recent experience supporting clients, this Viewpoint explores the complex commercial challenges of producing and marketing methanol, through the lens of the global shipping industry
- With methanol production costs being driven by feedstock (hydrogen and CO_2) and power, purchasing feedstock could prove cheaper than building a new hydrogen production plant or carbon capture if favourable deals can be agreed and mutually beneficial synergies found
- Success of methanol production facilities will hinge on securing sound commercial structuring along the integrated supply chain, including terms agreed with suppliers and offtakers

Figure 1: **Forecasted net GHG emissions from shipping sector**



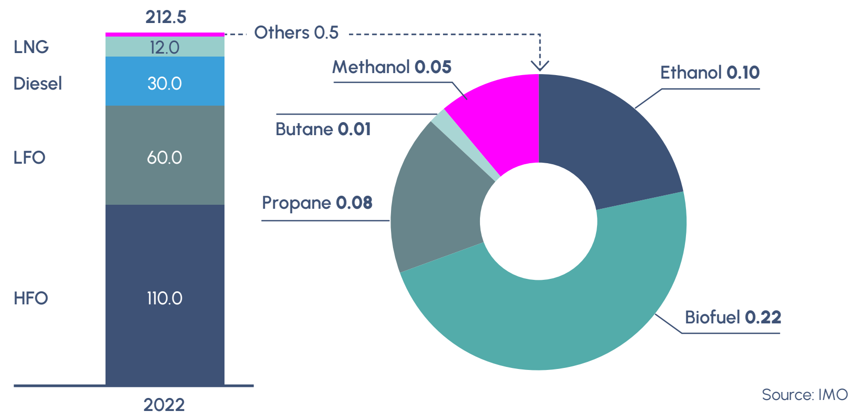
Source: IMO

In April 2025, the IMO's Marine Environment Protection Committee (MEPC 83) approved new requirements on GHG fuel intensity, in combination with a pricing and reward mechanism, taking effect from 2028. Measures like this will aid in the transition to green fuel, allowing for more accurate reporting in fuel blending and a gradual shift to greener fuels.

Unlike many other sectors, such as road vehicles, building heating, and construction, the shipping industry is considered "hard-to-electrify", bringing new challenges to global decarbonisation efforts. In 2022, ships over 5,000GT used 213kte of fuel oil, most of which comprised HFO and LFO. Low-carbon fuels, such as methanol and biofuel, had almost no significance in the fuel mix, and ammonia did not feature with it being deemed a "low-maturity, potential fuel" rather than having any current state use-cases. *See figures 2 and 3.*

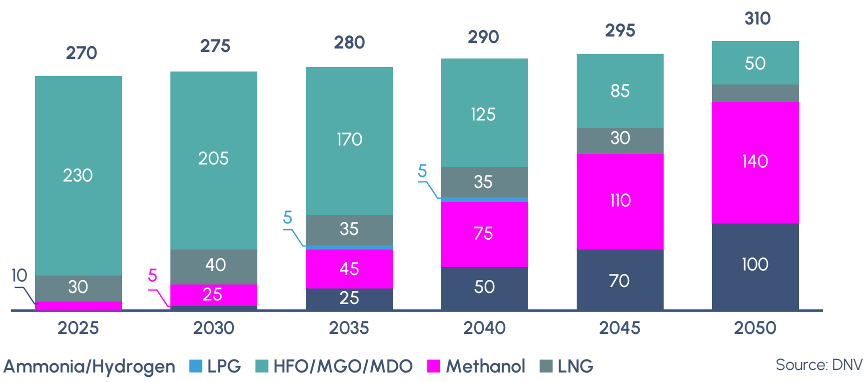
Despite the limited uptake, shipping companies are expecting to rely on low-carbon fuels to aid decarbonisation. A variety of alternative maritime fuels are being considered, but there is no clear winner, hindering uptake in the market:

Figure 2: **Actual breakdown of fuels used by ships of 5,000GT in 2022 (ktepa)**



Source: IMO

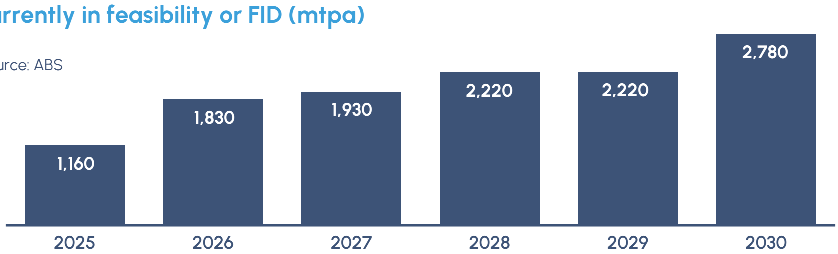
Figure 3: **Forecasted fuel demand for ships over 5,000GT (ktepa)**



Source: DNV

Figure 4 : **Potential e-methanol supplies for bunkering based on projects currently in feasibility or FID (mtpa)**

Source: ABS



- **LNG** can have lower emissions than conventional fuels but still has a more significant carbon footprint than alternative green molecules. Bio-LNG and e-LNG (created from synthetic methane) have a significantly lower carbon footprint to LNG, however these options face supply chain challenges and high costs to end consumers.

- **E-methanol** seems to be the most promising green fuel for the sector, but is expensive to produce, relies on the production of green hydrogen, and has not yet reached the necessary market scale. Grey methanol, made using natural gas, has a higher carbon footprint but also a lower price, potentially serving as a transition fuel to green and e-methanol through blending or other methods.

- **E-ammonia** was set to be the "next-big-thing" in the shipping industry several years ago, however concerns over safety, higher transportation costs than methanol, and infrastructure limitations have dampened demand.

- **Biofuels** have limited supply in the market due to the availability of sustainable feedstock required to produce them.

- **Green hydrogen** has a very high cost per calorific value, as well as supply chain challenges including difficulties in storage and transportation.

Despite the generally high costs of production associated with e-fuels, due to their high upfront capex and high feedstock opex costs, investors and governments are still pursuing production investments, but they want to see significant demand for the molecules before committing.

This is giving rise to a "chicken-and-egg" situation, where the cost of molecules will remain high as supply is low, resulting in low demand. Low demand is resulting in lack of new supply, keeping prices high – a continuous loop. *Figure 4* shows expected methanol supplies for bunkering until 2030, based on projects that are currently in the feasibility or FID stage.

The industry is beginning to shift focus to methanol

Both e-methanol and e-ammonia have advantages for decarbonisation in the sector but differ in feasibility. The current shipping order book appears to favour methanol over ammonia. This Viewpoint focuses on methanol as Gas Strategies see this as being the industry-leading green fuel for the shipping industry until at least 2035.

Methanol is beginning to gain traction in the market for bunkering due to its low-carbon footprint and ease of transportation and storage. It is chemically stable and liquid at ambient conditions making it easy to handle. Methanol is already widely used in the chemical industry with a global supply chain for its shipment by road, rail, and sea. Methanol is produced by reacting hydrogen and carbon dioxide together to form methanol and water.

270

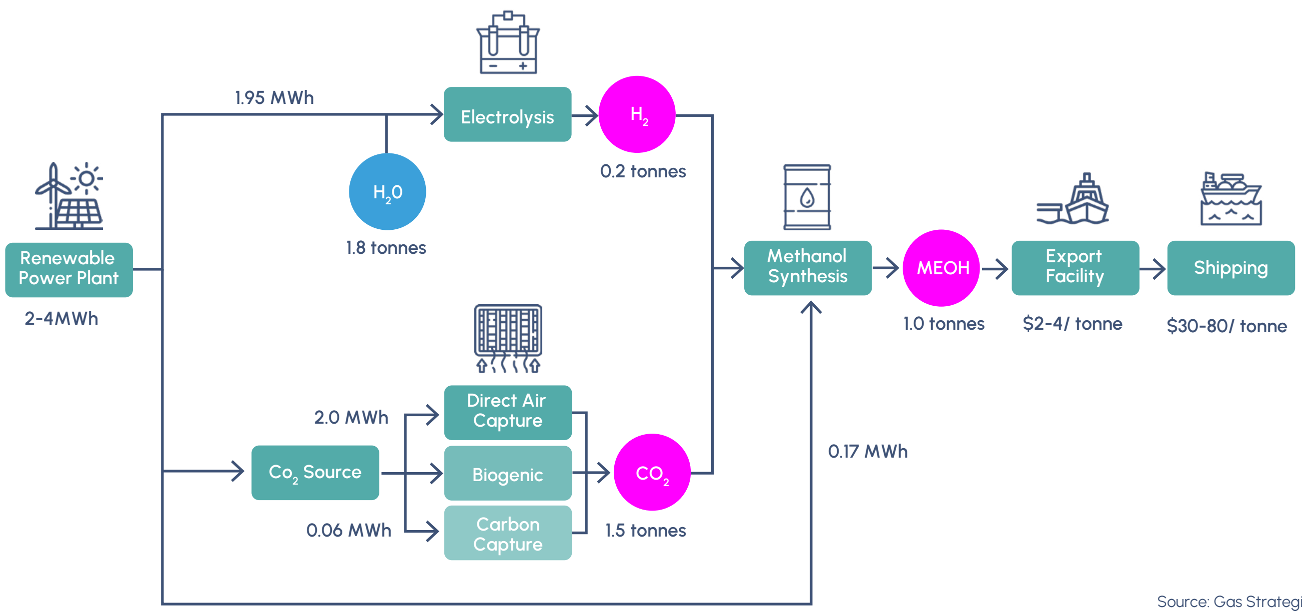
Methanol-fuelled vessels were on order or in operation in 2024.

CO_2 for use in the e-methanol value chain can be captured in different ways, as figure 5 shows. The Direct Air Capture method captures CO_2 already present in the atmosphere, which means it has the lowest overall carbon footprint. On the other side, carbon capture (particularly from non-renewable sources such as cement plants or other fossil-fuels used in industry) has a higher overall carbon footprint as the carbon used is still "new" carbon being released into the atmosphere, it is just being used twice.

With industry focus shifting towards methanol as the green fuel of choice for the future, some shipping companies have begun placing orders for methanol-powered vessels.

In 2024, an analysis of alternative fuel ships in operation and on order showed that almost 270 were methanol vessels, and only 16 were ammonia vessels according to DNV's Maritime Forecast to 2050. When these ships begin operating in a significant way, the impact on methanol demand will be substantial.

Figure 5: **E-methanol Value Chain to produce 1 tonne of methanol**



Source: Gas Strategies

The methanol market is not scaling because of low return on investment

While methanol offers a decarbonisation pathway for the shipping industry, the market is not scaling due to poor commercial viability and high levels of complexity and risk.

The cost of methanol production is driven by feedstock and power costs. Depending on the cost of electricity, green hydrogen is very expensive, in the range USD 5,000-10,000 per tonne. This is largely driven by the capital costs associated with building a hydrogen plant, particularly the electrolyser, and the power requirements to produce hydrogen with the electrolyser. Logistically, hydrogen is very difficult to store and transport, meaning that a methanol plant is typically designed as an integrated supply chain with the required hydrogen production.

If a methanol plant owner opts to build an in-house hydrogen production facility, the associated costs outweigh the long-term benefits. Gas Strategies has worked with a number of clients in this area and has found that the capex to build a hydrogen production facility to satisfy a 1,000ktpa methanol plant, which would require a 2GW electrolyser, can reach upwards of USD 2.5 billion including the cost of intermittent storage. Building a solar generation field to satisfy this energy demand could cost an additional USD 5 billion, not accounting for battery requirements.

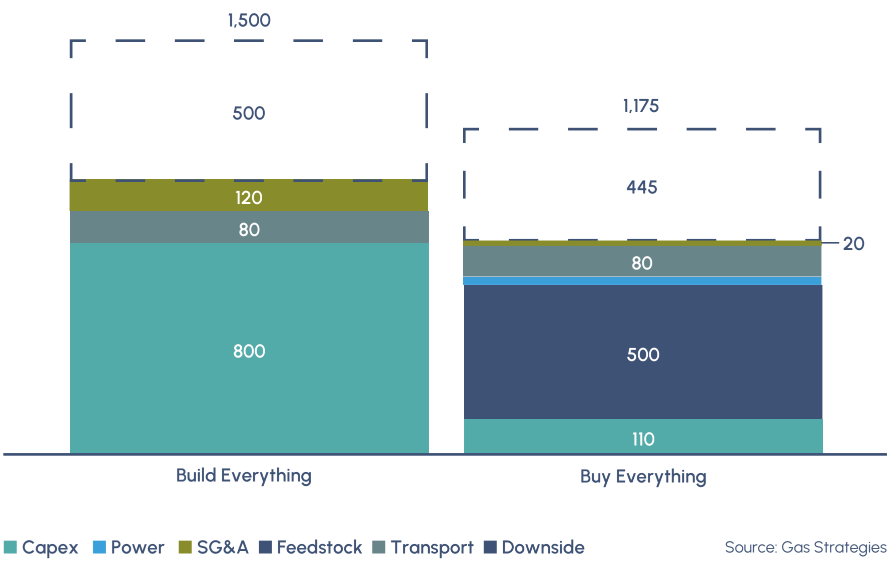
Similarly, the cost of carbon as a feedstock can be high and varies significantly around the world. In some countries such as the UK, USA, and Norway, carbon capture technology is implemented through government incentive-backed projects, with the key aim of reducing carbon emissions.

As a result, the captured carbon is a waste product, and the investment in the technology has been assigned to reduce carbon rather than to generate profit. In these cases, a methanol producer could offtake the CO_2 for free, or even at a negative cost. This dramatically boosts the commercial viability of the methanol plant.

But when carbon capture technology is installed by an emissions-heavy plant, for the sole purpose of meeting environmental compliance - and where they have not received subsidies from the government – those companies will likely seek to recoup costs by selling the captured CO_2. This would lead to a higher cost of feedstock CO_2 for methanol producers, potentially reaching up to USD 100 per tonne.

Alternatively, methanol producers can invest in their own carbon capture technology. Gas Strategies analysis suggests that the capex of a carbon capture plant that would satisfy a 1,000kpta methanol plant, from non-renewable CO_2 capture,

Figure 6: **Levelised cost of methanol under different scenarios ($/tonne)**



Source: Gas Strategies

would cost up to USD 650 million including the cost of equipment, compressors, and an air separation unit for providing oxygen as a feedstock to full combustion of CO into CO_2. Direct Air Capture would have a significantly higher capex, as well as more than double the energy requirements to capture the same volume of CO_2.

The above evidence suggests that the most viable approach to e-methanol production is through interdependent development. This would involve a number of parties and industry players and require several commercial agreements to fall into place.

For success to be secured, all of the commercial agreements need to seamlessly align throughout the value chain and the parties will need to collaborate to stimulate production. Some of these agreements may include local green hydrogen with access to low-cost green power and installed carbon capture technology with the sole purpose of reducing carbon emissions.

A methanol producer building their own green hydrogen facility and investing in carbon capture technology becomes immediately unattractive, with significant downside risk in what is still a developing market. *Figure 6* shows the levelised cost of methanol over a 25-year operating period for a plant that produces 1000kt/y of methanol.

20 years

is the approximate payback period for a large-scale methanol plant in the "Buy Everything" scenario.

In the "Build Everything" scenario, it assumes that along with the hydrogen plant there is also half a day's worth of compressed hydrogen storage and half a day's worth of battery storage, both of which are used in the event of an emergency shutdown. This also assumes that all renewable power comes from solar generation. For the CO_2, the producer will build carbon capture technology from a non-renewable source. In the alternative "Buy Everything" scenario, it is assumed that hydrogen and CO_2 are bought from a third-party producer and power used is bought from the grid or an IPP.

Figure 6 suggests, buying feedstock can be preferable to building your own feedstock supply, but only commercially viable if companies can enter into advantageous commercial agreements with feedstock suppliers for low cost of hydrogen and CO_2.

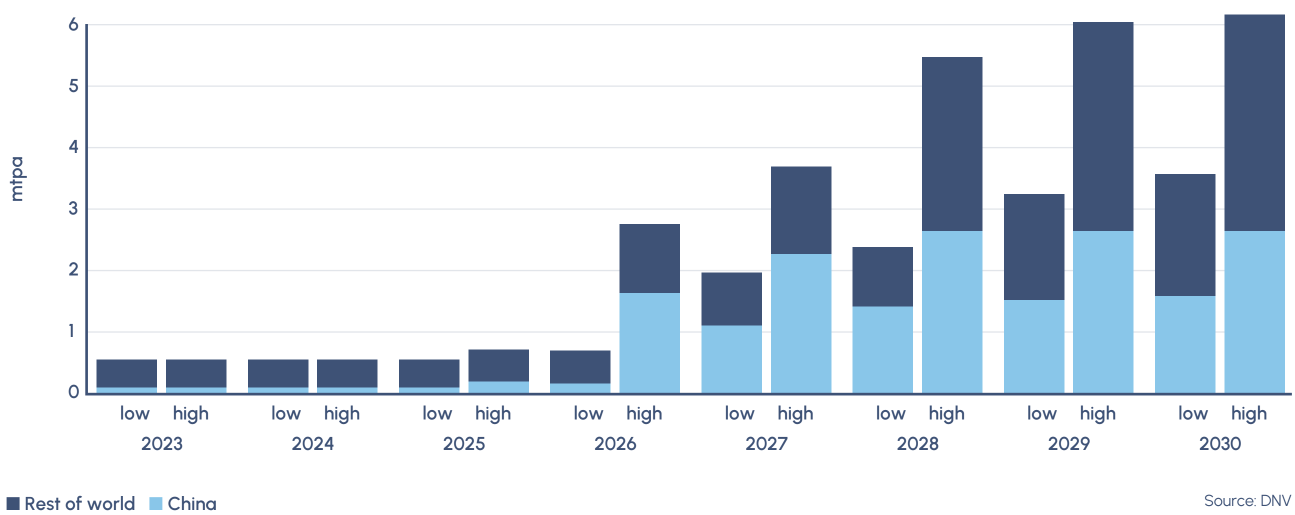
In both situations, access to competitive project finance is also a necessity for prospective green fuel producers, particularly given that the payback period for a large-scale methanol plant could reach over 24 years in the "Build Everything" base case scenario and just under 20 years in the "Buy Everything" base case scenario.

Governments in East Asian countries, such as China, Japan, and South Korea, are offering ultra-low interest financing (0.5-2%) for green molecule projects globally, due to limited domestic renewable power generation. In exchange for competitive financing, these countries want long-term, secure supply of the green molecules into their country.

Japanese firms such as Marubeni and Mitsui have both entered into agreements to invest in e-methanol production.

For example in 2023, Mitsui agreed to acquire a stake in European Energy's solar park and e-methanol production facility Kasso in Denmark, which synthesises green hydrogen and captured CO_2 to produce up to 42,000 tonnes of e-methanol annually.

Figure 7: **Global and Chinese supply of e-methanol**



Source: DNV

Meanwhile, China is set to dominate global methanol supply to 2030, reaching over 50% of global supply in a high case, aided by the government-backed financing options – see *Figure 7*.

In other parts of the world, such as Western Europe, the outlook for e-methanol production looks more challenged. Traditional financing, via private institutions, prioritises quick paybacks based on calculated and well-understood risks, typically in well-established sectors.

Methanol projects are capital intensive, require long-term commitments, and appear inherently high risk based on current market uptake, making investment into e-methanol production appear unattractive. As a result, many project developers will struggle to compete against projects backed by East Asian finance without intervention such as state-backed financing options.

The success and commercial viability of a methanol production facility hinges on three key factors: feedstock, financing and offtake. The effective negotiation of all three factors is key to viability. In the "Buy Everything" case, the producer must be able to negotiate low cost of hydrogen and CO_2, and geography may play a significant role in determining price and access to renewable power.

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Similarly, the project requires competitive financing, without which the likelihood of sustained success will quickly diminish. For a project to receive any financing, it needs to have some long-term offtake contracts and guaranteed revenue streams already planned, and financers will also want to see long-term feedstock agreements and capex estimations to understand the commercial health of the project in the long-term.

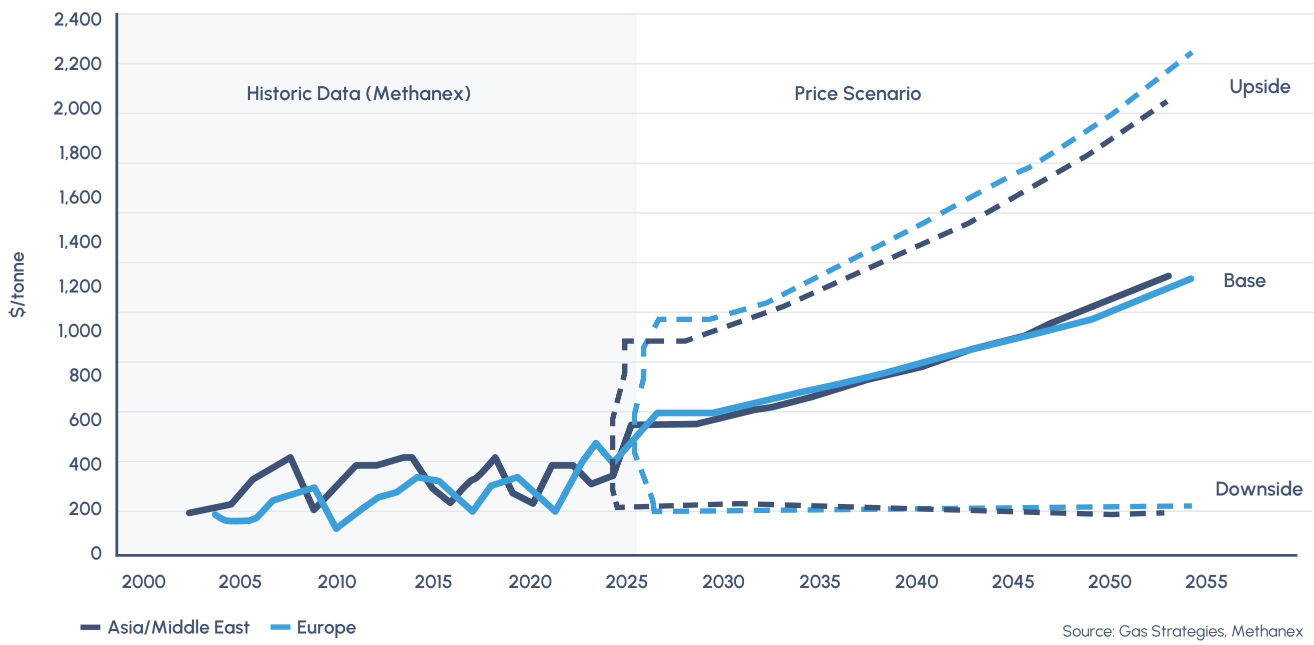
These long-term contracts must be at a price that covers the cost of production and financing, which can reach over USD 1000/t in the nascent stages of the market. In comparison, a tonne of VLSFO (very low sulphur fuel oil) can be bought on the market for around USD 550/t and in terms of energy content, e-methanol costs around four times more (USD 0.181/kWh for methanol against USD 0.048/kWh for VLSFO)

Gas Strategies expects that the price of e-methanol will vary between different geographies. Our base case for the Middle East and Asia suggests that the price of methanol will increase with inflation as demand ramps up and supply also increases.

In Europe, we expect there to be a 10% premium on the price initially, because of more stringent carbon emissions standards.

But that will eventually converge to the global price. Given that price is expected to increase gradually, offtakers can enter into advantageous long-term agreements in the early stages of market development, as they don't expect prices to drop in later years.

Figure 8: **Expected price of methanol**



Source: Gas Strategies, Methanex

Offtakers need to be prepared to accept higher methanol prices to stimulate the market

The price of methanol is highly dependent on the type, or the carbon footprint, of the methanol that is being bought. Grey methanol can be bought in the market for around USD 250 per tonne, whereas e-methanol with biogenic CO_2 sources can reach over USD 1,000 per tonne due to the far lower carbon footprint.

With grey and e-methanol being identical in chemical nature, shipping companies have been exploring the option of blending the two to reduce the price. This method could act as a gateway to stimulating the market.

The downside with blending is that the carbon footprint will be higher than if pure e-methanol is used. This may mean that shipping companies are no better off - in terms of reducing emissions – than if they had continued using LNG as a bunkering fuel, for example.

While offtakers have been weighing up the reputational benefits of lowering carbon emissions, other methods, such as carbon credits, could allow them to meet environmental targets without having to pay for expensive greener fuels.

Ultimately, the increased costs associated with reduced carbon emissions trickle down to end consumers. If shipping companies are not willing to pay higher prices, it is unlikely that there will be any traction in the market for greener fuel without strong international policy and regulation.

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Conclusion

The e-methanol market is expected to continue to grow until 2050, however the chicken-and-egg situation between shipping companies and producers requires strong international regulation and government backing to stimulate any large-scale activity.

There are concerns about the feasibility of mass methanol production, given the cost and amount of energy required. Production is also more likely to occur in areas where renewable energy is cheap, ports are nearby and/or large and biogenic CO_2 sources are available.

Uptake in the market is likely to rise gradually, with blending providing a gateway. Companies are expected to increase demand over time. Regardless of changing political mores and attitudes towards climate goals, companies will still be weighing up the economic costs against the reputational benefits of cutting carbon emissions - even if some of those costs are eventually passed on to consumers.

Sources: [1] IEA, International Shipping [2] IMO, 2023 IMO Strategy on Reduction of GHG Emissions from Ships

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