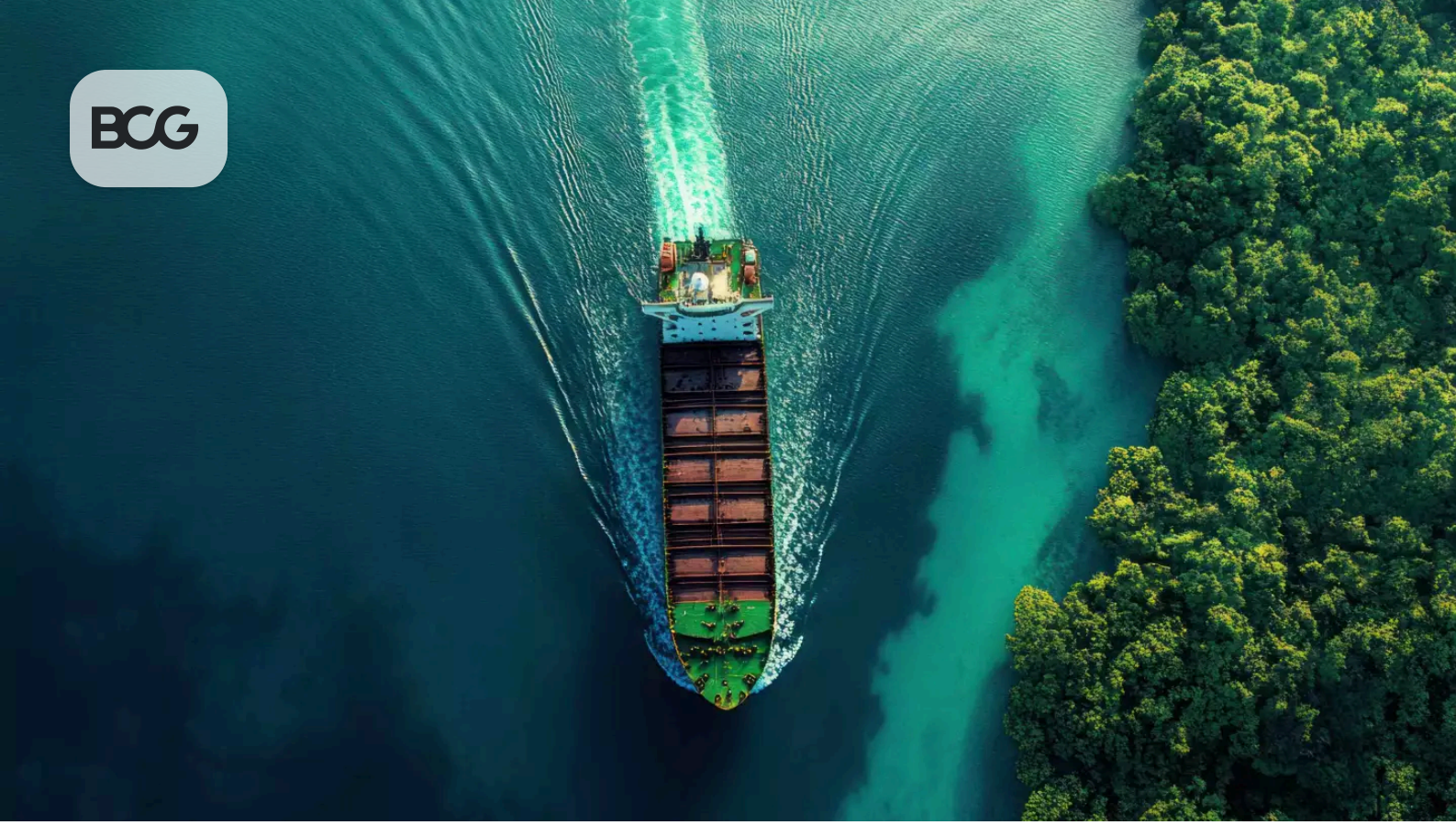

TRANSPORTATION AND LOGISTICS

Beyond Shipping: How Other Sectors Will Fuel Maritime Decarbonization

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The low-carbon fuel transition is gaining momentum, but much of the early demand is coming from sectors outside maritime. Road transport, power, chemicals, and aviation are moving quickly to decarbonize—and in doing so, they are shaping the market for biofuels, renewable methane, ammonia, and methanol.

Shipping will rely on many of the same fuels. But it is not the primary mover of demand for any of these fuels, and it cannot build the needed low-carbon-fuel supply chains alone. Its path to decarbonization will be influenced by the decisions and pricing of other sectors, which are locking in supply, influencing policy, and setting the pace for scale. Technology breakthroughs and regulatory action—such as adoption by the International Maritime Organization (IMO) of the Marine Environment Protection Committee's proposed MEPC 83 net zero framework—could accelerate progress. But even with such shifts, structural change before 2030 is likely to be incremental.

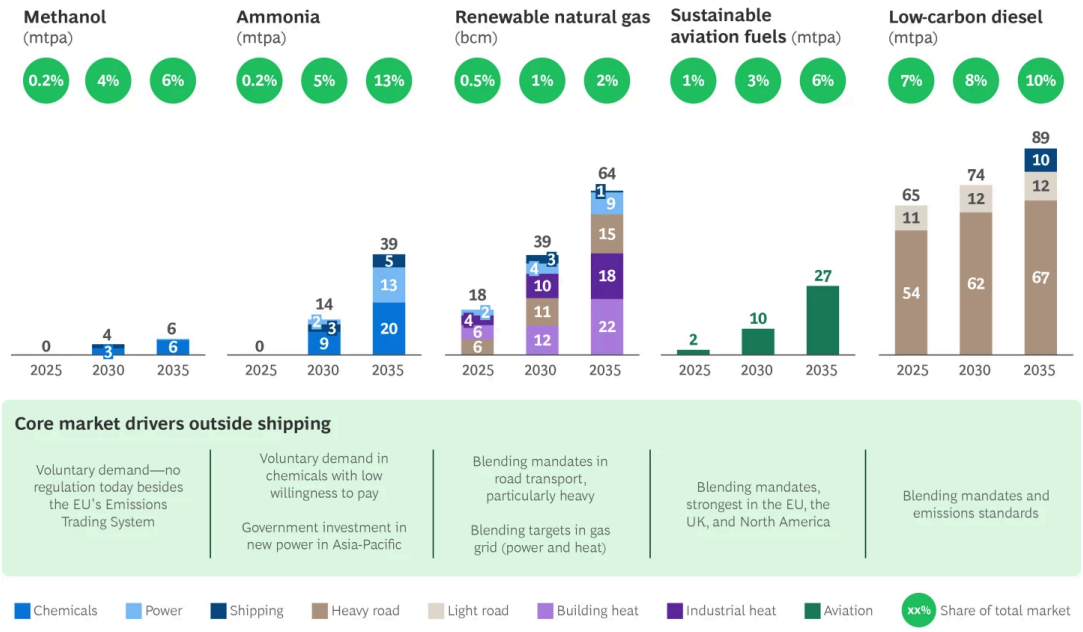
This puts a premium on action by individual shippers and by the sector as a whole. To remain competitive on time and cost, maritime players must engage with the broader fuel ecosystem now. This article examines the major low-carbon fuel options, the current market makers for each, and the steps necessary to secure viable pathways to supply.

Biofuels and Biogas

Long before the shipping sector began seriously exploring biomass-based fuels, road transport and other sectors had already built strong markets for them in response to earlier regulation. Those same sectors now drive demand for low-carbon diesel substitutes such as biodiesel, renewable diesel, biogas, and biomethane. (See Exhibit 1.)

EXHIBIT 1

Shipping Represents a Small Share of Biofuel and Biogas Demand



Sources: S&P Global; IEA WEO; GlobalData; BCG analysis.
Note: Does not include the impact of MEPC 83 on demand. Shipping demand from NavigaTE includes only pyrolysis oil and hydrothermal liquefaction. bcm = billion cubic meters; mtpa = million metric tons per year. Because of rounding, not all bar segment totals add up to the sum given.

Heavy-duty trucking fleets in California and Europe, for example, consume renewable diesel and biogas to earn credits and meet emissions standards. Power and gas utilities in Europe are scaling efforts to blend biomethane into natural gas streams to meet renewable energy targets.

Shipping, by contrast, is still at an early stage of the transition. Maritime players are testing biodiesel blends or liquefied biogas in dual-fuel engines, and drop-in fuels can reduce emissions on existing vessels, but total volume in these areas remains small in comparison to on-road demand.

Shippers' willingness to pay is also lower, given the existence of cheaper compliance options such as using fossil liquefied natural gas (LNG) in combination with offset certificates or simply paying the carbon charges. As a result, shipping remains a price taker in a market defined by others, with little control over the volumes it can secure.

In the 2020s, maritime decarbonization will likely lean on borrowed capacity in the form of biofuel and biogas. This will shape the market in several ways:

- **Competitiveness and Cost.** The greater the demand is for a fuel elsewhere, the higher the opportunity cost is for using it in shipping. For instance, a ship operator can purchase hydrotreated vegetable oil or biogas certificates, but doing so will entail paying a premium set by truck and bus fleet demand.
- **Fuel Sourcing and Partnerships.** In the short run, drop-in fuels and biomethane can help meet new carbon-intensity rules. For example, FuelEU Maritime allows biofuels to count as zero tank-to-wake emissions. But securing these fuels at scale will be difficult without a major expansion of supply. Long-term offtake agreements can help lock in volume, and joining consortia or purchase alliances may offer additional leverage.
- **Timing.** Low-carbon drop-in fuels are available now, but the bulk of those fuels is already committed. Unless production ramps up, shipping could face a supply crunch or exorbitant prices when trying to scale up usage over the longer term. The upside is that the market is beginning to get more organized.
- **Long-Term Potential.** Either shipping will have to piggyback on growth driven by road transport and power through smart sourcing strategies, or it will have to wait until those larger markets expand sufficiently to increase supply and lower costs.

Ammonia

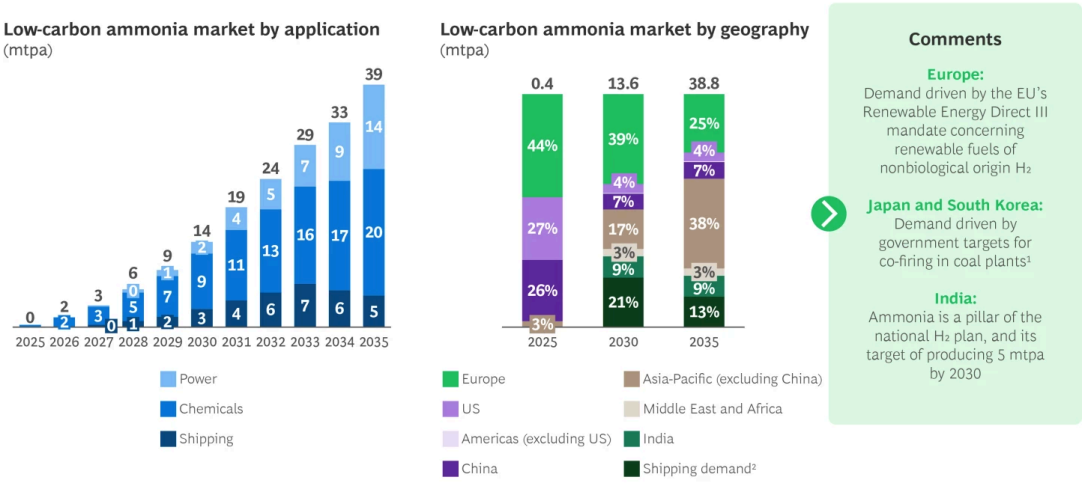
Among next-generation fuels, green or low-carbon ammonia (NH_3) stands out as a promising zero-carbon energy carrier for both shipping and power. But where will the spark that ignites the market come from?

Early signs point to the power sector in Asia as a potential key source of demand. (See Exhibit 2.) Today, demand for low-carbon ammonia is concentrated in Europe, driven by the chemicals market. But Japan and, to a lesser extent, South Korea—both of which are major economies with limited domestic renewables—plan to adopt ammonia co-firing in coal power plants as a central part of their energy transition. This could become a decisive long-term driver of demand.

EXHIBIT 2

Asia Could Be a Market Maker for Low-Carbon Ammonia

Chemical-driven demand in Europe is flattening, while power-sector growth in Asia is accelerating



Sources: S&P Global; IEA WEO; GlobalData; BCG analysis.
Note: Does not include the impact of MEPC 83 on demand; mtpa = million metric tons per year. Because of rounding, not all bar segment totals add up to the sum given or to 100%.
¹Currently under review by the South Korean government.
²Not split up by region.

Both countries have set ambitious targets for ammonia-based electricity generation. Japan, for example, aims to import and use millions of tons of ammonia annually by 2030 for co-firing across its coal fleet. Backed by government roadmaps and subsidies, and spurred on by energy security concerns, these plans are triggering substantial investment in ammonia production and import infrastructure. Japan alone has signaled that it will commit tens of billions of dollars over the next decade to building a global ammonia supply chain for energy use.

With this level of commitment, power-sector demand is making Japan—and potentially its peers—de facto market makers for fuel-grade ammonia in the 2020s. However, while Japan appears steadfast, recent statements in South Korea have introduced uncertainty regarding its future production volume.

The chemical industry, historically the main user of ammonia, is playing a less dynamic role in the shift to low-carbon supply. Fertilizer producers remain cautious because green ammonia is costly and most regions lack strong policy mandates. Aside from niche projects, specific national targets

such as India's goal of 5 million tons of green hydrogen-derived ammonia by 2030, and some voluntary action in countries such as Spain, the fertilizer sector has limited incentive to pay a premium for decarbonized ammonia.

This leaves the power sector, especially in Asia, as the chief source of new demand. Several projects in the Middle East and Australia to produce green or blue ammonia are already in development, with export to Japan and potentially to South Korea's power utilities in mind.

For the maritime industry, this is an important development. Companies that are considering ammonia-fueled vessels as an option for the 2030s can see that a large ammonia supply chain is starting to form, even though it will depend primarily on demand from the power sector for its growth. In practical terms, shipping will benefit from a market that it did not have to build. Demand from Asian utilities will help projects reach final investment decisions and will make the supporting infrastructure worth the capital.

LNG offers a precedent. Other sectors created the early market, and shipping made use of the supply and the bunkering network once they existed. A similar pattern may prevail with ammonia. If engine technologies and safety regulations progress through the next few years, ammonia could be a viable bunker fuel by the mid-2030s because power utilities in Asia pulled it into their energy mix and scaled its availability.

Shipping is a fast follower, not a market maker, in ammonia, and this fact will shape its fuel strategies in several ways:

- **Competitiveness and Cost.** The price of green and blue ammonia for shipping will depend on the scale that the power sector creates. If Japan and others build a large supply chain, unit costs should fall. If power producers are willing to pay a premium in response to energy security concerns or policy incentives, shipping may struggle to secure affordable volume. But if ammonia production expands far beyond power-sector needs, shipping could find itself in a buyer's market. Given this range of outcomes, shipping companies should monitor demand and price signals closely and watch for regulatory signals.
- **Fuel Sourcing and Partnerships.** To ensure early access, maritime players can partner with energy companies or consortia that are involved in ammonia projects. One option is to sign offtake agreements with producers that supply Japanese utilities. Certain trade routes, especially those linking low-cost production regions such as the Middle East and Australia to demand centers in Asia, could become strategic green corridors for ammonia-fueled shipping. Companies hauling iron ore, coal, or LNG on these routes, where ammonia tankers will also be active, could adopt ammonia propulsion themselves, creating natural synergies and more fully integrated value chains.
- **Timing.** Shipping should align ammonia-based projects with the buildout of ammonia infrastructure. Current forecasts suggest that bunkering, storage, and related safety protocols will develop alongside new import terminals in the late 2020s and early 2030s. This moves the

practical window for maritime adoption to the period from 2030 to 2035. Until then, ammonia engines and bunkering availability will remain in pilot. By aligning development pace with the power sector, maritime operators can adopt ammonia once production and logistics have scaled and proven to be sustainable.

- **Long-Term Potential.** If key breakthroughs occur in ammonia cracking that enable efficient point-of-use conversion to hydrogen, the ammonia market could expand rapidly. Success would position ammonia as a universal hydrogen carrier. Global demand could increase by 30% or more, anchoring supply and attracting new participants, including European utilities and industrial hydrogen users. That growth would give shippers a larger and more diversified supply base. This post-2035 factor will depend on R&D progress. In the meantime, shipping can benefit from the momentum of the East Asian power sector, but only through active engagement with that ecosystem.

Methanol

In contrast to ammonia, methanol (CH_3OH) has a less clearly defined market. Green or low-carbon methanol has drawn attention as a convenient liquid fuel for modified ship engines, and it is already being bunkered in small volumes. But the market maker has not yet emerged.

The chemical sector uses more than 100 million tons of methanol annually, but nearly all of it is gray methanol made from fossil sources. (See Exhibit 3.) So far, there is little sign of a broad shift among chemical producers and their customers to low-carbon methanol. The incentives simply aren't in place beyond very specific applications. And unlike transport fuels, chemical feedstocks face no widespread mandates or carbon taxes that might compel a switch. Although some consumer companies have experimented with bio-methanol in furniture or plastics for sustainability branding, these are niche cases involving small volumes of fuel.

One potential source of demand is aviation. Airlines are under pressure to decarbonize and must satisfy mandates for blending sustainable aviation fuel (SAF) into jet fuel. Most SAF today is bio-based, but an emerging pathway involves converting green methanol into a drop-in synthetic kerosene. If this process, known as methanol-to-jet (MtJ), becomes commercially viable, it could unlock a large customer base that is willing to pay for the fuel. Airlines, backed by carbon pricing and steep SAF penalties, are likely to accept the higher costs involved. BCG analysis indicates that MtJ could boost global methanol demand by up to 50% beyond current projections.

The shipping sector is currently the biggest proponent of green methanol, led by a few prominent companies that are betting on methanol propulsion. More than 300 methanol dual-fuel vessels are on order as of 2025, including over 100 large container ships. If all of these vessels ran on methanol, they would need roughly 13 million tons of the fuel annually—a clear demand signal.

The open question is whether these orders will translate into large-scale green methanol consumption or will act mainly as future-proofing hedges.

Many of the new builds designed to use methanol are likely to run on conventional fuels and will switch to green methanol only if the supply scales. Green methanol, whether bio-based or made from green hydrogen and CO_2, is currently far more expensive than marine fuel or LNG, and most operators can't justify paying the premium without strong incentives because they cannot easily pass the full cost on to their customers. Neither existing regulations, such as FuelEU Maritime, nor the IMO's proposed net zero framework mandates methanol use. LNG and biofuel blends can meet near-term emission targets, often with certification or pooling. It follows that, in the short term, shipping cannot anchor the green methanol market on its own. Easier compliance routes exist that do not entail building a completely new fuel ecosystem.

Methanol offers a cautionary case. Shipping may become its largest early adopter if all vessel orders play out in its favor, but even that may not be enough to spark a global commodity market. This state of affairs has several strategic implications:

- **Competitiveness.** Without strong policy support, methanol adopters could find themselves at a cost disadvantage against competitors that use cheaper LNG or biodiesel blends to meet regulatory requirements. Adoption can pay off if customers are willing to pay a premium to achieve a true net-zero supply chain. Otherwise, first movers may end up subsidizing the transition. Companies should focus their methanol deployment on routes or customers that make those premiums attainable, such as in lanes where consumer goods shippers have pledged to use carbon-neutral freight.

- **Fuel Availability and Sourcing Risk.** Relying on a fuel that lacks a strong external market maker raises the supply risk for shippers. Companies may need to co-create the market by investing in production projects or signing forward contracts that give producers the confidence to build capacity. Some carriers are already partnering with methanol producers or energy companies to secure future supply. Vertical integration could become necessary if broader market forces can't guarantee availability. The sector's inability to invest in large fuel projects imposes a further constraint on fuels without clear market makers, particularly methanol, and this challenge will grow if the IMO's net zero framework is not adopted.

- **Regulatory Dependence.** Methanol's prospects rest on regulatory changes. If, by the mid-2030s, regulatory policy effectively disallows fossil LNG or caps biofuel credits, shipping will have to use fuels such as green methanol and ammonia. A shift of that sort could turn shipping into the market maker for methanol. However, current policy trajectories, including IMO's initial greenhouse gas strategy and FuelEU rules, do not point toward mandating that outcome before 2035. Shipping leaders should stay closely engaged with the regulatory evolution and consider advocating measures that favor low-carbon fuels over transitional ones. The shipping sector may need to ask for the very rules that would force its hand to end the present stalemate and spur investment in fuels such as methanol.

- **Technology and Transition.** Blue methanol, which is made from natural gas with carbon capture, offers a lower-carbon alternative to gray methanol, but it reduces emissions by only about 10% to 15% relative to conventional marine fuel. That level of improvement is unlikely to satisfy future regulatory standards. Its limited benefit and relatively high cost also make blue methanol less appealing than transitional fuels such as LNG or biodiesel. Unless costs fall sharply, blue methanol won't play a major bridging role—and this increases the pressure on green methanol to succeed. Ethanol could play a part, given available first-generation supply of more than 100 million tons per year. However, demand from road transport, regulation in the EU, and monitoring, reporting, and verification requirements limit its use today. In effect, shipping may be ahead of its time and waiting for chemicals, aviation, or regulators to create the necessary conditions for a viable methanol market.

Trigger Points That Could Change the Game

Thus far, we have described the landscape under current trends and policies. However, several potential events could materially alter the demand outlook for these fuels:

- **Hard Global Regulation.** If the IMO adopts the Marine Environment Protection Committee's MEPC 83 package in 2026, steeper fuel-intensity curves or a meaningful global carbon price could ensue. Those shifts could increase longer-term shipping demand for low-carbon fuels. In the near term, the impact would be more signal than shock, as most owners can still comply by adopting efficiency measures and using LNG or biofuels. A true step change will come only if the carbon levy is high, enforcement is strict, and the accompanying mechanism directs support toward low-carbon fuels or new supply, such as methanol or ammonia plants. More liberal mass-balancing rules could help expand feasible supply, particularly of biogas and renewable natural gas (RNG).
- **Stricter Blending Mandates.** In China and other parts of Asia, proposed increases in biogas and biodiesel blending targets for road transport and gas grids could reshape global markets. A national mandate in China alone could expand global demand for RNG by 20%. Similar moves elsewhere in Asia or Africa would have a smaller impact, either because shippers are already meeting targets or because structural barriers persist. The broader effect is the same. Stronger mandates tighten supply for drop-in fuels and reinforce a pattern in which road and domestic energy sectors absorb most biofuels and thus limit maritime access, given the finite feedstock for biogas and biodiesel.

- **Methanol Market Shifts.** Broader adoption of low-carbon methanol in the chemical sector could provide an important boost, especially if environmental, social, and governance commitments or consumer pressure take hold in industries such as furniture, textiles, or construction. Even modest uptake could increase demand. Segments such as biomedical technology and branded consumer products could account for 1.5 million metric tons of green methanol annually. Although this level of demand would represent less than 10% of global methanol use—insufficient to scale the market on its own—it would diversify the market beyond shipping and strengthen the investment case for green production.
- **Ammonia Cracking Breakthrough.** A major advance in point-of-use hydrogen extraction could be transformative. It would let ammonia function as a practical hydrogen carrier across sectors such as transport, industry, and energy storage, sharply expanding its utility. If this becomes cost-competitive, demand could rise by roughly 13 million metric tons, about 33% above the base case. For shipping, this would mean a broader, more resilient ammonia supply chain, possibly anchored in global trade rather than concentrated in regional production. This scenario depends on parallel advances in hydrogen end-use technologies and is unlikely to occur before the 2030s.
- **Competitive Methanol-to-Jet Route.** If MtJ fuel becomes commercially viable—supported by Europe's sustainable aviation fuel mandates and stiff penalties for noncompliance—it could heighten demand for green methanol by around 3 million metric tons, an increase of roughly 50% over today's small green methanol market. The volumes involved are not huge, but aviation's willingness to pay premium prices could help scale production and lower costs. For shipping, the impact depends on timing. Because MtJ demand likely won't materialize before the 2030s, it offers little relief to shipowners looking to bunker green methanol in 2025—but it could reshape the market by 2035. It also introduces competition. Airlines could outbid shipping companies for green methanol unless production expands in parallel.

Adapting Fuel Sourcing Strategies to a Multisector Market

As fuel markets grow more competitive, maritime players will need to rethink how they procure their supply of low-carbon fuel. A strong sourcing strategy will likely include the following elements:

- **Collaborative Procurement.** Shipping companies can pool demand to strengthen their buying power and reduce risk. Consortia or buyers' clubs such as the Zero Emission Maritime Buyers Alliance commit to jointly purchase specified volumes of fuel, giving suppliers clearer demand signals and unlocking better commercial terms.

- **Co-investment Synergies.** Shipping lines can partner with others in their sector and across industries to secure reliable supplies of green fuel. A group of container lines might contract with a biogas producer for a large tranche of bunker certificates or jointly fund an green methanol facility for guaranteed volumes of the fuel. Similar opportunities exist across sectors. If a power utility is building a green ammonia import terminal, a shipping line could co-invest to ensure bunkering capability and long-term supply. Teaming with chemical companies that need green methanol as feedstock can unlock shared production, as happened with European Energy's Kassøe plant.

- **Customer Engagement and Value-Chain Integration.** Many cargo owners have already established sustainability targets, and maritime players are collaborating with them to decarbonize the full supply chain. Shipping offers one of the fastest ways for cargo owners to cut Scope 3 emissions without committing capital or redesigning their value chains. Such collaboration can take the form of premium agreements in which freight customers pay for carbon-neutral transportation, underwriting the carrier's purchase of green fuels. These contracts create customer-backed demand and lower the investment risk for carriers. Several lines have already signed route-specific "green corridor" deals with major retailers and manufacturers, under which customers share or absorb the added cost of green methanol or biofuel blends. These arrangements tie maritime fuel strategy directly to broader value-chain decarbonization plans and align incentives across stakeholders.

- **Advocacy for Supportive Policies.** Maritime players need policies that create real demand for low-carbon fuels and narrow the cost gap between those fuels and fossil-based options. These include direct fuel mandates or quotas for shipping, carbon pricing, contracts for difference, and production tax credits. Carriers can also push for inclusion in EU and national support programs and for an IMO-led carbon levy that redistributes funds to lower the price of green fuels. Adjustments to fuel standards such as stricter treatment of methane slip could steer investment away from transitional fuels such as LNG and toward zero-carbon options. Early, consistent engagement with regulators is essential to reducing first-mover risk and ensuring long-term access to the fuels that the sector will need.

- **Education and Ecosystem Building.** In order for maritime decarbonization to work, ports, regulators, investors, fuel producers, and cargo owners must possess a common understanding of what the transition requires. Shipping companies should lead that effort. They can spell out the sector's realities—the interdependence of stakeholders, the limits on cost absorption, and the need for coordinated action—and build fluency inside their own organizations about new fuels, safety, and operational changes. They can also help shape the emerging green-fuel economy. That means joining or forming coalitions (from fuel-specific groups such as the Green Ammonia Shipping Consortium to broader climate alliances), working with ports on multifuel infrastructure plans, and exploring co-investment or risk-sharing arrangements with fuel producers through offtake agreements, equity stakes, or volume guarantees. The more firmly the shipping sector positions itself as part of the wider energy transition, the easier time it will have attracting partners, securing support, and accelerating progress.

- **Multifuel Strategies and Fuel Flexibility.** Multiple industries will shape supply, demand, and pricing in the future. Shipping therefore needs to remain flexible and adopt multifuel strategies. Dual-fuel capabilities and a diversified fuel portfolio can enable carriers to shift with price movements, protect vessel value, and reduce exposure to any single pathway. Those strategies may include engines that can run on alcohols, LNG, drop-in biofuels, and eventually ammonia. Leaders should continuously monitor their varied fuel portfolio as markets develop.

Maritime decarbonization is subject to influence from airline boardrooms, utilities that are planning next-generation power plants, and government halls where regulators are setting renewable mandates. Shipping must find its place in this complex mosaic, collaborating when advantageous, influencing when possible, and innovating within its sphere of control.

Effective development of low-carbon fuel markets depends on having multiple sectors work in concert, each providing volume and investment. Shipping has the opportunity to contribute its voice to that chorus, so that the fuels it needs for decarbonizing are available on time and under terms that allow the industry to thrive. This requires shipping to take a more active role in developing new fuel supply chains in strong collaboration with the energy sector and other offtake industries.

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