Are you ready?

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With multiple regulatory pressures accelerating the transition away from conventional fuels, shipowners are increasingly being asked to commit to fuel choices that may not remain viable for the full operational life of their vessels. The need for long-term flexibility in fuel and engine strategy has never been more urgent – but preparing for future transitions requires a deep understanding of how technical decisions made today will shape a vessel's adaptability tomorrow.

At Deltamarin, fuel readiness is not an add-on – it's an integral part of smart ship design. From spatial planning and systems integration to life-cycle cost modelling and scenario analysis, our engineering teams work closely with owners to ensure their newbuilds are not only compliant at delivery but will remain competitive in an evolving market.

Let us then explain how to balance today's fuel strategy with tomorrow's uncertainty so that vessels will stay efficient, adaptable, and valuable for decades to come. We will do this by, among others, exploring real-world examples of cost trade-offs, conversion planning, class notations, and the cascading impact of fuel decisions on vessel systems (such as waste heat recovery).

What's driving the urgency

The regulations set at the 83rd meeting of the International Maritime Organization's (IMO) Marine Environmental Protection Committee (MEPC), as well as by FuelEU Maritime (FEUM), are giving a clear and strong signal that now is the time to consider how vessels being built today can fulfil environmental requirements throughout their operational lifetime. The impact is not limited to fuel choice – it extends to how fuels are produced and distributed, affecting operational and investment strategies alike.

At MEPC 83, the IMO agreed on mid-term greenhouse gas (GHG) reduction measures, setting a target of reducing the carbon intensity of shipping by at least 40% by 2030 versus 2008 levels and pushing towards a 70-80% GHG reduction by 2040. In parallel, FEUM came into effect in 2025, setting escalating annual limits on GHG intensity for ships calling at EU ports, with a 2.0% reduction target this year, up to 80% by mid-century. This will directly affect vessel design and fuel strategies, as compliance will require significant emissions reductions year on year.

Critically, these regulations have a broad geographic reach. While some owners previously planned to reposition or trade vessels outside the EU to avoid regional regulations, the new global IMO standards make that a less viable 'Plan B.' Ships will need to comply with increasingly stringent emissions standards wherever they operate, reinforcing the need for long-term flexibility in vessel design.

While the ship systems themselves are generally agnostic to the production method of alternative fuels, the environmental performance and regulatory compliance of the fuels are not. Over time, ships will likely shift from conventional bunkers to greener blends or entirely renewable alternatives. Increasingly, regulations are moving from a tank-to-wake approach – measuring only exhaust emissions – to a well-to-wake (WtW) framework that considers the entire fuel life cycle, from production to combustion. For example, FEUM sets GHG intensity limits based on WtW emissions, meaning that both upstream production and on-board combustion performance affect compliance. Even for fuels like bio- or renewable diesel, which are close in characteristics to conventional bunkers, there are important considerations regarding compatibility, availability, life-cycle emissions, and cost.

Today, the majority of ships adopting alternative fuels are dual-fuel (DF) vessels. For example, those operating on marine gas oil and liquefied natural gas (LNG) already enjoy a degree of flexibility, as both fossil and bio/synthetic blends can be used in these systems. However, if operational or regulatory pressures push towards adopting other fuels – such as methanol or ammonia – a conversion will be required. This is where securing a high level of fuel readiness can deliver significant benefits by reducing the complexity, cost, and downtime associated with future adaptations.

Assessing the (right) level of fuel readiness

When considering the appropriate level of fuel readiness, the starting point of the vessel is critical. Ships that rely solely on conventional fuels typically have the highest need for fuel readiness upgrades, but they also face the greatest technical challenges due to limited existing compatibility in systems and arrangement. In contrast, some of the DF LNG vessels recently delivered or under construction are built with tanks that can be adapted for alternative fuels, like ammonia or methanol, which can significantly reduce the complexity and cost of future conversions (however, this is not automatically the case with standard LNG tanks on existing vessels).

We divide fuel readiness into three primary levels to guide owners through these strategic decisions. First, minimal readiness, the most basic level, is designed to ensure that the vessel can technically be converted. It typically involves documentation and pre-approval drawings showing how the vessel could be modified but with no physical space reservations or installed equipment. Engine conversion kits may not be available yet but are planned for future release. However, executing a conversion from this baseline can be highly expensive and time-consuming, involving the installation of new tanks, re-routing of pipes and cabling, upgrading safety systems, and possibly even replacing engines – all of which would cause significant downtime.

Photo: Höegh Autoliners

Next, intermediate readiness aims to reduce future conversion costs and time by incorporating some physical preparations during the initial build. The design ensures that critical components – such as engines – can be converted with kits and that the vessel layout includes access routes that allow these components to be installed or removed with no structural modifications. These access routes refer to predefined paths within the vessel (such as removable deck panels, hatches, or bulkhead openings) that are sized and located to support both initial installation and future hauling or maintenance. Tanks are either already suitable or require only minor modifications for alternative fuels. There is space reserved, or pre-installed infrastructure, for auxiliary systems and fuel-handling equipment. The hazardous and non-hazardous zones are already planned with future fuels in mind, minimising later regulatory hurdles.

Finally, there's full readiness. This level equips the vessel to be immediately capable of operating on the alternative fuel – even if the actual fuel is not yet commercially available or bunkering infrastructure is limited. It includes fully installed fuel storage, supply systems, and engines either capable of DF operation or pre-certified for future conversion. In some cases, engine manufacturers may offer conversion kits for installation post-delivery, meaning the vessel is only a few minor steps away from operational readiness on the new fuel. This level of readiness gives the highest future flexibility but also involves the highest upfront investment.

Overall, fuel readiness opens the door to multiple future pathways, even where today's fuel solution might seem like a safe bet. In many instances, owners operating vessels in specific regions – e.g., where LNG, biogas, and eventually synthetic gas are readily available – might opt for LNG propulsion as the obvious choice. This fuel, along with its bio- and synthetic derivatives, offers lower emissions and some compliance assurance for the near future. That said, the market and regulatory landscape can shift rapidly. If future availability or economics change – for instance, if LNG supply becomes constrained or synthetic gas adoption is slower than expected – owners could find themselves exposed. Without fuel readiness built in, the investment in LNG-specific infrastructure could become a sunk cost. In contrast, if the vessel is designed with a degree of flexibility, that risk can be mitigated.

In many projects, a hybrid approach can also be advantageous – applying a full readiness level for one primary alternative fuel while maintaining intermediate or minimal readiness for secondary options. This ensures that owners do not over-invest but still retain flexibility if market conditions or regulations shift. Fuel-ready designs allow for this flexibility. Spaces and systems initially designed for LNG tanks and fuel handling can be dimensioned and arranged to accommodate alternative fuels with minimal modifications. Utility routes, structural supports, and hazardous zoning can be pre-engineered to be adaptable, reducing the complexity and cost of future conversions.

The optimal fuel-readiness strategy depends heavily on the ship type, operational area, trading profile, fuel availability, and the owner's long-term business plan. That's why at Deltamarin, we support clients with advanced scenario modelling and simulation tools. These models incorporate not only the vessel's operational profile but also projected GHG emissions pathways, cargo capacity impacts, and endurance trade-offs under various fuel strategies. Importantly, all current and emerging regulatory requirements – including the latest IMO and FEUM targets – are integrated into these simulations. This allows our clients to make informed, data-driven decisions about the right level of fuel readiness, the opportune conversion window, and the most resilient path to long-term compliance.

Saving money with fuel readiness?

Fuel readiness is often viewed as an additional upfront cost – but when properly considered, it's a fundamental investment in life-cycle value and operational flexibility.

Understanding the cost dynamics of fuel storage is key. LNG and ammonia, for instance, are both liquefied gases and can be stored in similar cryogenic tanks – but the tank material and design strength must be carefully specified to handle the specific properties of either LNG or ammonia (or ideally both). Methanol, on the other hand, can be stored in coated structural tanks, requiring different configurations, including protective cofferdams for safety. This matters because if designed carefully, an LNG tank can also be certified for ammonia and even methanol with only minor modifications. In contrast, a methanol-designed tank cannot be safely upgraded to store LNG or ammonia later. Some conventional fuel tanks can be designed with structural reinforcements or reserved space to allow easier conversion to methanol use in the future.

From a cost perspective, the logic is simple: investing in readiness at the newbuilding stage – when systems are already being installed – is significantly cheaper than trying to retrofit these capabilities later, when structural modifications, steelwork, and system reconfigurations will add substantial cost and downtime. Conversely, if fuel simulations and regulatory projections show that the selected initial fuel will meet long-term targets, a lower readiness level can be applied to avoid over-investing.

In one feasibility case study, we compared two configurations: a standard LNG fuel system and an LNG system with an ammonia-ready tank design. The cost increase for preparing the tank for future ammonia use at the newbuild stage was approximately 20% over the baseline LNG system. While this adds modest cost upfront, it significantly reduces long-term risk.

In contrast, if a vessel with a conventional LNG system were later required to convert to ammonia, the cost implications would be far higher. Not only would the original LNG tank – which may have cost around $6.0 million – become obsolete, but the retrofit would require an entirely new ammonia-compliant tank, plus major structural modifications and system adaptation. This could bring total costs up to $20m – over 200% higher than the ammonia-ready option at the newbuild stage. This includes scrapping the existing tank, procuring and installing a new one, and undertaking extensive steelwork (particularly if the tank is located deep within the vessel).

The takeaway is clear: when future fuel transitions are even a moderate possibility, it is far more cost-effective to prepare at the outset. The marginal investment today avoids substantial conversion costs, downtime, and technical challenges later. At Deltamarin, we help clients understand the total cost of ownership implications of their fuel-readiness decisions. By balancing initial CAPEX against future OPEX and retrofit risks, we ensure owners are making informed, financially sound decisions, optimising their investment not just for today's regulations but for decades of operational flexibility.

The impact of today on tomorrow

Early technical decisions made during the design phase have a profound impact on how easily – and cost-effectively – a vessel can adapt to future fuel transitions. While it might be tempting to focus on engine choice solely, true flexibility demands a broader, systems-level view from the outset.

Engine selection remains a critical factor, though. Traditionally, engine designs were optimised for a specific fuel type, but recent trends show manufacturers increasingly developing engines capable of multi-fuel configurations. Even so, important limitations remain; for example, many LNG-fuelled four-stroke engines are available in a more limited range of bore sizes and power outputs compared to conventional diesel engines, which can restrict flexibility in engine selection and future conversion options. Methanol and ammonia engines can sometimes be based on conventional or LNG platforms, but the initial choice can still lock in or limit future adaptability. Selecting an engine with a clear, documented conversion pathway to alternative fuels is an important safeguard for future flexibility.

Beyond the engine room, spatial and structural considerations play a major role in determining how straightforward – or costly – future conversions will be. Key examples include bunker station layout, ventilation systems and vent mast design, and tank space and routing. It is essential to position bunker stations during newbuilding to meet the safety regulations of alternative fuels, such as segregation requirements for hazardous areas. If designed thoughtfully from the start, this can usually be achieved with minimal or no additional cost. However, if not considered early, costly and complex structural modifications may be required later to meet safety standards for alternative fuels like ammonia or methanol.

Adequate separation distances between hazardous and non-hazardous areas must be maintained. If insufficient distance is allowed during initial design, extensive retrofits might be necessary – including repositioning major components or raising vent masts. Taller vent masts could also inadvertently impact vessel air draft, restricting access to certain ports and waterways, which adds significant operational limitations.

Providing flexible spaces and unobstructed routes for future installation of additional fuel tanks, piping, or auxiliary equipment (e.g., fuel treatment systems) can dramatically ease conversion efforts. Structural reinforcement or space reservation now prevents costly steelwork and downtime later in the vessel's life.

Beyond propulsion

As tightening regulations drive up the cost of emissions and future fuels, it has become increasingly important to design energy-efficient ships that maximise the use of all available energy – including waste heat that is typically recovered from exhaust gases. However, alternative fuels like methanol and ammonia introduce a significant technical challenge that is often underestimated in early designs.

One key issue is that methanol and ammonia combustion have different waste heat distributions, which reduces heat in the exhaust stream when compared to conventional fuels like marine diesel oil or LNG. This distribution has direct and indirect implications for on-board systems that either rely on thermal energy recovered from exhaust gases or are affected by their availability, including steam turbines, organic Rankine cycle (ORC) units, auxiliary boilers, exhaust gas boilers, and heating and ventilation systems.

If the vessel is equipped with waste heat recovery systems (e.g., for generating electricity or process heat) that are designed based on the thermal output distribution of conventional fuels, they may become oversized or underutilised when the ship transitions to alternative fuels. In such cases, exhaust gas boilers may no longer deliver sufficient heat output, and the vessel may need to rely more heavily on auxiliary boilers to meet energy demands. This shift can lead to higher fuel consumption, increased OPEX, and, in some cases, render advanced waste heat recovery equipment economically unviable.

In one recent study, Deltamarin identified that switching from diesel to methanol would result in an approximate 30% drop in available exhaust gas heat. To address this, the ship's heating system was re-engineered – transitioning from a traditional steam-based configuration to a hot water-based system. The updated design focused on maximising heat recovery from the engine's high-temperature cooling water, which is less affected by the fuel type and provides a more stable heat source. While some energy was still recovered from the exhaust gases, the shift in focus enabled the vessel to maintain reliable heating efficiency despite the lower thermal output of methanol combustion. Over the vessel's lifetime, this design adaptation helped ensure energy efficiency, reduce dependency on auxiliary boilers, and maintain optimal performance of both heating and ORC systems while reducing life-cycle emissions.

It is important to understand that there is no one-size-fits-all solution. The optimal configuration depends heavily on vessel type, operational profile, voyage patterns, and anticipated fuel pathways. This is why Deltamarin applies a systems-level approach to fuel readiness – not only considering propulsion but also carefully evaluating the cascading impact of fuel choices on auxiliary systems and long-term vessel operability. By doing so, we help clients avoid hidden inefficiencies and future-proof their ships against evolving energy realities.

The (real) value behind fuel readiness class notations

Most classification societies offer fuel readiness notations, and while the naming and specifics vary slightly, the basic structure is broadly similar. Typically, notations fall into three main categories. Design readiness: indicates how the vessel could be modified to accommodate alternative fuels based on design documentation. Tank readiness: focuses on the preparedness of the fuel tanks – materials, structure, and safety measures. Engine and boiler readiness: covers the propulsion and auxiliary machinery's capacity for future conversion.

Within each category, there is usually a three-tiered scale. A: conversion is possible in the future, but no physical preparations are made (essentially a 'paper' readiness, low cost). B: partial preparation – e.g., engine conversion kits are available, or the design accommodates future retrofitting without major structural changes. C: full readiness – the vessel is already equipped with most or all necessary modifications, requiring only minimal work for full compliance. Deviations from full compliance are minor, typically related to scheduling, technical availability, or other practical factors. For example, a vessel might have a B-level main engine (conversion kit available), an A-level auxiliary engine (future conversion possible but not yet prepared), and a C-level tank (fully built to the specifications required for alternative fuels).

However, it is important to note that class notations can sometimes offer a false sense of security. Many A and B levels involve little to no physical investment and are more about documentation and pre-approval than tangible shipyard work. As a result, while these notations can be obtained at relatively low cost, they do not necessarily reduce the future conversion burden.

Moreover, not everything that matters is captured by class notations, for instance, small but critical design features, such as dimensioning fuel handling room ventilation to accommodate more stringent requirements for fuels like ammonia or future-proofing hazardous zoning and space for fuel treatment systems. These elements often fall outside formal class criteria but can have a significant impact on future conversion costs, shipyard downtime, and regulatory compliance. If considered thoughtfully at the newbuilding stage, they can be included at negligible extra cost, but save substantial time and money during future retrofits.

At Deltamarin, we go beyond simply aiming for notations. We work closely with clients to critically assess which levels of readiness deliver real operational and financial value – and where it's worth investing a little more at the design stage to avoid bigger expenses later. By combining regulatory insight, technical detail, and cost-benefit analysis, we help owners avoid superficial readiness and instead achieve true future-proofing for their fleet.

In the making – other risks and unknowns

Despite the growing momentum around alternative fuels, there are still significant uncertainties that shipowners must navigate when preparing for the future.

While the IMO's current mid-term measures and the FEUM provide a framework, the details are still evolving – particularly around life-cycle emissions (WtW accounting) and future fuel certification standards. Regional regulations may also diverge, creating a patchwork of requirements that ships must meet in different trading areas.

Although fuels like LNG, methanol, and ammonia are technically viable, global bunkering infrastructure remains uneven. Betting on a fuel too early – or without ensuring long-term supply reliability – can expose vessels to operational risks or unplanned retrofitting costs. For instance, it took an entire decade to scale bioLNG supply so that 'gas-committed' shipping lines in the Baltic could increasingly use it instead of the fossil version (though with a higher price tag, this green LNG has opened the doors to banking on FEUM over-compliance, e.g., through pooling).

Engine and fuel-system manufacturers are still developing and refining DF and alternative fuel solutions. Delays in engine certification, supply chain constraints, or unexpected technical challenges can impact the timelines for safe and efficient fuel adoption.

Fuel pricing, carbon taxation schemes, and emissions trading systems are volatile and can shift quickly, affecting the cost-competitiveness of different fuels over the vessel's lifetime. We saw this in all vividness at the latest 'postponing' session of MEPC.

At Deltamarin, we help clients manage these uncertainties strategically rather than reactively. Our approach is to focus not only on current regulatory compliance but also on real emissions reduction and long-term operational efficiency. Instead of chasing regulatory targets that may shift, we guide clients towards robust, resilient design strategies that minimise life-cycle emissions under a wide range of future scenarios, preserve operational flexibility through modular, adaptable fuel system designs, and incorporate scenario modelling that stress-tests vessel performance against different fuel price forecasts, regulatory regimes and technology adoption curves.

Fully ready to serve

By prioritising the most efficient vessel design, owners can position themselves well for future regulations – many of which will become more stringent. Achieving genuine efficiency and low emissions cannot be reached simply by meeting today's minimum regulatory requirements; it requires forward-looking thinking that anticipates where the industry is heading.

Our mission is to ensure that the vessels we design today – be they tankers, bulkers, cruisers, ferries, ro-ros, and offshore units – are not only compliant at delivery but also competitive and resilient for decades to come, regardless of how the regulatory and fuel landscape evolves. Quite often, the vessel delivered is very close to the first concepts we developed – a testament to the robustness of our prior design work and the depth of our technical expertise.

Focusing only on a single vessel type or fuel can easily lead to blind spots, causing minor-seeming oversights that, if left unaddressed, may later have a disproportionate impact on cost, safety, or operational flexibility. A broad, integrative approach ensures that clients are protected from these avoidable risks; it means they're fully ready to serve seaborne trade – commercially and environmentally.

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