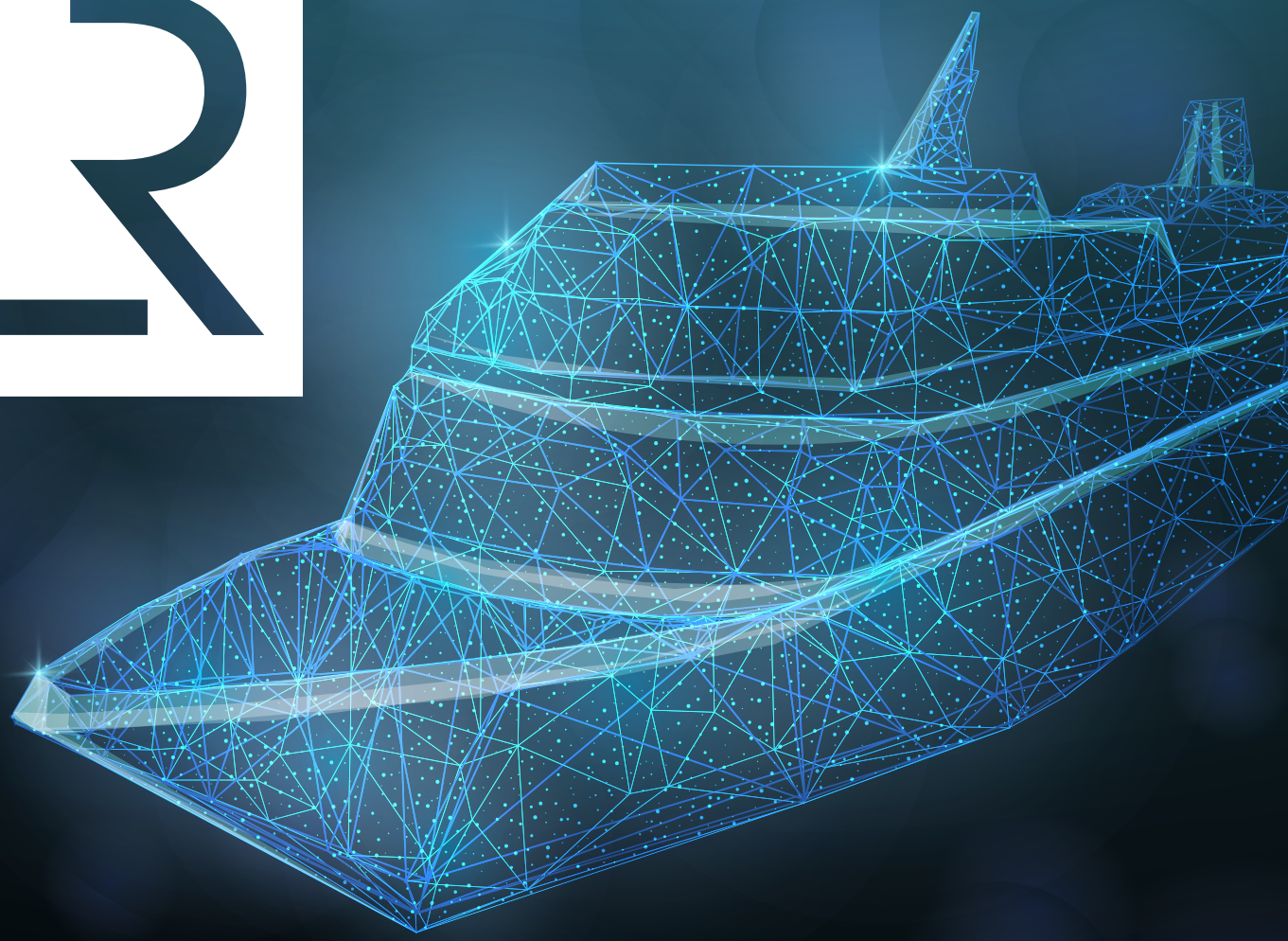


WHITEPAPER

Zero Ready Framework

Ensuring shipping can deliver our zero emissions future

Summary

Shipping faces a critical challenge. The energy transition is well underway and ocean going zero carbon ships must be in service by 2030. The industry is currently focussed on delivering zero Greenhouse Gas (GHG) emissions by fuelling with renewably sourced ammonia, hydrogen or methanol. But solutions for widespread deployment are not ready yet and ships built today have expected lifetimes of 20-30 years. So, the industry now thinks in terms of 'readiness', the ability to ensure that a vessel can use zero carbon fuel once this becomes feasible, either by building new vessels that have this capability from the day they are built, or by ensuring existing vessels can be easily converted.

But there is no common definition of readiness, and it can mean anything from a vessel fully equipped to bunker with alternative fuel today, to a vessel that could potentially be converted from fossil fuel power at some point in the future. Many so-called 'ready' vessels will require major retrofit, with significant safety implications and costs that could render the project uneconomic.

This paper presents a readiness framework for use by the industry that provides the clarity needed to support strategic planning and investment in assets with the greatest future prospects as we transition to zero carbon fuelled vessels.

We ask businesses across the industry to use this framework in development of strategies and plans. We also ask that you commit to only financing, building and ordering vessels that meet a clearly defined readiness level by specified dates. These actions will both help your business to manage the risks faced in the energy transition and clearly demonstrate your climate commitments to customers, business partners and end consumers.

Shipping needs to be making decarbonisation decisions today

Ambitions for decarbonisation of shipping are accelerating. At COP26, fourteen countries signed a declaration urging the IMO to take immediate action in order to achieve zero emission shipping by 2050[1]. The declaration sets a precedent for the IMO when it revises its 'Initial Greenhouse Gas (GHG) strategy[2]' in early 2023. Financiers, insurers and ship charterers are all pushing forward with initiatives focused on achieving zero emissions by 2050[3]. The increasingly stringent requirements placed on shipowners and their vessels will mean that without zero emissions vessels, or a clear plan for zero, it will be much harder for shipowners and ship builders to do business.

In addition to building new zero carbon fuelled ships, we will need to convert some of the existing fleet to different fuels. The transition strategy from the Getting to Zero Coalition indicates that, by number of ships, newbuilding and retrofitting activity will be of similar magnitudes over the period 2030-2050[4]. An assessment of a container ship route in Southeast Asia by the Maritime Decarbonisation Hub has estimated that 27% to 30% of vessels newly built in the period between 2022 and 2050 will require conversion to a different fuel in order to meet zero targets[5].

27%-30%

of vessels newly built in the period between 2022 and 2050 will require conversion to a different fuel in order to meet zero targets

Zero carbon shipping solutions are being developed but are not commercially widespread yet. As ships built today will still be in service in the 2040s, owners must plan for conversion to zero carbon fuel within the vessel's lifetime. To ensure the sector remains on the right transition path we require ships that are 'ready' to use zero carbon fuels, even if they run on a fossil fuel today.

1 https://em.dk/media/14312/declaration-on-zero-emission-shipping-by-2050-cop26-glasgow-1-november-2021.pdf
2 https://www.imo.org/en/MediaCentre/HotTopics/Pages/Reducing-greenhouse-gas-emissions-from-ships.aspx
3 https://lloydslist.maritimeintelligence.informa.com/LL1142408/Why-shipping-may-not-have-a-choice-when-it-comes-to-net-zero
4 A Strategy for the Transition to Zero-Emission Shipping, Getting to Zero Coalition, 2021
5 https://www.lr.org/en/resources/first-movers-in-shippings-decarbonisation/

Alternative fuel 'Readiness' is the new mantra – but what does it mean?

Announcements of alternative or future fuel 'ready' vessels are now a regular feature in the shipping press and industry discussion. For example:

> "The ship is prepared to run on hydrogen or ammonia

> "Allows for the future installation of zero-emission hydrogen technology… with a Liquid Organic Hydrogen Carrier (LOHC) concept.

> "Construction began today .. on the first large cruise ship designed to be methanol-ready for future conversion

A wide range of different vessels are being called 'ready'. Over 400 vessels in the world fleet and order book are termed alternative fuel 'ready'. Some have had a design for conversion to zero carbon fuel done as a paper exercise, without a plan for how the conversion would be actually carried out. Others have some or all the required equipment (for example: engine, tank, pipework, fuel management system) already installed. Another group of vessels have a dual fuel engine that could run on a zero-carbon fuel but may require an engine retrofit to do so.

Another frequently used term that has not been defined is zero carbon fuel 'capable'. There are hydrogen 'capable' cruise ships both in service and on order, but these use hydrogen for auxiliary power, not for primary propulsion. This means their emissions reduction impact at this time is relatively small. Likewise, several pilots and trials are underway that experiment with a zero-carbon fuel, but often only for auxiliary power or for a peripheral energy source, not for primary propulsion. Often these experiments are described as zero carbon 'capable' vessels.

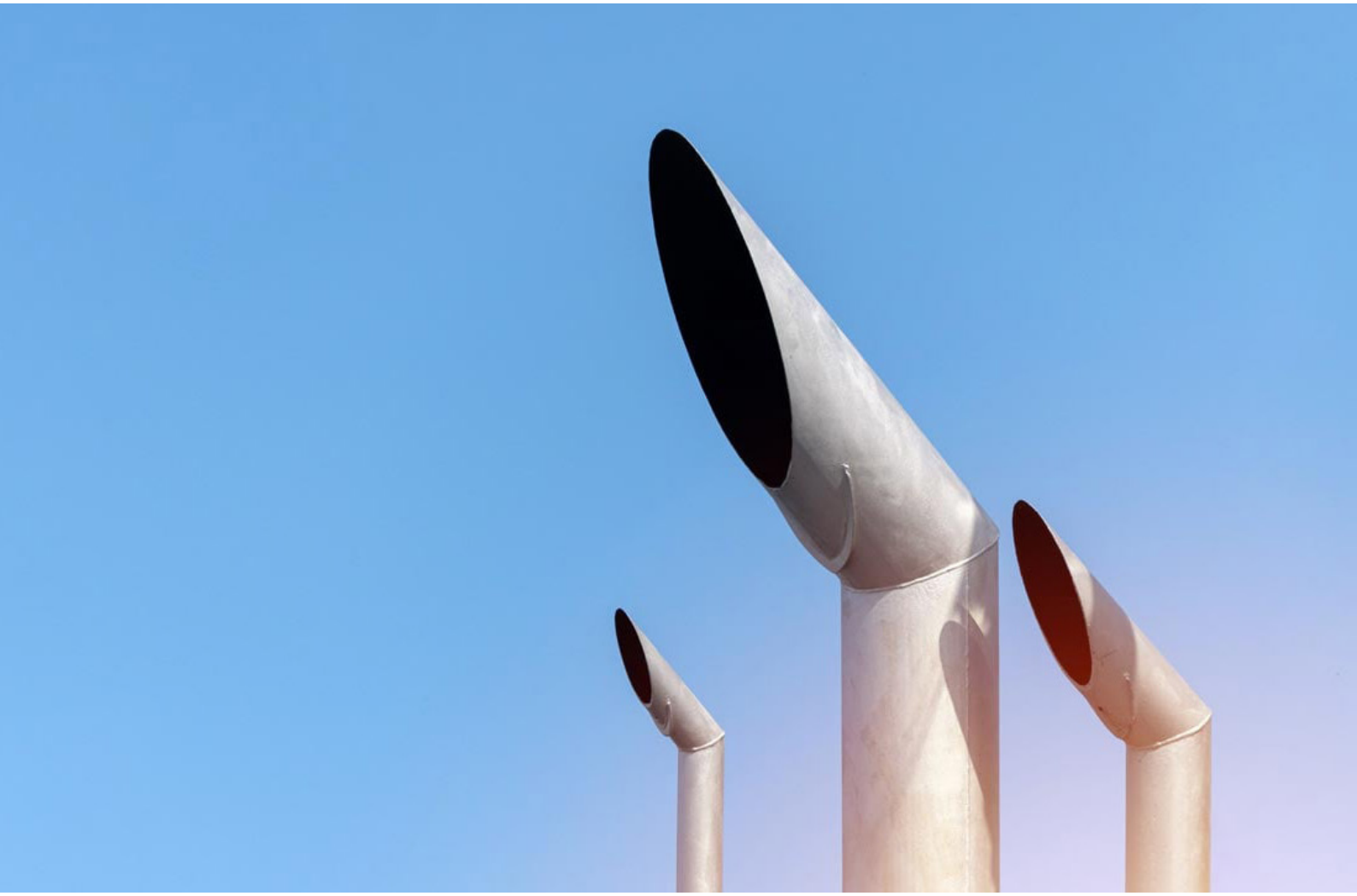
Vessel conversion is technically complex and involves significant costs. It may involve changes in layout, structural modifications to the vessel and replacement of pipework and systems. Very often the costs of conversion have not been accounted for in statements of 'readiness'. Experience with LNG tells us this is significant. A 15,000 TEU LNG ready container ship retrofitted in 2020 is said to have cost around $30 million and taken an estimated 105 days[6]. Very few LNG 'ready' vessels have so far been converted to operate on the fuel, in part due to the heavy costs and time out of service.

6 https://www.seatrade-maritime.com/europe/hapag-lloyd-breaks-new-ground-sajir-engine-conversion

Terms like zero carbon 'ready' and 'capable' are important. They indicate that a vessel is to some extent prepared for the energy transition. That doing business with this vessel through owning, investing, chartering or insuring it is less risky than with a traditional HFO fuelled vessel. Markets attribute value to these terms and that value is reflected in better commercial rates.

But it is not always clear to the investor, charterer, insurer or prospective owner, exactly what these statements and claims entail and what the full implications are of doing business with this vessel. Classification societies provide readiness notations that certify that the required level of safety can be achieved, subject to the work being carried out correctly. Many of the 'ready' vessels have 'approval in principle' for a conceptual design for conversion. This does not cover detailed design, costs or conversion plans. Many uncertainties remain. Conversion costs are not generally known and will be influenced by the level of readiness, as well as the scope of the conversion, and the rules to be applied at the time of conversion. Furthermore, each class society has its own system of rules, notations, descriptive notes and definitions of terms. As it stands, the industry does not have the clarity over zero-carbon fuel readiness needed to enable a successful energy transition.

How can we ensure that existing and newly built ships are truly ready for the energy transition?



A Zero Ready Framework will help to steer the industry on the right course

Figure 1 provides a framework for assessing the actual readiness of a vessel for the transition to zero carbon fuels.

Figure 1: The Zero Ready Framework

	Readiness standard		Criteria		
	Name	**Description**	**Capabilities**	**Additional requirements**	**Comments**
1	**Near net zero GHG vessel**	Capable of bunkering and operating for all onboard energy usage in all operating modes.	All required equipment installed and commissioned	Capabilities apply to all energy sources onboard Cannot be powered by fossil fuels	-
2	**Low GHG vessel**	Capable of bunkering and operating for primary propulsion in majority of operating modes.	All required equipment installed and commissioned	Capabilities apply to primary propulsion	Fossil pilot fuels acceptable Dual/multi fuels acceptable
3	**Conversion under preparation**	Primary propulsion capable of using fuels in scope. Some key components already installed but not yet commissioned.	Minimum requirements: • Engine retrofitted for fuel in scope, • Fuel storage tank in place	Capabilities apply to primary propulsion	-
4	**Designed for conversion**	Fossil fuel vessel with high level or detailed design for conversion.	-	Capabilities apply to primary propulsion	Detailed design is preferred to high level Ideally costings for conversion provided
5	**Potential for conversion**	Fossil fuel vessel with main engine that could use a fuel in scope, if retrofitted.	-	Retrofit pack available for main engine	Will become the norm as dual or multi fuel engines become the default
-	**Fossil fuel only**	Has no possibility of retrofit.	None	None	-

Five levels are defined, from 1 (highest level of readiness) to 5 (lowest level of readiness). Existing fossil fuelled vessels that have no possibility of conversion have no readiness level. By classifying vessels in this way, stakeholders are given clarity over the status of any given vessel and the industry will have a standard benchmark for comparing vessels when it comes to zero carbon readiness.

The framework can be applied to vessels in the existing fleet, that are newly built, or are on order. It is designed to accommodate any vessel that is or could be zero GHG emissions fueled, measured on a well to wake basis. At this point it is being applied to ammonia, hydrogen and methanol. Whilst the framework describes the asset, not how it is operated, it is the intention of the framework that vessels make use of the capability to be operated from zero carbon fuel as and when the fuel is available.

In addition, this framework does not address the resources used, or the production method for, the fuel actually used on board. It describes the capability to burn zero carbon (or 'green') fuel but does not indicate whether that fuel has actually been produced in a carbon emitting (e.g., grey) process. Likewise, it does not indicate whether any electricity used (e.g., for shore power) is renewably sourced.

This framework is independent of Class Societies' rules and notations. Certification from any class society may be used as evidence to support a given readiness level. As ships are modified during their lifetime, a vessel built to a certain level may be downgraded at a later date and may require a survey before being upgraded.

This framework is designed to be completely separate to current regulations such as EEXI and CII. These are aimed at near-term improvements in vessel energy efficiency (and therefore GHG emissions) but not targeted at the longer-term goal of zero-carbon fuels.

Level 1

The long-term goal is near net zero GHG vessels

Ultimately, 2050, all vessels in service need to all intents and purposes, be near net zero. This means capable of bunkering and operating with fuel with lifecycle emissions of net zero for all energy sources (be these propulsion or otherwise) and in all modes of vessel operation. We call these 'near net zero' to allow for the reality that even fuels without a carbon molecule may involve a small unavoidable release of some GHGs somewhere in the end-to-end supply chain. Such vessels, which cannot be powered by fossil fuels, are categorised as level 1.

As of today, very few vessels in service meet these level 1 requirements and those that do are short sea ships such as passenger ferries. Level 1 defines the aspiration for ocean going shipping and we expect businesses to publish strategies and plans showing how they intend to reach level 1.

Level 2

At present we are able to build low GHG vessels

For ocean going shipping, today's focus is on low GHG Vessels, categorised as level 2. These are ships that are capable of bunkering and operating today for primary propulsion in a majority of operating modes, often dual fuelled. They may use fossil pilot fuels or operate mainly using fossil fuels where zero carbon fuels are not yet available.

At present most of the level 2 ships in service are methanol capable, typically dual fuelled with a 2-stroke diesel engine. A majority are either tankers or containerships. There is also a healthy methanol capable orderbook.

Level 3

Vessels with conversion under preparation are a strong signal of intent by the industry

We describe vessels that cannot use zero carbon fuels today but have some of the components needed in place already, as conversion under preparation, categorised as level 3. This shows that the asset has advanced beyond the design stage and work is underway to make the vessel capable of propulsion with zero carbon fuel, albeit recognising there will be further conversion costs later. This category attempts to de-risk the asset and maximise optionality by balancing upfront investment against downstream investment.

An analysis of preparing container vessels for conversion to alternative fuels[7] by The Mærsk Mc-Kinney Møller Centre for Zero Cabon Shipping expands upon Level 3, going beyond the engine and tank, detailing additional factors such as:

- Allocation of space for new equipment
- Putting key structural elements in place to support new equipment
- Installing piping, cabling and ventilation

This study also examines newbuild and conversion costs for the container ship case study, addressing pros and cons of upfront investment now to maximise readiness vs downstream investment at the time of conversion.

7 https://www.zerocarbonshipping.com/publications/preparing-container-vessels-for-conversion-to-green-fuels-2/

Level 4

A design for conversion is the foundation of vessel readiness

Many vessels that are described as 'ready' are just at the design stage. For example, a fossil fuel vessel, existing or newbuild, has been subject to a design study showing how it could be converted to a zero-carbon fuel in the future. This may be a high-level conceptual design with general arrangement drawing showing how the layout would change. Or it may be a detailed design with complete equipment specification, identified components and detailed design drawings. There may have been an Approval in Principle (AIP) for the design provided by a classification society. Either way there is much to be done to make the vessel ready and usually the investment case is unquantified. In addition, design drawings often become out of date once a vessel has been in service for few years, as equipment is changed, and repairs and modifications are made. We categorise this as level 4, design for conversion.

Experience in shipping and other industries tells us how important it is to design safety in as early as possible (see box: Safety needs to built in from the beginning). The costs of adding safety in when converting an existing vessel are much higher than when newbuilding. And the level of safety achievable may well be lower. From a safety perspective the design stage is critical.

Safety needs to be built in from the beginning – Inherently Safer Design

By their nature, all fuels have some degree of hazard associated with them. The risks to people and the environment of accidents involving zero carbon fuels are different to the risks posed by traditional fuel oils. For example, ammonia is toxic and corrosive, creating a hazard for humans through exposure by inhalation or skin contact. We require safeguards to prevent ammonia releases and to recover the system to a safe state. In contrast, hydrogen is non-toxic and as an ambient gas it dissipates rapidly when released, but it is more reactive (i.e., explosive and flammable) than traditional fuel oils.

To eliminate or minimise the risks from zero carbon fuels it is best to begin during the early engineering design phase. This is where a simple approach known as Inherently Safer Design (ISD) can be most effective. ISD is an approach that focuses on elimination of hazards and where this cannot be achieved, for example because the hazard is the alternative fuel, the focus is on reducing the severity and scale of consequences, reducing the likelihood of accidents, and finally, providing protection from harm.

Applied early in design, ISD helps avoid redesign and retrofits at later stages that can be expensive and difficult to undertake. This approach not only reduces risk but can provide a design that is cheaper and easier to build, operate and maintain. This is because the design is likely to be simplified with fewer equipment items, instruments and 'add-on' safeguards – and this requires less supervision and intervention. This leads to a lower chance of an accident because there are fewer parts that can fail and fewer chances for human error to cause an accident.

As noted by the pioneer of ISD, Prof. Trevor Kletz, "What you don't have, can't leak" and as the car manufacturing pioneer Henry Ford said, "what you don't fit costs you nothing and needs no maintenance." These phrases are at the heart of ISD and precede the final common-sense check referred to by LR [me] as Meaningful Protection. That is, regardless of the residual risk always ensure that all obvious, simple, practical and cost-effective protections have been adopted.

Level 5

Dual fuel engines are becoming the default for newbuilding

Marine engine manufacturers are increasingly developing and offering engines of a modular design, that can be retrofitted to run on a different fuel simply by replacing or adding certain parts. The manufacturer typically offers these parts as a retrofit pack which can be purchased at a later date. This removes a barrier to later conversion in that there is no need for a complete engine replacement. However, in reality this represents a very low level of readiness as major investment is still required and all of the factors described above also need to have been addressed. We categorise this level of readiness as level 5, potential for conversion.

A call to action

This framework provides a new way for us, the shipping industry, to think about the readiness of new and existing vessels for the energy transition. It will enable businesses from all across the supply chain to demonstrate climate action to both customers and stakeholders. By committing to only 'finance, build or order vessels' that meet a clearly identified readiness level by a specified date, the strength of your actions will be clear to the public and to end consumers. It will also send a strong demand signal to fuel suppliers, stimulating investment in appropriate fuel resources and production facilities.

Markets now factor climate risk into day-to-day decision making. By showing stakeholders your plan to sustain and grow your business during the energy transition, you will reap business benefits across the board. Mitigating the risks can deliver increased demand for your product or service, improve financing rates, lower insurance premiums, and provide benefits in several other areas too.

The framework is also a tool for use across business, creating a common language and enabling fact-based decision making.

- **Shipowners and operators** can develop an appropriate strategy for their fleet, mapping out the retrofit or new build pathways.
- **Fuel suppliers** making strategic investment decisions can assess the growth of demand for new fuels.
- **Policymakers and regulators** will have better information, helping them create the right incentives to enable the industry to meet targets.
- **Shipbuilders and equipment manufacturers** will have better insight, supporting the right investments in skills, technologies and resources
- **Financiers and insurers** will be able to better optimise portfolios, investing in assets with a clear future whilst reducing exposure to climate risk.

Whilst this is a positive step forward, it does not address the entire picture as we have only considered the vessel, not how it is operated. Further work is required to ensure that vessels capable of using multiple fuels maximise their use of truly zero carbon fuels and thus minimise GHG emissions as the energy transition proceeds. At this time, we are encouraging the right type of construction and the operational challenge will be addressed separately. We encourage readers to get in touch with the Maritime Decarbonisation Hub (details below) and work with us to apply the framework in projects and initiatives.

The Lloyd's Register Maritime Decarbonisation Hub

The Lloyd's Register Maritime Decarbonisation Hub is a joint initiative between Lloyd's Register Group and Lloyd's Register Foundation. Our mission is to accelerate the sustainable decarbonisation of the maritime industry, by enabling the delivery and operation of safe, technically feasible and commercially viable zero-emission vessels by 2030 and beyond. We bring together thought leaders and subject matter experts with the skills, knowledge and capability to help the maritime industry design, develop and commercialise the pathways to future fuels required for decarbonisation.

www.maritimedecarbonisationhub.org

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