PtX

Climate protection needs alternative marine fuels

A PTX ROADMAP FOR THE MARITIME ENERGY TRANSITION

Contents


PtX

Our mission

On the path to climate-neutral shipping, we are working jointly to develop the production and use of Power-to-X (PtX) fuels and expand them over the next few years. We consider it realistic that by the year 2045 at least the intra-European maritime transport can be made climate-neutral.
To implement ambitious climate protection targets for shipping, significant investments need to be made in the production of and infrastructure for renewable fuels as well as suitable fleet tonnage.
We want to help optimize the sector-specific design of an emissions trading scheme and rules for maritime fuels in a way which achieves the necessary steering effect. We are convinced that we can reach our maritime climate targets in Europe faster!

VDMA VSM

Summary

International shipping accounts for the lion's share of the global transport volume - 90 per cent[1] of world trade is carried by sea. Ships are by far the most efficient mode of transport, but with a total annual consumption of around 350 million tons of conventional fuels, they are also responsible for almost three per cent of global greenhouse gas emissions. This immense fuel demand predestines shipping to be a pioneer in exploiting the market potential of synthetic, climate-neutral fuels and enabling their widespread use in other sectors of the economy as well. In particular, the industry can be a decisive enabler for the market ramp-up of hydrogen as the basis of all synthetic fuels (→ *e-fuels*) when produced from water and CO_2 using "green" electric power (power-to-X, PtX). From a technological point of view, intra-European shipping can become climate-neutral by 2045, provided that the regulatory framework is set to achieve this. This is an ambitious timetable that could enable the European Union (EU) to act as a role model at an international level. With this PtX Roadmap, the maritime industry presents a proposal describing the prerequisites.

A number of fuel options and production processes are available for shipping that will have to be scaled up industrially before the end of this decade. It is of critical importance that this be accompanied by an increased demand for renewable fuels. This should not take place at a project level, as has been the case to date, but systemically at the member state level.

In order for e-fuels to achieve the required energy density, carbon is usually required for production. This carbon should come from the air or biomass, or, initially, from unavoidable industrial emissions. The relevant technologies need to be scaled up industrially. At the same time, the EU must provide a legal framework that creates incentives for the market-wide use of CO_2 and the development of closed-loop systems.

To ensure that the EU lives up to its pioneering role and that intra-European shipping becomes climate-neutral by 2045, the maritime industry believes the following regulatory levers to be of vital importance:

- We support an ambitious reduction path for fleet-wide greenhouse gas (GHG) emissions, which can be achieved through the combined use of alternative fuels and measures to increase efficiency. In this context, we advocate an ambitious special path for intra-European shipping. From 2027, incremental GHG reduction steps could be implemented, starting at ten per cent and gradually increasing to 100 per cent by 2045. The calculation method and

reference year should be based on the approach described by the European → *FuelEU Maritime* initiative[2].

- The energy transition needs an **effective CO_2 pricing scheme** to make climate-neutral fuels competitive and to raise investment funding for restructuring the maritime economy. **Including shipping in the → *EU Emissions Trading System (EU ETS)*** can be an important building block towards this goal. However, the technical criteria for CO_2 pricing must be compatible with the certification and operating regulations.

- The maritime energy transition requires a legal framework to stimulate sustainable investments through a consistent orientation of financial products towards green technologies. The approach pursued in the → ***EU taxonomy*** of assessing ship emissions exclusively at the smokestack instead of looking at the **climate neutrality of a ship's entire propulsion concept** is not expedient. Only a → *well-to-wake approach*, which takes into account the greenhouse gases of the entire fuel value chain as pursued in FuelEU Maritime, adequately promotes the use of climate-neutral fuels.

- The EU Commission's revised Renewable Energy Directive II (→ *RED II*) provides for a binding increase in the share of renewable energies to at least 40 per cent in order to meet the rising demand for renewable energies associated with → *sector coupling*. However, to stimulate necessary investments, the target quota for renewable fuels of non-biological origin (RFNBOs) should be set at 2.6 per cent for 2026 and – as specified in the → *REPowerEU plan* – increased to five per cent by 2030.

- We support the initiative to build up PtX production capacity as planned by the EU Commission in the industrial alliance to promote the supply of alternative fuels **(→ *Renewable and Low-Carbon Fuels Value Chain Industrial Alliance*)**. In this context, the Alliance should set a **quantitative minimum target of 5 to 6 gigawatts (GW) of generation capacity for shipping by 2030** in order to make the success of the cooperation measurable.

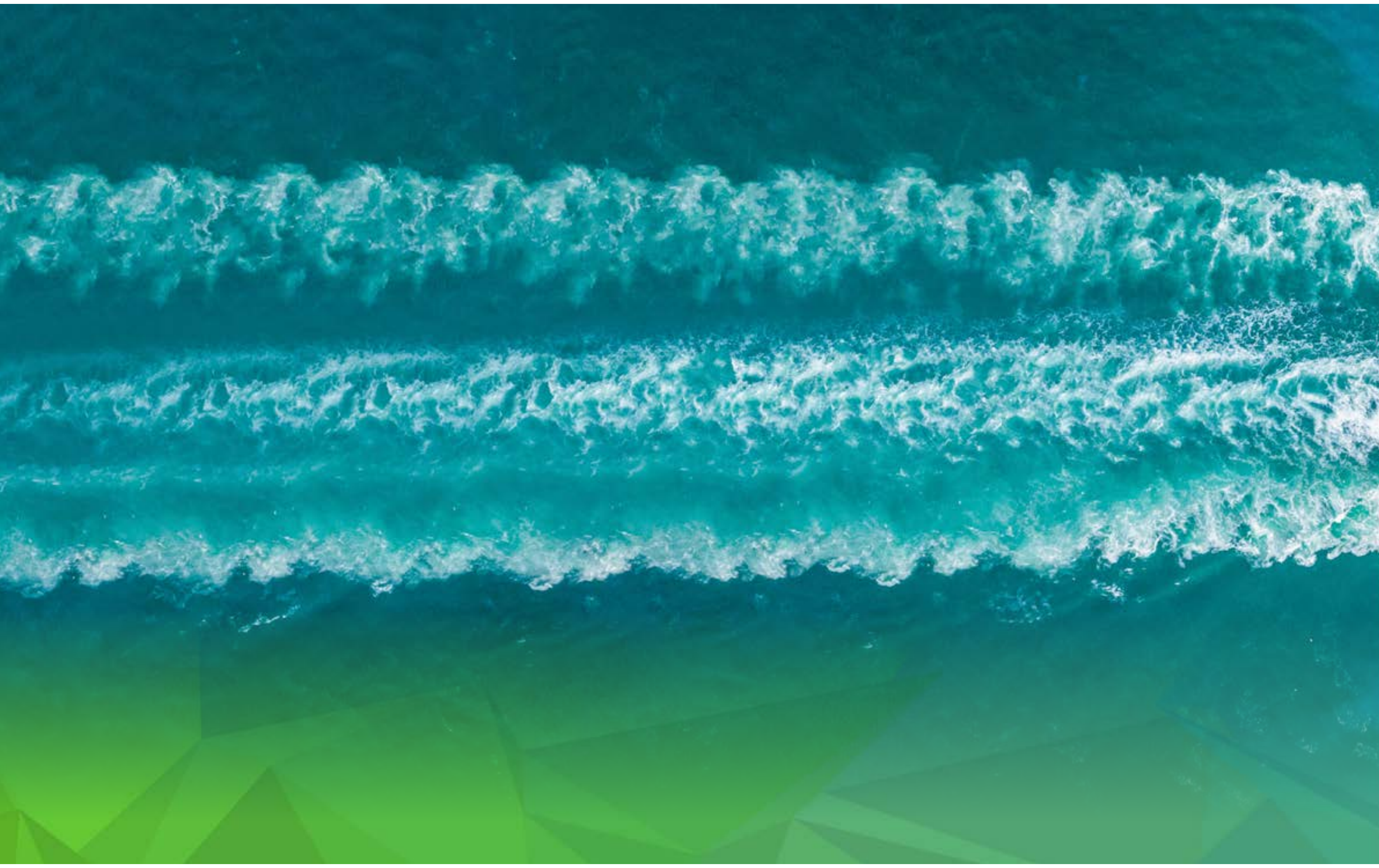
- Even in a climate-neutral economy, Germany and other European countries will remain permanent energy importers. We therefore support the strategy for external engagement in the energy sector **(→ *External Energy Strategy*)** as part of REPowerEU to drive international hydrogen partnerships. This way the EU can strengthen cooperation with its neighbours and increase export opportunities for European technology providers.

This PtX roadmap for the maritime energy transition describes the technological and required regulatory levers to achieve the ambitious climate targets. The maritime industry is ready for dialogue with political decision makers on further design and implementation measures.

I. Objectives and their achievement

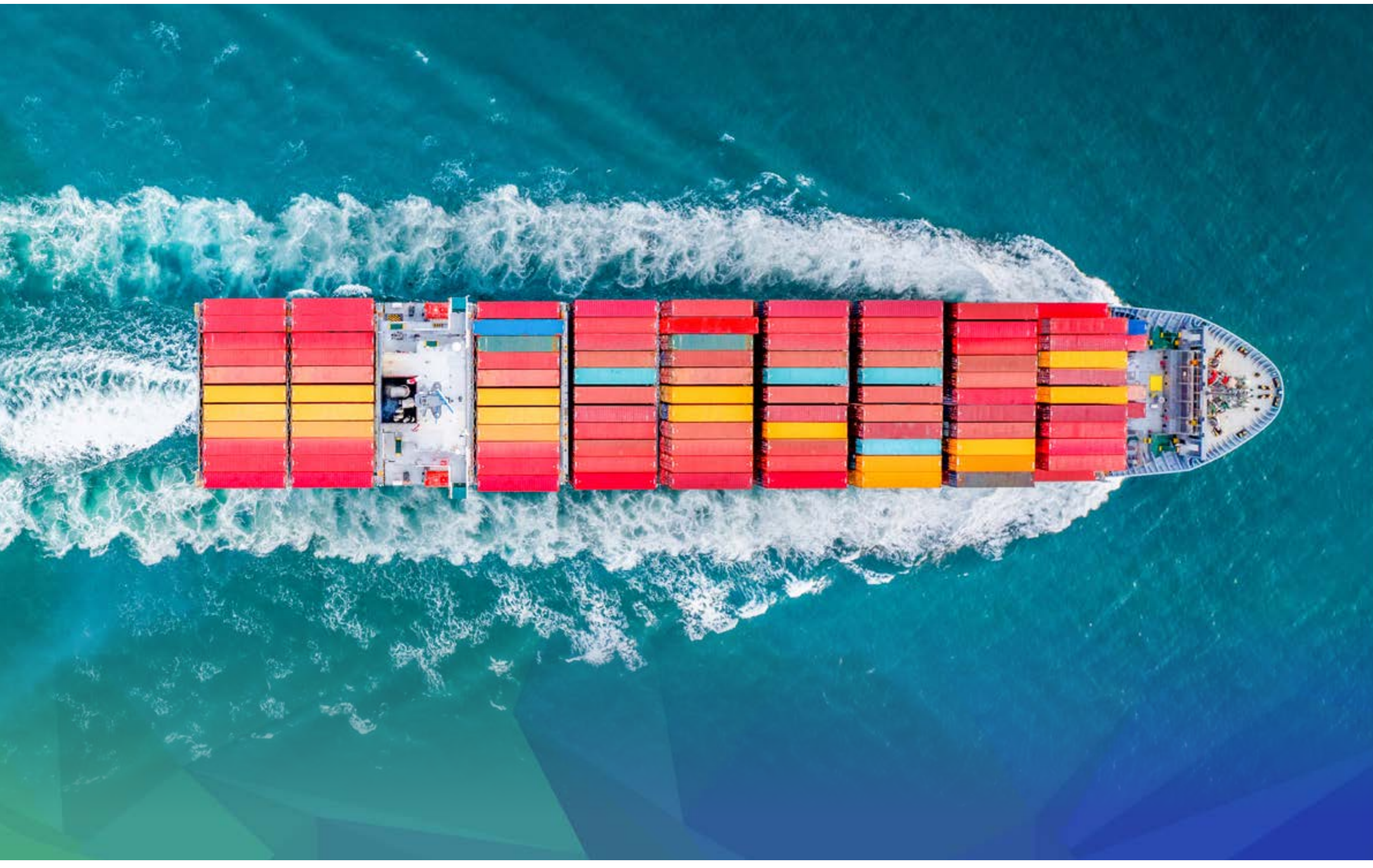
Maritime transport is the backbone of globalization. International shipping accounts for around 90 per cent of international transport capacity and is by far the most energy-efficient mode of transport. Freight shipping interconnects markets across the globe, and maritime tourism brings people of different nations and cultures together. Ships can continue to provide these services in a CO_2-neutral manner – marine technology is ready for significant energy savings and the use of climate-neutral fuels.

Cargo and passenger shipping will continue to grow strongly. Climate protection strategies suitable for shipping must be implemented at an industrial scale so that the maritime industry can make its contribution to overcoming the climate crisis. At the same time, shipping is a suitable enabler for the hydrogen ramp-up: the industry consumes around 350 million tons of conventional fuels annually and is responsible for almost three per cent of global greenhouse gas emissions[3]. This immense demand provides an ideal starting point for triggering the necessary upscaling and opening of the



market for climate-neutral fuels so other industries can benefit, as well. Because of their limited energy density, batteries and fuel cells can only be considered as supplementary propulsion technologies for ships over long distances. The use of e-fuels is essential. There is no reason to fear a negative impact on the international division of labour: even a doubling of fuel costs, for example, would only make the transport of a T-shirt one euro cent more expensive[4].

Nevertheless, with regard to the climate protection requirements for international shipping under international law, there is still resistance to be overcome which stands in the way of a rapid conversion of the global merchant fleet. In this situation, the European Union has the opportunity to play a pioneering role: it should restrict intra-European transport by sea and on inland waterways to CO_2-neutral vessels and press ahead with the development of the necessary production capacity for PtX fuels.



II. Technology development

Power-to-X (PtX) refers to the production of fuels from electricity, water and carbons. The letter X is a placeholder for gaseous and liquid fuels that can be used in shipping. PtX fuels are also called electricity-based fuels or e-fuels.[5] To make a significant contribution to greenhouse gas reduction, the use of additional renewable energy sources is crucial. The following sections present the main fuel options conceivable today and outline the processes for their production.

1. Maritime fuel portfolio

A broad range of fuels are available for maritime shipping. Each fuel has advantages and disadvantages, which can be weighed up against each other and are highly application-dependent. For example, carbon-free fuels which are less energy-intensive are cheaper to produce but have disadvantages in terms of infrastructure and on-board handling. Hydrocarbon-chain-based fuels require more energy in production but are likely to have practical advantages – they benefit from existing infrastructure onshore and on board ships. In this respect, a "trade-off" between fuel production costs and infrastructure costs should be assumed to exist. Both aspects must be weighed up accordingly.[6]

To enable market participants to further develop the various technology paths and optimize them for the given application, a clear legal framework is required. Below we provide a rough overview of common synthetic fuels.[7] For a global industry such as shipping, expecting production of e-fuels at suitable international locations (e.g. South America, North Africa, Australia) is realistic. Ultimately, the production price, which is largely determined by the local electricity cost, will be a decisive factor in choosing the locations for production facilities.

HYDROGEN (H_2)
Hydrogen produced using renewable energy is the energy carrier all climate-neutral synthetic fuels are eventually based upon. It is produced using water electrolysis, is carbon-free and can be converted directly to electrical energy in fuel cells. With suitable exhaust gas aftertreatment, H_2 can also be burned in combustion engines with virtually no emissions. However, due to its low volumetric energy density, it is unsuitable for ocean-going ships and is more likely to be used in coastal shipping.

AMMONIA (NH_3)
Ammonia is a synthetic fuel that can be produced using hydrogen-based PtX technology. In this case it has a small GHG footprint while emitting virtually no sulphur oxide, particulate matter or unburnt hydrocarbons during combustion. However, a serious disadvantage of ammonia is its significant toxicity. Its comparatively low production cost is offset by high investment costs needed for a future distribution infrastructure.

SYNTHETIC NATURAL GAS (SNG)
Synthetic natural gas can be produced from hydrogen, in this case by means of methanation. SNG produces the same low nitrogen oxide, sulphur oxide and particulate emissions as liquefied natural gas (LNG) but emits less greenhouse gas. A factor relevant to the climate is methane slip, but this is limited, especially in ocean-going ships. With the two-stroke engines predominantly used in these vessels, methane slip is very small. Thus SNG offers application-dependent advantages in terms of GHG emissions. Thanks to its chemical composition, SNG can be mixed with LNG at any ratio, making the use of liquefied natural gas progressively more CO_2-neutral to reduce emissions – an advantage for → *defossilizing* the existing LNG-powered fleet.

METHANOL (CH_4O)
Methanol is a biodegradable liquid fuel whose combustion significantly reduces

emissions such as particulate matter, sulphur oxides and nitrogen oxides. Methanol can, for example, be produced from biomass; when produced on the basis of green hydrogen, methanol is climate-neutral but (unlike ammonia) contains carbon. Since it can be stored under normal ambient conditions, methanol offers advantages over ammonia but will probably be somewhat more expensive due to the higher energy input required for its production. Methanol can be burnt in conventional propulsion systems, so no new engine technology is required.

SYNTHETIC DIESEL AND OTHER LIQUID E-FUELS

Synthetic diesel fuel, like other e-fuels, can be produced using PtX technology. These climate-neutral e-fuels burn significantly cleaner than their fossil counterparts. Apart from that, there is no difference in terms of transport and handling; these fuels can therefore be used in conventional engines as → *drop-in fuels*, helping to defossilize the fleet without having to modify the engines.

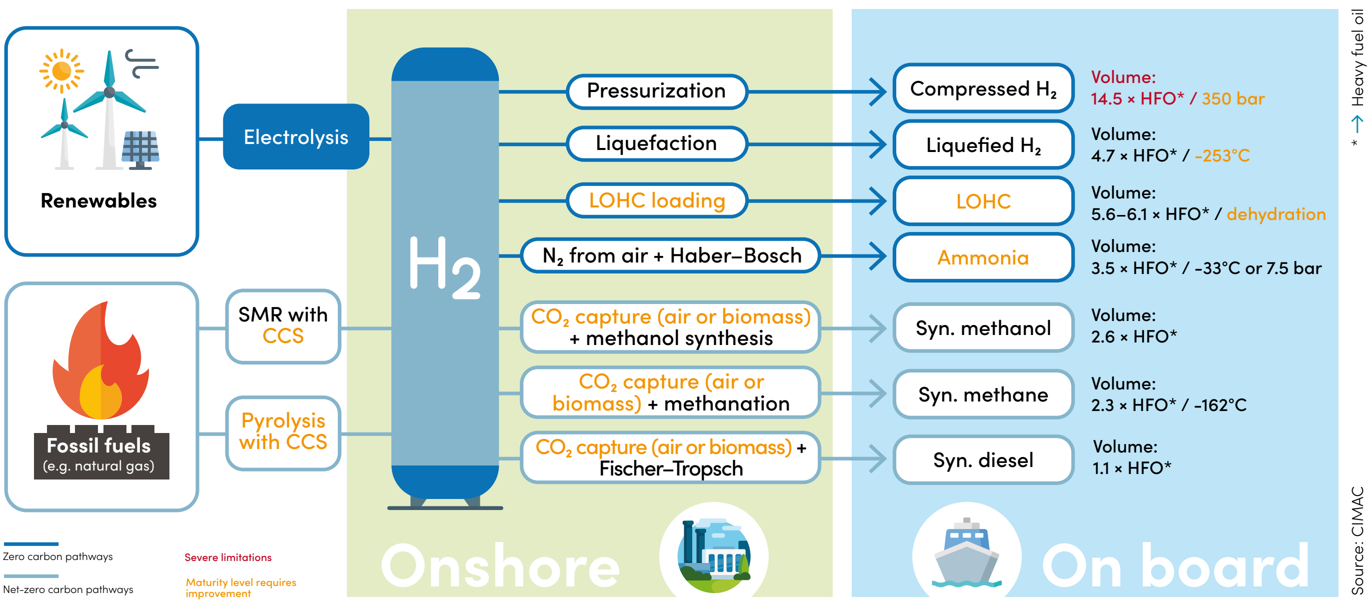
2. Manufacturing paths

The basis for all synthetic climate-neutral fuels is hydrogen production by electrolytic splitting of water. A variety of hydrogen derivatives can then be produced applying different processes:

- For ammonia synthesis, nitrogen (N_2) is separated from air by cryogenic air separation and then reacted with hydrogen (H_2) in the established Haber–Bosch process.

All other chemical conversion processes require carbon. Depending on the desired type of synthetic fuel, carbon dioxide (CO_2) can either be added directly or after conversion to carbon monoxide (CO). Carbon-based synthetic fuels may be gaseous (e.g. methane/SNG) or liquid (e.g. methanol, diesel):

- Methanation can be used to convert hydrogen and carbon dioxide to synthetic methane.



- Fischer–Tropsch synthesis is a process for the production of synthetic fuels (e.g. e-gasoline, e-kerosene, e-diesel) from carbon monoxide and hydrogen.
- Methanol (CH_4O) is synthesized from hydrogen and carbon dioxide using catalysts.

These power-to-X processes have long value chains. The European mechanical and plant engineering industry, which is dominated by medium-sized companies, is a leader in these processes. Notably, the value chains for different PtX fuels overlap: even with an optimal plant design, these processes generate by-products such as synthetic diesel, gasoline or other synthetic feedstocks that can be used by other transport sectors or the chemical industry. These by-products are likely to find buyers on the market and will enable plant operators to optimize their business models. They also prevent plant operators from depending on a small number of product groups, increasing their resilience by being able to offer a range of products.

3. Regenerative energy

With sector coupling, the demand for renewable energy increases. Driving its development is a prerequisite for enabling the production of climate-neutral PtX fuels.

The supply of renewable energy can be ensured by connecting production facilities to additional renewable power generation plants directly. Where this is impossible or even utilization of the PtX plant is essential, it may be connected to the general grid. The key factor for the assessment of additionality at the European level is the delegated act within the framework of the Renewable Energy Directive EU 2018/2001 (RED II). Besides additionality, RED II, as amended by the EU Commission, describes the requirements for the geographical and temporal connection between electricity procurement and PtX production. For PtX products from third countries, the same requirements must apply with regard to additionality (level playing field). The delegated act should be implemented to allow a timely PtX market ramp-up while accounting for sustainability aspects. From the maritime industry's point of view, it makes sense for the expansion of renewable generation capacity to be driven systemically at the member state level and not at the level of individual PtX projects.

4. CO_2 sources

Fuels usually require carbon to achieve high energy density. The following options are available: direct air capture (DAC) of carbon; using biogenic sources; or using CO_2 emissions from industrial processes.[8]

All options have specific advantages and disadvantages. DAC (by absorption or adsorption) and the use of biogenic sources create an almost closed CO_2 cycle. DAC technologies in particular must become significantly more cost-effective in the coming years and reach the necessary level of industrial maturity. In the case of biogenic sources (e.g. biogas plants, bioethanol plants, biomass cogeneration plants), decentralization and limited availability are the main challenges.

To facilitate the transition to a climate-neutral society as well as the PtX market ramp-up, using unavoidable CO_2 emissions from industrial processes for a limited time should be allowed. Doing so must not slow down the switch to greenhouse-gas-neutral production processes in these industrial sectors, however. An example would be using emissions from cement production for PtX production. It should be noted that industrial production sites emitting usable CO_2 are not always available at the ideal locations for PtX plants (see 5.). In these cases, the required CO_2 has to be transported from other production sites to the PtX plants.

To successfully establish the CO_2 cycles, the EU must provide a legal framework that creates incentives for the use of unavoidable CO_2.

5. Energy imports and transport logistics

Europe has huge potential for the generation of renewable energy. However, sector coupling massively increases demand, which the EU can only meet in partnership with other world regions to achieve climate neutrality. At the same time, the costs of generating electricity from renewable sources are among the main cost drivers for PtX production. The supply of renewable energies is limited, especially in Germany, and the electricity costs resulting from the levy, apportionment and tax systems are therefore high. Hydrogen produced in Southern and Central Europe should ideally be transported through pipelines and used directly (e.g. heavy-duty transport sector, steel industry).

By exporting PtX technologies and importing climate-neutral energy sources, the EU can make a significant global contribution to climate protection and the UN Sustainable Development Goals. The EU can diversify its energy imports while remaining a leading global technology supplier. By building new competencies and strengthening existing local players, the hydrogen economy can support the economic development in producing countries. Local value creation can arise from the direct production of PtX products and related services, from upstream and downstream parts of the value chain, from infrastructure that is required locally, or from renewable energy technologies. From a geopolitical perspective, the use of e-fuels enables diversification of the energy supply. Foreign direct investments, new industrial structures and knowledge transfer can also support the transformation within specific countries.

The PtX approach enables simple storage and transport of imported renewable energy from distant regions of the world. Both may be accomplished using existing infrastructure, reducing transport costs (see box).

The infrastructure is ready for transporting hydrogen derivatives

Hydrogen is best transported by pipeline. The pipelines must either be newly built, or existing natural gas pipelines must be converted.[9] Hydrogen derivatives can use existing infrastructure for transport.

AMMONIA

Ammonia is used worldwide in fertilizers, pharmaceuticals, beauty products and water treatment, among other applications. Supply chains and regulations as well as dedicated terminals for handling ammonia exist in ports around the world. Current customers for ammonia are typically agricultural and industrial distributors or consumers.

With a global network of ammonia terminals and storage facilities in place, a bunkering network could be implemented quickly and cost-effectively. The bunkering process itself would be very similar to that of other gaseous fuels. The greatest risk associated with ammonia is not its flammability but its toxicity.

METHANOL

Methanol is used in numerous land-based applications and has been traded and transported in chemical tankers for many years. The production, transport and handling of this fuel occurs through dedicated infrastructure that can be repurposed on a larger scale for the use of methanol as ship fuel. Since most existing infrastructure can either be reused or supplemented with minimal capital expenditure, the bunkering of methanol is straightforward. The hydrogen derivative can be transported in liquid form at ambient temperature. This makes methanol easier to store and handle than liquefied natural gas (LNG), ammonia and hydrogen.

III. Sustainability criteria

The maritime industry must make its contribution to achieving the sustainability goals, which are widely accepted by society and can be technically realized by the industry. The challenges are enormous: global climate protection, pollution prevention, sustainable use of resources and protection of the marine environment, and the transition to a circular economy. In this environment, the maritime industry must prove to be an innovative and competitive partner in applying environmental and climate protection technology.

The special technical and economic conditions facing the shipping and supply industries must be taken into account when formulating sustainability criteria in order to ensure complete, timely and efficient achievement of the objectives. In addition to unchangeable natural conditions affecting transport by sea and inland waterways, the internationality of shipping in particular makes it difficult to arrive at a consistent common definition of "sustainable ships" across national and jurisdictional boundaries.

1. International Maritime Organization (IMO)

The International Maritime Organization (IMO), headquartered in London, is a specialized agency of the United Nations (UN). It develops binding international maritime laws which govern the design and operation of ships.

The conventions and codes passed by IMO lay down requirements for various pollutants and the climate gas CO_2. Furthermore, IMO will pass new regulations to establish a maritime recycling economy in the near future.

However, IMO processes are affected by the core challenge of all UN institutions: having to reach consensus among more than 170 member nations ranging from highly industrialized to developing countries. Therefore IMO decisions

usually take long to be adopted and are not very ambitious in terms of content and time.

An example is the IMO GHG Strategy, which does not account for current ship technology: it will achieve climate-neutral shipping too late to avert the worsening global climate crisis. In principle, however, IMO's climate protection instruments are designed to be open to new technologies. Supported by a life-cycle assessment of marine fuels, which is currently being developed, they provide an indispensable basis for the use of climate-neutral and low-emission PtX fuels.

2. European Union (EU)

As a strong, homogeneous economic area and high-tech world region, the EU naturally pursues more ambitious sustainability goals and sets more demanding limits and application deadlines than, for example, IMO. The maritime industry expressly supports these efforts in the area of climate protection. After all, essential technologies for saving energy, increasing efficiency and using regenerative energy sources directly have reached application maturity.

Furthermore, PtX fuels have reached the technological maturity for industrial scaling which can be taken into account when defining climate policy targets. In the medium term, synthetic fuels are indispensable building blocks for the realization of climate-neutral maritime and inland shipping. The legislation and initiatives introduced, adopted or proposed as part of the European → *Green Deal* recognize the role of PtX fuels for shipping.[10] The EU criteria and instruments developed for this purpose should be aggressively marketed internationally to achieve a global level playing field for shipping in the medium term. Ultimately, the maritime energy transition can only succeed in an international context.

IV. Promotion of the market ramp-up

Production and use of PtX fuels have neither been established in shipping, nor are they competitive under current economic conditions. The EU and its member states must give greater support to PtX as an important building block (not only) of the maritime energy transition at all levels. The → *"Fit for 55"* package requires a sector-specific design in terms of reduction targets, sustainability criteria and funding instruments, as well as the development of production capacities and international energy partnerships as part of an import strategy.

1. DEMAND

Set ambitious reduction targets

The maritime industry welcomes the initiatives of the European Union to set more ambitious climate protection targets and bring them to life through concrete regulatory measures.

Significantly more ambitious target values for the year 2030 (compared to the IMO GHG Strategy) and the achievement of climate neutrality as early as 2045, at least for European shipping, are necessary – and feasible, provided that all maritime opportunities (climate-neutral PtX fuels, technical and operational efficiency improvements, direct use of renewable energy sources) are exploited. Doing so will allow the European Union to live up to its international function as a role model for the global maritime energy transition.

IMPROVE FUEL QUALITY AND ENERGY EFFICIENCY:

- We support a clear reduction path for GHG emissions that can be implemented through the combined use of alternative fuels and other measures (in particular increasing energy efficiency). To achieve the climate targets more quickly and act as a role model internationally, we propose a separate reduction pathway for intra-European shipping[11] which will enable Europe to achieve climate neutrality as early as 2045. In this context, it must be examined how the European legislator can ensure general adherence to this path, taking into account international regulations (IMO):

2027: 10% GHG reduction
2030: 30% GHG reduction
2035: 50% GHG reduction
2040: 75% GHG reduction
2045: 100% GHG-reduction

The calculation method and the reference year should be applied in analogy to FuelEU Maritime. In discussions with the EU bodies it must be determined how the outlined target path can be incorporated into regulatory terms. Care must be taken to ensure that the resulting regulation as a whole is transparent and comprehensible – which is not always the case in the Commission's current proposals.

Without a sustainable market ramp-up of synthetic fuels (RFNBOs), it will not be possible for the maritime sector to achieve full climate neutrality. Accelerated development of RFNBO production capacities and price incentives for their use are essential in order to progressively increase the competitiveness of RFNBOs:

2027: 0.3 million tons of RFNBOs[12]
2030: 1 million tons of RFNBOs[13]
2035: 4 million tons of RFNBOs[14]

The estimated quantities are based on two assumptions: first, that a switch to RFNBOs is necessary in the long term; and second, that energy efficiency measures as well as other alternative fuels can account for 50 per cent of the envisioned GHG reduction in the short and medium term. When introducing such quotas, fuel importers must be required – and potential users may be required – to purchase only the existing resources. The regulatory framework must be carefully formulated accordingly and agreed with all stakeholders. Implementation within the scope of the RED II revision, for example, is conceivable, provided that sector-specific quotas can be included.

When defining the applicability, care should be taken not to restrict the regulations to vessels covered by the MRV (i.e. ships larger than 5,000 gross register tons). Applying this limit would fully exclude many vessels which play an especially important role in intra-European waters and are often designed and built in Europe (such as tugs, offshore service vessels, ferries or yachts). The increasing availability of RFNBOs alone will not guarantee that the propulsion systems of these vessels are defossilized as well.

Early and effective incentives for RFNBO use would ramp up the market and allow production at the required level to become competitive. In combination with readily available energy efficiency measures as well as increased direct use of renewable energy sources, exhaust gas aftertreatment as well as on-board carbon capture and storage, it is possible to fully avoid GHG emissions by 2045.

INTRODUCE A PRICING SCHEME FOR CO_2 EMISSIONS:

- The energy transition requires effective CO_2 pricing to make climate-neutral fuels competitive while generating investment capital for restructuring the maritime economy. Including shipping in the EU

Emissions Trading System (EU ETS) can become an important building block towards this goal.
- To avoid conflicting objectives, the technical criteria for pricing must be compatible with licensing and operating regulations. To this end, it is necessary to levy the fee based on a life-cycle analysis of the total GHG intensity of fuels. If possible, the funds generated should be fully channelled into supporting the transition of the maritime economy (sector-specific maritime or ocean fund).
- To avoid competition distortions it must be ensured that shipping between the EU and third countries is counted on a pro rata basis (50 per cent).

MAKE MARITIME SUSTAINABILITY CRITERIA COMPATIBLE:

- The maritime energy transition needs a legal framework to stimulate sustainable investments through a consistent orientation of financial products towards green technologies. However, the taxonomy criteria for determining environmental sustainability must be designed to be compatible with the technical approval and operating regulations for ships and maritime equipment and allow for PtX fuel options that are suitable for the industry.
- The approach pursued so far is not helpful. Ship emissions are assessed "end-of-pipe" exclusively while the climate balance of a ship's propulsion concept as a whole is ignored. In this way, no positive effect is achieved with regard to the climate crisis, but the innovation and competitiveness of the maritime economy is severely damaged. The Taxonomy Regulation therefore also contradicts the FuelEU Maritime Initiative, which resolutely pursues the approach of a holistic life-cycle methodology.

- Transitional regulations appropriate to the sector must be incorporated into the sustainability criteria while accounting for the special implications of the market ramp-up of synthetic fuels in the maritime sector. The aim must be to toughen the requirements gradually instead of jeopardizing the transition process through sudden changes.

INCREASE THE SHARE OF RENEWABLE ENERGIES IN FUEL PRODUCTION:

- As part of the RED II revision, we support raising the binding target quota for renewable energies to at least 40 per cent in order to meet the increasing demand for renewable energies associated with sector coupling.
- Given the ambitious overall target of reducing GHG emissions by 55 per cent by 2030, renewable fuels of non-biological origin (RFNBOs) will have to make a significantly higher contribution. To encourage investments, the 2.6 per cent quota should apply as early as 2026. The RFNBO quota should be doubled by 2030.

2. PROMOTE

State start-up financing for "green" shipping

The maritime energy transition requires intensive government support for research, development and innovation (RDI), investment in environmentally friendly ships, and the production of PtX fuels:

- The national and European R&D funding programmes must be adapted to reflect the technological challenges of PtX use and receive better funding. It is important to consider and promote continuous process chains from generation to integration and use in ships in demonstration and pilot projects.
- In addition, rapid industrial implementation requires regular investment support for PtX-ready ships and watercraft as well as the associated infrastructure, which is open to technology, and continuously accessible.
- At the EU level, demand for PtX technologies should also be stimulated within the framework of a European fleet renewal programme. In this context it must be ensured that a large part of value creation takes place in European companies.

RENEWABLE AND LOW-CARBON FUEL VALUE CHAIN INDUSTRIAL ALLIANCE:

We support the EU Commission's initiative to develop PtX production capacities. To make the success of the cooperation measurable, the industrial alliance for the promotion of alternative fuels should set itself a quantitative minimum target for the year 2030 in the order of five or six gigawatts (GW)[15] of generation capacity for shipping alone.

- Due to the overlapping value chains for PtX products, the alliance should not focus exclusively on the production of PtX products for aviation or shipping but on synthetic fuels in general.

3. COOPERATE

Energy partnerships and import strategy

PtX processes are key to achieving climate neutrality. Hydrogen and its derivatives will be needed in large quantities in the future. Germany and other European countries will remain energy importers in the long term. The European mechanical and plant engineering industry as well as the maritime sector can make a significant contribution to global climate protection by building up PtX capacity and using it for shipping. We therefore support the **EU External Energy Strategy for hydrogen**. The following objectives should be pursued:

- In line with the Paris Agreement, create and use suitable instruments to support climate-friendly partnerships and create financial added value for operators on the ground;
- Identify partner countries at an early stage and promote hydrogen/energy partnerships that create the right conditions for ensuring investment security for German companies in potential supplier countries;
- Support the development of optimal import routes by ship (energy sources, ship types, infrastructure) as well as the development of corresponding transport capacity;
- Enable international trade agreements by means of guarantees of origin and regulatory recognition of imported renewable energy via PtX.

Glossary

D

Defossilization
The term "defossilization" describes the transformation of an economic or energy sector with the aim of replacing fossil fuels with renewable, CO_2-neutral alternatives. Defossilization should not be confused with "decarbonization", which refers to a complete reduction of carbon dioxide emissions. → *12*

Drop-in fuel
Drop-in fuels are alternative fuels (biofuels or e-fuels) that can be blended in with conventional petroleum-based fuels because of their similar chemical compositions (e.g. E10 petrol) and can thus be easily distributed using the infrastructure already in place. → *12*

E

E-fuels
Climate-neutral fuels with the same properties as gasoline, diesel or kerosene. In the future, electric fuels will play a key role in the global reduction of climate-damaging greenhouse gases. Liquid synthetic fuels are produced from water and CO_2 using electricity. Only renewable energies, in particular solar, hydro and wind power, are used in the production of e-fuels. → *6*

EU Emissions Trading System
The European Union Trading System (EU ETS) is a key European climate protection instrument. It is designed to give companies (plant operators) which emit less CO_2 than their competitors an economic advantage.
For this purpose, the member states issue emission allowances to the plant operators who can then trade them freely on the market. This puts a price tag on the emission of greenhouse gases.
It is planned to include shipping in the EU Emissions Trading System. However, there is still no agreement on the exact implementation within the legislative process.
→ *7*

EU Taxonomy for Sustainable Finance
Since 2022, the EU Taxonomy Regulation has been a key component of the EU's Green Deal. It provides companies, investors and political decision makers with a binding set of rules for climate and environmentally friendly activities and investments. The aim is to ensure that future funds will flow into environmentally sustainable investments wherever possible. However, the regulation is controversial because of its implications for the shipping industry. For example, LNG, methane or synthetic fuels are not considered sustainable according to the taxonomy. → *7*

External Energy Strategy
One part of the REPowerEU reform package addresses the future supply of non-Russian fossil fuels to EU states within the framework of the External Energy Strategy. → *7*

F

Fit for 55
"Fit for 55" refers to the EU's goal of reducing net greenhouse gas emissions by at least 55 per cent by 2030. Accordingly, existing EU climate protection instruments (e.g. emissions trading, RED, EED) are to be adapted to the new target and further instruments (including Climate Social Fund, FuelEU Maritime) are to be added. → *18*

FuelEU Maritime
The FuelEU Maritime initiative will promote measures for the use of sustainable alternative fuels in shipping and ports in Europe. To this end, the following points are to be implemented:

- Removal of market barriers to the use of such fuels.
- Provide clarity on which technical options are marketable.

The initiative is part of a package to bring the sector in line with the EU's goal of becoming climate neutral by 2050.
Source: ec.europa.eu → *7*

G

Green Deal

Through the European "Green Deal", the 27 EU member states want to become climate neutral by 2050. The concept was presented by the European Commission under Ursula von der Leyen on 11 December 2019. As a first step, greenhouse gas emissions are to fall by at least 55 per cent by 2030 compared to 1990 levels. → 17

H

HFO

Heavy fuel oil (HFO) has a particularly high viscosity and high density. HFO is mainly used as marine fuel. An important distinguishing feature of heavy fuel oils is their sulphur content. → 12

R

RED II

The Renewable Energy Directive II (RED II) is the renewable energy directive for the expansion of renewable energies in the EU. The directive sets the goal of increasing the share of renewable energies in the European electricity mix to at least 32 per cent by 2030. The directive is currently being revised to achieve more ambitious expansion targets for renewable energies by 2030. An increase to more than 40 per cent by 2030 is recommended. → 7

Renewable and Low-Carbon Fuels Value Chain Industrial Alliance

Aims to develop strategies for renewable and low-carbon fuels. The aim is to improve the supply of sustainable fuels for aviation and shipping.

Source: hanse-office.de → 7

REPowerEU

With the REPowerEU plan, the European Commission is responding to the recent strains and disruptions in the global energy market caused by Russia's invasion of Ukraine. Concrete measures of the REPowerEU plan are intended to drive the diversification of the energy supply, the expansion of renewable energies and the promotion of energy efficiency measures in order to replace fossil fuels in households, industries and power generation in the long term. → 7

S

Sector coupling

Refers to the combination of the energy-intensive "sectors" of power generation, heat and transport. The holistic approach envisages gradual replacement of fossil fuels such as gas or oil with renewable energies and renewable electricity. → 7

W

Well-to-wake

The well-to-wake approach takes into account the emissions that occur at each stage of a fuel's life cycle – from production to use as a ship fuel. Under this approach, a marine fuel can be classified as carbon neutral and still cause tailpipe emissions if its total carbon emissions are zero when the entire life cycle of the fuel is taken into account. → 7

Endnotes

1 Source: A Zero Emission Blueprint for Shipping, London: International Chamber of Shipping, 2021

2 There, the year 2020 is currently indicated with reference to the data according to the MRV Regulation EU 2015/757.

3 Source: Fourth IMO GHG Study 2020 – Final Report, Delft: CE Delft, 2020

4 Source: e.g. https://www.nabu.de/imperia/md/content/nabude/verkehr/140623-nabu-hintergrundpapier_container-schifftransporte.pdf

5 In the Renewable Energy Directive (RED II), these energy sources are referred to as "renewable fuels of non-biological origin" (RFNBOs).

6 See for example https://www.cimac.com/publications/publications350/cimac-on-future-marine-fuels-new-position-paper-published-copy2.html

7 In the EU, these are referred to as "renewable fuels of non-biological origin" (RFNBOs). Some of these fuels can also be produced on a fossil basis or as biofuels; they are not discussed in depth here but certainly play a role for a successful market launch (for example, in the case of methanol).

8 See for example Energy Environ. Sci., 2018, 11, 1062-1176 (https://pubs.rsc.org/en/content/articlepdf/2018/ee/c7ee02342a).

9 Rik van Rossum: European Hydrogen Backbone, Guidehouse, April 2022, available at https://gasforclimate2050.eu/wp-content/uploads/2022/04/EHB-A-European-hydrogen-infrastructure-vision-covering-28-countries.pdf

10 The EU hydrogen strategy is decisive for the ramp-up of hydrogen and allocates the use of hydrogen and other PtX products to sectors such as shipping and aviation. Similarly, the revision of RED II and the FuelEU Maritime Initiative recognize the need for PtX market ramp-up. With REPowerEU, the ambitions regarding the market ramp-up of hydrogen were once again significantly increased in order to end the dependence on energy imports from Russia.

11 44 million tons of fuel for shipping in the EU according to MRV in total, of which 32 per cent for intra-EU traffic, plus approx. 10 per cent not included in MRV; results in approx. 15.6 million tons.

12 Seems feasible from today's perspective and gives a clear market signal at a very early stage, even if the contribution to GHG mitigation is not yet significant.

13 Covers about one-fifth of a 30 per cent GHG reduction rate.

14 Covers about half of a 50 per cent GHG reduction rate.

15 The value corresponds to the above-mentioned 1 million t RFNBO by 2030, with an approximate assumption of a diesel-equivalent fuel.

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Contact

VERBAND FÜR SCHIFFBAU UND MEERESTECHNIK E.V.

VDMA e. V.
Lyoner Straße 18
60528 Frankfurt am Main
Germany
Tel. +49 (0)69 660 30
E-Mail p2x4a@vdma.org
www.vdma.org

VSM
Steinhöft 11
20459 Hamburg
Germany
Tel. +49 (0)40 28 01 520
E-Mail info@vsm.de
www.vsm.de