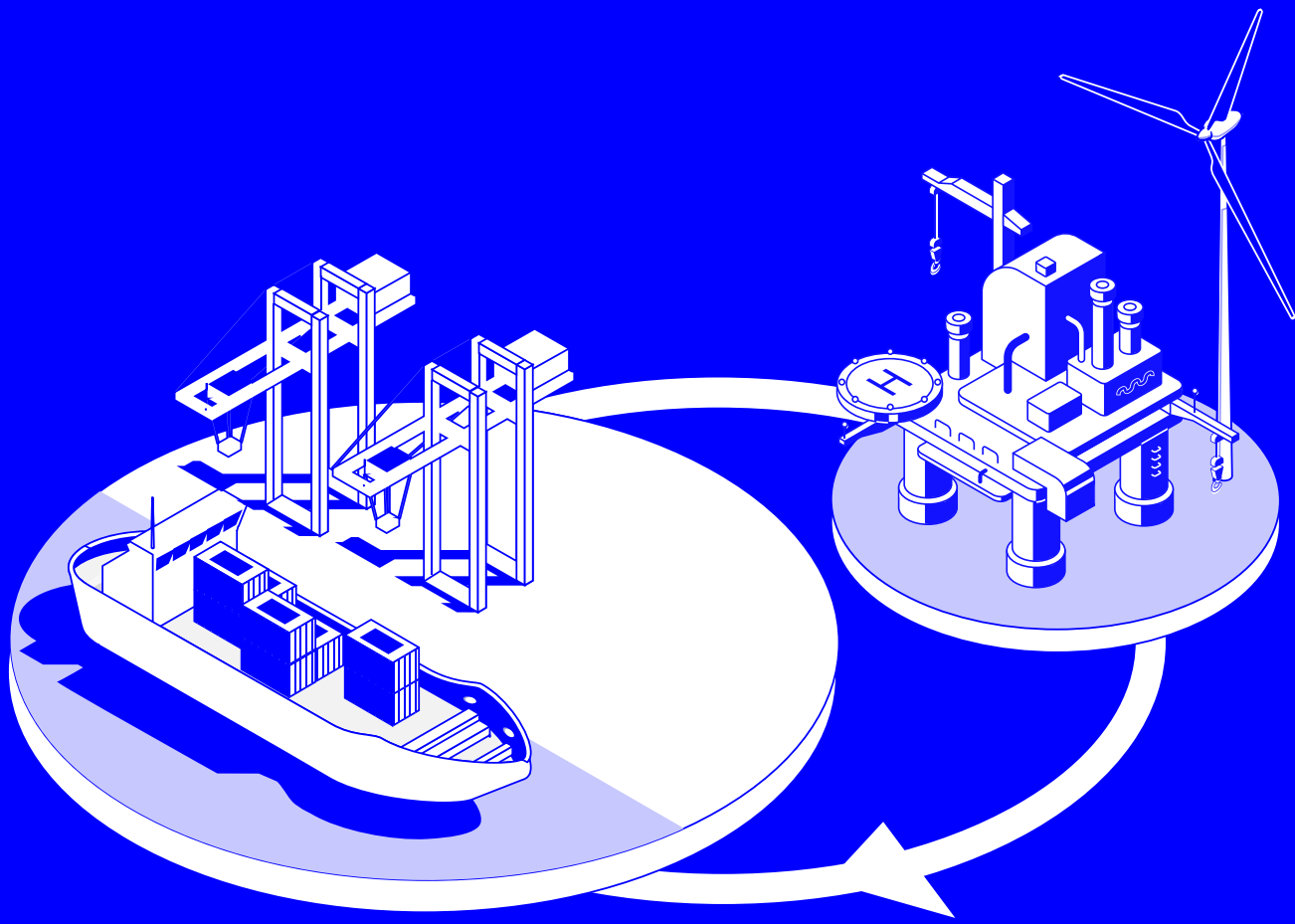

Circular opportunities for maritime: **building blocks for business, now and in the future!**

Maritime Sisters

BLUE CITY

Exploration 2023

Commissioned by the Province of South Holland

provincie Zuid-Holland

Reason, approach and content

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Overarching political-strategic agendas:
Maritime Masterplan & Regionale Maritieme Agenda

Cluster organizations:
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Knowledge institutes and classification societies:
MARIN, SmartPort, TNO and Bureau Veritas

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At the request of the Province of South Holland, Circulair Zuid-Holland (circular South Holland) and coordinator Maritime economy, the Maritime Sisters, in collaboration with BlueCity, have conducted a study into the circularity experiences of maritime sector stakeholders. The aim of this research is to test if the maritime sector is open to circularity, and to what extent circular principles are already reflected in the sector. The results of this study are included in this report.

In view of developments in the climate and use of raw materials, it is becoming increasingly urgent, not only to increase sustainability based on emission reduction targets, but also on raw material efficiency and value retention of materials, components and equipment. The maritime sector plays an important role in our economy and our society and has put the Netherlands on the map as a maritime nation internationally. At the same time, as a major consumer of materials, the sector has a significant footprint. Circularity can be a way to take sustainable steps and reduce that impact, something we have seen in other sectors. But how does this actually work within the maritime sector? How is this theme experienced within the sector and what could be addressed by business, governments and knowledge institutions?

This report provides a cautious first answer to the question: ‘How does the maritime sector view circularity?’ Which circular themes are at play, to what extent is there support for the focus on value retention of materials/raw materials and where are the opportunities and bottlenecks?

The report is a summary of insights we have gained during thirty discussions, both formal and informal, with market parties, network and industry organisations, knowledge institutes and managers of political-strategic agendas from the maritime sector. From shipbuilders to maintenance providers, from service providers to electrical engineers, from the regional political agenda to a maritime classification society. To the left is a brief overview of the parties that have contributed to the creation of this report.

We start the report by providing a brief insight into how the maritime sector is positioned and organized. We also explain which (sector) stakeholders are active in the maritime region of South Holland. For the discussions, in order to obtain a broad picture, we made a selection of maritime players active in the various subsectors of the sector. We explain how they consider the various life phases of a ship and whether they are already applying circular principles, be it consciously or unconsciously, before we dive into the sustainable depth with these parties. The starting point for this are the existing overarching sector agendas.

We used the discussions to look for circular examples, opportunities and challenges. In so doing, an attempt was made to let go of sustainability jargon and to look with an open mind at how the sector itself describes themes, opportunities and obstacles around topics such as raw material (re)use, life extension, repair, modular design and construction.

Reason, approach and content

Using case studies, illustrations from the sector and quotes from our discussion partners, we highlight what the interviewees have shared about (utilising) what already exists in terms of overarching agendas, knowledge, initiatives and resources surrounding sustainability and raw material use, as well as where there is the energy to further develop opportunities and what starting points there are.

In this report, you can read how the sector stakeholders and the Province of South Holland can react to the above. It is worth bearing in mind that this documents is the result of an initial exploration. It can serve to stimulate discussion about how, and where, you can start. Various points will require further investigation. Our advice is to fill in what is missing together with the various parties in the sector, especially the companies active within it. Therefore, we end the report with a series of recommendations for a potential follow-up trajectory towards collective steps, which could make an impact by building on the work of existing initiatives.

Does this stimulate you interest? Would you also like to contribute as a company. Then please contact us, you can find contact details towards the end of the report.

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Important note: Circularity is not in itself a goal. The goal is a sustainable maritime future. A circular strategy is aiming for optimal (re)use of raw materials, with the highest value for the economy and the least damage to the environment. All these things are important for a future-proof sector. Our most important starting point in this exploration, therefore, is: helping companies to take (further) steps in this area. To do this, you have to meet companies on their own ground, literally the places where they come (together), and figuratively where they are in the process.

Management Summary

"We are positively surprised." A lot is already happening, there is still (much) more potential and the building blocks are there!

"In the maritime sector/shipbuilding, the generation before us did not see the connection between knowledge of newbuilding and decommissioning. This generation is now stepping back and the new generation sees things very differently."

Roel de Graaf - Managing Director
Netherlands Maritime Technology

The Dutch maritime sector, perhaps against all expectations, has a lot going for it that could help it become a leader in circularity. It is a very capital-intensive sector, with a lot of high-quality regional manufacturing industry and vessel owners who require continual maintenance. A ship, in principle, is built to remain in operation for as long as possible. Repair, refit and retrofit have, therefore, long been a feature of the sector. Ingenuity has put us on the world map as a maritime nation and is also exactly the reason there is such potential here to contribute to CO2 reduction and raw material impact; essential features for a resilient and future-proof sector.

The sector is already thinking in modular construction. This is reinforced by developments to prepare ships for (more) sustainable propulsion and the fuel of the future. The material intensive nature of the sector emphasizes the importance of a raw materials strategy, aimed at the retention and reuse of materials and components. This is expected to be reinforced by the scarcity of raw materials, the first signs of which we are already beginning to see.

The current motives, with a few notable exceptions/ frontrunners, are however mainly financial in nature and the effect of modular design, or a retrofit project is by no means always sustainable (in terms of saving material, environmental impact and/or CO2 reduction). Legislation and regulations mainly prescribe steps in the field of energy efficiency and emission reduction. This is also the emphasis of an overarching agenda such as the Maritime Masterplan, with which the sector aims to have 30 sustainable, future-proof ships in service by 2030. The reuse cycle remains a point of attention across the sector, which is mainly arranged in a linear fashion for the construction and maintenance of (high-quality) ships. For a circular economy and value retention of maritime applications, closing the chain (here) is essential.

The fact that circularity is not self-evident is reflected in the lifecycle of a ship. Different parties are active in each phase and interaction between them during the different phases is limited. As a result, a ship is not yet designed integrally with the end of its lifecycle and decommissioning in mind. Incorrect incentives in the system hinder the achievement of the optimal lifespan and reuse. Consider the maximum age requirements of a ship to operate in certain markets, or the strict requirements to qualify for financing for sustainable investment. In addition, a ship regularly changes owner and/ or operational profile in the use phase. It is important to keep such factors in mind when looking at the feasibility of projects such as a materials passport or 'Product as a Service' (PaaS) (where ownership remains with the producer, e.g, the shipyard or supplier).

At the same time, the new generation sees and seizes opportunities, including sustainability ambitions and the economic perspective. Only by combining these two factors (social and economic future relevance) can things be sustainable for the long term. The new generation confirms the distinctiveness, the new revenue models and the strategic advantage that circular thinking and acting creates. But they also encounter challenges. Getting new revenue models off the ground and breaking through silos is not easy if old standards still apply. Steps in the circular field therefore often still take place within the company's own borders.

This study lists all the opportunities and challenges we have encountered. In the table on the next page we summarize which circular practices we recognize in the maritime sector. We distinguish between widely applied circular principles, emerging practices among frontrunners and opportunities to get things off the ground.

Management Summary

"By dealing more smartly with materials and value retention, added value can be created for companies and the sector, now and in the future."

"There is, as yet, no incentive from legislation and regulations. I do see players in the sector that are getting started with this from the sustainability/business model & differentiation perspective. I also see the scarcity of raw materials as a future trigger. I expect that circularity and product reuse will take off."
Martijn Nieuwenhuijs - Marine & Offshore Chief Executive Netherlands Bureau Veritas

Circular principles have been applied in the maritime sector traditionally. And, despite the linear approach, we recognize examples of circularity, as well as parties, active in all phases of the lifecycle, that are willing to stick their necks out.
This means that the building blocks are already in place to expand emerging circular practices into sustainable business (as usual), to reinvent the sector and to make a significant contribution to international sustainability challenges. Looking at the (focus of) existing overarching agendas and initiatives, we see opportunities, on the one hand in the hardware in operation, and on the other at either end of the supply chain. Financing and the right incentives are important points of attention if we are to move from a linear to a circular lifecycle.

With a sustainable maritime future in mind and the aim to help companies to take (further) steps in this area, we now distinguish **three thematic circular starting points for the maritime sector:**

1. Retrofitting and lifecycle extension of existing ships
2. Modular design, construction and preservation for sustainable shipping
3. High-quality reuse and remanufacturing of components and ships

Overarching themes, as it were, with opportunities that market players indicate they want to begin or have already begun, but are now looking for cooperation, support, knowledge and/or financing. In short: knowledge, skills and finance must come together.

From "in the Netherlands we are shipbuilders and not ship breakers" to "in the Netherlands we build the best recyclable ships". Thanks to the application of circular principles, not only the lifespan, but also the business case of ships and individual components is optimal and we retain essential raw materials. In this way we guarantee a future-proof maritime sector, both nationally and internationally.

That is the point that we set on the horizon based on the discussions we have had, and for which we want to build on the foundation we laid in 2023 in collaboration with the national government, the province of South Holland, Municipality of Rotterdam, Maritime Delta, NML, TKI Maritiem, NMT and KVNR and frontrunner companies. By perpetuating circularity on both the maritime sector agenda and the Maritime Master Plan, as well as in the annual agendas of cluster organizations and on the radar of companies, we create opportunities. Now and in the future.

Design:
- For multiple functions
- For maintenance
- For refit
- For retrofit
- For optimal energy consumption
- For decommissioning & reuse

Construction:
- Optimal material use and waste reduction
- Modular construction
- Green passport
- Green(er) construction
- Materials passport
- High-quality reuse of waste/residual materials

Operation:
- Conversion for new purposes
- Conversion for longer lifespan
- Circular systems onboard
- Waste reduction
- Leasing (ships)
- Leasing (equipment)
- Conversion more sustainable
- Rejuvenation for financing
- Extension of maximum lifespan

Decommissioning:
- Responsible decommissioning
- Remanufacturing of parts
- Revaluation & certification

Common practice
Forthcoming
Opportunities

Contents

1. The position of the maritime sector

Added economic value:

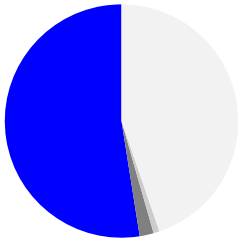
€56.500.000.000

Number of jobs in the maritime sector:

539.344

Amount of goods transported:

896.000.000 tonnes



Maritime transport: 896 mil. ton
Road transport: 767 mil. ton
Air freight transport: 1,5 mil. ton
Rail transport: 37 mil. ton

The maritime sector is of great strategic importance for the Netherlands. Adding 56.5 billion euros worth of value to the economy, and providing some 539,344 jobs[1], the sector is responsible (directly and indirectly) for 6.6% of Gross Domestic Product, as well as 5.5% of all employment in the Netherlands (directly and indirectly). In addition inland shipping and seagoing transport together were responsible for the transportation of 896 million tons of goods through the Netherlands in 2022 (to provide an example of the importance, the aero industry accounts for 1.5 million tonnes, the rail sector for 37 million tonnes of freight traffic, only road traffic comes close to maritime with a share of 767 million tonnes[2]). In short, the maritime sector plays a key role in our economy.

Internationally, the picture is the same. The Netherlands is a top player on the maritime world map. It is ingenuity, entrepreneurship and perseverance that have put it there. These are essential ingredients for innovation, as well for achieving our national raw materials and sustainability ambitions. In addition, as one of the top sectors[3], 'Water & Maritime' is therefore of great strategic importance nationally. Top sectors policy and industry and network organizations work together with the companies that make up the sector to maintain our competitive position and innovative strength.

Alongside digitalization, sustainability is gaining increasing attention among maritime stakeholders, although we see that attention is mainly focused on the so-called scope 1 CO2 emissions. Within the maritime sector, this primarily translates into sailing on sustainable fuels, or, where relevant and financially feasible, electrification. For example, the Maritime Master Plan which seeks to achieve 30 different emission-free and digital ships by 2030, aims to provide a calling card demonstrating an essential role in future-proof shipping worldwide. Opportunities and obstacles for regional cooperation are addressed in the Regional Maritime Agenda, with the aim of firmly positioning the Maritime Delta, now and in the future.

In short: the sector has a rich history and a lot is already happening.

2. Maritime in South Holland

Number of maritime companies:
5.165

Number of jobs:
42.260

Added economic value:
€6.200.000.000

Production value:
€17.900.000.000

[1]The Maritime Delta covers the municipalities of Alblasserwaard-Vijfheerenlanden, the Rotterdam Rijnmond region (Capelle/Krimpen/Vlaardingen), Delft, the Drechtsteden, Schiedam, Voorne-Putten and Werkendam.

Additional information:

- Largest port in Europe
- Strong maritime manufacturing industry and maritime business services
- Specialized in producing high-end ships
- Leading companies in offshore and dredging

If we zoom in further on the Dutch maritime industry, much of the activity is located in the provinces of South Holland (32%), North Holland (13%) and North Brabant (9%). See figure 2.1. This situation has arisen historically, due to the location of the Port of Rotterdam in the heart of the province of South Holland. In the Rotterdam region (including the Drechtsteden), there are today over 3,730 maritime companies. If we consider the entire Maritime Delta[4], the figure rises to 5,165 companies. The added value of the Rotterdam region is 6.2 billion euros, with a production value of 17.9 billion euros, providing work for 42,260 people. This represents a contribution to the provincial GDP of 5.2%. In short, the sector offers considerable economic potential in the heart of the province of South Holland.

South Holland, and specifically the so-called Maritime Delta, specializes in the design, construction, operation, and maintenance of high quality vessels. The area features a wide range of companies. At the head of the chain are the design bureaus, companies such as Vuyk Engineering Rotterdam, C-Job, TWD, Saltwater Engineering, Sea of Solutions, or shipbuilders such as Damen Shipyards Group, Oceanco, Holland Shipyards, Neptune Shipyards and Royal IHC. Further down the chain there are ship owners such as Anthony Veder, Boskalis, Van Oord and Kotug. Boskalis and Van Oord are leaders in the offshore sector and construction dredging. These are all supported by companies that maintain, repair and refit ships, such as Royal Roos, ROG Shiprepair, and Damen Shiprepair & Conversion.

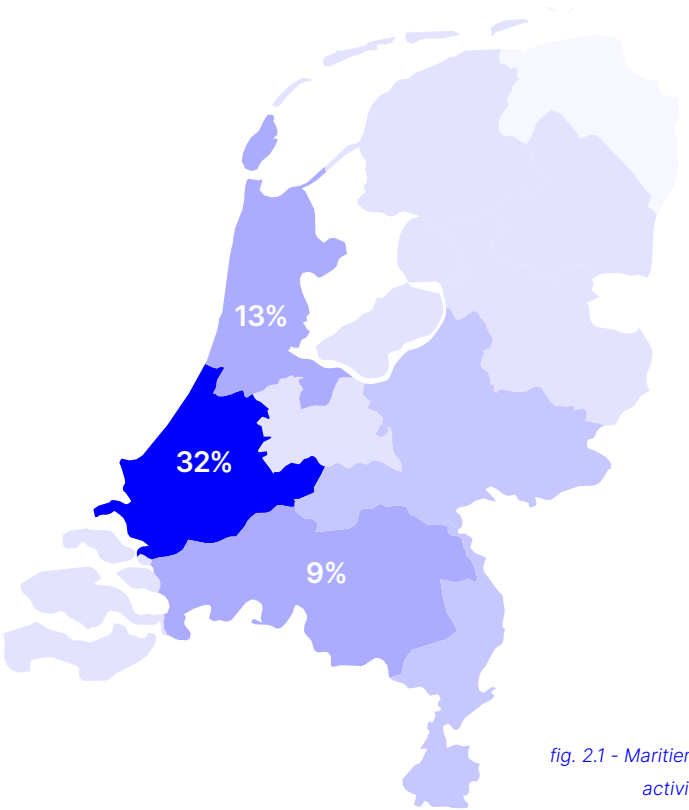


fig. 2.1 - Maritieme activity[1]

Traditionally, the Dutch maritime sector, including in South Holland, has been less focused on end-of-life services (typically referred to as 'scrapping' or decommissioning in maritime terminology). Vessels are frequently resold before they reach the end of their lifespan. As a result, the decommissioning of the vessel often takes place in other countries. Companies in the Netherlands that offer this service include Damen Verolme Rotterdam, Holland Shipyards (carrying out the decommissioning in Vlissingen), Sagro (Vlissingen) and Elegant Exit Company (Drachten). Although the emphasis here is on South Holland, we would like to mention that there are also leading players located in the north of the country that are also included in this study.

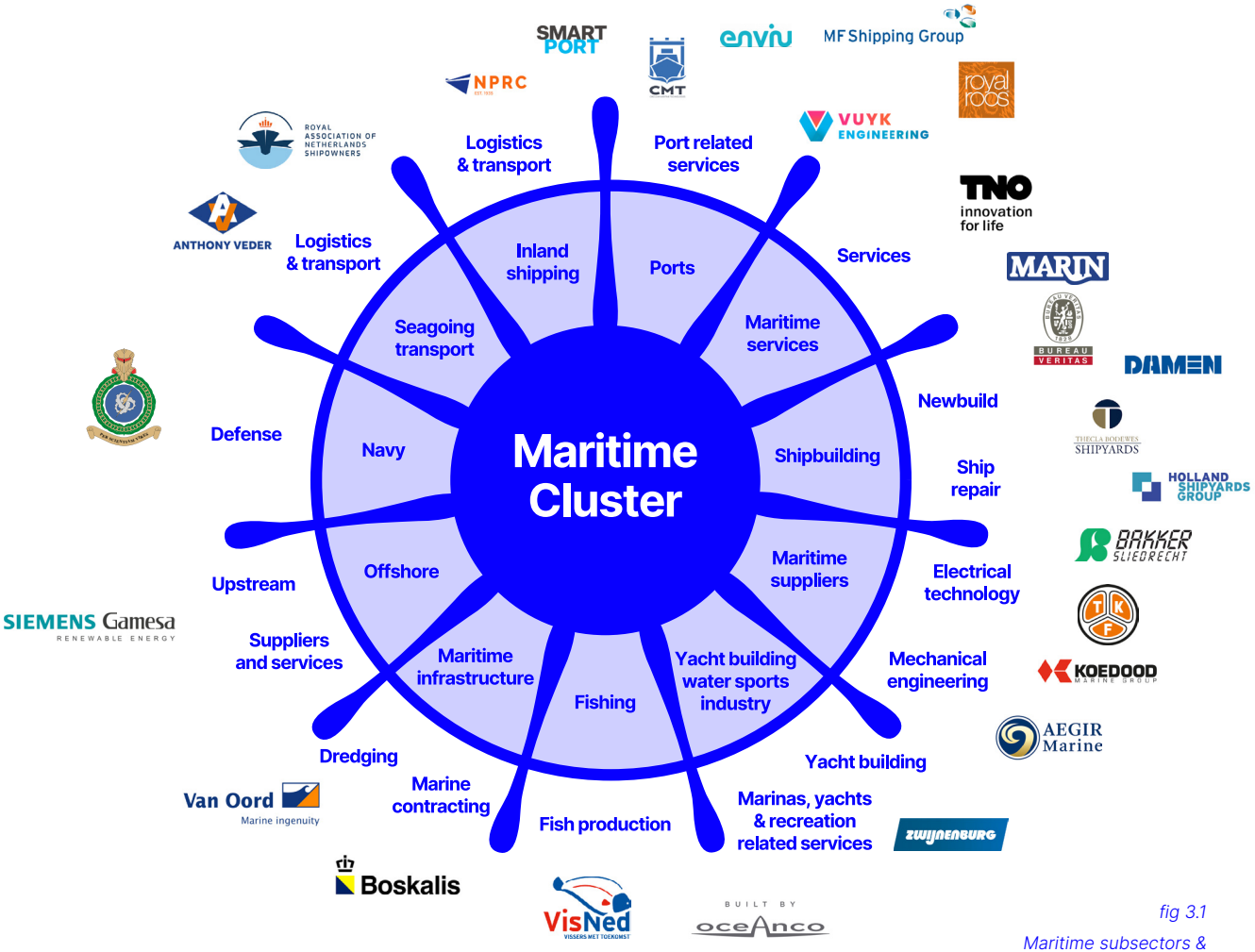


fig 3.1
Maritime subsectors & conversation partners

3. Market players and stakeholders in the maritime sector

Before we dive into sustainable depths, we believe it is important to consider the companies and the supply chains that constitute the maritime sector. Any exploration of the opportunities and challenges of circularity requires an analysis of these diverse stakeholders. In reality, the maritime sector is a collective name for everything related to the transport and protection of goods, materials, services and people over water. As such, the maritime sector consists of eleven subsectors. In order to gain a clear picture of the relevant themes, opportunities and hurdles, we have decided to speak to at least one party representing each of these subsectors. These parties can be seen in figure 3.1

Maritime Delta Maritime by Holland.
Nederland Maritiem Land High Tech, Hands On
TKI Maritiem Nederland Maritiem Land
NETHERLANDS MARITIME TECHNOLOGY

3. Market players and stake-holders in the maritime sector

The emphasis of this diversity is important, as different themes, projects and chain partners are relevant to the approach to circularity taken per subsector. It is also worth adding that figure 3.1 does not provide a complete picture of (nuances within) the subsectors, it simply provides an initial impression. Given the situation described above, it is unlikely an integrated approach or policy for circularity spanning the entire maritime sector will be relevant for market parties. For example, the subsectors of construction dredging and fishing are a world unto themselves. They are also deep within the field of 'building with nature'. These have not been considered in the scope of this report. However, 'best practice' and lessons learned can be found here for a possible follow-up.

We believe it is important to explicitly integrate circularity within the existing political agenda of the most important cluster organizations and knowledge institutions that determine the course of the maritime sector. This is why we have started our exploration among those parties. Sector organizations such as Netherlands Maritime Technology (NMT), The Dutch Maritime Network (NML), TKI Maritiem, Royal Association of Netherlands Shipowners (KVNR) and parties such as NPRC (the largest European inland shipping cooperative) and Maritime Delta play an important role in promoting the shared interests, innovation and cooperation within the sector. To a certain extent, they determine the themes and policy frameworks behind such initiatives as the Maritime Master Plan and the Regional Maritime Agenda. Knowledge institutions are continuously working on the further development of our knowledge base and its application. This includes parties such as MARIN, SmartPort, TNO and Bureau Veritas.

Ultimately, it is also important to share the findings of this report with the national political arena, which appointed Kees van der Staaij as ambassador for the maritime manufacturing industry. He is working towards an integrated national maritime industry policy and is implementing and executing the Sector Agenda for the maritime manufacturing industry (including naval construction).

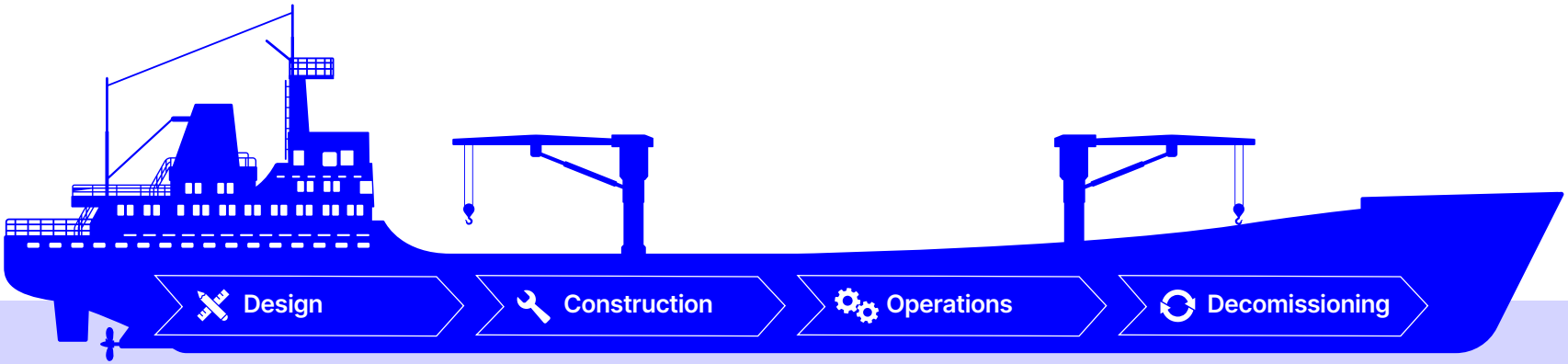


fig. 4.1 - The lifecycle of a vessel

4. Maritime thinking and the lifecycle of a vessel

As already mentioned, there is a relatively large manufacturing industry in the Netherlands. It is, however, good to emphasize that while the high value work typically takes place within Europe, other activities are frequently undertaken in countries with low wage economies. Therefore, a lot of importation and transportation takes place during the design, construction and maintenance of a ship.

If you wish to approach the sector with a circular perspective, it is logical to take the lifecycle of a vessel as the starting point. The (Dutch) maritime sector consists of a network of companies that together ensure our capabilities to design, build, operate, maintain and ultimately decommission ships. This is the so-called lifecycle of a ship, as shown in figure 4.1. While this chapter provides a general picture of the sector, it should be noted that this is not applicable to all processes or companies in the maritime sector.

There are major differences per subsector. Consider the different market segments and their corresponding positions in the value chain. This also translates into a different focus and/or approach in terms of circular methods, projects and/or innovations. At the same time, a circular line can be drawn in broad outline. Traditionally, our Dutch maritime sector has focused on long lasting, high-quality materials, components and systems, and innovation. In principle, a ship is built to operate for as long as possible, while providing optimal performance. Due to this, repair, refit and retrofit have long held an important position in the sector. We also see that, in anticipation of the fuel of the future, lifecycle extensions are increasingly being carried out. Modularity not only makes for efficient design and construction processes, but also makes it easier to replace propulsion and other systems or components during the life of the vessel.

Considering the type of business in the region, we see a lot of manufacturers and associated services. Together, these companies deliver high-quality vessels and keep them in operation. This includes companies providing design, maintenance and lifetime extension services. Additionally, we observe considerable interest in sustainability among frontrunners. On paper, we already see various circular services in operation. However, they are not referred to as such within the industry, perhaps because such services do not always lead to the optimal lifecycle and reuse.

4. Maritime thinking and the lifecycle of a vessel

fig. 4.2 - Boskalis multifunctional ship Ndeavor. Photo courtesy of Boskalis.

Circular principles are inherently linked to the sector, but incorrect incentives in the system (requirements of ports or shippers relating to maximum age of vessels, and the difficulty of financing sustainability measures) hinder optimal lifespan and reuse. We need to move towards rejuvenating ships, returning them to new, or factory delivery condition and ultimately reusing components. Huge steps can be taken here, and I am happy to open our agenda for that!"

Roel de Graaf - Managing Director
Netherlands Maritime Technology

In general, different parties in the market are active in each of the 'four life phases'. These parties are dependent on each other and can achieve better results by working together smartly. This cooperation remains insufficient and in fact the four phases still frequently work as separate silos. As a result, the lifecycle of a ship can be seen as a linear process. We certainly see this in times when the market is under pressure and little money is earned (and interests are therefore sometimes conflicting).

Design

In the design phase, an engineering firm designs a ship. It can also be the case that the ship is designed in-house by the shipyard. In shipbuilding, a distinction is made between ships that are designed entirely according to the customer's wishes, the so-called one-offs, and standard ships. With the latter, as the name implies, a standard design is applied. The shipyard determines which components and systems the ship consists of and often builds to stock. This results in the owner being able to put the vessel into service quickly. An additional advantage of the standard ship design for the client is that

4. Maritime thinking and the lifecycle of a vessel

components can be exchanged between ships of the same design within the fleet. In addition, the crew is used to the systems and can therefore easily be deployed on various ships. Standard ships are also often designed in a modular fashion. This offers an efficient construction process. With straightforward replacement of components and systems, maintenance is also efficient. This principle has been in use for some time, especially in subsectors such as 'dredging and marine', where vessel are subject to intensive use in heavy conditions. Vessels are also increasingly being prepared (and therefore designed) for multiple applications and/or functions, such as the Boskalis ship Ndeavor. This is a multifunctional ship that can dump rocks, lay cables and undertake dredging. This allows the ship to be adapted relatively easily and, therefore, more cost effectively during its lifecycle, with, for example, the installation of alternative cranes or systems.

Traditionally in ship design, we have seen a focus on optimizing loading and/or deck space and material use from an economic perspective. Presently, in part driven by the EEDI*, we increasingly see ships being designed for fuel savings and emission reduction. An example is the Riveer Ferry designed by Holland Shipyards in collaboration with CoCo Design. Thanks to a weight saving of 80%, they have achieved both the conversion to battery propulsion and an extra stop on the route, without deviating from the schedule.

In anticipation of the necessary developments on the way to emission-free sailing, we are also increasingly encountering 'design for retrofit'. In anticipation of the fuel of the future, we observe ships increasingly being designed modularly and equipped with dual fuel engines or diesel-electric systems, which can be adapted to another fuel, such as methanol, hydrogen or a fuel cell, in the future. In such cases, the design of the vessel takes into account the extra space required by alternative energy carriers. An example is Royal Friday's dry bulk coaster, a ship that can transport different types of dry cargo and can easily be converted from MGO (marine gas oil) to various hybrid propulsion options such as battery or LNG. In anticipation of the fuel of the future, modular hybrid energy solutions, for example from Bakker Sliedrecht, can also provide a solution. Ships sail more economically (in terms of both costs and CO2), maintenance costs are reduced and ships become more future-proof in terms of tenders.

It is good to emphasize here that the effect of this modular thinking, and the inclusion of different functions, does not automatically result in sustainability. Neither does it necessarily lead to a reduction in (primary) material consumption during shipbuilding. Currently, modular design is primarily used to increase efficiency, and as a result of lacking clarity with regard to alternative future fuel types.

* EEDI = Energy Efficiency Design Index

4. Maritime thinking and the lifecycle of a vessel

Construction

Alongside modular design, modular construction is also a relatively common practice in the maritime sector. This is comparable to Lego, with modules of the most important systems and components delivered to a shipyard already assembled for efficient installation. Additionally, the optimal use and waste reduction of valuable materials such as steel, piping and cables has been a focus point for years in order to reduce the cost price of the vessel, as well as the yard's margins.

In the case of customization, also called a one-off ship, the vessel owner often provides a so-called 'makers list' containing their preferred main components and systems. The aim here is to gain control over the price, quality and lead time of the construction. For the remaining equipment, the yard is typically at liberty to make selections and undertake negotiations with suppliers. This offers yards more freedom to request circular components and is an opportunity to innovate. For some systems or components, however, the suppliers have a high level of monopolization, with the yard dependent, for example, on just one or two suppliers.

Green(er) building is an emerging phenomenon. Sustainability is on the agenda of every shipyard we spoke to. Damen Shipyards wants to take 'cradle to cradle' responsibility for its ships and has included this goal in its strategy. Holland Shipyards generates its own power with solar panels in order to be able to build ships in a sustainable way. The company is also exploring possibilities to capture volatile organic compounds.

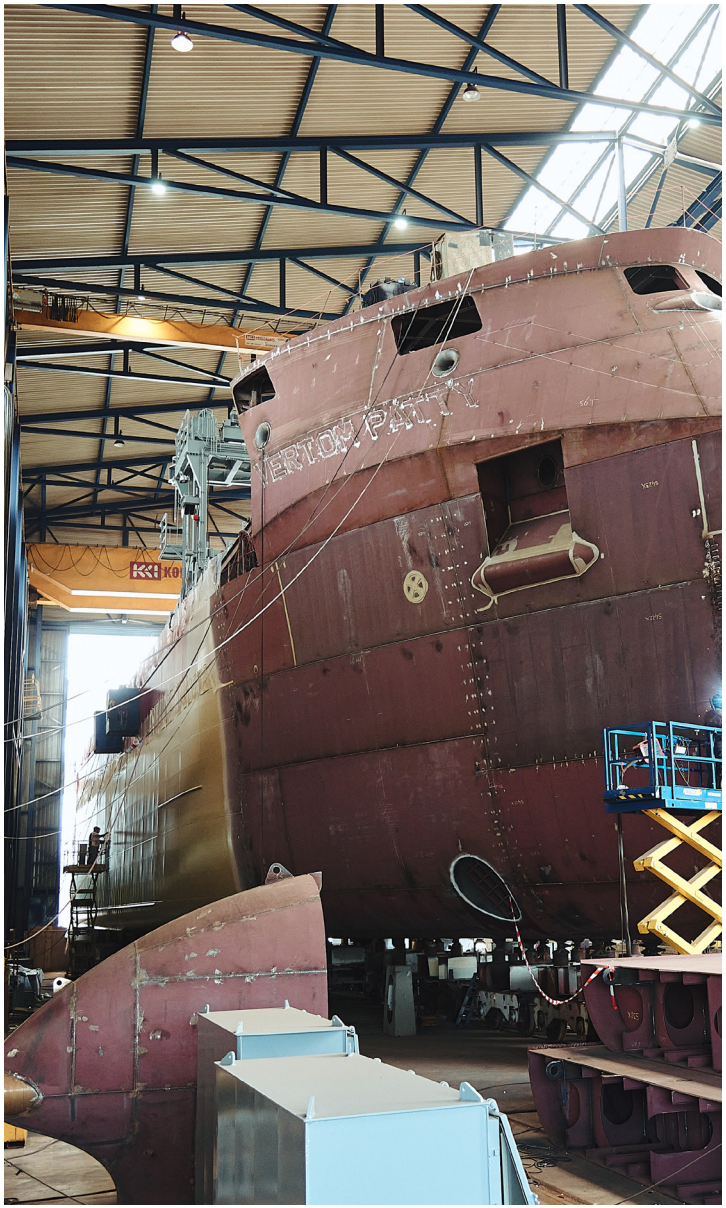


Fig. 4.3 - Vertom Patty under construction (section construction). Photo courtesy of Thecla Bodewes Shipyards.

4. Maritime thinking and the lifecycle of a vessel

Fig. 4.4 - Electric ferry from Holland Shipyards. Photo courtesy of Holland Shipyards.

In consultation with clients, yards are also exploring the possibility to use more sustainable materials in the ship. This, however, comes at a price and raises the question of who wants to foot the bill. Although this is not (yet) enforced, shipyards record use of hazardous substances in a so-called 'green passport'. At Oceanco, new yachts are 'designed and built for refit' if the customer agrees, and existing yachts are converted into fully-fledged 'new' ones.

High-quality materials are frequently applied by all parties. This means that the circular opportunities for Dutch shipbuilding are, by definition, high because the materials and components simply last longer and can often be reused. For example, it is not unusual during the construction phase of a ship to reuse existing gastanks after careful testing, after which the ship is classified as new.

A final interesting development is the rise of leasing structures in which shipbuilders help finance sustainability steps, such as for the Blue Amigo ferries by Damen Shipyards. In this way, the shipyard remains the owner of the materials (i.e. the ship) and the ship owner does not purchase the ship, but the service it provides (in this example passenger transport). This so-called Product as a Service (PaaS), a revenue model focused on leasing ships, is an interesting opportunity for shipyards to bind customers to them, and to generate better, more timely maintenance, with the potential to ensure parts remain optimal and functional for longer (in turn reducing material consumption). 'Ship as a Service' is also already used by Damen Marine Services, among others, with a diverse fleet of ships for rental with various types of contract.

4. Maritime thinking and the lifecycle of a vessel

Fig. 4.5 - Van Oord's Svanen. Photo courtesy of Van Oord.

Operation

During the operational phase of a ship, owners generally follow the planned and mandatory maintenance schedule. Unplanned repairs (and, therefore, material use) takes place as a result of incidents. Maximum uptime, optimum lifecycle and lifespan extension are generally the starting points here. In certain cases, repairs are even carried out while the vessel is underway. For larger serial machine parts such as (electric) motors or deck equipment, 'exchange parts' are already being used. Maintenance of components and installations seems to offer a piece of low hanging fruit; our discussions revealed much to be gained in the extension of life through smart (preventative) maintenance.

Modifications and retrofits have traditionally been commonly undertaken to enable a ship to operate for different purposes than were originally intended. Consider the installation of wind turbines after a vessel has been used for years to perform heavy lift operations. Additionally, vessels are often given a new purpose. Van Oord's Svanen is an iconic example of repurposing. Built by BallastNedam in 1991 for the construction of the Great Belt Bridge in Denmark, then made suitable for wind farm construction and, due to a merger, it has been owned by Van Oord since 2014. Thanks in part to excellent maintenance still active as an installation vessel and suitable for the heaviest wind turbine foundations. In this subsector (offshore) we also see rental of vessels on a project basis as very common.

4. Maritime thinking and the lifecycle of a vessel

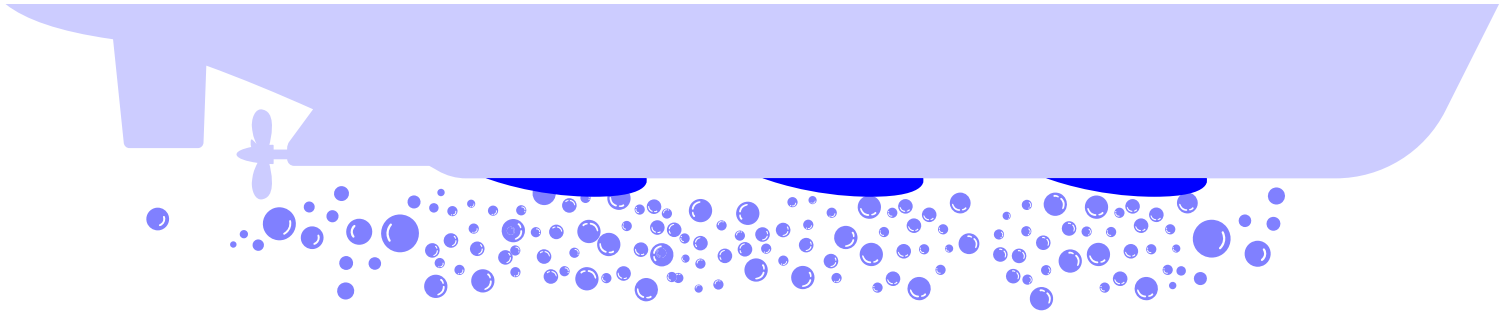


fig. 4.6 - Alfa Laval OceanGlide. Source: Alfa Laval.

* EEXI = Energy Efficiency Exisiting Ship Index,
* CII = Carbon Intensity Index

In recent years, triggered by legislation, regulations and environmental impact, many steps have been taken to achieve more sustainable maritime operations. On board, circular (water) systems have been installed, such as ballast water and bilge water separators. Waste flows such as plastic, paper, cardboard, glass, food waste (crew) and maintenance waste have been tackled, with waste delivered separately to ports, where processing unfortunately often leaves much to be desired. The use of plastic bottles on board ships has been significantly reduced with water purification systems such as that provided by Hatenboer Water.

In addition, we see a lot of emphasis on more efficient use of fuels during the operational phase. Legislation and regulations such as the EEXI and CII* prescribe emissions reduction and higher energy efficiency of existing ships. In this area we see more and more interventions at both the digital and hardware levels. For example, dashboards allow the measurement, and therefore adaptation, of the captain's behaviour. Retrofits see the installation of systems that improve sailing performance or capture exhaust gases. For example, Alfa Laval OceanGlide creates an air layer around the hull that significantly reduces a ship's resistance in the water, saving up to 8-12% on fuel. Such retrofits aimed at energy efficiency are becoming increasingly common, which is logical considering the condition of the existing fleet and increasingly stringent regulatory requirements. However, the major challenge is the financing of such projects. This is discussed further in chapter 7. A 'Refit Alliance' has now been set up for inland shipping. Among other things, this examines the experience of the dredging sector with financial support for greening. For yacht building, the municipality of Rotterdam intends to set up a 'circular lab' for retrofitting for market parties, in which a completed CIRCO track on retrofitting with BlueCity is followed up.

With regard to the above, it is good to emphasise that, in practice, newbuilding and vessel maintenance are not generally carried out by the same party. This is partly due to the fact that maintenance takes place at a shipyard favourably located with regards to shipping routes. In addition, in the Netherlands we only build technically high-quality ships and not so much large cargo ships.

4. Maritime thinking and the lifecycle of a vessel

*We mainly assume cargo ships here. The number of movements of a work vessel or the cranes on board, which can no longer handle the size of new wind turbines, means that this looks considerably different for such ships. There are also positive outliers here, such as Heerema's crane vessels Balder and Hermod, which date from 1978, the first of which is still in operation.

Decommissioning

The fact that we build technically high-quality ships is one of the main reasons for the low level of decommissioning taking place in the country. The majority of ships in the Netherlands are resold before they approach the end of their lifespan (after an average of 30-40 years)*. The end-of-life responsibility, including associated costs, lies with the current owner. Typically, vessels owned by Dutch owners have been very well maintained. As such, they are in good condition and in high demand at the point of resale. A ship can change hands multiple times during the usage phase. This is often influenced by market developments. In times of scarcity (low demand), for example, we see ships being resold more frequently (fleet downsizing), or that companies merge (placing owners in a stronger position). Conversely, we see newcomers entering an overheated market.

This makes the end of a ship's lifespan a bit of a 'black box'. Be that as it may, ships are still all too frequently scrapped on beaches in India, Bangladesh or Turkey. There are also several parties that have tried, or are trying, to do this in a more sustainable way, such as Offshore Shiprecycling Rotterdam (OSRR), Sea2Cradle and Elegant Exit Company. Circular Maritime Technologies (CMT), in trying to get this off the ground, is tackling one of the biggest challenges; maximizing the yield from a responsibly dismantled ship. See the case study in chapter 7.

An exception to the above are inland ships (and barges). These are often either decommissioned locally or take on a new role as a houseboat, which in circular terms can be considered as repurpose (while retaining the main functions, another destination and/or use is found). However, a side note related to the existing infrastructure for decommissioning is that the valorization of steel frequently does not take place at a high level.

5. Financial interests: large assets, large interests, small margins

"We see that certain customers are postponing their decisions to invest in new vessels in anticipation of the fuel of the future. Often not included in that consideration are the higher costs of lifetime extension and decommissioning."
Karin Orsel – Founder & CEO MF Shipping

"We make suboptimal choices in design and construction because our ships have to be written off in 20 years, while they can easily last 10-20 years longer."
Arthur van der Kaay – SHEQ Manager Anthony Veder

It is important to bear in mind that the maritime sector, like construction, is not only a capital-intensive, but also a very material-intensive sector. It deals in large, heavy assets on the balance sheet. During transport or project execution there are large financial interests and risks, frequently offering only small margins in relation to the costs of a ship. As such, from the perspective of the vessel owners, there are considerable risks involved. The same can be said of shipyards, who often pre-finance a ship during its construction.

During construction, operation and maintenance, time is money. When it is not operating, a ship costs money. As such, we see various parties throughout the sector making decisions and choices that are sometimes at odd with one another.
A shipbuilder will look to deliver a vessel on time and as competitively priced as possible. An owner will look to deploy it in a competitive manner, etc. In addition to the (safety of) crew, other important factors in decision making include uptime and fuel consumption.

In reality, we see that newbuilds, life extension projects and maintenance are primarily undertaken when the economy is performing well, resulting in plenty of work for the ships. Orders are more easily given when demand is growing. One result of this is a shortage of vessels in the market, and full order books at the shipyards, which has an impact on both costs and lead times. A vessel owner may pay the 'top price' for a newbuild vessel, or even more for a second-hand one that is immediately available. Conversely, the same effects can be observed when the economy is underperforming and less vessels are ordered. In this case, an owner will do all they can to get the best price from the yard, which then places pressure on the suppliers' prices further down the chain.
The choice to undertake a lifetime extension, or repair project, then, is typically made in times of economic prosperity, or in anticipation of the fuel of the future. Many vessel owners postpone investment decisions, meanwhile the long term effects (decommissioning) may not be factored in.

Optimal lifespan viewed through a (realistic) maritime lens

Looked at from a positive angle, the capital-intensive nature of the sector means that circularity is, in principle, at its heart. After all, there is a financial interest in achieving the optimal lifespan of a ship. The average lifespan of a ship is 30 to 40 years. However, the optimal lifespan is viewed from the aims that the present owner has for the vessel, and not the potential total lifespan. This in turn is linked to shippers' requirements. In general, tankers are no longer accepted by major leading shippers and ports after 20 years, which means that a vessel owner's investments often has to be written off over a shorter period than the total potential lifespan of a ship.

With regards to the above, it is important to note that the practices and phases mentioned are general and intended to illustrate current thinking and practices in the sector. They do not, therefore, hold true for all parties. For example, Anthony Veder invests counter-cyclically, a practice that enables them to purchase new ships at a better price, creating savings that can be invested in innovations.

6. Sustainability & circular thinking

*EEDI = Energy Efficiency Design Index
EEXI = Energy Efficiency Existing Ship Index
CII = Carbon Intensity Indicator
SEEMP = Ship Energy Efficiency Management Plan

*IMO: A London-based organization that establishes agreements at the international level between participating member states to make shipping as safe and environmentally friendly as possible

AFIR: Alternative Fuels Infrastructure Regulation, part of the Fit for 55 package, setting concrete targets for the roll-out of sufficient charging points and filling stations for alternative fuels in the EU for cars, planes and ships

If you consider the way the maritime sector thinks and acts through circular glasses (without using sustainability/circularity jargon), it immediately becomes apparent that, in theory, the sector lends itself well to circular thinking and acting. The maritime sector is a very material intensive sector and relies heavily on the 'technical cycle' of raw materials. Read: large volumes of heavy materials that are finite and sometimes either scarce or complicated by geopolitics.

In addition to direct emissions resulting from use of fossil fuels, the so-called embedded impact is considerable. The embedded impact, or scope 2 and 3 emissions, in addition to CO2 emissions, factors in the energy, water and land use, as well as the environment impact of materials used by the sector for logistics, construction, maintenance, parts, services and, ultimately, decommissioning.

For the purpose of this analysis, the CO2 and environmental impact of goods transported globally by the maritime sector is not considered. Sustainability is a relatively new topic for the maritime sector. The management of and focus on sustainability in the sector is primarily aimed at so-called scope 1 emissions (those directly resulting from fossil fuel use). This means energy transition and increasing sustainability of ships via efficient use of fuels (EEDI, EEXI, CII, SEEMP*). At the international level, sustainability is now high on the agenda, in spite of the fact that shipping initially fell outside the scope of both national and international climate agreements. Fortunately, this his now changed. The International Maritime Organization (IMO*) has the ambition to achieve a 40% reduction in CO2 by 2030 and a halving of emissions by 2050.

During the COP27[5], a number of countries called for more ambitious targets. Dutch ship owners are aiming for a 70% reduction of greenhouse gases by 2050, compared to 2008 levels. A recent breakthrough is the European agreement for making international shipping more sustainable. In the coming years, large seagoing vessels must gradually reduce their CO2 emissions, beginning in 2025 with a 2% reduction. Ultimately, the goal is to reduce CO2 emissions 80% by 2050 compared to 2020[6].

It should be noted that these rules will only be applicable to vessels over 5,000 gross tons, such as large container vessels and cruise ships. The KNVR would like to see the rules applied to all cargo ships, including smaller ones from 400 gross tons. As the fleets of over half of all Dutch ship owners feature smaller vessels, this is an opportunity to accelerate greening. It does, however, present owners with a challenge, having significant cost implications. The question is whether sufficient green fuel can be produced to reduce CO2 emissions to the desired extent. On the positive side, an agreement in principle has now also been reached at the EU level on the AFIR*, which should promote the roll-out of European infrastructure for alternative fuels.

6. Sustainability & circular thinking

"Let's work together and put this on the agenda within TKI (innovation agenda Top Sector Water & Maritime) and organize an ambitious circular view of the Maritime Masterplan, including design, reuse of components, etc."

Bas Buchner – Chairman TKI Maritime & President MARIN

In alignment with its leading position, the Netherlands is very ambitious and wants to use the Maritime Masterplan, not only to become future-proof, but also to present a calling card showcasing its potential to play an important role in future-proofing the global fleet. The Maritime Masterplan aims, by 2030, to develop, build and operate thirty reliable, competitively costing climate-neutral ships in the four value chains that are important to the Netherlands: coastal and inland shipping, dredging, offshore wind, and maritime safety. The Ministry of Defence and the Rijksrederij (Dutch Governmental organization operating vessels on behalf of numerous government departments) will play an important role in this as launching customers. The three reasons for the implementation of the Maritime Masterplan at this time are as follows:

1. Accelerating the (global) maritime energy transition
2. Increasing national security and European strategic autonomy
3. Strengthening the Netherlands' earning potential

How do we improve a ship and its operation? The objective is to transport goods using as few scarce resources, and with as small a footprint, as possible. The plan prioritises the fuel of the future (from well to wake), as this is both the highest cost item and has the most significant impact on the environment in terms of (direct) emissions. On board, digitalization will be used to reduce both fuel consumption and operational costs. This will consist of a digital platform on which data is stored in support of the three processes of design, construction and commissioning of vessels, enabling collaboration in a cyclical

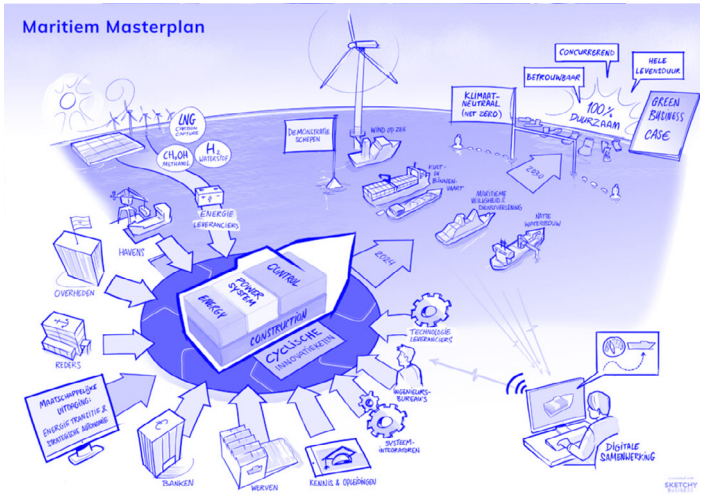


fig. 6.1 - The Maritime Masterplan. Source: NML

innovation. The reuse cycle has, as yet, not been included. With the exception of the Regional Maritime Agenda (RMA), circularity is not on any of the agendas. We also see no references to the raw materials agreement or Nationaal Programma Circulaire Economie (National Circular Economy Programme). There does, however, seem to be support for integrating circularity and a raw materials strategy into the plan, provided that it supports one of the above mentioned three pillars. This is evident from discussions with stakeholders such as NML, TKI Maritiem, KVNR, NMT and MARIN. All the umbrella organizations that we spoke to have also indicated a need for more clarification of circularity; what it means for the sector and the opportunities it offers for the parties they represent.

6. Sustainability & circular thinking

"If we really want to put the Netherlands on the map as a maritime nation, we need to collaborate much more (with a patchwork of associations and initiatives) and have significant ambition in terms of legislation and regulations that support long-term investments. Due to the accumulation of sustainability legislation and regulations, we are often busy solving a problem without having a clear long-term perspective."

Ben Vree - Ambassador Maritime & Offshore and explorer Regional Maritime Agenda

"If we want to be the best in 10 years, it is essential that we take that into account now."

Thecla Bodewes - CEO Thecla Bodewes Shipyards and figurehead Top Sector Water & Maritime

The attention on raw materials and environmental impacts surrounding scopes 2 and 3, including legislation and regulations, is therefore not explicitly present in the sector if we consider the political agenda or policy steering mechanisms. Shipping is of course included in the scope 3 of shippers and we also see this reflected in initiatives to make supply chains more sustainable, for example, in the case of Heineken and Ikea.

Attention for the maritime sector from circular agendas

At the same time, there also seems to be a lack of attention on the maritime sector from the circular agendas. Nationally, there is a Grondstoffenakkoord (Raw Materials Agreement) and now a Nationaal Programma Circulaire Economie (National Programme for Circular Economy). We observe, though, that the Ministry of Infrastructure and Water Management does not mention the maritime sector at all in its current raw materials agreement. Formally, the maritime sector could be included in the transition agenda for the manufacturing industry, which affects initiatives for making steel more sustainable, and the sector plays a role in consumer goods, given its share in Dutch freight traffic. But nowhere is this explicitly stated.

Nationally, however, with some exceptions, policymakers and market stakeholders alike do not seem to have realized that this sector relies heavily on steel and therefore has CO2-intensive production and a heavy embedded footprint. This is comparable with the lack of recognition that some of the metals required by the industry are becoming harder to acquire (due to physical scarcity or geopolitics). The latter is striking because the core business of this sector is the security of the supply of goods, materials and resources. The sector has become very familiar with increasing incidences of delays in delivery, particularly since the coronavirus pandemic and the Ukraine war. However, the principle of security of supply of raw materials and components still provides limited motivation to consider circular possibilities, such as material reduction, reuse and recycling. The same applies to ownership of ships at the end of their lifecycle. As soon as a ship has been written off, a ship owner will often want to get rid of it. Sometimes, this is also dictated by legislation and regulations. There is no strategic consideration yet for the preservation of materials and raw materials at the end of the lifecycle. It is striking that, in the Netherlands, consideration for the end of life is virtually non-existent or is not (yet) anticipated. Similarly, the urgency of a raw materials strategy remains insufficiently represented on the maritime agenda.

Considering the sheer number of issues to consider, this is understandable. It is, however, no longer acceptable given the current context. Apart from the anticipated shortage of raw materials, this is the moment to ensure the preservation of our industry and our position as a maritime leader.

7. Circular opportunities for maritime: building blocks for business, now and in the future!

"Our circularity initiatives originate from intrinsic motivation, but to be honest, they also present a better commercial story to the customer. However, the business case is often still challenging. It is difficult to find the right support from the government, targeted subsidization can be a huge acceleration factor."

Marco Hoogendoorn - Director Holland Shipyards

This study provides insight into the fact that, as well as the entrepreneurship and ingenuity required, various circular principles and many building blocks for circular thinking are already inherent to and present in the maritime sector. The discussions we had provide a picture of the themes that are at stake and offer many starting points for opportunities, but also challenges to overcome. It should be borne in mind that this is a reflection of just thirty discussions. It is anticipated that (much) more can be found. Moreover, all the opportunities mentioned represent just the tip of the iceberg (and therefore require further exploration).

With economic effects as a driving force since time immemorial and legislation and regulations that will extend beyond emission reduction (including the Corporate Sustainability Reporting Directive), we see interesting opportunities arising in combination with the sustainability ambitions of shippers and shipyards, suppliers and ship owners. Parties that go beyond the required steps, who are, therefore, leading the way confirm this; it offers a unique selling point, new revenue models and, thereby, strategic viability. The anticipated scarcity of raw materials is a final stimulus to take steps towards circularity.

With a sustainable maritime future in mind and the aim to help companies take further steps in this area, the most significant opportunities we see have been formulated according to four guidelines:

- There are market/chain parties with interest (support)
- It concerns a commercial opportunity in the (relatively) short term (business)
- It fits in/connects with the primary process (lifecycle)
- The effect is truly sustainable (future-proof)

These opportunities go beyond a single project and should therefore be viewed as overarching themes under which multiple projects can be realized. We distinguish three thematic starting points, with a number of promising projects and cases below.

1. Retrofitting and life extension of existing ships

The chance to significantly increase the operability of the existing fleet as a result of a sound business case between those shipping goods, vessels owners and investors, with financing and regulations aligned with a long-term perspective.

As a result of legislation and regulations, existing ships face considerable adjustment; they must gradually increase their energy efficiency, with a significant reduction in emissions. This is reinforced by a growing demand in the market for increasingly sustainable, or even fully sustainable, transportation. A good example of this is Heineken's zero-emission trade route, for which the diesel-powered inland container vessel 'Alphenaar' was converted to fully electric propulsion by installing a single battery container on board; a so-called ZES-pack (six pack) with a 'pay per use' model. The certainty offered by a 10-year contract for the transport of 'sixpacks' with ZES-packs made this investment possible. When considering the existing Dutch fleet of 2,375 seagoing[7],

7. Circular opportunities for maritime: building blocks for business, now and in the future!

** For the European market, IMO Tier III regulations have been in force since 1 January 2021, in the Emission Control Areas (ECAs) in the North and Baltic Seas. This means that all ships with an engine power over 130 kilowatts must comply with the IMO Tier III regulations. The regulations also apply if an engine larger than 130 kW is installed during a retrofit project.*

** For inland shipping, the Central Commission for Navigation on the Rhine introduced the CCR phase 1 (CCR1) emission standards in 2003. The CCR1 standard specifies limit values for the emission of nitrogen oxides, carbon monoxide, hydrocarbons and particulate matter. This standard was replaced in 2007 by the CCR phase 2 (CCR2) standard. In this standard, the limit values have been lowered compared to CCR1.*

** NOx = Nitrogen oxides, SOx = Sulphur oxides*

and 8,000 inland[8] vessels, you quickly reach the conclusion that this not only represents a huge challenge, but also an opportunity to make a significant step towards sustainability. This is particularly the case in the region where the entire chain is present, with companies such as Royal Roos, who think in innovative solutions and whose perspective extends beyond what is required, as well as (many) vessel owners with their interest in the matter. They want, not only to take steps towards increased sustainability, but also to realize economic benefits, provided their vessels can be deployed for a sufficiently long period of time.

This is where a significant challenge arises: it requires considerable investments that are difficult to repay in the present system, and for which not all ships qualify.
For example: To retrofit a coaster to methanol propulsion currently costs an estimated €8 million (following an initial investment of €12-14 million). This is an investment that a ship owner may not be able to bear alone. To compound the problem, they may also find it difficult to source financing. In conversation with Thecla Bodewes Shipyards, the company suggested that banks find it difficult to finance the additional costs of green innovations. “In addition, it is difficult for shipping companies to make these significant investments at a time when we do not yet know in which direction the development of sustainable fuels is going.”

In order to stimulate sustainable choices on board existing ships, certain systems and components are also excluded, which, in anticipation of a retrofit, can play an important role in keeping that investment manageable. You could think of Tier 2 engines* with which a significant reduction in emissions can be achieved and which are reportedly easy to convert to methanol propulsion.

Case: longer life at lower costs, win-win of engine overhaul (Koedood)

With an engine overhaul, all parts except for the engine block and crank shaft are replaced. However, we do not fully utilise the potential of this traditionally circular practice for inland shipping. New inland vessels are required to be equipped with a stage V engine to further reduce emissions. Owners of existing vessels are faced with the decision of whether to install a new stage V engine or overhaul the current CCR1 or CCR2 engine, following which it can last another 10 years. With a catalytic converter and particulate filter, emissions can be significantly reduced. In theory, even achieving the same reduction in particulates, NOx, SOx* and CO2 as a stage V engine, but with 25-30% lower costs. You might consider this a no-brainer, and a potential solution to the reluctance of financiers, and the wait-and-see attitude of ship owners (waiting for stage V subsidies), as well as an opportunity not to have to say goodbye to good equipment unnecessarily early. The issue? No class certificate for existing engines. This is an interesting case to delve into with discussion partner Koedood, RDW and other stakeholders. Is stage V certification possible for reconditioned engines?

7. Circular opportunities for maritime: building blocks for business, now and in the future!

"If we are involved earlier in the process, we can build a yacht hull in such a way that parts of the vessel are modular. This means, for example, that in the future, we can switch to a more sustainable propulsion configuration or a ship can be extended more easily. This literally and figuratively increases the potential of the vessel!"

Wouter Huig - Project Engineer Zwijnenburg

In brief, financing (with a long-term perspective on sustainability steps) is a focus point. Here we see an opportunity to bring together shippers, ship owners and investors to create the business case (and make the right choices). The initiative of Future Proof Shipping, Nike and, among others, Holland Shipyards, Koedood, Nedstack and Rabobank for the conversion of the inland vessel 'FPS Maas' to hydrogen is therefore a perfect example. In addition, regulations are a long-term theme that must also be addressed. Besides the condition of a ship, age plays an important role in extending its lifespan. The maximum age of a (sea) vessel to qualify for re(tro)fit is currently 18 years and, as discussed above, certain client companies and ports also apply a maximum lifetime. As long as the maximum age does not increase or the age of the ship is not considered reduced by proper maintenance or re(tro)fit, there remains the chance that the return on investment will be insufficient – a missed opportunity to significantly extend the operability of the existing fleet!

It would be an opportunity if, after maintenance or repair, an actual lifespan extension could take place by means of inspection and certification. Moreover, it would be financially attractive if the accounting value of a ship is not depreciated linearly, but if there were also 'credits' resulting from maintenance. As a result, a ship would retain its actual value for much longer periods during its lifetime. There is a good chance that the sector is already very well equipped for this, with the maintenance schedules, parts delivery, modular thinking and yards that are in place. In addition, this is important because the sector is heavily focused on finances. KVNR and NMT, among others, are already in discussions with various financiers on this theme.

2. Modular design, construction and maintenance for sustainable shipping

Developing and maintaining components, systems and ships based on sustainable deployment of (scarce) materials and closing the lifecycle.

Where modular design and construction are mainly applied for efficiency at present, we see an opportunity to use them to achieve more sustainable shipbuilding and operation, both in the relatively short and longer term.

Circular thinking results in design, construction and operation coming closer together. Maintenance becomes easier and therefore, if all goes to plan, more cost-effective, because components and systems are easier to reach and can be quickly disconnected. Imagine that this is applied with decommissioning and/or the future upgrade of a ship in mind. As a result, future retrofits would not only be more efficient but also more cost-effective and a ship can be (re)sold with potential.

In the short term, we also see opportunities for modular design that can be used to make conversions cost- and time-efficient. For example, Zwijnenburg is currently designing a standardized hydrogen stern for a series of existing inland vessels that all face the same sustainability challenge.

Modularity also makes it possible to view the lifespan from the perspective of the various components. If these can be reused, this can be an incentive for (better) maintenance of individual components, systems and installations.

7. Circular opportunities for maritime: building blocks for business, now and in the future!

"There is much to be achieved here if we design ships modularly. Hulls can last 60 years if properly maintained."
Annet Koster - Director KVNR

The better a hull is maintained, the longer it will last and the higher the quality for it to be used at the end of its lifetime. Extending the lifecycle through smart (preventative) maintenance of the main components such as engines and installations such as electrical cabinets, also emerged from the discussions as an opportunity for the short term.

A broader perspective: if responsibility for end of life lies in the Netherlands, then high-quality re-use becomes more interesting. This allows the lifecycle loop to be closed locally. Optimizing decommissioning and valorisation creates a positive incentive in the short term as the residual value is higher.

In the short term, a PaaS (Product as a Service) revenue model can also provide a solution. We see more and more parties experimenting with leasing structures; for both vessels and components. For example, Hendrik Veder markets its cables in this way; combining the combat of waste with a new revenue model. Beequip makes it possible to deal with existing equipment more intelligently, enabling smaller parties to make use of it. It will be interesting to see whether this can be rolled out more widely and, if so, how.

There must be quite a shift in power, from the ship owner to the shipyard or perhaps a third party, to actually get this off the ground on a large scale. This raises the question of whether this is the key to 'endless life'.

In any case, actually closing the lifecycle is a huge opportunity to keep high-quality materials, as well as those that are likely to be scarce in the near future, here in Europe.

Case: High-quality dismantling increases earnings (Circular Maritime Technologies)
CMT tackles one of the biggest challenges to actually get local decommissioning off the ground. This is, namely, maximizing what a cleanly decommissioned ship can deliver, aiming for a reuse percentage of 99%. CMT's technology not only enables a safe and clean process of circularity, but also provides a good price at the back end for the components and materials recovered. It is expected that 90% of this can be reused, and the remaining 9% will be converted into valuable gas or electricity at the shipyard. The technology will be further validated and scaled up in the coming two years, and that is also the challenge. The capital-intensive nature makes financing difficult, especially in this validation phase. The supply of ships is an important point of attention here. Collaboration with stakeholders in the market makes it a promising development in any case. From a strategic point of view and industrial interest, both the steel industry and shipbuilders see the importance of this for a future-proof sector.

'Circular by design' ships will contribute to this. On a smaller scale and therefore closer in time, there seems also to be an opportunity to develop components and systems from sustainable deployment of (scarce) materials. Think of material saving thanks to smart design. In addition to retaining critical materials in the future, scarcity can also be a trigger for (high-quality) reuse in the short term. This is, not coincidentally, the final thematic starting point that we see.

7. Circular opportunities for maritime: building blocks for business, now and in the future!

3. High-quality reuse and remanufacturing of components and ships

From exchange parts to revaluation, recertification and reuse of components with high-quality perception and benefits, possibly even for complete ships.

While exchange parts for engines are already a common phenomenon, presently high-quality reuse of components is only taking place on a very limited scale. The most important reasons to change this are the limited availability of new parts, as well as economic and ecological benefits.

The interest shown by both shipyards as well as suppliers/ service providers makes this an opportunity worth consideration. Perception and (re)certification, while points of attention, do not seem to outweigh the expected benefits and the solution for scarce raw materials.

Case: Reusing a 20-year-old component as new (AEGIR)

For equipment made up of multiple components, reuse is not self-evident. AEGIR-Marine wants to overcome this by decommissioning and rebuilding a 20-year old tunnel thruster in collaboration with the Bureau Veritas classification society and the Technical University of Delft. Their goal? To certify the remanufactured thruster as new and install it on a ship. The expected benefits are promising: 60-80% ecological, 40-60% economic and a solution for scarce raw materials. As with resistance: perception and the conflicting interests of OEMs are challenges that can be expected.

fig. 7.1 - Tunnel thruster. Photo courtesy of AEGIR-Marine / photographer Ferdinand Harts.

7. Circular opportunities for maritime: building blocks for business, now and in the future!

"We have already made significant steps ourselves, but often we are much more ambitious than we need to be. That makes it challenging as soon as we look beyond our borders. Without compensation, there is limited motivation among suppliers to trace the origin of materials. We need knowledge/ experience from other sectors, physical space, and hands and budget to find things out."
Dewi Wesselman – Sustainability Coordinator Damen Shipyards

For the reuse of components such as valves and heating, ventilation and air conditioning systems (HVAC), Oceanco and Heinen & Hopman, among others, are undertaking a study. Damen is also interested in circular components and intends to dismantle a 50-year-old tug to see what can be reused. The company does mention, however, valuation and certification as points of attention. During our conversation, Bureau Veritas appeared to be interested in looking at the project from a classification and certification perspective.

Return logistics is not yet, or at least only to a limited extent, available and therefore also requires attention. The same is true of the space to store these components and/or a 'marketplace' to find items and to match supply and demand. Anthony Veder also mentioned this with regard to Hendrik Veder's mooring lines, used to secure ships in ports. They sometimes have to be replaced abroad and are too expensive to take back on board the ship because there is no deck space available.

A more advanced example or ideal is to build a complete ship from reused components or even to 'remanufacture' a complete vessel and return it to a new condition. In principle, the year of construction remains the year of construction in the Netherlands, but what if it was possible to actually register as new a ship that has been completely restored to its original specifications? With the condition, of course, that these specifications are aligned with current standards. Remanufacturing in combination with certification could lead to actual rejuvenation.

This is a vision that both KVNR and NMT are discussing and/ or want to discuss with stakeholders and which they see as a distinct opportunity for the Dutch maritime sector.

In line with this is the so-called 'moonshot' with which we conclude this chapter.

Circular yard builds circular ship
Multiplying energy on circular materials and components by stimulating and facilitating (supply chain) cooperation.

A circular shipyard that builds a circular ship is, of course, the ultimate vision (from various discussions) in which both the above themes and numerous stakeholders come together. We also see opportunities to take steps in this direction in the short term.

At shipyards, we see various starting points for circularity that go hand in hand with the sustainability ambitions of the yards themselves. These are inspired by a combination of customer demand, distinctiveness and own ambitions. We see the (green) energy in all these parties to take further steps here. Many yards have already taken steps to reduce waste (including materials). The valorisation of the remaining waste, incidentally, seems to be low-hanging fruit (see other opportunities in the appendix). At the same time, there is still a lot to be done. To achieve this, stakeholders (often) have to look beyond their borders. This, however, is where the challenges begin.

7. Circular opportunities for maritime: building blocks for business, now and in the future!

"Responsible sourcing is becoming increasingly important. We want to make agreements with all yacht builders regarding use of materials and components. This is a clear request from owners and their teams, but still comes to a limited extent from suppliers. For main components there is a high 'power of suppliers', we are dependent on one or two suppliers."

Wim Verhoeff - Fleet support Oceanco

In shipbuilding (as well as in the operational phase and maintenance) we see more and more interest in the origin and reuse of materials. This is also a point of focus. TKF Twentse Kabel Fabriek is the first maritime supplier with a materials passport. They originally got this in order to serve the energy sector. As yet, the demand for such a passport is very limited in the maritime sector. This confirms, with a few exceptions, that the maritime sector is not yet working on a large scale with regard to embedded footprint and the potential to reuse materials. We do, however, see an interest in changing this with all the shipyards we have spoken to. Oceanco is committed to responsible yacht building and is working on mapping out its entire footprint and wants to ultimately move towards 'design for endless life'.

Case: Breaking down silos for circular components (Damen Shipyards)

It is necessary, in order to install circular components on board to break down silos – both with suppliers and with operators. Several parties are interested in becoming the launching customers for Damen Shipyard's circular 'crew cabin'. The cabin would be installed, for example, on a crew supply vessel, transporting mechanics to wind farms on a daily basis to undertake maintenance.

The cooperation of suppliers is crucial but they are often reluctant to spend time and energy on it as "they do not have the data readily available and often have to figure it out from the start". The challenge, therefore, lies in the traceability of the materials used.

When actually taking cradle-to-cradle responsibility, cooperation throughout the supply chain, i.e. with all suppliers, (maintenance) yards and the ship owner, is essential in order to realize, but also to enforce it. A promising initiative in this area is the so-called circular crew cabin that Damen Shipyards wants to develop in cooperation with launching customers and suppliers.

Case: Less resistance – in water and the environment (Anthony Veder)

Anti-fouling is of great importance in reducing the resistance of a vessel in the water. It consists of a layer on the hull to prevent growth of micro-organisms. It plays an essential role in the operation of a ship, contributing to both the realization of fuel savings and the protection of the hull from corrosion. The challenge? The best anti-fouling systems do prevent growth, and they last a long time, too (so the ship does not often have to drydock). However, they are far from environmentally friendly. Anthony Veder wants to experiment with environmentally friendly anti-fouling, but what does this mean ecologically and economically during the entire operation? The challenge: this type of anti-fouling is often much more expensive. This raises the question of what the business case looks like if we consider the entire lifecycle.

"We are now making the decision purely economically when purchasing. I would like to look at alternatives in the total business case. It would be a huge help if experts could help to bring these together and if we could make time for it."

7. Circular opportunities for maritime: building blocks for business, now and in the future!

For more sustainable choices on the front end there is not only interest among shipyards, but also among owners. Both Holland Shipyards and Anthony Veder mentioned ‘antifouling’ as an opportunity to significantly reduce the burden on the environment.

The right stimulation & silos to breakdown for circularity

The major challenge in circular design in the maritime sector is to align the financial drivers and consequences for a business case. For this, it is essential that there are incentives and that they lead to the right place. Parties such as Fastlines Belgium and TNO are discussing the possibility of a label to indicate how green a ship and/or transport actually is. This will allow consumers and those shipping goods to make a more sustainable choice and will become a competitive element for further greening. For this, it is essential that the entire footprint of a ship is mapped out. A note here is the importance of incentives stemming from ports, for example, ending up in the right hands. That is to say, with the vessel owners and operators, and not with freight forwarders.

So, on the one hand, there is interest in circular materials, and on the other for circular components, but the various stakeholders do not always find each other and often do not have all they need to explore the business case. We see here an opportunity to boost this energy by stimulating and facilitating cooperation in the supply chain.

8. Conclusion

"Knowledge and expertise are indispensable, but cash remains critical in order to pay for the knowledge and expertise, and to guarantee a country's prosperity. It is important that clients are willing and able to pay for knowledge and expertise."

Thecla Bodewes - CEO Thecla Bodewes Shipyards and figurehead Top Sector Water & Maritime

"The Maritime Masterplan is primarily about new technologies on board new ships. We still have much to achieve when we consider reuse, use of materials and circularity. That is where the opportunities lie!"

Annet Koster - Director KVNR and co-initiator Maritime Masterplan

"Creating added value for companies and the sector with a smart approach to materials and value retention." The result of this is a future-proof maritime sector, both nationally and internationally.

Why should the Netherlands, and specifically this region, actively work on circular opportunities for the maritime sector? In addition to the economic importance of the sector for the Dutch industry, and in particular the province of South Holland, all the stakeholders throughout the value chain are active in the region. However, in order to start thinking in a circular manner, as opposed to a linear one, we must increase collaboration.

As yet, circularity is not firmly fixed on the map for the maritime sector. At the same time, though, principles of circularity have been applied in the sector. Plus, there is now a new generation of entrepreneurs keen to start working towards circular principles. Every one of the people we spoke to mentioned the economic potential of circular initiatives, which are increasingly, though not exclusively, explored from a sustainability angle. These initiatives mainly take place within the company's own borders because existing silos are difficult to break through. Innovation is therefore often incremental. In short, much remains to be done. In order to scale up incremental innovation and make such practice business as usual, it is important to emphasize the circular opportunities present in the sector.

The building blocks are already in place;

- There is a high **appetite** for innovation and sustainability among entrepreneurs.
- There is focus on sustainability on political strategic agendas and a **willingness** to (further) explore and accelerate the role of circularity in this.
- There is **willingness (or courage)** within the national government to work on economic opportunities in order to increase the Netherlands' competitive position and accelerate the major social transitions.

In addition, there are both strategic and commercial reasons for the sector to focus on circularity, both in the short and long term. Consider, for example:

1. **Cost savings through smart use of materials is low-hanging fruit.** Think, for example, of waste that is becoming increasingly expensive to dispose of, and materials that are also becoming increasingly expensive, and which require longer delivery times. These factors make it economically interesting to reduce the volume of used materials.
2. **Availability, strategic autonomy and differentiation** make it 'strategically smart'; certain raw materials are becoming scarcer, plus a sustainable proposition attracts new business, according to many of the people we spoke to. Basically, it's a win-win situation.
3. **Employment and young people's passion for sustainability.** Circularity is a trigger, especially for younger people, who are very much in demand in the sector also to stimulate innovation.
4. **Retaining the value of raw materials and sustainable business practices** are essential for a **future-proof sector,** and thus for **maintaining our maritime industry and competitive position.**

8. Conclusion

With a sustainable maritime future as a starting point, and looking at existing initiatives and their focus on scope 1 emissions and fuels, the greatest opportunities lie in the hardware of the operation, and on the beginning and end of the chain (and therefore related to scopes 2 and 3). Read: increasing the lifespan and potential of existing vessels, incorporating circular principles into the design and construction of newbuilds, and maintaining and restoring value. Financing and incentivization are important points to address if we are to move from a linear lifecycle to a circular one.
We can draw inspiration from subsectors such as dredging and fishing, which have already taken important steps (and have, therefore, learned lessons) in programmes such as 'working and building with nature'. Additionally, offshore is leading the way in terms of circularity, both with its tendering procedures and its solutions, which are reinforcing one another.

An eye for circularity in offshore wind

An important subsector that we do not want to forget is offshore wind. This is a sector unto itself, with its own supply chain and unique challenges. It is an emerging market that has arisen with the need to create a sustainable future. Already, circularity is playing a bigger role in offshore wind than it is in the maritime sector (including the weighting process for contract tenders) and will probably develop much faster. This offers opportunities for the region, especially in collaboration with the Province of North Holland (building on the report 'Ruimte voor circulaire windturbines' (space for circular wind turbines) in both decommissioning and in creating new business for ports. There is, however, no physical space available. Working together, the provinces can help to ensure the creation of an industry for the circular processing and lifetime extension of wind turbines.

Naturally, the maritime sector must overcome a number of challenges:

- **Perception & requirements:** "highest quality at the best price" is frequently the starting point in a request/tender. Classification societies, accountants and insurers may play a role in the perception of reused components and ships.
- **Manpower and capacity:** the fact that there is often no business case for initiatives in this area makes it difficult to free up people for projects.
- **Knowledge:** both development and dissemination, from boardroom to operation.
- **Resources:** by definition a focus point as margins are generally small.
- **Cooperation of suppliers and supply chain partners:** This is crucial in order to get circular initiatives off the ground across silos, but also when challenges arise. Who will pay for the hours? Ship owners can expect to create a 'pull effect'.
- **Availability of alternatives:** there is no (large-scale) infrastructure for the reuse of materials and components, except for common exchange components. This applies to both the matching of supply and demand and space for storage and transhipment.
- **Traceability & valuation:** as yet, there is no 'common practice' to determine and record this. This applies, on one hand, to used materials and to components that come from a (dismantled) ship on the other.
- **Legislation and regulations:** requirements covering the maximum age of a ship are in place to ensure safety. However, at the same time, they hinder achievement of the optimal lifecycle and steps to sustainability.

8. Conclusion

- **Financing:** uncertainty about the fuel of the future and lifespan and component requirements make the (re) financing of ships a challenge. In addition, the payback period is a point that requires attention. Circularity is, in some cases, immediately interesting from a financial perspective (material savings). Sometimes, though, it is also a risk and requires a different business model and/or longer payback periods (environmental effects are not yet passed on, which means that new materials are sometimes cheaper and more easily available than reused ones).

A sustainable ship is still on average 30% more expensive[9] than a conventional one. What does that picture look like if you approach it in a circular manner and consider the entire lifecycle? The building blocks are there. In the recommendations we set a point on the horizon to bring together the necessary **knowledge, expertise and finance** to convert this into sustainable business.

9. Recommendations

Circularity – the opportunity to secure our leading position in the international maritime sector. Make circularity part of the maritime agendas on the one hand and make maritime part of the political circular and sustainable agendas on the other! At the same time, help pioneers get into the saddle in order to initiate a sustainable movement. Now is the time!

The conclusions above make clear there is an opportunity to (further) consolidate circularity in the maritime sector, to realize a sustainable, and therefore future-proof, sector. They also make it clear that stakeholders also see and recognize this. From the strategic perspective, it is about preservation of raw materials, industry and, in the longer term, our competitive position as a maritime nation.

Looking at the large concentration of maritime (manufacturing) industry, it is logical that the province of South Holland has included 'maritime' in its circular transition agenda and is considering setting up a specific programme. This also includes issues that are not yet being addressed at the national level. CO2 reduction and circularity are closely connected; with measures such as material efficiency, lifecycle extension, and the switch to, and reuse of, less environmentally harmful raw materials. The Netherlands Environmental Assessment Agency estimates that action on circularity can achieve 20% of the intended reduction in CO2. Efforts within the province can help ensure circularity is included in the objectives of the sector and those of the companies within it, in addition to energy targets. An area requiring attention is the CO2 reduction of interventions during and at the end of the lifetime. By definition, retrofitting is not necessarily sustainable, while recycling, especially of steel is extremely energy intensive.

There is energy and, therefore, momentum amongst maritime service providers, suppliers, ship owners and shipbuilders, who together form the supply chain. Market-wise things are progressing well, and thus there is room for innovation. Circular business cases and cross-company collaborations, though, remain limited. Knowledge, expertise and finance must come together. And it is precisely here that the province can play an important role, acting as a facilitator and driver, especially given the energy and movement to help SME (manufacturing) companies advance with circular transitions.

In short, **pioneers must act**, and **political support** is required. Therefore it is very positive that the Maritime Masterplan was approved last year by the National Growth Fund and that Kees van der Staaij, as envoy, along with the Rijksregiebureau, plays an important role in the execution of the Sector Agenda for the maritime manufacturing industry. This is, therefore, the time to fix circularity permanently on the agenda. As Thecla Bodewes, shipbuilder and figurehead of the top sector Water & Maritime said: "**If we want to be the best in 10 years, it is essential we take this into account now!"** NML is open to an **"ambitious circular view"** of the Maritime Masterplan and TKI Maritime has noted circularity as a theme they want to further elaborate on together following our conversation. The Regional Maritime Agenda is also looking to accelerate the theme. In short, the time is now!

9. Recommendations

From “in the Netherlands we are shipbuilders and not ship breakers” to “in the Netherlands we build the best recyclable ships”. By applying circular principles, we optimize not only the lifecycle, but also the business case and the lifespan of individual components. Also, essential raw materials are retained. In this way, we guarantee a future-proof maritime sector, nationally and internationally.

Following our discussions, this is the goal that we set on the horizon, which we continue to work towards together with the national government, the province of South Holland, Maritime Delta, NML, TKI Maritiem, NMT and KVNR and the pioneers (companies). By perpetuating circularity on both the maritime Sector Agenda and the Maritime Master Plan, as well as the annual agendas of cluster organizations and keeping the subject on companies’ radars, we create opportunities. Now and in the future.

Important starting points for the recommendations are:

- Focus on the needs of companies. This must be the starting point and therefore also leading in any support that is established (counters/consultations/resources etc.).
- Meet the companies on their ground, literally and figuratively. In concrete terms, this means where they are in their process, what capacity they have and where we can find them (connecting to existing and active network agendas).
- Joint approach where possible, individual approach where necessary. Always focused on the supply chain.
- Connecting to overarching (maritime) agendas and, in line with the energy transition already underway, matching the province’s transition path for the circular manufacturing industry.
- Intelligent use of the support resources already available from governments and companies to start where the energy is. The government can also play an important role as a launching customer, which includes circularity as one of the starting points and/or weighting factors for contracts awarded for newbuilds and maintenance for the existing fleet.
- The maritime sector is both capital and material intensive, and therefore requires serious money in order to advance with projects. This means that resources must be made available for the long term and discussions must be held about the explicit requirements of the maritime sector with regards to the circular agenda. The benefit of the large volumes involved is the sector has the potential to make a very large impact on circularity.

9. Recommendations

Our explicit advice is not to make circularity or a circular programme a goal in itself. But to start with companies where there is energy, to meet them on their terms and to support them with knowledge and capacity, thereby taking smart, collective steps by building on an existing foundation. Within the maritime sector, deployment works best from the place where companies (already) come together. And in collaboration with and for companies. A joint approach/ action plan is necessary in order to reach, meet and support companies. Circularity is a means to ensure this, a way to start working on value retention, compliance with European and international regulations, supply guarantees, sustainability steps etc.

The approach we propose: together with companies within the cluster further develop the themes and help pioneers take steps that are complementary to the overarching agendas of the Maritime Master Plan, the Regional Maritime Agenda and the Sector Agenda. To learn together and create appealing examples and, thereby, inspire the masses to also begin to work on circularity.

The proposal for a deepening step (phase 2) towards this, with both the forerunners (companies) and the political-strategic organizations, has been accepted by the province of South Holland and the municipality of Rotterdam. This is, so to speak, a coalition-forming phase in which the foundation for circularity in the maritime sector is further laid with, among other things, a number of concrete actions, and in which an annual programme for 2024/2025 was set up; in which we cleverly use moments when relevant networks come together!

Smart collaboration is not only the secret behind the most talked-about innovations in our sector. In our opinion, it is also the key to converting ‘circular opportunities for maritime’ into sustainable business. In short: step forward if you are involved in circularity, need help or want to start with it. Joining forces is important and we must tackle this together, as a sector and in the various supply chains, if we are really going to make a difference and an impact.

We are ready. Are you?

With thanks to

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Translation: Ben Littler of Buoy Communications

Appendix: knowledge, expertise and commercial opportunity

We see the following requirements (the list is not exhaustive) for the necessary knowledge, expertise and commercialization for converting circular opportunities into sustainable business.
Knowledge: in this assessment we have discovered starting points for further exploration of the following topics:

- (Interpretation) forthcoming scarcity of essential raw materials and components.
- (Interpretation) impact figures of residual flows/components for refit (including current processing, volumes and opportunities to undertake projects at a higher quality, see CMT case study).
- Origin/traceability and (possible) role of a materials passport.
- Re(tro)fits with (most) potential in the context of existing fleet.
  Following close cooperation with relevant sector organizations such as KVNR and NPRC, we conclude the watchwords for retrofits are increased efficiency with optimal added value.

Expertise: the maritime and circular worlds must come together to identify opportunities and create the frameworks within which maritime circular projects and business cases can get off the ground, with the help of agenda setting/ network formation/lobbying for vision & commitment:

- Integrating and putting circularity on the agenda within maritime networks and overarching agendas.
- Jointly formulating a circular ambition for a sustainable sector and identifying opportunities, for example how to support smaller ship owners in taking steps in this direction (in collaboration with KVNR).
- Joint lobbying of, and involving the right parties to address challenges (for example, financiers and employer's organizations) and to use/develop resources to (be able to) seize circular opportunities, in collaboration with the province of South Holland and the municipalities.
- By perpetuating the presence of the maritime sector on the national and provincial circular agenda, commitment and (lacking) resources will be realized.

Commercial opportunities: circularity must offer commercial opportunities in order to be viable for companies. In the short term, this can be achieved through incremental interventions and smart materials use (and savings). If circularity is to truly become a commercial opportunity in the long term, far-reaching supply chain collaboration will be required, together with innovations in the areas of:

- Valuation & (necessity for) recertification.
- Lifespan extension, rejuvenation & financing
- New business models such as PaaS.

And finally, the (right) incentives, in the right place, for sustainable (in this case circular) choices. The role of governments (national and regional) is, therefore, to ensure that there is a level playing field for companies that stick their necks out and make increasingly sustainable choices. In order to make this scalable, there must be a financial reward.

The commitment of companies is an essential factor in creating movement (that is sustainable over time). If there is a business case, a pull effect will (automatically) arise. To determine the right deployment:

- Further inventory of case studies, concrete examples and projects that parties want to start (and which therefore already have energy).
- Facilitate commercial collaboration outside the company boundaries between supply chain partners by 1-2 (chain) projects to create this pull effect. Project examples: circular components (Damen circular 'crew cabin', etc.) and remanufacturing and certification of component (AEGIR-Marine, etc.)
- Set up initiatives from the province of South Holland and governments, focused on challenges and opportunities. Looking at the inventoried cases/opportunities, there seems to be a particular need for financial support at start-up, bringing together chain partners, connection/facilitation across company boundaries, circular expertise to further develop initiatives, business case support (on lifecycle and supply chain), consortium formation, access to financial support and personnel to figure things out.

Appendix: terminology and abbreviations

Terminology explained:

Refit: replacement of parts/components

Retrofit: addition or replacement of parts/components with the aim of modernization

Conversion: repurposing of vessel

Abbreviations:

EEDI = Energy Efficiency Design Index

EEXI = Energy Efficiency Existing Ship Index

CII = Carbon Intensity Indicator

SEEMP = Ship Energy Efficiency Management Plan

IMO = International Maritime Organization

AFIR = Alternative Fuels Infrastructure Regulation

CCR = Centrale Commissie voor de Rijnvaart (Central Commission for Navigation on the Rhine)

NOx = Nitrogen oxides

SOx = Sulphur oxides

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Would you like to read more about steps being taken in other sectors towards circularity (in Dutch)? Visit circulairemaakindustrie.nl.

Appendix: other cases we have noted (opportunities for deployment with and for companies)

Here we provides details of additional opportunities for maritime circularity, whereby we distinguish between interesting initiatives to pursue and/or accelerate, and low-hanging fruit.

Relevant projects that are underway or in the planning:

- Oceanco intends to map its total footprint using a list of materials and the impact associated with them. The aim is to cover both raw materials and the production process, where they want to start by measuring steel, aluminium and plastic.
- Damen intends to dismantle a 50-year-old boat previously operated in the Port of Dunkirk. The aim is to ascertain the residual value of various components and see what can be reused. The lessons learned during this undertaking will then be used to maintain, as high as possible, the value of materials used. Bureau Veritas is interested in the outcomes of this analysis.
- What is the most high-quality application of the steel at the end of the vessel's life? Do you have the right grade? Maybe the quality used in ships/ship in 20 years is too high? (Damen)

Low-hanging fruit:

- High-quality reuse of materials: "There are already ten shipyards on the river that all have waste flows that we can do something with. Could the province provided finance to someone who will consider this?" (Oceanco).
- Better destination for waste? Reuse seals (between wet and dry parts of the vessel) instead of incineration and CO2 capture as current option (AEGIR).

Initiatives to track and/or accelerate:

- Well-to-wake development of the fuels of the future in working groups around methanol (Green Maritime Methanol) and hydrogen (SH2PDRIVE) where knowledge institutions and sector stakeholders come together.
- Maritime Hydrogen wants to pave the way to emission-free sailing and is investing in the development of packing and unpacking technology for hydrogen as a solid. Their dream: to have ships sail on hydrogen in a closed system in the future.
- Decom Cockpit (follow-up offshore wind exploration/ SmartPort study) for the valorisation of wind turbine blades. The challenge: how to create a new supply chain and share the pain and gain?
- Hendrik Veder now has a PaaS business model for cables. This means that the product remains the property of Veder up to and including the end of life. They have the responsibility for reuse, which impacts how they market and design the product. The challenge: return logistics and value determination?
- Circular shipyard of CMT, Enviu & Huisman, among others.
- BiVa Refit Alliance Drechtsteden.
- Last but not least, at the time this study was conducted, Future Proof Shipping was working in collaboration with Holland Shipyards, Koedood and Nedstzack on the conversion of the FPS Maas from a conventional inland vessel to emission-free transport on hydrogen, to operate for Nike. The ship 'H2 Barge 1' was launched May 25th 2023. This was followed, more recently, by the conversion of a second vessel, FPS Waal, to operate between Rotterdam and Duisburg, 'H2 Barge 2'.

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