Ministry of Infrastructure and Water Management

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CENTRAL COMMISSION FOR THE NAVIGATION OF THE RHINE

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STUDY ON FINANCING THE ENERGY TRANSITION TOWARDS A ZERO-EMISSION EUROPEAN IWT SECTOR

CCNR Member States:

Study consortium:

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Study on Financing the energy transition towards a zero-emission European IWT sector

Deliverable – Research Question D

Final report

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Definition list

Asset company: In the context of this study, these are companies owning the assets such as containerised energy systems and provide these to vessel owners as a service.

CAPEX (CAPital Expenditure): Capital expenditures are for major purchases that will be used in the future. The life of these purchases extends beyond the current accounting period in which they were purchased. Because these costs can only be recovered over time through depreciation, companies ordinarily budget for CAPEX purchases separately from preparing an operational budget.

Collateral: Collateral is an asset that a lender accepts as security for extending a loan. If the borrower defaults on her loan payments, the lender may seize the collateral and sell it to recoup some or all of his losses. Collateral can take the form of real estate or other kinds of assets, depending on what the loan is used for.

Component: leasing or pay-per-use can apply to an asset (e.g. a car or truck to be leased). In this study the focus as regards leasing and pay-per-use is mainly on the powertrain of a vessel and to a lesser extent on the entire vessel. Therefore the word ‘component’ is more appropriate in this report. An example is a containerised power pack (e.g. Lithium-ion battery container) which can be put on board for providing energy.

DPF (Diesel Particulate Filter): This is a component in the exhaust system of an internal combustion engine for filtering of soot and particulate matter from the exhaust gases. A DPF component is usually applied for reaching Stage V emission levels of internal combustion engines using diesel with power over 300 kW.

LCOE (Levelized Costs Of Energy): also called levelized cost of electricity (LCOE), can be defined as the average net present value of the cost of produced energy by, for example, the powertrain of a vessel. It is usually expressed in units of eurocents per kilowatt hour (kWh), considering the economic life of the powertrain and the costs incurred in the purchase, service, repair, maintenance and the energy costs. It is basically the same principle as the TCO, however, in addition, the LCOE divides the TCO figure by the amount of energy.

Leasing: Leasing is in principle a form of renting. However, contrary to rental agreements, a leasing agreement covers in general a longer time span, usually for periods longer than one year, and with specific provisions regarding the responsibilities of both the lessee and lessor during the lease period, in order to ensure that both parties are protected.
An *operational lease* provides a contractual arrangement calling for the lessee (user) to pay the lessor (owner) for using an asset. Property, buildings and vehicles are common assets that are leased. Industrial or business equipment is also leased. The lessor is the legal owner of the asset; the lessee obtains the right to use the asset in return for regular rental payments. The lessee also agrees to abide by various conditions regarding their use of the property or equipment.
In comparison to operational leases, there are also *financial leases*, which means that the ownership belongs to the user. The user has a loan for purchasing an asset in which the asset itself is the collateral for the loan. The consequence is that the equipment is in the financial books of the user, which affects the financial ratios of the company.
Another scheme is *vendor leasing*. In this scheme the supplier/seller of the equipment plays a role in establishing a leasing agreement or loan (financial lease) to sell the equipment. Vendors may

have framework contracts with financial institutes providing the leasing schemes or have their own leasing companies. Therefore, it is basically a financial lease or operational lease, in which the marketing/sales of the leasing scheme is done by the vendor.

Mortgage: A mortgage is a debt instrument, secured by the collateral of specified property, that the borrower is obliged to pay back with a predetermined set of payments. Mortgages are also known as "liens against property" or "claims on property." If the borrower stops paying the mortgage, the lender can foreclose to recover the loan.

OEM (Original Equipment Manufacturer): An original equipment manufacturer (OEM) is a company that produces parts and equipment, for example engines for inland vessels.

OPEX (OPerational EXpenditures): Operating expenses are the costs a company incurs for running their day-to-day operations. Companies report OPEX on their income statements and can deduct OPEX from their taxes for the year in which the expenses were incurred. OPEX are therefore short-term expenses and are typically used up in the accounting period in which they were purchased.

Pay-per-use: Metered services, also called “pay-per-use”, are any types of payment structure in which a customer has access to resources but only pays for what the customer actually uses. The pay-per-use business model is often combined with a subscription model. In the energy sector it is also known as “Energy as a Service” or “EaaS”. EaaS addresses the support to clients to choose between the variety of energy-related options. Eaas is intended to provide guaranteed (lower) energy costs, higher reliability and resiliency, sustainability solutions and optimised operations without the need for the client to have capital expenditures or additional staff.

Residual value: The residual value is the estimated value of a fixed asset at the end of its lease term or useful life. In lease situations, the lessor uses the residual value as one of its primary methods for determining how much the lessee pays in periodic lease payments. As a general rule, the longer the useful life or lease period of an asset, the lower its residual value.

SCR (Selective Catalytic Reduction): This is a component in the exhaust system of an internal combustion engine for the conversion of nitrogen oxides, also referred to as NOx, with the aid of a catalyst into diatomic nitrogen (N2) and water (H2O). A gaseous reductant, typically anhydrous ammonia, aqueous ammonia or urea, is added to a stream of flue or exhaust gas and is adsorbed onto a catalyst. SCR components are usually applied to internal combustion engines using diesel in order to reach Stage V emission levels.

Ship operator: The operator is the person who operates the vessel on his behalf and at his risk, holding the operator’s certificate. If the vessel is operated for more than one entity, the operator shall be the person who actually operates the vessel and is authorised to take decisions concerning the vessel's economic and commercial management.[1]

Ship owner: owner of the ship, holding the certificate of belonging, who may or may not be also the operator of the ship.[2]

TCO (Total Cost of Ownership): It is a calculation that reveals the cost of owning and using products or services for a given period. The calculation therefore covers the total cost of

[1] https://www.ccr-zkr.org/files/documents/modelesCertiAttest/Recommandation_autorites_en.pdf
[2] https://www.ccr-zkr.org/files/documents/modelesCertiAttest/Recommandation_autorites_en.pdf

acquisition and operation rather than just acquisition. Total cost of ownership helps to judge the viability of making an investment. For example, instead of buying a powertrain solely on its sale price, a TCO assessment would include the cost of interests, depreciation, repairs and energy over the lifetime of the powertrain. The analysis might conclude that a powertrain with a higher price tag might have a lower total cost of ownership throughout the lifetime of the powertrain (e.g. due to lower energy costs).

Uptime: a period of time when something (as a machine or factory) is functioning and available for use.

Executive summary

This document answers research question D of the main-study on the potential of pay-per-use and leasing schemes for the IWT market, in view of the transition towards a zero-emission IWT sector. The main question of research question D is:

What is the potential of pay-per-use and leasing schemes for the IWT market?

The main focus for these schemes will be the powertrain of the vessel and to a far lesser extent the entire vessel itself. The potential of pay-per-use and leasing schemes is being analysed through research work for the following three sub-questions:

- D1: What are the characteristics of such schemes and how do they fit with current financing mechanisms in the IWT sector?
- D2: What are the drivers and barriers for the widespread implementation of such schemes?
- D3: What is the potential market for ‘pay-per-use’ and leasing schemes?

Summarising, the following answers are concluded based on desk research and interviews.

D1: What are characteristics of such schemes and how do they fit with current financing mechanisms in the IWT sector?
Leasing and pay-per-use schemes are really different as compared to the current traditional way of financing in the IWT sector. The traditional way consists of the vessel owner obtaining mortgage financing from a commercial bank. In case of need for a new (clean) engine or other retrofit works for the powertrain, the vessel owner usually requests an additional loan from the commercial bank, which is then added to the existing mortgage. It is estimated that around 70%-80% of the fleet is still covered by mortgage financing.

With leasing and pay-per-use, the user of the asset has to pay fees for the time or usage of the asset to the owner. The user of the asset therefore avoids the capital expenditure and the uncertainty of a low residual value. An additional characteristic of pay-per-use and leasing schemes is that the asset is generally taken back by the owner after the expiration of the lease term or after the asset is being fully utilised.

The current traditional way of financing (mortgage financing) poses a bottleneck for applying leasing and pay-per-use, specifically as regards leasing powertrain components. The bottleneck concerns the risk for the owner of the components from a legal point of view as regards the property right. More specifically, the owner of the component can lose his property right in case the vessel owner goes bankrupt. In case of bankruptcy, the holder of the mortgage (usually a commercial bank) has the first right to claim the property value of the vessel, including all fixed components attached on the vessel. The fact that the majority of vessels is covered by mortgage financing (conventional way of financing) has an impact on the opportunities for leasing and pay-per-use financing.

D2: What are the drivers and barriers for the widespread implementation of such schemes?
There are a number of interrelated factors at play, which can act as a driver or barrier in the implementation of pay-per-use and leasing schemes for the greening of the fleet. Most importantly, there should be a real economic and/or financial benefit for the vessel owner and lender to conduct a leasing or a pay-per-use agreement. This could be a significant CAPEX (CAPital EXpenditures) reduction and risk reduction for a vessel owner who wants to invest in a clean powertrain, since leasing and pay-per-use schemes remove the upfront investment barrier. Access to capital is expected to be easier for large companies who take the role as lessees or asset companies. In addition, economies of scale could be expected for them from joint procurement (see research question E deliverable). However, such schemes can only make business sense if the advantage they generate is not cancelled out by the significantly higher OPEX for the vessel owner resulting from the new propulsion system.

In addition to the bottleneck as regards property right, there is also a lack of standardisation in the IWT sector. Vessels are mostly customised, which also applies to the equipment on board of the vessel. Providers of leasing or pay-per-use schemes prefer to provide a standardised asset with a properly estimated residual value, an asset that can be traded relatively easily as a second-hand object. And it should be possible to remove standardised assets in a relatively practical way from a vessel for use in other vessels or other applications. The current nature of the existing fleet however, allows this only to a very limited extent. Hence, the high share of traditional mortgage financing and the lack of standardisation therefore are big constraints to the application of leasing and pay-per-use financing models.

Concluding, in order to enable economies of scale and mitigate the risk of losing ownership for the owner of the component, the component to be put on board through a leasing or pay-per-use scheme needs be a standardised product with a standardised interface enabling a relatively practical exchange with other vessels or use in other applications. In addition, the component should have a high uptime, work in an appropriate manner and be reliable. Preferably, this would be a transferable containerised energy providing system with the required shore infrastructure in place. Components which are being permanently attached to the vessel (e.g. clean engine or fixed hydrogen-electric or battery-electric installations) and become part of the vessel from a legal point of view are therefore considered not appropriate for leasing and pay-per-use for the existing fleet.

D3: What is the potential market for 'pay-per-use' and leasing schemes?
In general, it can be concluded that the market potential of leasing in the context of the transition to zero-emission is very marginal. This form of financing is just marginally being applied in IWT, there are significant barriers for leasing especially as regards leasing powertrains or related equipment such as engines. Neither are there any ongoing or foreseen initiatives aiming to overcome these barriers and apply leasing as a financing instrument for investments in greening.

It is therefore expected that lease constructions will not play a noteworthy role in the transition towards a zero-emission fleet in 2050.

The situation however may change if in the future new and large players would enter the market, for example planning to build a larger number of standardised identical new vessels, using a high level of autonomous navigation to make a business case compared to conventional ships. In case of such a breakthrough, there may be options for renting or leasing such standardised/autonomous equipment to other parties.

The expectations are different for pay-per-use schemes. There are some slight differences between leasing and pay-per-use schemes. From a very basic point of view, with leasing the user pays for the time the asset is rented whereas with pay-per-use one merely pays for the specific use of the asset. The pay-per-use concept fits relatively better in the current day's 'servitization' trend. There is also a widely known initiative in the IWT sector aiming to utilise the pay-per-use concept on a large scale and foster the deployment of zero-emission techniques in IWT. In June 2020 the company Zero Emission Services[3] BV (ZES) was launched, with large industrial parties behind it (Wartsila, Engie, ING Bank, Heineken, Port of Rotterdam) which targets the first commercial applications of pay-per-use schemes in IWT for zero-emission powertrains.

The market potential relates to a specific category of vessels and operational profiles. Pay-per-use concepts can best be combined with standardised containerised energy systems. The ideal target group for such containerised energy systems, both from a technical and operational point of view, are dry cargo vessels carrying containers in a rather structural way. Based on expert opinion, this category consist in total of just a few hundred vessels almost exclusively concentrated on the Rhine countries and mostly in The Netherlands, Germany and Belgium.

There are a number of factors which could influence the market potential in the coming years though, such as the deployment of new vessels designed according to the containerised energy system concept making it more suited for the concept as compared to existing vessels from a technical point of perspective. Another factor could be technological advancements in the battery industry, enabling relatively lighter and compact batteries, which in turn broadens the scope of possible applications with, for example, vessels carrying dry bulk or push boats. Furthermore, also the development of green hydrogen and fuel cell technology and the related costs is highly relevant as this may also fit in a containerised powerpack to provide energy for electric vessels.

Seen the first results for parts of research question C (technologies and their economic assessment), it can be concluded that in particular battery and fuel cell technologies to be applied on new vessels are promising for a pay-per-use concept. However, at the current framework conditions, these technologies are expected to be much more expensive compared to application of internal combustion engines with renewable fuels (for example Stage V with HVO). The total costs of ownership for the vessel owner/operator is expected to remain decisive for the larger scale uptake. Therefore, it will also depend on the ambition level of governments and the level of

[3] https://zeroemissionservices.nl/en/home-english/

public support (grants) for further promotion of full zero-emission technologies promoting full electrification of vessels (e.g. fuel cell/ battery technologies) and how this is reflected in the financial scheme for IWT in the future. Possible with new financial schemes the business case can be improved by means of funding for the investment costs and incentives on the operational side.

1. Introduction

The main question of research question D is:

What is the potential of pay-per-use and leasing schemes for the IWT market?

The transition towards a zero-emission IWT sector in 2050 will require high capital investments, especially for the zero-emission technologies which involve fuel cells and/or high battery capacity. This creates a barrier for ship-owners. The implementation of leasing and/or pay-per-use schemes could provide an opportunity in overcoming the financing barrier. Although, it will appear that some technologies are more suitable for the application of pay-per-use and leasing schemes as compared to others, a technology neutral approach is the starting point as regards the analysis of such schemes.

In the context of such schemes, large third companies will own the component instead of the owner of the vessel. This may help to create economies of scale and to get a better access to financing. The type of applicable financing instruments for such larger companies may also be rather different compared to the opportunities for relatively small individual ship-owners.

A relatively new concept is the modular (battery electric) powertrain application for short distance container shuttles by barge. Market parties are developing a pay-per-use scheme for electric powertrains with 'energy as a service' contracts for modular and exchangeable containerised energy systems. Energy as a service means that the investment in the powerpack[4], maintenance, charging/refuelling and logistics is taken care of by service providers.

The main question will be answered by three sub questions. The specific research questions are:

- D1: What are characteristics of such schemes and how do they fit with current financing mechanisms in the IWT sector?
- D2: What are the drivers and barriers for the widespread implementation of such schemes?
- D3: What is the potential market for 'pay-per-use' and leasing schemes?

The answers on question D1 can be found in chapters 3 and 4. The answers on question D2 can be found in chapter 5 and the answers on question D3 in chapter 6.

In order to get an overview on the potential of pay-per-use and leasing schemes, it is needed to understand how they could work and how they relate to traditional loans/mortgages, which apply to the vessel as a whole (not just a component). A question is, if and to what extent such schemes can be applied for the whole powertrain, or components of the powertrain system of an inland vessel. For banks, the (residual) value of the vessel is an important element and the collateral to cover the risks on the loans. Moreover, there are expected differences between retrofit solutions and newbuild vessels. For newbuild projects there is much more flexibility, both in terms of the

[4] Such a modular and containerised powerpack can be a lithium battery but may also be an ICE generator-set or fuel cell power unit, it can anticipate to technologies and fuels becoming available and affordable

technical configurations as well as the financing of the vessel as a whole and the financing of the powertrain and individual components (e.g. exchangeable battery packs). All these differences and criteria need to be addressed in order to be able to make conclusions on the application of pay-per-use and leasing schemes.

One of the key drivers, relates to a possible reduction on the total costs of ownership (TCO) of technologies suitable for leasing/pay-per-use, which would derive from the application of such schemes. It is clear from the work done by DST for parts of research question C that the battery and fuel technologies are yet much more expensive and are not expected to become competitive in the near future compared with combustion engines. Furthermore, the investments are exploding compared to investments needed for combustion engines powertrains (either retrofit or a new Stage V engine). As regards OPEX there may be an advantage for electricity, however, also effects such as loss of payload and loss of time for swapping battery containers needs to be taken into account for the operation of the vessel. As regards fuel cell applications, it is expected that full sustainable fuels for fuel cells will remain more costly compared to renewable drop-in fuels for combustion engines. Moreover, other elements are also important such as the real availability of such green fuels (made from wind/water/solar power, e.g. by means of electrolyses) and also the servicing/recharging and bunkering/transhipment facilities along routes in Europe which are used by inland vessels. In this respect, an issue is the dependency on the shore infrastructure, which may cause a classic ‘chicken and egg’ dilemma.

2. Methodology

The analysis on the potential of pay-per-use and leasing schemes for the IWT market is based on both desk research and interviews with experts in the field. Chapter 3 is fully based on desk research, whereas the subsequent chapters are based on both desk research and interviews.

Desk research includes literature on the principles of leasing and pay-per-use as well as literature on innovative financing in IWT[5]. In order to get an understanding of the characteristics and the applicability of such schemes to the IWT sector, interviews were done with organisations involved in financing (providing loans) and organisations which are working on leasing schemes and providing pay-per-use/energy-as-a-service solutions. A number of interviews and consultations were carried out for this question with experts from the following organisations:

- Bank für Schiffahrt
- Credit Maritime
- Caisse des Dépôts
- ING Bank
- Rabobank
- Koedood
- ENGIE
- Port of Rotterdam
- Beequip
- Marine Finance House
- EIAH/EIB
- Wärtsilä
- Koolen Industries
- Clean Energy Hubs / Provincie Gelderland
- Skoon

A questionnaire was developed which was used as a guidance for the interviews. Furthermore, draft report versions were shared with experts with the request to validate and add information.

It was investigated for which type of equipment and energy supply leasing or pay-per-use schemes can be applied to renew the powertrain of the vessel. One of the key questions was into what extent current engines (owned by ship-owners) can be replaced by new engines/powertrains owned by third parties. Which type of technological solutions could be suitable for such leasing/pay-per-use schemes was also reviewed.

Organisations which provide mortgages for vessels (including engines) were asked about issues relating to the value of the collateral and ownership in case of bankruptcies in relation to leasing and pay-per-use for powertrain components. Discussions with banks took place to check into

[5] https://lngbinnenvaart.eu/wp-content/uploads/2019/08/Act-3.2-4.2-pilot-study-on-innovative-financing.pdf & https://www.eicb.nl/wp-content/uploads/2016/08/EICB001-18_rapporten-LNG_02_dynamisch.pdf

what extent (new) Stage V diesel engines can be leased and into what extent electric and other relatively clean powertrains can be applied with pay-per-use schemes.

Moreover, interviews helped to formulate an opinion on the reduction of costs for the ship-owner deriving from the application of such schemes.

To conclude on research question D, information from research question C was reviewed and taken into account (draft study performed by DST). It must be noted that at this moment in time (mid July 2020) the research question C is not fully answered. Information on the TCO on fleet family and fleet level is not yet available. In particular, the TCO of advanced biofuels or sustainable synthetic fuels (PtL) combined with after treatment (SCR, DPF) for internal combustion engines, is very relevant to make conclusions on the business potential for full-electric drivetrains using containerised powerpacks (e.g. hydrogen FC and batteries). However, based on the results provided so far for research question C on energy costs and investment costs, it already becomes clear that TCO for fuel cell and battery powered drivetrains for vessels will be characterised by higher TCOs compared to using internal combustion engines.
As a result conclusions can be made related to the expected market take-up under current framework conditions and as result changes needed in the current framework conditions to make a business case for zero-emission technologies compared to ‘business as usual’.

Furthermore, other elements were investigated and reviewed such as the availability of the servicing/recharging and bunkering/transhipment facilities along routes in Europe which are used by inland vessels.

The results of D2 fed into D3 to assess the potential of leasing and pay-per use schemes based on the drivers and bottlenecks. The market potential of such schemes is mainly based on the technical/economic assessments coming from research question C combined with information on the applicability of such schemes to existing vessels, seen from the financing point of view (D1) and the barriers and drivers (D2).

3. Characteristics of pay-per-use and leasing schemes

3.1 Definition of leasing schemes

Leasing is in principle a form of renting, although there are differences between a general lease agreement and rental agreement. Contrary to rental agreements, a leasing agreement covers in general a longer time span, usually for periods longer than one year, and with specific provisions regarding the responsibilities of both the lessee and lessor during the lease period, in order to ensure that both parties are protected.[6]

Hence, leasing differs from the conventional way of financing in the IWT sector, which is mortgage financing through a commercial bank. According to this traditional approach, the vessel owner obtains a mortgage financing to eventually become the owner of the vessel. Whereas with leasing, one has to pay leasing fees for using the asset to the owner for a certain period of time and the asset is generally taken back by the owner after the expiration of the lease term.[7]

As regards leasing, there are a number of different types of leasing agreements. Popular examples are ‘operational lease’, ‘financial lease’ and ‘vendor lease’.

An operational lease provides a contractual arrangement calling for the lessee (user) to pay the lessor (owner) for using an asset. Property, buildings and vehicles are common assets that are leased. Industrial or business equipment is also leased.[8,9]

Broadly put, an operational lease agreement is a contract between two parties, the lessor and the lessee. The lessor is the legal owner of the asset; the lessee obtains the right to use the asset in return for regular rental payments. The lessee also agrees to abide by various conditions regarding their use of the property or equipment. For example, a person leasing a car may agree that the car will only be used for personal use.

The user (lessee) does not bear risks concerning the residual value of the asset, since the ownership and risk is at the lessor. The risk of the residual value is taken into account in the contract price for the operational lease. For this reason, an operational lease may be more expensive than financing the equipment by means of a bank loan or a financial lease. Usually, with an operational lease, additional services are included in the contract between the lessor (owner) and the lessee (user). Examples are insurance of the asset, maintenance and repair of the asset. This may also give economies of scale for the lessor compared to a situation where each individual takes care of these services by him/herself, which is a benefit for the user.

[6] https://www.legalnature.com/guides/lease-agreement-vs-rental-agreement
[7] https://www.wallstreetmojo.com/finance-vs-lease/
[8] https://nvl-lease.nl/operational-lease/#
[9] https://www.beequip.nl/binnenvaartschip-leasen/

It is also possible that the lessor reduces the risk on the residual value by means of agreements with a third party to take over the ownership after the end of the lease contract (e.g. the supplier of the asset).

In comparison to operational leases, there are also financial leases, which means that the ownership belongs to the user. The user has a loan for purchasing an asset in which the asset itself is the collateral for the loan. The consequence is that the equipment is in the financial books of the user, which affects the financial ratios of the company.[10,11]

The advantage compared to a regular loan from a bank is that the collateral has a value development which may lead to a longer duration for the depreciation and repayment of the loan. Moreover, the residual value may be incorporated in the calculation of the final payment, as the asset can be sold after the agreed term. As a consequence of taking into account the specific economic lifetime and the expected residual value, the monthly rate may be lower compared to financing via a regular bank loan.

Another scheme is vendor leasing. In this scheme the supplier/seller of the equipment plays a role in establishing a leasing agreement or loan (financial lease) to sell the equipment. Vendors may have framework contracts with financial institutes providing the leasing schemes or have their own leasing companies. Therefore, it is basically a financial lease or operational lease, in which the marketing/sales of the leasing scheme is done by the vendor.[12]

3.2 Definition of pay-per-use schemes/energy as a service

Metered services, also called "pay-per-use", are any types of payment structure in which a customer has access to potentially unlimited resources but only pays for what they actually use. Metered services are becoming increasingly common in the information technology (IT) sector. With utility computing, for example, a company can purchase computing resources to match fluctuating needs. This approach is promoted as being more cost-effective for the company than maintaining a large infrastructure that exceeds the company's average computing power requirements.[13]

Pay-per-use has been the forever pricing model in some industries. You pay a fixed access fee plus a variable fee for what you consume. An example are mobile phone network suppliers who offer a choice between different size packages. One package may include 500 minutes talk plus 2 GB data per month and the subscription holder loses what is not used. Pricing models are very similar as internet service providers. Typically, in many other industries, such schemes currently take the form of a combination of a monthly subscription model with a pay-per-use charge on top.[14]

[10] https://nvl-lease.nl/financial-lease/
[11] https://www.rabobank.nl/bedrijven/zakelijk-financieren/lease
[12] https://nvl-lease.nl/vendor-leasing/
[13] https://searchcio.techtarget.com/definition/metered-services
[14] https://www.innovationtactics.com/pay-per-use-business-model/

One definition reads as follows “when customers pay for a service monthly that was once purchased in a single payment.” Modern day examples include Netflix and Spotify for consumers and Salesforce and Workday for businesses.

In recent years, such models have been spreading to industries that one would not have expected, such as software and even automotive. However, the pay-per-use business model often combined with a subscription model are now common in these industries. The economic benefits of pay-per-use offered to consumers will make it a successful business model in more industries.

In the energy sector it is also known as “Energy as a Service” or “EaaS”. EaaS addresses the support to clients to choose between the variety of energy-related options. EaaS is intended to satisfy the needs of customers wanting a single-point solution to simplify and improve their energy situation with:

- Guaranteed (lower) energy costs
- High(er) reliability and resiliency
- Sustainability options
- Optimized operations
- No major capital outlay
- No requirement for additional staff

Basically, these customers want a surrogate to manage all aspects of their facilities’ energy needs, not just installing energy efficiency hardware. They want what is called an “Energy as a Service (EaaS) provider”.[15,16]

The Uber business model provides a helpful analogy. Uber provides a transportation service that takes people from place-to-place and eliminates the risks and inconvenience of car ownership such as purchasing, financing, maintaining, licensing, insuring, cleaning, fuelling, navigating, driving and parking. Just as Uber manages all aspects of the user’s transportation experience, Energy as a Service manages and optimizes the energy purchasing experience to minimize cost, risk and confusion.

3.3 Applications in the transport sector

3.3.1 Leasing

Leasing is quite common in the transport sector, examples are leasing of cars, trucks, trailers, rolling stock for rail transport (e.g. locomotives) and airplanes. The assets are highly standardised and produced at high numbers by large OEMs.

Leasing allows fleet operators to use vehicles without the upfront costs, hidden or unexpected fees and credit obligations that often go hand in hand with the process of buying an asset. With leasing, the full value of the vehicle can be deducted as a tax expense (not the residual value).

[15] https://www.engiemep.com/news/choosing-an-energy-as-a-service-eaas-provider/
[16] https://perspectives.se.com/energy-efficiency/schneider-electric-top-energy-as-a-service-provider

Furthermore, the entire price of the vehicle is financed and, as the invoice is issued in the name of the entity, there's no need to advance the VAT. Down payments are not necessary for leases and fleet operators can pay for the cost of the vehicle on a monthly basis instead of carrying its liability on their balance sheet. This means that operators have more credit flexibility to invest capital in other areas of their business, and can better focus on their overall business model, instead of worrying about down-payments or credit repayments on assets (as with buying).[17]

Crucially, leasing avoids having to include depreciation costs in the balance sheets. Furthermore, fleet operators can capitalise on the fact that the residual value is usually very close to the market-value of the vehicle, allowing them to buy the vehicle after the leasing term ends. This means that until the end of the lease period, they have three options: to keep the vehicle, to return it, or to lease a more modern version.

As with renting, fleet operators engaging in leasing can upgrade to newer technologies much quicker than if they owned their own fleet due to shorter trade cycles.

Disadvantage are that cancelling a lease before the end of the lease period can result in significant extra costs. Companies are locked into using the same type and number of vehicles for large periods of time, increasing operational costs if they cannot adjust fleet size according to falls in demand. Additionally, for companies looking to own the vehicle(s), they only technically have 'full ownership' once the contract ends, limiting what they can do with the vehicle until that point.[18]

3.3.2 Pay-per-use

A well-known example of pay-per-use in transport is the taxi or the Uber service. With Uber, a user simply enters a pick-up request, a destination, number of passengers and pays with a few buttons pushed on a smartphone. Uber automatically knows where to pick-up the customer, dispatches the closest vehicle and calculates the fastest routes to the customer pick-up point and to the destination, based on real time traffic data.

One of the first applications of pay-per-use was for jet engines back in the late 1990s. Back in the day, when an airliner's engine approached end-of-life (based on flight hours) or failed abruptly, the airlines would purchase a replacement engine from vendors like Rolls Royce, install them and maintain them. An unexpected engine failure could cost the airlines millions in engine replacement costs, lost flight revenue, need to reschedule stranded passengers, need for back-up aircraft, buffer engine inventory, crew over-time, etc. But given the multiple models of planes in a typical fleet, there were often multiple engine models to keep track of and monitor. It became apparent that airline service departments were not qualified or equipped to maximize the life of its jet engines, often replacing them prematurely or letting them run until they failed unexpectedly. Rolls Royce realised that the airlines did not want to be in the "jet engine business", the airlines wanted to focus on flying passengers from point A to B.

[17] https://www.sfleblanc.ca/en/transport-equipment-financing-benefits-of-leasing/
[18] http://www.leaseurope.org/index.php?page=trends-research-presentation

Rolls Royce developed a new “subscription” model called “power-by-the-hour.” Basically, it was Engine-as-a-Service (EaaS). For a flat hourly rate per engine, Rolls Royce would handle installations, check-ups, maintenance and decommissioning. From the viewpoint of the airlines, this was perfect. The finance department loved the predictability of the subscription payments, as opposed to the “lumpiness” of engine purchases and overhauls. The airlines loved not having to spend resources on engine inventory, repair facilities, technicians and engine liability insurance. The advantage for Rolls Royce was economies of scale. Since they were now managing the lifecycle of hundreds or thousands of aircraft engines, they could invest heavily into studying how engines performed, how to keep detect potential failure points, what types of preventative maintenance was most effective, etc. Rolls Royce became the experts in, not only designing and building jet engines, but also operating and repairing engines.

For the airlines, EaaS transfers the responsibility to a vendor that treats engine efficiency and safety as their core competency. The “power-by-the-hour” model is intended to keep the uptime as high as possible. It's not advantageous if it breaks down since the service will only be paid by the client for the time that the asset is operational. [19]

There are also examples of ‘Power by the Hour’ in the Marine sector. Power-by-the-Hour is a new service from Rolls-Royce Marine, and they have an agreement with short sea liner shipping company Nor Lines. The service builds on Rolls-Royce’s many years of experience with equipment monitoring, proactive servicing and available solutions in the aerospace market.

The agreement means that Nor Lines is handing responsibility for service planning and performance back to the equipment’s supplier, Rolls-Royce. Nor Lines pays a fixed charge per hour of operation, per ship. Rolls-Royce will monitor the equipment aboard each vessel from on shore through the use of onboard sensors. It will be able to connect to the ship and carry out service activities remotely or, if necessary, send out a service engineer to do the job. The agreement also covers planned maintenance, while day-to-day maintenance aboard ship will be carried out by the shipping company itself.[20]

[19] https://www.linkedin.com/pulse/subscription-economy-did-start-power-by-the-hour-gene-likins/

[20] https://www.rolls-royce.com/media/press-releases/2017/24-05-2017-nor-lines-and-rr-sign-landmark-power-by-the-hour-service-agreement.aspx

4. Conventional financing, leasing and pay-per-use in IWT

4.1 Conventional financing

Financing in the IWT sector is being done in a relatively traditional way, where vessels are being financed through a bank with a mortgage loan. In case of a repowering (new engine) or other investment need, the bank can simply provide an additional loan or adjust the existing mortgage loan. The bank usually provides a mortgage loan covering up to approximately 70% of the financing need, whereas the remaining 30% is financed through own funds, which often consists of private loans from the family or it comes from the seller of the ship. Around 70%-80% of the fleet is still covered by mortgage financing.

After the 2008 financial crisis banks became more cautious in providing financing to the IWT sector. Apart from the stricter regulations for banks, this certainly also had to do with the fact that large IWT banks became overexposed to the IWT sector mainly due to financing too many newbuild projects and a lower demand for freight transport resulting in overcapacity. IWT companies were increasingly unable to turn to the bank for loans, certainly for relatively small amounts below approximately half a million euros. Consequently, alternative providers of financing appeared on the market such as crowdfunding platforms and credit unions who do want to accept the financing applications that are refused by the bank, naturally at relatively higher rates, as these parties do take the risk that the bank refuses to take.

4.2 Leasing

The occurrence of leasing in the IWT is not being excluded, both in terms of leasing equipment and vessels. There could be examples of leasing agreements for objects like a car crane to place on board of a vessel or a radar equipment. There are also companies actively offering leasing services for the IWT sector, offering leasing products to lease complete vessels or equipment[21]. A construction that comes close to leasing and which is relatively more common in the sector, concerns the pooling of pushed lighters which is then being managed by a cooperative and used for shipping. A bareboat charter could also be seen as a lease agreement, where the vessel owner is paid a fixed rate by the chartering party for a certain period of time and the chartering party is responsible for both the operation of the vessel and the related voyage costs including the arrangement of the crewing.[22]

However, leasing a complete vessel and even more, leasing powertrains, is not being done on a considerable scale. There is an interplay of a number of factors which can explain the minor role of leasing products in the overall financing in IWT, these are:

- The conflict of leasing products with the traditional and dominant mortgage financing (see chapter 4.4 for more details)
- The highly specialised and customised nature of IWT assets

[21] https://www.beequip.nl/binnenvaartschip-leasen/
[22] https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Energy-and-Resources/dttl-er-ifrs-sp-leasesproject.pdf

- The lacking market for second-hand assets
- The lack of standardised equipment and OEMs for inland vessels (e.g. as compared to trucks, locomotives)
- The long lifetime of equipment
- The mixed use of vessels, also for living on board (function as a home for the owner/crew)

The IWT sector is highly fragmented, consisting of relatively small companies owning one or two vessels. The vessels, in case of freight transport, are being used for both the transportation of goods as well as to live on board of the vessel. The mixed use of the vessel makes it difficult to lease a complete vessel. In the traditional situation, the owner of the vessel prefers a customised vessel based on his own specific needs and preferences and hence wants to have the feeling of ownership. On the other hand, the lessor prefers to provide a standardised asset with a properly estimated residual value, an asset that can be traded relatively easily as a second-hand object. However, this is not possible in case of customised vessels, even more for objects installed on board, as compared to complete vessels. Experts in the field state that engines used on board of vessels are almost never traded on a second-hand market and have nearly no residual value, making it unattractive as lease object for a leasing company. This is also due to the relatively long technical lifetime of engines used in inland vessels. Standardised equipment which could be removed in a relatively practical way from a vessel and be used in other vessels or other applications, would be more suited for leasing.

Another aspect that is underlined by an expert in the field, is the fact that there are serious risks for a lessor of inland vessels based on experiences with bareboat charter agreements. There is a high possibility that the lessee will fail to take proper care over the vessel. In contrast to trucks for example, vessels are relatively complex assets. And in contrast to aviation, the IWT sector is less regulated, especially in terms of compliance with maintenance and repair (e.g. there is no such thing as an "airworthiness directive" for IWT). The sector is also a traditional and much more fragmented one and less professionally organised as compared to rail and aviation. All these elements make it a risky business for lessors to lease inland vessels.

4.3 Pay-per-use

Pay-per-use is a relatively new concept in the IWT sector and a totally new way of financing. It can be classified under the energy-as-a-service concept which is explained in chapter 3. There is currently only one widely known initiative in the IWT sector, which is referred to as the Green Circles coalition. Heineken, ING, ENGIE, Port of Rotterdam, CCT, Wärtsilä, Eneco and BCTN have joined forces in this coalition for the deployment of Modular Energy Concepts (MEC). This coalition aims to achieve zero emission inland container shipping and to this end, wants to deploy four zero emission pilot vessels within the green South Holland corridor.[23]

Efforts were made in 2019 and 2020 to set up a joint venture company for the deployment of the concept. This MEC company named "ZES BV" (Zero Emission Services)[24] was officially launched on

[23] https://zoek.officielebekendmakingen.nl/stcrt-2019-39775.html
[24] https://zeroemissionservices.nl/en/home-english/

2nd of June 2020. ZES will provide containerised energy storage systems (initially containerised batteries and later on possibly containerised hydrogen/FC systems) as an energy source on board of vessels. ZES will invest both in the shore infrastructure, as well as in the containerised energy storage system. The aim of ZES is to expand to more shipping routes and more ships. A network of open access loading points will be set up along the main waterways and existing logistics hubs such as container terminals. An important element in the business model is the multi-client usage of batteries. Batteries are also used for stabilising the energy grid which creates substantial revenues for the ZES company. When battery containers are not on board a vessel, they can be used to stabilise the electricity grid. Network stabilisation, the balancing supply and demand, is essential for a reliable electricity network. In the future, the supply of electricity is expected to fluctuate more as more use will be made of solar poles and wind turbines and less use of power stations. Maintaining grid stability is expected to be increasingly a matter for small resources such as, batteries, boilers and heat pumps. In addition, the containers can be used to meet temporary demand for electricity, for example during events or at construction sites.

ZES believes their system is future-proof because it is independent of an energy carrier. ZES will start with using batteries, but if hydrogen becomes cheaper in the future, hydrogen technology-equipped containers will be able to supply power. The ZES charging stations will also be designed to allow for synergies with other technologies, such as hydrogen. Moreover, also containers with combustion engines can be used (containerised mobile electricity generator sets), for example using HVO or Bio-LNG to serve as 'range extender' complementary to the battery containers which provides flexibility and reliability.

The company will also highly invest in the overall standardisation, in the interfaces between e.g. the shore infrastructure and batteries and batteries and vessels, and in the containerised energy storage systems which will receive a type approval from the classification societies. The company aims towards an open access model. This will all result in a more efficient use of the batteries. Hence, ZES can purchase the assets on a relatively large scale and deploy them more effectively, enjoying economies of scale and possibly providing zero-emission techniques relatively cheaper as compared to the case when an individual vessel owner would invest in it. Moreover, the owner of the vessel will use the containerised energy storage system based on a pay-per-use concept. The fee could for example be based on used kWh of energy, thereby removing the need to invest up-front in expensive batteries or hydrogen/FC systems. Furthermore, repair and maintenance will be taken care of by ZES.

However, the vessel owner still need to invest in equipment which will be permanently attached to the vessel and become part of the vessel, from a legal point or perspective, such as the electromotor, the electrical installation, power management system, etc. This also concerns the required installation to be done at a shipyard. Depending on the type of vessel and the required equipment, these costs can amount to €350,000 to €850,000 per vessel according to the preliminary results of the DST study. The required equipment and related installation cannot be provided by ZES, since this specifically relates to the vessel and falls into the ship financing category, whereas ZES only focuses on providing the containerised energy storage system, which is not attached to the vessel and hence no part of it. Currently there are more than 80 freight vessels already running with electromotors (diesel-electric propulsion). Consequently, retrofitting an existing vessel and investing in equipment which will be permanently attached to the vessel, to get it ‘plug & play’ ready for the containerised energy system concept, will imply additional cost and financial barriers. This barrier may be too big to be economically viable for the vast majority of the existing fleet. Grants for covering the additional costs of retrofitting existing vessels to electric propulsion could help to overcome these barriers.

The first phase of the operations includes high CAPEX investments and risks for the ZES company. Consequently, they will only focus on companies active in the IWT sector who can provide a high level of certainty. Agreements for the containerised energy storage systems are preferably concluded with the shipper. In the initial phases, the ZES company will not conclude agreements with small vessel owners or those active on the spot market who cannot offer the same level of guarantee.

A second example of a company that offers pay-per-use concepts to the IWT sector is SKOON, this company works on a similar concept, based on the pay-per-use principle, to provide containerised battery systems on board of vessels, although on a relatively smaller scale as compared to ZES. SKOON indicates that vessel owners will be able to obtain a containerised battery system in a relatively flexible way, paying based on the capacity per day or month. Companies requiring a containerised battery solution for a longer period could conduct a leasing agreement.

The transition towards zero-emission and the need for relatively expensive zero-emission techniques could stimulate the further deployment of financing schemes based on the pay-per-use principle. Zero-emission propulsion installations such as hydrogen-electric and battery-electric installations are CAPEX intensive, which also was presented in the draft report of DST for parts of research question C of the Main Study. Pay-per-use schemes could however considerably lower the up-front investment barrier for companies if the vessels are already ‘plug & play’ ready to use battery containers as main energy source on board of vessels (for propulsion and hotel load). For the future it is expected that more newbuild vessels could be made ‘plug & play’ ready for such schemes. However, for retrofit there is still a rather big financial barrier.

The energy transition, from a global point of perspective, is being seen by those companies such as ZES as an asset service. The customers should only need to pay for the service, whereas the company providing the service will take care of all the investments, repair and maintenance. ENGIE provides services where they construct a building that is as ‘green’ as possible, takes care of the water, electricity, insurance, etc. and rents it to the customer as a service per m2. Banks as Caisse des Dépôts are involved in providing financing to such “asset companies”. Companies which are able to invest on a rather large scale in greening, enjoying economies of scale, and providing the assets to end-customers as a service.

Last, it is being stated by the interviewees in the financing sector that pay-per-use models are more advantageous as compared to leasing from the vessel owner’s point of perspective. From a very basic point of view, with leasing you pay for the time you rent the asset whereas with pay-per-use one merely pays for the specific use of the asset.

4.4 Impact of conventional financing on leasing and pay-per-use

There is one major bottleneck in applying innovative financing configurations such as leasing and pay-per-use, specifically as regards leasing powertrain components. There are risks for the provider of the equipment from a legal point of view as regards property right. The provider (lessor/asset company) can lose its property right in case the vessel owner goes bankrupt. Most vessels are financed through mortgage loans from commercial banks. Vessels with an ongoing mortgage, being the majority of the fleet, will become property of the first mortgage holder (mostly a bank in the IWT sector) in case of a bankruptcy. This concerns the vessel including the equipment permanently attached to the vessel, an engine and its corresponding equipment could fall into this category. In the context of property law, the engine which is rather attached in a fixed way will become part of the vessel through accession and loses its separate existence. Hence, a vessel without engine is not complete from a legal point of perspective, whereas the bank, as the first mortgage holder, is entitled to a complete ship.[25]

The fact that the majority of vessels is covered by mortgage financing therefore has an impact on the opportunities for leasing and pay-per-use financing. This will be explained further in-depth in chapter 5.

[25] The Dutch jurisprudence "1936, No. 757 (Sleepboot Egbertha)" is being used often in this context. It is being concluded in the "LNG Breakthrough" project that the situation and as such the potential risks for the lessor, will probably not differ much in other popular flag states in IWT (p.25): https://lngbinnenvaart.eu/wp-content/uploads/2019/08/Act-3.2-4.2-pilot-study-on-innovative-financing.pdf & https://www.eicb.nl/wp-content/uploads/2016/08/EICB001-18_rapporten-LNG_02_dynamisch.pdf
The respective legal risks are also confirmed during interviews with the banks (Bank für Schiffahrt, Caisse des Dépôts, Rabobank and ING bank).

5. Drivers and barriers for further implementation of innovative financing schemes for greening in IWT

The further deployment of innovative financing schemes such as leasing and pay-per-use schemes will depend on a set of interrelated factors acting as drivers and barriers for the further deployment of these schemes, ranging from economic factors to cultural ones. The barriers and drivers will be determining the market potential of these schemes. The most relevant drivers and barriers are analysed in the sections below.

5.1 Economic

There are a number of economic factors which could either act as a driver or barrier for implementing leasing and pay-per-use schemes, both from the vessel owner's point of view as well as from the financiers' point of view.

For the uptake, it is needed that a leasing or pay-per-use agreement brings significant economic benefits for the vessel owners/operators, compared to a conventional financial agreement (mortgage/loan) with the bank. Leasing and pay-per-use possibilities could mean that the vessel owner gets relatively easy access to the capital market, where for instance, this was previously not possible with a bank for a traditional loan. In addition, real economic benefits could take the form of a significant CAPEX reduction for a vessel owner who wants to invest in a clean powertrain, since leasing and pay-per-use schemes remove into some extent the upfront investment barrier for vessel owners. However, the vessel still needs to be 'plug & play' ready for such electric power sources, which means electric motors, management systems and interfaces. This will also imply a CAPEX estimated between €350,000 to €850,000 per vessel (source DST draft report Research Question C). Moreover, there shall not be a higher OPEX, which may be difficult seen the low prices of diesel oil (note that diesel oil is duty and tax free). However, a competitive OPEX for the vessel owner/operator could be realised in case the provider of the leasing/pay-per-use scheme benefits from:

- other revenues for the equipment (e.g. peak shaving / electricity network stabilisation)
- economies of scale (large scale procurement of clean powertrains, energy (electricity, hydrogen, biofuels, etc.) and repair/maintenance contracts);
- better utilisation of the standardised components by multiple users, ensuring a lower risk and acceptable residual value;
- large sums of grant (e.g. CEF) which could not have been obtained by individual vessel owners;
- better access to finance resulting in lower capital costs;

A prerequisite is that these benefits are passed on to the client (vessel owner) while the vessel owner can be financially supported in the extra costs to make the vessel 'plug & play' ready to use such standardised energy containers.

If these financial advantages are not in place, or even more, if a pay-per-use or leasing contracts are eventually even more expensive, then there is not much reason for the vessel owner to engage in leasing or pay-per-use schemes. Moreover, there can be other negative economic impacts like loss of cargo space, payload (due to heavy containerised systems) and limited operational area for the vessel (due to limited infrastructure/capacity for the containerised system). However, it may also provide opportunities like improved turnover and long-term certainty due to long term contracts with shippers willing to make long term commitments for zero-emission IWT (companies like for example HEINEKEN supporting and promoting ZES BV).

Since leasing is hardly, or not used at all, in IWT to finance propulsion installations, and pay-per-use has only recently entered the IWT market, there is currently no financial data available that can be used to draw a clear financial comparison between conventional financing and leasing/pay-per-use for financing propulsion installations.

5.2 Logistic/operational

The application of leasing and, a step further, pay-per-use, requires the equipment and its handling to fit in a rather practical logistic and operational process. It should be able to place and install the equipment (i.e. containerised energy system) in a relatively easy manner on board of the vessel, thereby minimizing the idling time for the vessel and the handling time/costs for the service company or terminal in case a containerised battery system needs to be replaced by a charged containerised battery system, replaced for maintenance/repair, exchanged with another party, etc. During the interviews, the construction sector was cited as an example, where a piece of equipment such as a generator or excavator can be placed on the construction site relatively easily and where, after being utilised, it can be relocated also relatively easily to another customer at an alternative construction site.

As regards the containerised energy system, which fits ideally in the pay-per-use concept, there should be a real infrastructure and facilities to optimize the logistics process. An important condition for such a concept to work is the presence of multiple locations to exchange empty containerised energy systems with charged ones and as well as to charge empty containers. These locations should be beneficial for both the vessel owners/operators as well as for the provider of the containerised energy systems. For vessel owners/operators this means minimising possible circumventing, ideal locations could be container terminals on the core waterway network along the sailing routes. For the provider of the containerised battery energy systems this includes locations with enough power grid capacity (for example near power plants) and with existing facilities for the handling of the equipment. However, possible locations that meet these conditions are limited in number. According to our interviews about the ZES concept, there are in total around 10 up to 15 such locations in the Netherlands, which will geographically be the first focus of the ZES company. For fuel cell/hydrogen containers, the range of autonomy might be larger, resulting in less need to exchange the energy containers, however it is yet unclear if and when there will be a commercial business case for hydrogen/fuel cell technology in IWT.

Furthermore, the exchange of such containerised energy systems should not take significantly more time as compared to the bunkering time for diesel. For example, a barrier for the uptake of LNG was the significant longer bunkering time, resulting in additional idling time for the vessel. It shall be noted that bunkering operations for diesel can even be performed during sailing by a bunkering vessel, resulting in no time loss at all. It can be concluded that the business as usual situation is therefore rather competitive and efficient and it will be rather challenging to provide a competitive TCO with a containerised/swappable energy system.

5.3 Organisational

A condition from the organisational point of perspective, especially as regards the provider of pay-per-use schemes, is that the vessel owner has a rather stable and predictable business. I.e. that the company is not active on the spot market but rather has a long-term contract with a shipper guaranteeing sufficient cargo flows throughout the contract period. Even more, the provider of pay-per-use prefers to enter into a contract directly with the shipper instead of with individual vessel owners.

From the vessel owner's point of perspective, or the shipper, the company providing the pay-per-use scheme should be the single contact point taking care of everything as this fits within the pay-per-use principle. The vessel owner or shipper should pay an all-in fee for the provided energy including handling, re-charging/fuelling, maintenance, repair, insurance, etc. And all these aspects must be taken care of by the company with which the pay-per-use contract is concluded so that the ship owner or shipper can be relieved from the burden.

5.4 Technical

There are important technical conditions to be met if leasing and pay-per-use schemes are going to be implemented in the IWT sector, as also touched upon in chapter 4. The equipment to be leased or hired through a pay-per-use concept should not be permanently attached to the vessel and hence not become part of the vessel from a legal point or perspective. It should be rather possible to remove the equipment from the vessel in a relatively easy way, a containerised energy storage system and a standardised interface between the vessel and container is one of the best ways to guarantee this.

As regards the containers itself, the interviewees believe that multiple techniques can be put in a container (batteries, hydrogen/FC, ICE's). However, batteries are most suited to be put in a container in the short term, seen also the additional revenues as batteries are used for electricity network stabilisation during the time they are not on board of vessels. The uptime of the system should be sufficient, the container should work in an appropriate manner and should be reliable. Service level agreements can be made accordingly.

In case of a containerised system, not all types of vessels will be equally suitable for the placement of a container or containers on board of the vessel. Container vessels will be the most practical target group. A containerised energy system will have the least impact on the cargo load capacity of container vessels, and furthermore, the required logistics systems already exists for this market segment. Docking stations can be placed on container terminals and container vessels can exchange containerised systems at these points.

The applicability of this concept on existing dry bulk vessels, push boats and tankers will, in general, be relatively limited as compared to container vessels. The containerised energy system will have a relatively large impact on the cargo capacity in case of dry bulk vessels. The applicability of the concept on vessels carrying dangerous goods is currently not within the scope of the ZES company. Tankers have a cargo area which has certain requirements, making it difficult to apply the concept on these type of vessels. Existing push boats are also relatively less suited for the concept due to restricted available space on board of the vessel. Large push boats have more space available, however these vessels have a significant power demand. For the current battery technology, this would mean that several battery containers have to be placed on board in order to meet the power demand. This has big impacts on the space requirement and especially in terms of weight. An alternative solution would be to limit the number of batteries and change batteries more frequently, however this will have a significant impact on the operations. Since large push boats usually don’t stop to bunker fuel and certainly don’t stop multiple times during a single itinerary. Bunkering is usually being done through a bunker boat.

The technical applicability can be very different in case of newbuild projects, where vessels (e.g. push boats) can be designed according to the containerised energy system concept and make the vessel more suited for the concept. Moreover, in case technologies further develop in the future, the space and weight of such containerised energy solutions may reduce which enlarges their market potential.

5.5 Legal

Conducting leasing or pay-per-use agreements are not accompanied by legal difficulties in case the agreement concerns a complete newbuild vessel without a mortgage loan. However, a mortgage loan can be combined with a leasing or pay-per-use contract if the newbuild vessel is designed accordingly in a modular way. A bank may provide a mortgage loan to a vessel owner strictly for a limited share of the vessel excluding its modular powertrain system. Whereas the leasing company or asset company providing the pay-per-use scheme could provide the contract for the modular (e.g. containerised) energy system or other type of standardised equipment which will not be permanently attached to the vessel.

The legal aspects become really relevant in case a leasing or pay-per-use agreement will be conducted with owners of existing vessels with an ongoing mortgage on the vessel, which currently applies to around 70%-80% of the IWT fleet. As clarified in chapter 4, leasing an object which will be permanently attached to a vessel, such as a clean engine or fixed hydrogen-electric or battery-electric installation, bears risks for the lessor/asset company. Since in case of a bankruptcy, the bank, as the first mortgage holder, is entitled to the complete ship. This is a huge barrier for a lessor/asset company to provide equipment like an engine to a vessel owner.

The situation is different though in case the leasing or pay-per-use agreement concerns a modular standardised energy system, such as a containerised battery system. An existing vessel could be retrofitted and made suitable for a connection with a containerised battery system, a system which would not be permanently attached to the vessel, consequently resulting in less risk for the company providing the leasing/pay-per-use agreement. In such a case the vessel owner, bank and supplier of the pay-per-use agreement could mutually agree that the containerised battery system can be taken off the vessel, should there be a bankruptcy.

The bank is, in principle, willing to cooperate in such an agreement, provided that the risk is not too great. In case of a bankruptcy, the bank should seize a vessel which is able to sail, just as initially financed. Hence, removing the containerised energy system should not have an impact on the ability of a vessel to sail. Thus, when retrofitting, the vessel owner could decide to keep the conventional propulsion system on board to safeguard this. Alternatively, if it concerns a vessel whose mortgage has already been largely repaid, then the risks of seizing a vessel not able to sail may be manageable for the bank.

5.6 Cultural

An important and unmissable aspect is the cultural one. The IWT sector is a traditional and conservative one. An innovation in terms of financing (pay-per-use/leasing), technique (containerised 'clean' energy system) and operations (charging/fuelling, repair, maintenance, etc.) can be perceived as a quite radical one by the sector. Hence, it is very important to create a sufficient level of acceptance among the parties active in the sector. In the first deployment stages the innovation should be tested in pilots. If the benefits to the shipowner become apparent during the pilot tests, this can be an incentive for the rest. Such results should be disseminated in a relatively transparent and accessible way.

6. Market potential for leasing and pay-per-use for greening in IWT

Chapters 4 and 5 provided insights into respectively the current applications of leasing and pay-per-use in IWT and the drivers and barriers for the widespread implementation of these instruments. This chapter will further elaborate on these findings and draw conclusions about the market potential for leasing and pay-per-use as financial instrument to support the greening in IWT towards reaching the zero-emission objective in 2050.

Leasing is currently just marginally being applied in the IWT sector as a financing instrument to finance equipment to be used on board of the vessel, neither to finance a complete vessel. And if applied, it mainly concerns objects which are not permanently attached to the vessel and hence do not become part of the vessel from a legal point of view. Examples are leasing agreements for objects like a car crane or radar equipment. In contrast to pay-per-use schemes, there are currently also no significant initiatives ongoing with which it is attempted to finance the transition towards zero-emission through lease constructions.

The potential for leasing in financing greening is really limited in the current framework conditions. The current marginal role of leasing constructions in IWT, the significant barriers for leasing as clarified in the previous chapter, and the lacking initiatives to utilise leasing constructions as financing instruments in the transition towards zero emission, all together limit the market potential of this financial instrument in the transition towards a zero-emission fleet in 2050. It is therefore expected that lease constructions will not play a noteworthy role in the transition. There might be a different situation however in case of new standardised and modular vessel train concepts for example, based on full autonomy in the further future. These concepts may have a different business case and it is possible that the market structure will be different with big market players developing such concepts. In case of standardised units, leasing and pay-per-use may apply to such concepts.

The expectations are slightly different for pay-per-use schemes, both based on the characteristics of pay-per-use schemes and on the presence of a widely known rather significant initiative trying to utilise this concept in the transition towards zero-emission IWT (ZES). As regards the characteristics, from a very basic point of view, with leasing you pay for the time you rent the asset whereas with pay-per-use one merely pays for the specific use of the asset. Making the latter more advantageous from the vessel owner's point of perspective. The pay-per-use concept also fits relatively better in the current 'servitization' trend which can be found both in the business and consumer markets.[26]

The MEC initiative ZES is currently the only widely known initiative in the IWT sector, aiming to utilise the pay-per-use concept by making greening in the sector relatively affordable for vessel

[26] https://www.forbes.com/sites/insights-intelai/2018/09/21/the-big-promise-of-everything-as-a-service-ongoing-revenue-smarter-services/#34e812f07d7d

owners through a new financial and technical concept. The focus of this initiative will, at least at first instance, be on vessels carrying containers with long term contracts sailing predominantly in The Netherlands (Provinces of North and South Holland / ARA region). It is being assumed that the whole concept will achieve its financial break-even point once approximately 100 vessels are equipped with the containerised energy system. This should therefore be the minimum number of vessels that ZES should focus on.

The overall theoretical market potential of pay-per-use schemes for the European IWT sector depend on a number of factors. First of all, the technology offered in the containerised energy system is important to determine the potential. Based on previous results, batteries will be the main focus for containerised energy systems due to the ability to use batteries also for the stabilisation of the electricity network.
First results from research question C (draft DST study) show that battery-electric propulsion systems could play a significant role in the eventual fuel mix of the IWT sector in 2050, depending on the ambition level. This especially applies to the scenarios in which emissions need to be reduced by 98% and 100%. In both scenarios as presented in the DST report, battery-electric powertrains have a rather significant share in the fleet families dry cargo vessels (<80m and 80-109m) and day trip/small hotel vessels. With containerised batteries though, the latter fleet family will be less suited from a technical point of view.

It shall be remarked that the feasibility of reaching such emission reduction levels is expected to highly depend on grants made available to vessel owners, or will depend on legislative measures to make the business as usual scenario more expensive or to impose much more strict emission standards. Therefore, a lot depends on the policy interventions on international level.

Second, it is assumed that additional asset companies, similar to the ZES company, will enter the IWT market on the long term to provide standardised containerised energy systems as a service. The overall target group would be vessels carrying containers. This category is the most practical target group, since containerised energy systems will have the least impact on the cargo load capacity of container vessels, and furthermore, the required logistics systems already exists for this market segment.

Container vessels actually belong to the category of dry cargo motor vessels. Dry cargo vessels can carry both containers or dry bulk depending on the assignment. There are approximately 7,015 dry cargo vessels in Europe out of a total of 12,263 vessels used for commercial transport, which amounts to a share of 57% of the total fleet (excluding floating equipment).[27] However, given this share, only the part carrying containers in a rather structural way will be suitable for the pay-per-use concept. Moreover, the limited energy density plays an important role, which makes it logical to apply containerised battery containers at container vessels operating on short distances on canals. Vessels which operate on long distances, at rivers with high power needs (e.g. Rhine) are less suitable. Also vessels carrying dry bulk on a regular basis, next to containers, will be less suited since the containerised energy system will have a relatively large impact on the cargo capacity when carrying dry bulk.

Container transport is almost exclusively concentrated on the Rhine countries and makes up only about 11% of the total IWT transport performance in the EU and Switzerland. Whereas ores, sands, stones and building materials represents 26%. The energy sector (petroleum products and

[27] https://www.prominent-iwt.eu/wp-content/uploads/2015/06/2015_09_23_PROMINENT_D1.1-List-of-operational-profiles-and-fleet-families-V2.pdf

coal) represents 25%. Agricultural products and food products account for 15%. Chemicals for 11%, metals 6%, and wastes and secondary raw materials (including scrap steel) account for 3%.[28]

It can therefore be assumed that rather a large part of the dry cargo vessels is being utilised for the transport of dry bulk. Furthermore, out of the group which carries containers, the target group would be vessels carrying containers in a structural way. The network of fixed container liner services fits within this scope. Companies playing a significant role in this network are for example Danser and Contargo, of which the former has an own fleet consisting of 8 vessels and about 70 charter vessels, and the latter a permanent fleet of 46 vessels and 15 towed units.[29]

There is unfortunately no solid data available on the number of vessels used structurally for container transports in Europe. However, based on expert opinion, it is being assumed that in total just a few hundred vessels would fit the scope of dry cargo vessels carrying containers in a structural way for multiple years This could be the potential number of vessels which are suitable for applying a pay-per-use scheme and containerised swappable energy systems. However, this will also depend on the roll-out of infrastructure along inland terminals on international waterways like the Rhine and willingness of involved transport chain partners to make long term arrangements to provide sufficient guarantees for related investments in vessels, infrastructure and swappable energy containers.

In practice though, there will be additional factors influencing the potential. For example, the ability of the vessel owner to invest in the required equipment and make the vessel ready for a battery-electric or fuel cell electric propulsion. This concerns equipment which will be permanently attached to the vessel (e.g. electromotor and the electrical installation), and these costs can easily amount to €350,000 - €850,000, depending on the type of vessel (source draft DST report Research Question C). This equipment cannot be provided by the asset company, since this relates to the vessel and falls into the ship financing category. Therefore, this financial barrier is also quite significant and high levels of public support (grants) will be needed to overcome these barriers.

Furthermore, assuming that containerised energy systems will mainly consist of containerised batteries, and given today's battery technique, the concept would mainly be suited for short distance container transport. While for long distance transport (e.g. Rotterdam to Basel, Antwerp to Bonn), the vessel would either need to exchange batteries frequently or store multiple containerised batteries on board, which would both have a severe impact on the operations.

Another option might be to use other technologies like hydrogen and fuel cells in containerised applications. However, it is yet unclear if there is sufficient green hydrogen at affordable prices and if the fuel cells are available. Moreover, there are questions also from the viewpoint of the total societal Life Cycle Costs on the applications of batteries and fuel cells seen the specific materials needed.

New vessels can also influence the market potential and provide more opportunities, since vessels can be designed according to the containerised energy system concept and become more suited for the concept as compared to existing vessels, from a technical point of perspective. For example in case of large scale new building of vessels, e.g. in case of a disruptive innovation by a breakthrough of autonomous navigation with no personnel on board might change the picture.

[28] https://inland-navigation-market.org/chapitre/2-freight-traffic-on-inland-waterways/?lang=en
[29] https://www.danser.nl/en-gb/Fleet / https://www.contargo.net/assets/pdf/infodownload/brochures/Co-A4-Folder-2019-Ansicht.pdf

Especially as such innovations could involve modular vessels and serial production, there may be much bigger opportunities to apply 'pay-per-use' and also leasing of such vessels.

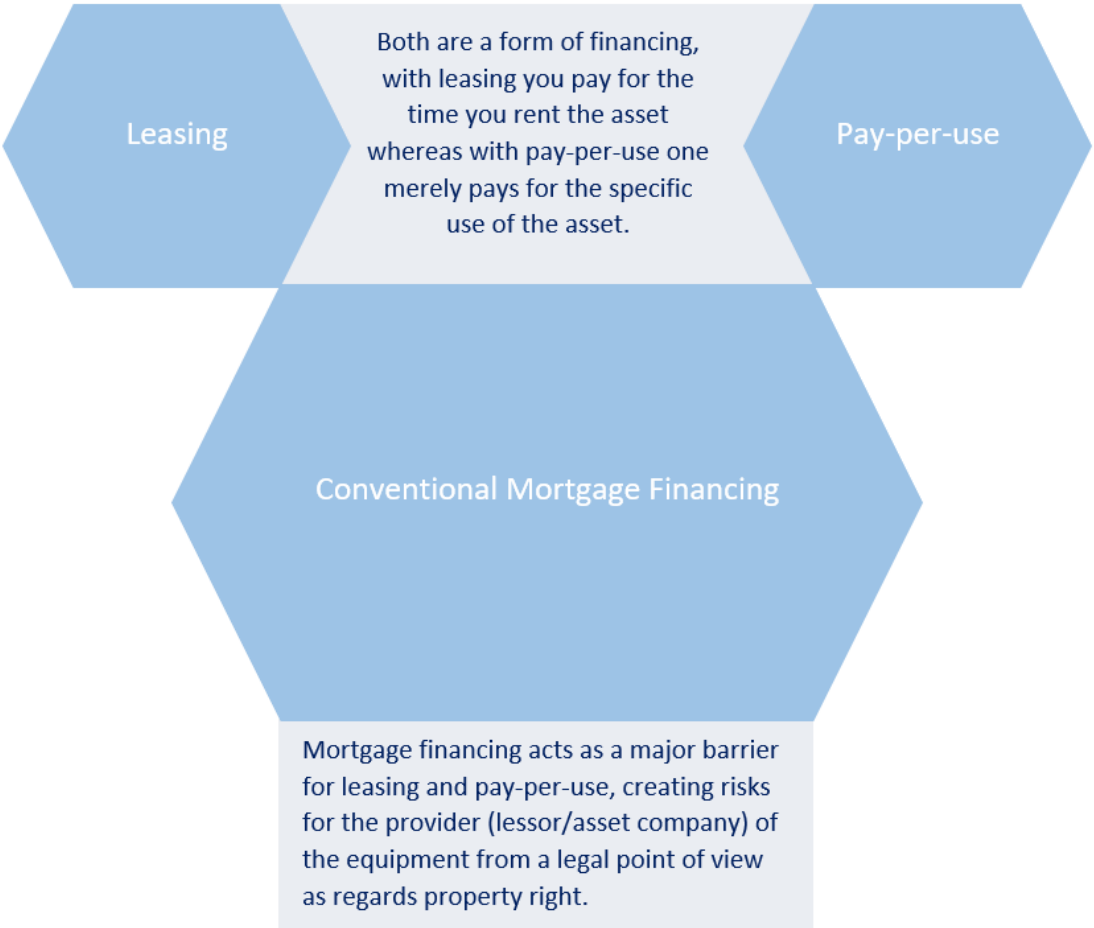
7. Conclusion

This report performed an analysis to provide an answer to the main question of research question D:

What is the potential of pay-per-use and leasing schemes for the IWT market?

The transition towards a zero-emission IWT sector in 2050 will require high capital investments in the power train of vessels, especially for the zero-emission technologies which involve fuel cells and/or high battery capacity. This creates a financing barrier for ship-owners. It is analysed what opportunities leasing and pay-per-use schemes could provide in this respect.

It is first analysed what the characteristics are of leasing and pay-per-use schemes and how both financing instruments fit with the current conventional way of financing in the IWT sector. The graphics below provide a summarising overview:



Further elaborating on this finding, it is investigated what the drivers and barriers are for a possible widespread implementation of both financing instruments. Six interrelated factors are at play, which can act as a driver or barrier in the implementation of pay-per-use and leasing schemes for the greening of the IWT fleet.

These factors are:

1. Economic
2. Technical
3. Legal
4. Logistics/Operational
5. Organisational
6. Cultural

The first three factors play an important role. There should be a real economic and/or financial benefit for the vessel owner and lessor or asset company to conduct a leasing or a pay-per-use agreement. Benefits for vessel owners could be significantly reduced CAPEX for investments in electric powertrains. However, this advantage should not be cancelled out by significantly higher OPEX generated by the new propulsion system while also there may be a CAPEX barrier to make the vessel 'plug & play' ready to use containerised electricity sources. The lessor and asset company could benefit from economies of scale, e.g. through joint procurement.

In order to enable economies of scale and mitigate the risk of losing ownership for the owner of the component, the component to be put on board through a leasing or pay-per-use scheme needs be a standardised product with a standardised interface enabling a relatively practical exchange with other vessels or for use in other applications. In addition, the component should have a high uptime, work in an appropriate manner and be reliable. Preferably, this would be a swappable containerised energy providing system with the required shore infrastructure in place. Components which are being permanently attached to the vessel (e.g. clean engine or fixed hydrogen-electric or battery-electric installations) and become part of the vessel from a legal point of view are therefore considered not appropriate for leasing and pay-per-use.

Hence, a standardised containerised energy system together with an adequate shore infrastructure will be the way forward. Leasing though will most likely play a very marginal and no noteworthy role in enabling the deployment of such energy systems. It is currently just marginally being applied and there are no significant push factors at play in the IWT market trying to deploy leasing as a financing instrument in the transition towards zero-emission.

Pay-per-use schemes fit relatively better in the current day's 'servitization' trend and there is one major initiative in The Netherlands trying to push this concept and utilise it in the zero-emission transition. On 2nd June 2020 the company Zero Emission Services (ZES) was launched. This company is backed by Heineken, ING, ENGIE, Port of Rotterdam, CCT, Wärtsilä, Eneco and BCTN. The coalition aims to deploy a Modular Energy Concept (MEC) over the next years with a strong focus on short distance container transport in The Netherlands and Belgium between inland terminals and seaports Amsterdam, Rotterdam, Moerdijk and Antwerp.

The market potential of such a concept relates to a specific vessel type and operational profile. The ideal target group for such containerised energy systems will be vessels which are carrying containers in a rather structural way. Based on expert opinion, this category consist in total of just a few hundred vessels almost exclusively concentrated on the Rhine countries and mostly in The

Netherlands, Germany and Belgium. Moreover, the container transport on shorter distances using canal networks is the main market, seen the limited need to swap battery containers during the journey, thus avoiding time loss during operation and limiting the loss of payload which affect the revenues for the vessel owner.

The current potential of just a few hundred vessels is subject to change depending on future developments. New vessels designed according to the containerised energy system concept could enlarge the potential. Furthermore, technological advancements in the battery industry, making batteries relatively lighter and more compact, could provide opportunities for the application of the concept on board of vessels carrying dry bulk or push boats.

Furthermore, in case of a disruptive innovation by a breakthrough of autonomous navigation with no personnel on board might invoke a large scale of new building of vessels. Especially as such innovation could involve modular vessels and serial production, there may be much bigger opportunities to apply ‘pay-per-use’ and also leasing of such vessels on the medium/long term.

Concluding, the potential of pay-per-use and leasing schemes for the European IWT market in the context of the transition towards a zero-emission fleet in 2050 will be rather limited on the short and medium term. Leasing will not play a noteworthy role under the current framework conditions. The situation is however a bit more beneficial for pay-per-use schemes, it is foreseen though that the potential will be, especially at first instance, limited to just a few hundred vessels, whereas the total European IWT fleet consists of approximately 12,263 vessels.

Ministry of Infrastructure and Water Management

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