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DOI

[10.1007/978-981-19-6138-0_11](https://doi.org/10.1007/978-981-19-6138-0_11)

Publication date

2023

Document Version

Final published version

Published in

Proceedings of PIANC Smart Rivers 2022 - Green Waterways and Sustainable Navigations

Citation (APA)

van Koningsveld, M., & Pauli, G. (2023). Presenting the Work of PIANC TG234 “Infrastructure for the Decarbonisation of IWT”. In Y. Li, Y. Hu, P. Rigo, F. E. Lefler, & G. Zhao (Eds.), *Proceedings of PIANC Smart Rivers 2022 - Green Waterways and Sustainable Navigations: Green Waterways and Sustainable Navigations* (pp. 122-134). (Lecture Notes in Civil Engineering; Vol. 264). Springer.
https://doi.org/10.1007/978-981-19-6138-0_11

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Presenting the Work of PIANC TG234 “Infrastructure for the Decarbonisation of IWT”

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Abstract. PIANC provides guidance and technical advice for sustainable waterborne transport infrastructure. To address the challenge of making inland navigation infrastructure sustainable, a Task Group “Infrastructure for the decarbonisation of Inland Water Transport” (TG234) was set up in January 2021. The objective of the TG was to identify knowledge gaps and major challenges that need to be urgently addressed and advise PIANC on further actions, such as setting up a working group. A report was to be delivered in early 2022. The TG involved a range of international experts who met every three months on-line. They jointly participated in the following activities: sharing experiences in their area of expertise; gathering, organising, and discussing literature; discussing the perspective to be taken while reporting; contributing an overview of the developments either in their country or organisations and of course in the various discussions. A final report was produced that took the perspective of the waterway manager, highlighting a number of key questions that need to be answered in the transition to reduced/zero emissions. With the state-of-art knowledge gathered by the group, it became possible to identify the existing knowledge gaps and the major challenges that need to be addressed. The report can guide PIANC in evaluating the best way forward to address the decarbonisation of IWT infrastructure.

Keywords: Inland waterway transport · Decarbonisation · IWT infrastructure · Alternative fuels

1 Introduction

The availability of zero-emission fuels infrastructure, including onshore electric power supply, will be key to enable zero-emission vessels and increase the competitiveness of IWT as a whole, at a time when other modes of transport are reducing their ecological footprint. To address the challenge of making inland navigation infrastructure sustainable, PIANC Task Group TG234 “Infrastructure for the decarbonisation of Inland Water Transport” was set up in January 2021. The objective of the TG is in line with the declaration of PIANC, namely developing approaches to decarbonise the operation of port and navigation infrastructure (i.e. move to net-zero emissions), whilst at the

same time enabling the reduction of greenhouse gas emissions from vessels by providing the necessary facilities, infrastructure and, where appropriate, incentives. For this purpose TG234 was tasked to identify knowledge gaps and major challenges that need to be urgently addressed and advise PIANC on further actions. The findings of TG234 have been written down in a final report that has been submitted to INCOM (PIANC 2022). The report serves as a coarse knowledge base to guide further steps towards a rational approach to developing infrastructure for the decarbonisation of IWT.

2 Approach

The steps taken by the TG to identify knowledge gaps and challenges are listed here briefly. As suggested in the Terms of Reference (TOR dated October 1st 2020) and to provide first insights into the decarbonisation of IWT, TG234 compiled key developments per country/organisation that participated in the TG. Similarly, main developments per energy carrier were also compiled. These compilations or briefing notes form an integral part of the report and are summarized in Chapter 3. Next, attention was given to the questions that an actor striving for decarbonisation would have. A comprehensive list of questions was drawn up in Chapter 4 and an approach was suggested over how to answer them in Chapter 5. Some conclusions are drawn in Chapter 6.

3 Key Developments Related to Decarbonisation of Infrastructure

A feasible starting point for the members of TG234 was to create briefing notes on key developments on zero emission IWT as they observed them in their own countries/organisations. In the following, short summaries per briefing note are included. Next to the key developments per organisation or country, briefing notes were also made of a number of promising new energy carriers. It is clear that the work done so far is not yet comprehensive at global scale, but it provides an inspiring first step.

3.1 Key Developments per Country or Organization

Short Report Decarbonisation IWT Europe. In 2019, the European Union presented the European Green Deal with the aim of ensuring that the continent is greenhouse gases (GHG) emission-free by 2050. In July 2021, the European Commission adopted a set of proposals (Fit for 55 package) to make the EU's climate, energy, transport and taxation policies fit for reducing net GHG emissions by at least 55% by 2030. The initiatives include Alternative Fuels Infrastructure Regulation (AFIR), the Renewable Energy Directive (RED) and the Energy Taxation Directive (ETD). AFIR supports the deployment of alternative fuels infrastructure, including refueling points for natural gas and hydrogen. Member States are required to set up

national policy frameworks to establish markets for alternative fuels and report their progress. RED deals with the promotion of energy from renewable sources and has set a binding target to produce 40% of energy from renewable sources by 2030. The ETD aims to ensure the proper functioning of the EU internal market by ensuring that energy taxation is aligned with climate objectives.

Short Report Decarbonisation IWT CCNR. The Central Commission for the Navigation of the Rhine (CCNR) has drawn up a roadmap (Adopted on 9 December 2021) to lay the foundation for a common approach to the energy transition and emissions reduction by all stakeholders. This roadmap should be understood as the primary CCNR instrument for climate change mitigation and setting transition pathways for the fleet (new and existing vessels), suggesting, planning, and implementing measures directly adopted or not by the CCNR, and monitoring intermediate and final goals set by the Mannheim Declaration. In 2021, CCNR published the results of in-depth studies over financial instruments to be seen as part of a broad discussion process at Rhine, European and international level. It mandated its committees to feed the study results into the PLATINA3 project, desiring an action plan for the further development of a European funding and financing instrument to be drawn up and detailed. CCNR regularly organizes workshops on innovative technologies.

Short Report Decarbonisation IWT Austria. The current political ambitions to decarbonise IWT in Austria are higher than those on European level. The Mobility Masterplan 2030 and Government Programme 2021–2027 make concrete recommendations while also committing to endeavours such as installing shore power units. Implementation projects prepared by the Austrian waterway company, Viadonau, include the installation of shore power supply for cargo vessels at selected existing and future berths, and implementation plans for cruise vessels are underway. CCNR and Viadonau have set up an international conference aiming at international harmonisation of technical standards and the operational and billing systems of a future shore power system along the European waterways.

Short Report Decarbonisation IWT France. In order to meet the GHG emissions reduction targets in the transport sector, policies have been set up for the inland navigation sector. The “Mobility orientation Act” of 2019 eased the establishment of low emission zones (ZFEs) while the “National hydrogen plan” of 2018 aims at achieving mass-production of green hydrogen as a fuel for mobility. A bill entitled “Delivery of a vessel certificate for a restricted navigation”, that was introduced in 2019 allowing green vessels to derogate from the EU technical regulations if they operate on a limited journey in an area of local (national) interest, has proven efficient. As a result, the French inland fleet will welcome hydrogen and GNC powered vessels in the coming years.

Short Report Decarbonisation IWT Germany. The Federal Climate Protection Law (Bundes-Klimaschutzgesetz – KSG), amended by the German Federal Parliament in 2021, aims to achieve GreenHouse Gas (GHG) neutrality in Germany by 2045. The Federal Ministry for Digital and Transport (BMDV) will support climate friendly inland navigation with subsidies for decarbonisation and development of inland waterway infrastructure as well as with research and development. It has commissioned

work, to be published in 2023, to develop energy efficiency indices for inland navigation together with a proposal for their practical implementation. German IWT companies are already investing in climate neutral vessels. The report concludes that IWT in Germany has a chance to survive, when it will be innovative and when there will be an adequate regulation for GHG emissions from transport, including carbon pricing, that honours the inherent energy efficiency of IWT.

Short Report Decarbonisation IWT Netherlands. The targets for emissions reduction in the Netherlands have been drafted in the Dutch Green Deal on Maritime and Inland Shipping and Ports (2019), signed by various governmental authorities, trade associations, ports, sector representatives and research institutes, each with a list of planned actions. Numerous initiatives have been launched e.g., investing in shore power facilities for around 500 state berths, a national ban on degassing while sailing (to be introduced step by step), examining blending biofuel obligation in inland shipping vessels. The Dutch national government has set up a supporting system for innovations such as fully emission-free powered ships for the inland shipping sector. Funding schemes have been put in place for greening of the Dutch fleet. Another initiative to stimulate the decarbonization of the fleet is a new labelling system for inland vessels' emissions performance. Attention will be given to the necessary bunkering infrastructure and the safety requirements and legal framework to facilitate the introduction of new energy carriers in the inland waterway sector in the coming year.

3.2 Key Developments Per Carrier

Short Report Hydrogen for Propulsion. Pressurized hydrogen storage is currently furthest developed for mobile applications (inland shipping) and is the most applied method in current hydrogen vessel projects. Liquid hydrogen could be an option as a mid-term solution when liquefaction plants are built and the fuel price comes down. Bunkering can take place via four different configurations: truck-to-ship, ship-to-ship, bunker stations and swapping of tank-containers and depends on the physical state in which hydrogen (pressurized, liquid or hydrogen carrier) is stored on board inland navigational vessels. The most feasible scenario for the short-term is swapping pressurized hydrogen in swappable containerized containment systems (tube-containers) at container terminals. Regulations for the use of hydrogen on board of-, and bunkering of hydrogen to inland navigational vessels are still under development. The availability of hydrogen as a fuel for vessels relates to hydrogen fuel production as well as to provision of bunkering infrastructure in a sufficient number of ports in the operating area. Strategic engagement of a large industrial player (gas producer, utility company, oil or energy major), who is not only aiming at supplying (moderate amounts of) green hydrogen to inland waterway vessels but also to large consumers along the Inland Waterways, is required for a breakthrough.

Short Report Biofuel for Propulsion. Rapeseed methyl ester, also known as OLEO100, is a biofuel produced exclusively from rapeseed oil. It can be used in its pure form and does not need to be mixed with a fossil fuel. It has an energy density

comparable to that of diesel (slightly lower). Similar to diesel/gasoil, OLEO100 is used in internal combustion engines and can be mixed with diesel, it is therefore compatible with existing conventional propulsion systems. It is mainly used by heavy road vehicles, but it is being tested for application on inland vessels. Currently, refuelling is done either by refuelling trucks or directly by drums delivered to the refuelling station. It can be regarded as a conventional fuel when it comes to existing rules. OLEO100 is not considered harmful for human nor the environment, no specific policies are needed. Infrastructure changes required are minor and costs are therefore negligible compared to other alternative fuels. If available on location, OLEO100 refuelling specifics are comparable to those of conventional fuels; since comparable energy density and viscosity means comparable volumes and refuelling times. The main challenge is the long-term availability of this fuel if it is widely adopted.

Short Report Methanol for Propulsion. Methanol is a climate neutral fuel, when it is produced from renewable energy and can be used as fuel for combustion engines or for fuel cells. Methanol has a low energy density compared to gasoil/diesel fuel. Otherwise, it is rather similar to diesel/gasoil and be used for all applications. Bunkering is possible from bunkering vessels, tank trucks and fixed tank stations. The required safety distances are also similar to diesel/gasoil. Safety risks during methanol transport are well understood and safety measures in place. Technical requirements and standards for methanol as fuel on inland navigation vessels are under development in Europe. Infrastructure costs are on the same level as for diesel/gasoil and low in comparison to other alternative/climate neutral fuels. More refuelling (bunkering) stops are needed because of low energy density. The main challenge is the high cost for methanol itself, when it is produced from renewable energy. Otherwise, methanol could become a standard fuel for inland navigation.

Short Report Battery Electric Propulsion. A battery electric propulsion system consists in general of rechargeable batteries, electric switch board and an electric propulsion system. Because of low energy density, battery electric propulsion is most suitable for ships that travel short distances (between stops). Fixed batteries require electric charging points at mooring places and exchangeable batteries require cranes, e.g., on container terminals with nearby charging point. Infrastructure costs are high as many charging points are needed and as rechargeable batteries for inland navigation vessels require a high-capacity power supply. Battery fires are rare, but hard to control. Technical requirements and standards for rechargeable batteries exist or are under development. In Europe, national and EU policies support the implementation of charging points at suitable locations of the inland waterway network. Battery costs are expected to further decrease, and energy density will increase, allowing battery electric propulsion becoming a technical and economically feasible alternative for certain inland navigation tasks. According to the latest RWS studies on the safety aspects of new energy carriers, the surrounding safety zones between the location of the battery containers and the surrounded buildings can be as low as 5 m. The most important recommendation is the location awareness for energy services. This is particularly important in case of shipping accidents.

4 Relevant Questions for Waterway Managers

4.1 General

From Chapter 3 it can be concluded that the path to decarbonisation of IWT is different for different corridors and in different countries. While a relatively short list of potential energy carriers appears to emerge when discussing decarbonisation, which carrier (or a mix of carriers) is likely to emerge as preferred depends on a whole range of local situations. In practice, it is seen that vessels owners and bunker station operators have a strong influence on the alternative energy carriers they would like to use (bottom-up). But at the same time, the question whether a selected alternative energy carrier is going to be successful at the corridor scale can depend on a range of policy measures and subsidy schemes (top down). While momentum for change appears to be stronger bottom-up, TG234 considered that a top-down approach could provide a stronger rational framework. So while fully aware of the bottom-up as well as the top-down perspective, TG234 decided to take on the perspective of a waterway manager that faces the need for decarbonisation of his/her waterway. By discussing step-by-step the kind of questions that arise, a structured approach to decarbonisation emerges.

4.2 List of Questions

TG234 foresees that a waterway manager that seeks to decarbonise his/her network encounters the questions listed below:

- i. What are the most promising technologies (or energy carriers) for the decarbonisation of IWT?
- ii. What is the overall transport challenge in my network (amount of cargo, number of passengers, from where to where now and in the future)?
- iii. What is the state of the water transport network and of the fleet that operates on it (proportion of vessels of given type/classification, now and in the future, alternative transport modes)?
- iv. What is the energy consumption that is associated with the transport challenge, given the current and future state of the network as well as of the fleet and the waterway conditions in the future considering impacts of climate change? (Emission hotspots?)
- v. What type of energy carriers can replace the current ones, what quantities of fuel are needed where, and how will these fuels affect range, payload, velocity, etc.?
- vi. Where should we position bunkering points or refuelling stations? What are the charging/fuelling times and the waiting times at refuelling stations?
- vii. How can the estimated demand for alternative fuels (electricity, hydrogen, methanol, etc.) be supplied over the network?
- viii. What are the standards or existing regulations that must be followed?

What are the most promising technologies (or energy carriers) for the decarbonisation of IWT?

The impact on the infrastructure for the decarbonisation varies substantially with the different energy carriers. As was shown in the short reports of the previous chapter,

biofuel for decarbonisation allows for continuous use of the existing refuelling infrastructure, whereas a switch to electric propulsion would require building a totally new infrastructure. Furthermore, none of the future energy carriers is suitable for all transport tasks. Therefore, the waterway manager is well advised to get a good understanding of the different technologies or energy carriers for the decarbonisation of IWT. This will also help him or her to efficiently consider the following questions.\

What is the overall transport challenge in my network (amount of cargo, number of passengers, from where to where, now and in the future)?

It is important to consider what the transport challenge is in the network. The type and amount of cargo that needs to be transported, in combination with the origin and destination of this cargo, determines the demand for transport and also the location of the bunkering infrastructure of the new energy carriers. It is also important to assess whether or not there are alternative transport modes that are likely to compete with inland shipping.

What is the state of the water transport network and of the fleet that operates on it (proportion of vessels of given type/classification, now and in the future, alternative transport modes)?

When it is clear what the transport demand is depending on future traffic flows and the vessels required to transport it, it becomes important to assess the potential for transport over water.

Looking at the state of the water transport network will reveal the vessel classes (PIANC 2020) that will be able to fulfil the transport demand. The maximum vessel class that can operate on a waterway is typically restricted by a maximum available air draught (e.g., due to the presence of fixed bridges), a maximum allowable width, length and draught (e.g., due to the presence of locks) and the presence of other width and depth bottlenecks (Van Dorsser et al. 2020; CCNR 2021c; Vinke et al. 2022). Other aspects that can come into play are traffic intensity and environmental aspects like wind and current. The state of the waterway, the available water depth and the ambient current conditions influence the amount of energy that is associated with the transport function.

The waterway classification determines the maximum size of the vessels that can use it. Beyond that it is important to know the composition of the fleet that is available to perform the transport function on the waterway network. Not all vessels that are part of the fleet will be of the maximum size. Smaller vessels will need more trips to transport the same amount of cargo compared to larger ships. Older vessels might still have older engines that may perform less when it comes to emissions. Also, it is important to assess the availability of alternative transport modes, e.g., road, rail, pipeline. When alternatives are available *and* capable to accommodate a significant modal shift, this will put more pressure on the inland shipping sector to adopt/convert to other energy carriers.

What is the energy consumption that is associated with the transport challenge, given the current and future state of the network as well as of the fleet and the waterway conditions in the future considering impacts of climate change? (Emission hotspots?)

When the transport demand (volumes, origins, destinations), the state of the waterway network (e.g., water depths, currents), and the state of the fleet (composition, engine

ages, etc.) are known, the associated energy demand for transport can be estimated using vessel resistance algorithms (Bolt 2003; Vehmeijer 2021; Segers 2021; Van Koningsveld et al. 2021; Rijkswaterstaat, 2022a, b) (Fig. 1).

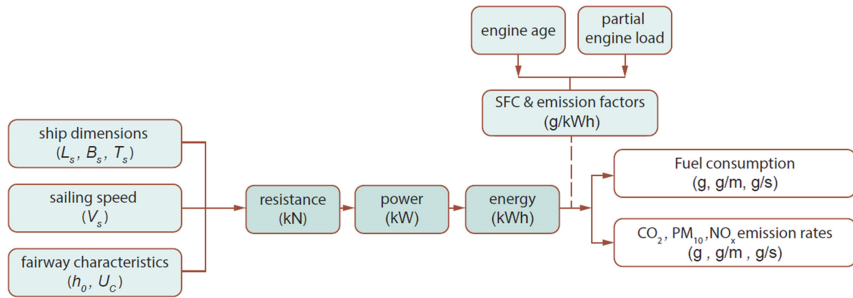


Fig. 1. Methodology for estimating emissions for IWT vessels (image modified from Segers, 2021, by TU Delft Ports and Waterways is licenced under CC BY-NC-SA 4.0)

For modern waterway networks that are already actively used, the availability of Automatic Identification System (AIS) data can be an important source of input. Depending on the country of origin, digital information on the state of the waterway network may also be openly available.

AIS data, combined with waterway network data, can be utilised to provide a promising first estimate of the energy demand that is associated with the transport function. To estimate future demands, growth/shrinkage scenarios can be of use.

Table 1. General SFC and emission factors of CO₂, PM10 and NO_x for diesel fuel and different engine construction year classes (source: Ligetink et al. 2019 and modified based on the emission standards described at DieselNet (2021)).

construction year classes	weight class	Fuel consumption [g/kWh]	CO ₂ [g/kWh]	PM10 [g/kWh]	NO _x [g/kWh]
1900–1974	L1–L3	235	746	0.6	10.8
1975–1979	L1–L3	230	730	0.6	10.6
1980–1984	L1–L3	225	714	0.6	10.4
1985–1989	L1–L3	220	698	0.5	10.1
1990–1994	L1–L3	220	698	0.4	10.1
1995–2002	L1–L3	205	650	0.3	9.4
2003–2007 CCR-1	L1–L3	200	635	0.3	9.2
2008–2018 CCR-2	L1–L3	200	635	0.2	7
2019–2019 CCR-2	L1–L3	200	635	0.2	7
2019–20xx STAGE V	L1	205	650	0.1	2.1
2020–20xx STAGE V	L2 and L3	190	603	0.015	1.8

It is useful to take the energy consumption (kWh) as a basis for analysis, since empirical information is typically available to estimate the associated fuel consumption, via so-called Specific Fuel Consumption factors (g/kWh) (Table 1). When assumptions are made on partial engine loads and engine ages also CO₂ and environmental pollutant emissions can be estimated (Hulskotte 2013; Smart Freight Centre 2019; Wijaya et al. 2020).

It may be worthwhile to validate these coarse estimates with actual energy consumption, fuel use and emissions. Also, it will be useful to document the current locations and capacities of bunker facilities.

With the above method so-called energy consumption, fuel use and emission footprints can be generated for individual vessels. Overall patterns can be generated by aggregating the footprints of individual vessels that together represent the traffic on a corridor (Jiang et al. 2022).

Such heatmaps, created from individual contributions, can be used to identify hotspots and identify root causes. This information can be used to design policies to reduce emissions (Segers 2021). On the long term such policies will probably involve zero emission energy carriers, but in the years before those other measures may be necessary in an effort to reduce emissions.

More coarse methods to estimate energy consumption, fuel use and emissions may also be used. Various methods are available that estimate fuel use per tonne kilometre (tkm) based on empirical data. While these methods are easier to use, especially in situations of limited data availability, they are less useful to test new situations. The most practical way forward as such is a trade-off.

What type of energy carriers can replace the current ones, what quantities of fuel are needed where, and how will these fuels affect range, payload, velocity, etc.?

Once the total energy demand, fuel use and emissions, as well as the locations and capacities of current bunker facilities are known, it becomes possible to estimate the required volumes in case alternative energy carriers would be considered.

Alternative energy carriers will have a different energy content than more traditionally available options. Also, other energy carriers may involve alternative energy conversion systems. For each energy carrier/energy conversion combination it should be investigated what the potential influence on sailing range, payload amount and sailing velocity is. If only the sailing range is affected, an increased number of bunker stops is the main transport efficiency impact. If the range remains the same but the amount of payload is affected, the main transport efficiency impact is an increased number of trips required to transport the same amount of cargo.

Where for the previous question AIS data could be used as a basis for quantification of the current state, testing the effectiveness of alternative policies requires simulation. A common approach for this these days is the use of agent-based meso-scale simulation models (Van Koningsveld and Den Uijl 2020; Jiang et al. 2022). With such models the effect of changes to the vessels (the agents) can be assessed beforehand.

A typical question is of course what performance indicators are most suitable. Given that a known amount of cargo needs to be transported a typical measure of transport performance is the unit of tonne kilometre (tkm), or the tons of cargo times the km of distance over which it needs to be transported. Obviously, an important indicator is the

cost of transport. When we are interested in energy, fuel and emission efficiency respective units of kWh/tkm, g fuel/tkm and g emission/tkm become relevant.

It is good to realise that in the cost and emission units the efficiency of the transport chain becomes visible. Let's imagine that 3.000 tons of cargo need to be transported over 100 km. Then the transport performance can be expressed as $3.000 \times 100 = 300.000$ tkm. This performance is irrespective of vessel size. But now let's assume this cargo is transported with a vessel that has a capacity of 3.000 tons or a vessel that has a capacity of 1.500 tons. In the first case the cargo can be transported by 1 full trip to the destination and 1 empty trip back to the origin. In the second case 2 full trips and 2 empty trips are needed to transport the same amount of cargo.

Depending on local circumstances and vessel properties this will result in different emission patterns: there is good chance that the second option will have a poorer total efficiency in terms of e.g., g CO₂/tkm, at the same time the emission source in terms of g CO₂/s or g CO₂/km can be lower since the emission will be spread out over time. While for CO₂ the totals are likely to be of interest, the actual peak values may be of interest for other environmental pollutants like fine particle emissions such as PM10. It will also be interesting to see what the cost effects are the situation will be complicated further when aspects like ambient current and available water depth are included. It is clear that the total performance of the IWT mode is complex. An increasingly popular approach these days is that the effects of policies are tested in simulation models or digital twins. It is necessary to do this since relying on intuition or coarse empirical data may yield unreliable results. Especially since the use of alternative energy carriers can affect things like sailing range (refuelling more often, and possibly taking longer/shorter), amount of payload that can be carried (more trips required) and perhaps the velocity profile that can be achieved. Information on refuelling/charging times and waiting times will influence the cost competitiveness of a suggested solution.

Where should we position bunkering points or refuelling stations? What are the charging/fuelling times and the waiting times at refuelling stations?

Insight in the total energy demand over the network tells the waterway manager something about the capacity requirements of the bunker stations/charging stations on the network. Insight in the range of vessels for different energy carrier/energy converter combinations will tell the waterway managers something about the maximum inter-distance of the bunker stations/bunker vessel.

How this all works out in detail will depend on the current vessel mix, and scenarios for possible future vessel mixes as well as on scenarios for the energy carrier mix that is assumed to be used on the network.

It is good to realise that also developments in other transport modes will be of interest, as well as developments in other corridors. In the end the selected solution (or mix of solutions) must be price competitive compared to available alternatives. Unless the other transport modes lack the capacity to accommodate a modal shift, poor price competitiveness will lead to the decline of the IWT mode.

How can the estimated demand for alternative fuels (electricity, hydrogen, methanol, etc.) be supplied over the network?

Insights in potential locations and capacities of alternative fuel bunker points are already an important step forward. But the availability (and cost) of alternative energy

carriers may also be a deciding factor. When the supply of sufficient amounts of a given energy carrier is problematic, a preferred energy carrier, while potentially suitable, might not become the implemented solution. Availability of certain energy carriers can vary significantly from one location to the next. This is at least one of the reasons why it is not possible to point to any one energy carrier as a preferred solution that fits all.

What are the standards or existing regulations that must be followed?

Next to demand for and the potential supply of alternative energy carriers, another important factor for likely success or failure of an energy carrier is the presence/absence of regulations. Mandatory safety margins for example, may pose inhibiting restrictions on the implementation of a given energy carrier.

5 Suggested Approach to Answer the Questions

The questions posed in Chapter 4 are key for any waterway manager to contemplate while decarbonising the IWT mode. TG234 suggests that these questions should be addressed first before detailed guidance can be provided on the actual dimensions of the required energy-related infrastructure components. It makes a big difference if you are dealing with a very busy shipping corridor that supports a wide range of vessels and substantial cargo flows, or a much smaller waterway that caters to a limited number of vessels and only one cargo type. Or if you are dealing with a waterway system that has substantial current vs one that has more calm conditions. In any case, waterway managers need a good understanding of the most promising technologies and energy carriers for the decarbonisation of IWT. Therefore, PIANC could compile the information that allows waterway managers to gain this understanding without having to do their own research.

6 Conclusions

The report concludes that PIANC could consider setting up a WG that focuses on the methodological approaches in the field of decarbonisation of inland waterway infrastructure that are at different development stages at an international level. A subsequent PIANC WG could work on coupling guidelines with the currently lacking standards in the field. A complicating factor is that insights on decarbonization are still very much under development. As a result it may not be easy to collate best practices since these are continuously being developed and updated. An alternative could be to approach the decarbonisation challenge with a Permanent Task Group/Strategic Initiative, such as the Permanent Task Group on Climate Change.

Acknowledgements. The report on which the paper is based has been produced by an international Task Group convened by InCom, comprising the following members (in alphabetical order): Cees Boon, Peng Chuandsheng, Nathaly Dasburg-Tromp, Turi Fiorito, Man Jiang, Mark van Koningsveld (chair), Hugo Lopes, Ulf Meinel, Hyumin Oh, Baptiste Panhaleux, Gernot Pauli (co-chair) and Poonam Taneja.

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