PLATINA3
IWT policy platform

D5.1 Report on consolidated R&D roadmap and implementation plan for IWT

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Table of Contents

Executive Summary

Across the four thematic PLATINA3 work packages “Market”, “Fleet”, “Jobs & Skills” and “Infrastructure” four horizontal topics are distinguished:

- **Climate resilience**
- **Climate change mitigation and air quality improvement**
- **Digitalisation**
- **Modal shift**

Climate resilience is understood as readiness to deal with worst case scenarios resulting from a progressively changing climate. Here, direct impacts, e.g. caused by droughts leading to low-water conditions or sudden events like severe precipitation leading to flooding can play an important role. In addition, indirect impacts in particular in association with water scarcity have to be considered too. E.g. the extraction of water for agricultural purposes caused by insufficient precipitation may result in conflicts of interests between the different stakeholders of waterways what for the inland waterway transport (IWT) sector has to become prepared, demanding an integrative approach involving all relevant stakeholders. This topic and scope concerns not only the rivers and free flowing sections on the Rhine-Danube corridors, but also canal waterway networks in Europe. Therefore, the whole TEN-T waterway network is concerned and needs to be addressed.

In PLATINA3, climate resilience was mainly addressed in the Tasks 2.2 and 4.1 to conclude and recommend on the actions required to adapt vessels (Task 2.2) as well as the infrastructure (Task 4.1).

The topic of **climate mitigation and air quality improvement** concerns the transition to low or zero-carbon intensity energy usage by inland vessels and the reduction of the air pollutant emissions (NOx, PM) of vessels. This was addressed in PLATINA3 Tasks 1.5, 2.1, 2.5, 2.6, 2.7, 3.1 and 4.2. In Task 1.5 it was concluded that for a successful modal shift from road towards inland waterway transport, the vessels need to be competitive with the emission performance of low/zero-emission trucks, which are expected to become operational in the near future. In Tasks 2.1, 2.5-2.7 detailed conclusions and recommendations have been made in terms of the actions needed for the fleet to enable this transition. In Task 3.1 attention was paid to the requirements relating to jobs & skills in terms of the competences of the workforce. In Task 4.2 attention was paid to the energy supply infrastructure along waterways and in ports, which also requires a drastic development to be able to supply the vessels with low/zero-carbon energy.

The topic of **digitalisation** is not a goal by itself but an important supporting development required to remain competitive and to improve the connectivity to ports, other transport modes and the clients (e.g. to keep the direct costs low and to allow synchromodal solutions). As was made clear in Task 1.3, digitalisation as well as digital integration is crucial to increase the modal share of IWT and to be able to significantly contribute to the modal shift goals as presented in the EU Green Deal. Automation may also support navigation in becoming even safer and more efficient. In addition, automation contributes to overcoming difficulties associated with the shortage of personnel by increasing the attractiveness of working in the IWT sector. The latter became clear from Tasks 2.3, 3.3 and 4.3.

Last but not least there are specific RD&I recommendations from the tasks on achieving **modal shift and increasing the use of inland waterways**. However, it shall be noted that the modal shift opportunities do heavily rely on the first three topics. Without climate resilience, vessels will not be able to sail economically, while green vessels and digitalisation will be required by the future clients. For modal-shift, specific RD&I actions are required and have been identified in Tasks 1.1 and 1.2 and partially in

Task 1.3. They discus for example the actions needed to unlock the potential of new markets, or the implementation of new loading units and transhipment systems.

The following sections present the main conclusions on the identified RD&I topics which are not yet addressed in the Horizon Europe (HEU) Working Programme 2021-2024. Therefore, these identified topics are considered the PLATINA3 recommendations for RD&I topics to be addressed in the upcoming calls of the Horizon Europe working programme for the next years (2025-2027).

The focus of this report is on the recommendations for further research to be programmed in Horizon Europe. It needs to be stressed that in parallel also attention is needed to support the deployment of innovations, for example on European level by means of calls in CEF and Innovation Fund.

Climate resilience

Relating to climate resilience **two RD&I topics** have been identified (based on the work in WP2"Fleet") in relation to fleet adaptation. These are focussing on raising the climate resilience of inland vessel designs and improved forecasting of climatic conditions.

Research on inland vessel designs with a higher degree of climate resilience can be supported by a series of RD&I efforts. This concerns the development of new materials, new bow thrusters, adaptation of existing vessels, research on framework conditions for vessel design, impact of new energy carriers and zero-emission solutions on vessel draft in view of low water events, prediction of ship operation and model tests.

In addition, RD&I efforts are also needed with respect to the provision of reliable data on and forecasting of climatic conditions, as a precondition for the proper retrofitting and design of inland waterway vessels. Future vessel adaptation measures shall thereby not negatively affect the operation of vessels at normal navigation conditions, e.g. increase the energy demand during normal conditions.

All research topics mentioned above as well as the ones to follow below become obsolete if a functioning infrastructure is neglected as it is the backbone of a working inland waterway transportation system. With respect to climate change and infrastructure, some research and development has been carried out. However, this is fragmented and mostly on a local level, e.g. the KLIWAS project for the German waterways, Climate Resilient Networks for the Dutch waterways or the last three Horizon Europe projects CRISTAL, PLOTO, ReNEW. A comprehensive picture with a common climate modelling basis is still missing, e.g. for the Danube region as highlighted in the PLATINA 3 Stage Event 3. This calls for one big or a few comprehensive climate change projects on European level involving all relevant representatives of member states concerned, which shall be continuously initiated. One or two small projects are considered not sufficient at all, taking into account the different geographical, technological and regulative conditions present in Europe on the TEN-T waterways. Hence, the RD&I items for the infrastructure side to be considered relate to:

- creating a data basis containing short and long term climate change projections,
- further development of integrative planning procedures for inland waterway infrastructure projects,
- development of innovative methods for waterway maintenance and management, and
- development of innovative methods for waterway surveying and measuring.

These topics are described in detail in the report. The approach has to be a multi-disciplinary one considering integrative planning in relation to navigation, the environment as well as other water users like industries with a need for water extraction or even land borne activities having an impact on the water regime of a river, e.g. sealing of wider areas impacting the ground water level or sudden discharge of rain into a river. PLATINA3 recommends therefore to launch a large integrated EU project to cover these elements taking into account the various types of waterways, stakeholders and disciplines.

Climate change mitigation and air quality improvement

Related to climate change mitigation and air quality improvements, **twelve RD&I topics** have been identified (stemming from all four work packages). Already some projects being currently implemented are being supported by Horizon Europe, such as SYNERGETICS and RH2IWER, while the Work Programme for 2023 also included calls for further development in this field (see also PLATINA3 Deliverable 2.1).

Clarity on a regulatory level is necessary for shipowners to take further steps towards energy transition, as well as for energy suppliers and related stakeholders on corridor level. Currently, several technologies of different maturity levels exist and it is not defined yet which will be dominant and approved for the next decades by regulations. This creates reluctance to invest.

There are specific subjects for further research identified, which have not yet been addressed in Horizon Europe 2021-2024, both on technological level but also in the field of standardisation, as well as on regulatory and policy level. Moreover, a mind shift will be needed among stakeholders, as well as setting the competence standards for education and training of personnel to work with the new energy carriers and technologies. In this respect there is a big need for more demonstration and pilot projects in this field. Projects and studies are needed for the further development of energy carriers like methanol, hydrogen and batteries as well as Onshore Power Supply (OPS).

As the impact of newly built vessels on the emission performance of the entire inland fleet is marginal, the adaptation of existing vessels – the so-called legacy fleet – also needs to be in the scope of research and demonstration projects. This includes also social and cultural aspects which may influence retrofitting opportunities such as the market structure and the demography of vessel owners. A range of specific research elements from the side of energy infrastructure has been identified in WP4 of PLATINA3. Last but not least the policy and regulatory framework needs dedicated attention to be brought in such a state that the use of new energy carriers is enabled. It shall aim at incentivising the use of clean energies, and provision of a competitive edge to the frontrunners in the inland waterway transport market.

Digitalisation

Related to digitalisation, some **17 RD&I topics** have been identified (stemming from the work packages 2, 3 and 4). A large share of the recommended RD&I activities addresses the automation of vessels as well as the waterway infrastructure and ports. This not only concerns the technical development, but also the regulatory development and competence standards for the human capital. In addition, digitalisation plays a key role in the integration of IWT in supply chains which carry out transportation tasks. Horizon 2020 projects such as AUTOBARGE and AUTOSHIP provide first insights to build upon.

Synchromodality brings added value, also in case of disruptions of logistic chains, while automation brings more flexibility to operations, fleet management and supply chain integration of IWT solutions into transport management platforms. This shall help to align all transport modes (focused on their particular segments) and to work towards future collaboration and coexistence rather than strong competition, where IWT was consequently losing its market share. This requires more attention to communication and exchange of information using novel technologies, while safeguarding privacy, data protection and cyber security. It requires also collaborative business models, joint investments and strong international cooperation (e.g. port community and exchange systems). Actions are needed with regard to automation and robotization. Enhancements and developments shall be carried out with respect to new situational awareness systems for multiple functions, combining physical and digital assets. Moreover, developments of advanced solutions and systems to support the progressive automation of nautical services for vessels are needed, as well as cargo handling and other port operations. Attention is needed on improved solutions for human-machine interactions, including the application of new technologies such as artificial intelligence, predictive analytics, big data and

augmented reality. This also requires the development of future-proof regulations to allow and support the successful uptake of these innovations.

Modal shift / increased use of inland waterways

Relating to modal shift, **four RD&I topics** have been identified (stemming from WP1 Market). The project SEAMLESS is already funded in Horizon Europe and addresses the link with automation and integration with ports and other modes. Moreover, the Horizon Europe Work Programme 2023 includes a call for projects "developing small, flexible, zero-emission and automated vessels to support shifting cargo from road to sustainable Waterborne Transport" which addresses several research needs identified in PLATINA3.

Further attention needs to be paid to new markets which can be unlocked for IWT. Here, as an example, the energy transition provides an opportunity, as RD&I is recommended to investigate and showcase how IWT can be developed to transport alternative energy as well as (captured or green) CO_2 as well as project cargo for wind turbines and other innovative technologies. There are other transport flows with market potential for IWT as well, such as continental cargo of palletised goods, recycling materials and also in city logistics with a revival of local canal networks. It is necessary to conduct (pilot) projects to analyse the viability of such new transport assignments using IWT. The implementation and analysis of such (pilot) projects deserve the necessary funding to gain knowledge and identify and address economic, financial, technical and regulatory obstacles and challenges, which need to be overcome to tap these new markets.

An overarching challenge and task in this context involve the creation of awareness. The competitiveness of IWT could be further strengthened by the development and implementation of communication and marketing activities displaying the advantages of IWT. Lessons should be learned and communication and marketing concepts should be further improved. It should be investigated how this can be done in the best way and which strategy and means/IT tools can best be used for this.

This can all be brought together in a comprehensive roadmap for modal shift also considering the greening and digitalisation aspect, i.e. the development of a roadmap for IWT-related modal shift and decarbonisation and integration in supply chains. It needs to discuss the type loading units to build on, the preferable transport modes to use for specific transportation tasks, the infrastructures to be developed, and incentives to be put in place with a time horizon towards 2050. Without such a roadmap, there is a risk that too many technologies will be developed in parallel (and many of them abandoned later) and that the overall (policy) objectives are not reached.

List of abbreviations

AFIR	Alternative Fuels Infrastructure Regulation
CAT	Connected and Automated Transport
CBAM	Carbon Border Adjustment Mechanism
CCNR	Central Commission for the Navigation of the Rhine
CDNI	Convention on the Collection, Deposit and Reception of Waste Generated During Navigation on the Rhine and other Inland Waterways
CEF	Connecting Europe Facility
CESNI	European Committee for Drawing up Standards in the Field of Inland Navigation
CFD	Computational Fluid Dynamics
CSRD	Corporate Sustainability Reporting Directive
DC	Danube Commission
DG MOVE	Directorate-General for Mobility and Transport
EC	European Commission
EGD	European Green Deal
EHDB	European Hull Database
EP	European Parliament
ETD	Energy Taxation Directive
ETS	EU Emissions Trading System
ETSI	European Telecommunications Standards Institute
ESR	Effort Sharing Regulation
ES-QIN	European Standards for Qualifications in Inland Navigation
ES-TRIN	European Standards laying down Technical Requirements for Inland Navigation
FF55	Fit for 55
GA	Grant Agreement
GDP	Gross Domestic Product
GHG	Greenhouse Gas(es)
H2020	Horizon 2020
HEU	Horizon Europe
ICE	Internal Combustion Engine
IWT	Inland Waterway Transport
IWW	Inland Waterways
LNG	Liquefied Natural Gas
NFRF	Non-Financial Reporting Directive
NRMM	Non-road Mobile Machinery

OPS	On-shore Power Supply
OPEX	Operational Expenditures
PM	Particulate Matters
RED	Renewable Energy Directive
RD&I	Research, Development & Innovation
RIS	River Information Service
SRIA	Strategic Research and Innovation Agenda
SSMS	Smart and Sustainable Mobility Strategy
SSS	Short Sea Shipping
STEERER	Structuring Towards Zero Emission Waterborne Transport
TEN-T	Trans-European Transport Network
Tkm	Tonne-kilometre
WP	Work Package
ZEWT	Zero Emission Waterborne Transport

List of Figures

1. Introduction

As described in the Grant Agreement (GA), PLATINA3 is a Horizon 2020 (H2020) project that provides targeted coordination and support activities to promote Inland Waterways Transport (IWT) in Europe. PLATINA3 makes the bridge towards future research, innovation and implementation needs within IWT in Europe. A key objective is providing the knowledge base for the implementation of the EU Green Deal in view of further development of EC`s IWT action programme (NAIADES) towards 2030. PLATINA3 addresses priority topics for the success of IWT:

1. integration & digitalisation of IWT in view of modal shift & synchromodality;
2. zero-emission, automated & climate resilient fleet;
3. skilled workforce anticipating to zero-emission & automation;
4. smart & climate resilient waterway and port infrastructure with clean energy hubs.

The PLATINA3 project and this Deliverable are thus structured around the fields of Market, Fleet, Jobs & Skills and Infrastructure.

This project's work package (WP5) addresses the broader 'Roadmaps and stakeholder engagement' topic and it is divided into five tasks according to the main issues that need to be addressed by the partners, each with its own deliverables:

- D5.1 Report on consolidated R&D roadmap and implementation plan for IWT;
- D5.2 Report on policy implementation plan for IWT (roadmap and matrix);
- D5.3 Report on framework plan for strategic interaction and formation of Advisory Board (AB);
- D5.4 – D5.9, 6 PLATNA3 Stage Events, one report for each of the six Stage events;
- D5.10 Report on "Towards a European IWT policy observatory".

Although there is no hierarchy of the tasks and deliverables in this WP, there is nevertheless a good connection between them. Thus, deliverables D5.4 – D5.9 are meant not just to present the summaries of the Stage Event discussions, but also to help identify which are the key takeaways from the stakeholders that the PLATINA3 partners need to include in their work. And a significant part of this information is relevant for the D5.1 content, either directly – in particular from the 5th and 6th Stage Events Reports – or via other PLATINA3 deliverables from other WPs. Deliverable D5.3 sets the framework for the work with the project's Advisory Board, which will provide both input to and the validation of the advanced D5.1 draft. The other two deliverables address either the current IWT policy aspects that the RD&I Roadmap needs to build upon, or the future policies that can/should help its faster implementation.

In addition to the information provided to D5.1 from the other WP5 deliverables, a vast amount of information from the other PLATINA3 WPs was integrated into the D5.1 content. This deliverable is in

fact a synthesis of the most important RD&I recommendations coming from the WP1-WP4 findings and conclusions.

Complementary to the PLATINA3 input, which includes the information gathered from the Advisory Board and the Stage Events, D5.1 also encompasses information extracted from the EC's previous Strategic Transport Research and Innovation Agendas, but also an analysis of the relevant past and on-going EU-funded RD&I calls and projects, particularly those from H2020 and HEU. This broad approach ensures that the final D5.1 presents a picture as comprehensive and accurate as possible of the main IWT needs and future activities in terms of RD&I and deployment/implementation.

2. General Framework and Methodology

2.1 Task Description

The objective of Task 5.1 is to prepare an overall RD&I roadmap and implementation plan for IWT based on the technical work in WPs 1-4, and in coordination with other relevant Research and Innovation Agendas.

As a first step, a structure to collect input for the roadmap and implementation plan had been developed by the partners, to ensure synergies and to avoid duplication of work with other WPs but also other documentation. This structure had then been used to coordinate and consolidate all technical inputs from WP1-4 and inputs received from external initiatives. Before concluding on the RD&I needs, a check was done whether the RD&I topics are already addressed fully or partially in the Horizon Europe Working Programme 2021-2024. This check enables to filter out the ones which already are addressed and allows to focus on the missing elements and topics in the RD&I Working programme for the year 2025-2027.

The final deliverable is directed towards the European Commission, Member States and Third Countries to ensure the content is taken up in relevant EU and national programmes, and distributed broadly by the PLATINA3 partners.

2.2 Structure of this document

The main structure of the document consists of:

- an overview and brief analysis of most relevant policies at the European level focused on IWT, with a potential impact on RD&I needs;
- four thematic chapters, each of them dedicated to one of the PLATINA3 project's thematic WPs: markets, fleet, jobs & skills, infrastructure. These chapters contain the main explanations and RD&I recommendations in the respective thematic areas;
- crosscheck of the identified topics with the Horizon Europe calls in WP 2021-2024
- the conclusions and recommendations.

3. Most relevant policy initiatives related to IWT

In this Deliverable, RD&I is seen as means to an end, namely to contribute to the solution of the most important societal challenges, that have been addressed in a series of recent European policies. PLATINA3's work comes in the context of the effort to achieve several targets by 2050, in particular those related to climate change & adaptation, digitalization and modal shift – increasing the use of IWT for passenger and in particular freight traffic.

The climate targets had been first enshrined at the international level, via the Paris Agreements, and then at the EU one, via the Green Deal and subsequently the 'Fit for 55' package (FF55 package). The latter creates the intermediate, 2030 climate-related targets at the EU level for different economic sectors, including for transport. They are reinforced by the Sustainable and Smart Mobility Strategy (SMSS) which, in addition to emissions reduction, also sets the goal of increasing transport by inland waterways and short sea shipping by 25% by 2030, and by 50% by 2050.

The SMSS provides for how the EU transport system can achieve its green and digital transformation and become more resilient to future crises, and some of its policy targets have a strong IWT focus:

- 90% reduction of greenhouse gas emissions in transport by 2050;
- by 2030, there will be at least 100 climate-neutral cities in Europe. Scheduled collective travel under 500 km should be carbon neutral by 2030 within the EU;
- transport by inland waterways and short sea shipping will increase by 25% by 2030, and by 50% in 2050;
- zero-emission (marine) vessels will be market-ready by 2030;
- by 2050, a fully operational, multimodal Trans-European Transport Network for sustainable and smart transport with high-speed connectivity.

Complementary, IWT has a dedicated policy instrument at the EU level, the NAIADES III Action Programme. The NAIADES III main objectives are to continue and enhance the modal shift (in particular for freight) towards the IWT, while at the same time making it 'greener', 'smarter' and more attractive and sustainable, also in terms of jobs. This comes as a continuation of the two previous NAIADES programmes that have contributed to the progress of the IWT sector, each of them benefitting from a supporting CSA call, which determined the two previous PLATINA projects.

The chapter provides an overview of the main policy developments at the European level relevant for the IWT, and how they impact both the sector and its RD&I activities. This chapter is focused particularly on the NAIADES-III Action Programme and the comprehensive 'Fit-for 55' package.

Consequently, the IWT is witnessing a series of 'push and pull' policy, legal, technical, financial and business factors that are paving its way towards a deep transformation by 2050, and whose main issue concern: the climate-related targets, climate resilience, digitalization and modal shift. And owing to these extensive challenges and opportunities, the PLATINA3 partners have embarked on a mission to help the sector further advance on its transformative pathway by building upon the previous PLATINA projects and other relevant activities, as well as proposing new solutions and activities. Deliverable D5.1 is designed to prepare an overarching RD&I roadmap that will help the IWT address these challenges and opportunities.

3.1 'Fit for 55' Package

The publication of the 'Fit for 55 package' (FF55 package) is the most recent development at the EU level. Launched on the 14th of July 2021, it is a package of EC proposals to make the EU's climate, energy, land use, transport and taxation policies fit for reducing net greenhouse gas emissions by at least 55% by 2030, compared to 1990 levels. They represent in fact the legislative tools to implement a major part of the European Green Deal and to achieve the targets set by the European Climate Law. All proposals are harmonised between themselves, to ensure a coherent overall approach.

In summer 2022 the European Parliament (EP) had started defining its views and counterproposals on the different legislative acts encompassed in the FF55 package, and at the time this deliverable had been finalised the EC, EP and the Council were engaged in trialogues to reach a common agreement on the final versions of these texts.

The legislative proposals that have may have a significant impact on the IWT and the transversal aspects relevant to all the segments of the waterborne transport sector are outlined below, and a succinct analysis is presented.

It must be underlined that the information below concerns the situation of the EU legislation as of November 2022, and that the final legal texts may differ from the information presented below.

The Effort Sharing Regulation

The Effort Sharing Regulation[1] (ESR) assigns strengthened emissions reduction targets to each Member State for buildings, road and domestic maritime transport, inland waterway transport, agriculture, waste and small industries. Recognising the different starting points and capacities of each Member State, these targets are based on their gross domestic product (GDP) per capita, with adjustments made to take cost efficiency into account.

The Renewable Energy Directive

The Renewable Energy Directive (RED)[2] update, as proposed by the EC, will set an increased target to produce 40% of the Union's energy from renewable sources by 2030. All Member States will contribute to this goal, and specific targets are proposed for renewable energy use in different sectors, including transport. *Thus, the proposal introduces a target for reducing the greenhouse gas intensity of transport fuels by 13% by 2030 compared to 2010 level*. However, Member States may decide for themselves how to distribute the targets over the different transport modes which are fuelled in their countries. The targets are not necessarily the same for all modes and differences can occur between Member States. This brings risks with the principle for striving for an equal level playing field.

Another potentially relevant aspect is that in order to meet both the climate and environmental goals, sustainability criteria for the use of bioenergy are strengthened and Member States must design any support schemes for bioenergy in a way that respects the cascading principle of uses for woody biomass.

[1] Effort Sharing Regulation | European Commission (europa.eu)
[2] Amendment to the Renewable Energy Directive to implement the ambition of the new 2030 climate target | European Commission (europa.eu)

In more detail, the revised RED encompasses:

- the increase of renewable electricity is foreseen to also be used to produce (more) *synthetic fuels for hard-to-decarbonise transport sectors* such as maritime transport;
- the roll-out of more renewable energy and electrification is translated into an expanding charging infrastructure. In view of the long-life span of recharging points, *requirements for charging infrastructure* should be standardised (or at least harmonised) and kept updated in a way that would cater for future needs, and would not result in negative lock-in effects to technology and services' developments;
- increasing the level of the energy-based targets on advanced *biofuels and biogas*, coupled with the introduction of a target for renewable fuels of non-biological origin, should ensure an increased use of the renewable fuels with the smallest environmental impact in transport modes that are difficult to electrify. Consequently, for the 2050 milestone there is a likely increased demand for advanced biofuels, especially in the waterborne transport sector;
- the EU will maintain the 'multipliers'[3] as one of the incentives for the uptake of renewable energy in certain sectors (a multiplier of 1.2 for maritime), thus allowing to account more than the actual energy content consumed. A multiplier of 2 for biogas and advanced biofuels produced from certain feedstocks is also incentivised in such a manner;
- a key element intertwined with the RED is the forthcoming Offshore Renewable Energy Strategy. It *introduces an ambitious objective of 300 GW of offshore wind and 40 GW of ocean energy across all the Union's sea basins by 2050*. Member states should jointly define the amount of offshore renewable generation to be deployed within each sea basin by 2050, with intermediate steps in 2030 and 2040. These objectives should consider the offshore renewable energy potential of each sea basin, environmental protection, climate adaptation and other uses of the sea, as well as the Union's decarbonisation targets. This is a tremendous opportunity for the ZEWT partners to not only get a better image of the energy sources that they could (almost) directly use, but also to be involved in some of these developments.

The EP proposals to the EC text contain the following main aspects of relevance for the waterborne transport sector: the share of renewable energy to be raised to 45% by 2030; in the transport sector, deploying renewables should lead to a 16% reduction in greenhouse gas emissions, through the use of higher shares of advanced biofuels and a more ambitious quota for renewable fuels of non-biological origin such as hydrogen[4].

[3] The achievement of RED targets by the Member-States is facilitated by several 'multipliers' on energy content, both for the transport sectors and for specific fuels. This is done through their use in the calculation of the share of renewable energy in the transport sector (via a methodology is provided by the EC). For the maritime sector it means that the renewable fuels consumed are counted with a weighting of 1.2 in the formula used for the share of renewable energy targets.

[4] Parliament backs boost for renewables use and energy savings | News | European Parliament (europa.eu)

The revised Alternative Fuels Infrastructure Regulation

The revised Alternative Fuels Infrastructure Regulation (AFIR, the former AFID)[5] caters for the deployment of infrastructure for certain alternative fuels that require distinct infrastructure and that are market ready. Though this is aimed in particular at the road transport sector, some of its provisions are relevant for the IWT as well – in particular, the Regulation requires that ships have access to clean electricity supply in major ports on the TEN-T network.

In more detail, the relevant provisions for the waterborne transport sector are the following:

- as stated in its explanatory memorandum, the proposed regulation "delivers on the clear requirement of the European Green Deal to oblige docked ships to use shore-side electricity. It is fully complementary to FuelEU Maritime Initiative by ensuring that *sufficient shore-side electricity supply is installed in ports to provide electricity while passenger ships (including ro-ro passenger ships, high speed passenger crafts and cruise ships) and container vessels are at berth, and accommodating the demand for decarbonised gases*, i.e. bio-liquefied natural gas (LNG) and synthetic gaseous fuels (e-gas)". Further distinctions are made for other ship types and their needs;
- more precisely, the new legislation foresees that practically all maritime ports (including the dual ports such as Rotterdam, Antwerp, Constanta, etc.) on the *Trans-European Network of Transport* (*TEN-T) Core and Comprehensive networks will have sufficient shore-side power output to meet at least 90% of the electricity demand from the ships*. On the other hand, the requirements for the IWT ports are less stringent: the only target is that all IWT ports on the TEN-T networks need to provide at least 1 on-shore power supply (OPS)[6];
- in addition, there needs to be a *sufficient coverage of LNG refuelling stations* in the maritime TEN-T ports to meet the current and future necessities of ships travelling within the TEN-T core network by 2025. However, biogas and e-gas should also be used for operations, not just the 'regular' LNG. This requirement on LNG does not exist for inland ports but can also influence the IWT segment, especially the routes close to the larger maritime ports;
- together with the FuelEU maritime initiative, it contributes to overcoming the current "chicken-and-egg" issue, which has meant that the very low demand from ship operators to connect to the electric grid while at berth has made it less attractive for ports to invest in short-side electricity – with a focus on the TEN-T ports. Both maritime and inland waterway transport are included in this Regulation.

Member-States also need to prepare and then adopt national plans that ensure the roll-out of the AFIR-targeted infrastructure.

[5] Revision of the Directive on deployment of the alternative fuels infrastructure | European Commission (europa.eu)

[6] All TEN-T core inland waterway ports by 1 January 2025 and all comprehensive inland waterway ports by 1 January 2030. In the TEN-T network there are in total 173 comprehensive inland ports and 69 core inland ports with 15 hybrid comprehensive ports (sea and inland) and 26 hybrid core ports (sea and inland)

Revision of Energy Taxation Directive

A **revision of the Energy Taxation Directive (ETD)**[7], proposes to align the taxation of energy products with EU energy and climate policies, promoting clean technologies and removing outdated exemptions and reduced rates that currently encourage the use of fossil fuels. It is to be seen as a strong complement to the new Emissions Trading System (ETS) proposals and in relation with existing international regulations in this context.

In the cases relevant for the IWT sector, the proposals will support the *deployment and uptake of clean energy and fuels while removing fuel tax exemptions that are in place and increasing the taxation on fossil fuels/energy. The proposal also seeks to exclude the bunkering of ships outside EU ports, thus preventing a de facto carbon leakage*.

Indeed, the directive on the taxation of energy products (Directive 2003/96/EC) currently in force foresees an optional tax exemption for energy products supplied for use as fuel. The rationale behind such an exemption lies in the role that inland navigation already plays in cutting transport-related greenhouse gas emissions. Indeed, a modal shift to less carbon intensive modes of transport, such as inland navigation, is a considerable advantage in terms of reducing greenhouse gas emissions in particular. Given the current and foreseen structure for the short to medium-term of the mix of energy sources used by the waterborne transport sector, this is likely to lead to a higher impact than on many other sectors. For this reason, some stakeholders have the opinion that any change in the current taxation of energy sources used in inland navigation should in any case be phased in.

The Carbon Border Adjustment Mechanism

The **Carbon Border Adjustment Mechanism (CBAM)**[8], as proposed by the EC, will put a carbon price on imports of a targeted selection of products to ensure that ambitious climate action in Europe does not lead to 'carbon leakage'. This will ensure that European emission reductions contribute to a global emissions decline, instead of pushing carbon-intensive production outside Europe.

While the provisions of this initiative do not directly concern the RD&I efforts of the IWT sector, it can significantly impact on its future demands and business models. In addition to this mechanism there are numerous other EU measures designed to mitigate climate change and stimulate circular economy targets, but also to strengthen and at the same time broaden the domestic (EU) industry. These measures can likely result in two major changes for the sector:

- *a decrease in the type of goods carried by deep-sea shipping, in particular by reducing the imports of several raw materials and manufactured goods*, corroborated with a change of the structure of the other types of imports;
- *an increase in the short-sea shipping and inland waterways transport*, as more and more production sites are brought closer to or within the EU countries. These entail an increase in the

[7] Revision of the Energy Tax Directive | European Commission (europa.eu)
[8] Carbon border adjustment mechanism | European Commission (europa.eu)

short-sea and inland waterways traffic, as well as a change in the structure of the fleets (types of ships) dedicated to these traffic segments.

These new operational demands and business models will likely impact the technological developments per se, as well as on the choices of which technologies should first receive more RD&I efforts.

The EP proposals go even further, with the accelerated phasing in of the CBAM (from 2027) and broadening its scope to include organic chemicals, plastics, hydrogen and ammonia as well as indirect emissions[9]. This may have an important impact for IWT as a whole not just in terms of the new ship types and/or services needed but also in terms of energy supply and costs, since most forecasts estimate that the EU will not be able to satisfy its hydrogen demand solely from domestic sources and will need to import significant quantities from other (neighbouring) countries.

Air Quality requirements being made more strict

Another relevant development is the planned revision10 by the EC of the air quality standards11. The EC published the proposal in October 2022. It is a part of the EU Green Deal. The proposed revision aligns the air quality standards more closely with the recommendations of the World Health Organization. For example, the annual limit value for fine particulate matter (PM2.5) will be reduced by more than half.

The consequence of reducing the annual limits by means of this legislation would be that local governments may have to take strong measures to bring emission limits down. As already many cities have imposed low emission areas for road vehicles, the attention may also come to other emission sources, such as inland navigation vessels. Especially for cities located along inland waterways and close to major ports, this can have an impact on the requirements concerning air pollutant emissions for inland vessels and may give another reason to speed up the emissions reduction for inland vessels.

3.2 The NAIADES III Communication

The European Commission tabled in June 2021 a 35-points action plan to boost the role of inland waterway transport in our mobility and logistics systems. The core objectives are to shift more cargo over Europe's rivers and canals, and facilitate the transition to zero-emission barges by 2050. This is in line with the European Green Deal and the Sustainable and Smart Mobility Strategy.

NAIADES III and its challenges related to Markets

Despite obvious environmental advantages the modal share of the EU inland waterway transport sector has remained behind expectations in the last decades. The Markets challenges as addressed in the NAIADES-III Action Programme relate to the creation of:

- Seamless integration into multimodal mobility and logistics systems
- Boosting the uptake of more sustainable transport modes
- A well-functioning inland waterways internal market

[9] Carriages preview | Legislative Train Schedule (europa.eu)

[10] See https://environment.ec.europa.eu/topics/air/air-quality/revision-ambient-air-quality-directives_en

[11] See the latest WHO Air Quality Guidelines, published on 22 September 2021: https://apps.who.int/iris/handle/10665/345334

The seamless integration of inland waterway transport in multimodal supply chains requires the physical and digital connection to other transport modes. The physical connections are primarily established via inland ports and multi-modal transhipment platforms. The network of multimodal and interoperable terminals is deemed insufficient both in the terms of quality and quantity. The uptake of more sustainable transport modes is considered to be hindered through the lack of a level playing field across transport modes, especially regarding the environmental performance of transport modes. The Commission intends to combat this situation principally by introducing the 'polluter pays' and 'user pays' principles and by establishing an EU framework for the harmonised measurement of emissions. A well-functioning IWT market is hampered by partly outdated legislation on accessing the inland waterways market which does not consider the European Union's geographical extension.

NAIADES III and its challenges related to IWT Fleet

NAIADES III gives specific attention to the fleet, aiming for the transition towards a zero-emission fleet. With respect to RD&I the NAIADES III presents that:

"The newly established Zero-Emissions Waterborne Partnership will promote research in zero-emission vessels technology, innovative propulsion systems and sustainable fuels, also in close collaboration with the Battery Alliance, the European Clean Hydrogen Alliance and the Renewable and Low-Carbon Fuels Value Chain Alliance." '

Furthermore, it announced that the European Commission will "assess the need for further legislative measures to promote the uptake of zero-emissions vessels. As a first step, an agreed EU energy index methodology is needed for monitoring and reporting carbon intensity of inland waterway vessels. This will serve to define carbon intensity reduction targets and draw up a technology roadmap for the deployment of zero-emissions shipping by 2050".

Flagship 3 of NAIADES III is "Speeding up certification procedures for innovative and low-emission vessels". This means that the "European Commission will also assess how best to facilitate and speed up the safe testing and certification of innovative and low-emission vessels when reviewing Directive (EU) 2016/1629. Various programmes such as Horizon Europe, CEF, LIFE or regional funds could consider launching pilot projects to test innovative and low-emissions vessels in order to develop supportive enabling regulatory frameworks".

The NAIADES III document also points out that financial opportunities, in particular for smaller operators, should be facilitated by public authorities at regional and national levels, by the river commissions, as well as at EU level through funding instruments such as InvestEU or CEF. Furthermore, synergies between small operators could be pursued, for instance through joint purchasing, joint innovation actions or further consolidation. The galvanising role of the Inland Waterway Transport Platform will be crucial in this regard.

Another section in NAIADES III is focussing on smart inland waterway transport, which also has an impact on equipment on board of vessels. The Flagship 6 "A roadmap for digitalisation and automation of IWT" does also include automation aspects on vessels and services.

Last but not least, the climate adaption of vessels is also mentioned in NAIADES III. It describes that the greater frequency of low-water events will require a faster development and roll-out of innovative,

climate-adaptable vessels able to sail with low water levels while minimising impacts on aquatic ecosystems. NAIADES III explains that Horizon Europe will provide support to adapt fleets to future environmental, climate, and safety requirements and to develop and test new methods of transport infrastructure maintenance and upgrades in order to improve safety, climate resilience and environmental impact (including air and water pollution and biodiversity) and accommodate evolving transport modes.

NAIADES III and its challenges related to Jobs & Skills

A stronger inland navigation sector also needs to be able to offer quality jobs, career opportunities and high social, safety and security standards to attract well-trained people. As like other modes of transport, the inland waterway transport sector suffers from a lack of attractiveness, in particular for young people and women. The NAIADES III Action Programme thereby addresses a number of key challenges, namely, the atypical working conditions, a lack of information on the labour market structure, the cross-border nature of many working contracts causing unclarity about applicable labour laws and social security rules. Furthermore, the various requirements to ensure safe navigation are deemed partly outdated, as crewing requirements do not consider new technologies and working practices and workload aboard. An effective and flexible legal framework at EU level in the sphere of crewing requirements would need to be supported by reliable, real-time, digital controlling tools. PLATINA3 developed recommendations on competencies for future crews to be used as basis for training, education and examination to be able to work with innovative technologies for greening the fleet as well as automation on board.

NAIADES III and its challenges related to IWT Infrastructure

The NAIADES III Action Programme addresses the main issues related to Infrastructure that caused sub-optimal use of the EU's inland waterway network. Firstly, a lack of coherent infrastructure as well as a lack of coordinated fairway quality assurance is mentioned as a main reason for relatively low use of the inland waterway network. Additionally, disruptions induced by periods of droughts and floods, limit the capacity of inland waterway transport infrastructure. These disruptions are expected to occur more often as a result of climate change impacts. Further research will be required to determine the possible impacts of climate change. As inland waterway transport activities themselves can also exert pressure on aquatic ecosystems (as a consequence of hydro-morphological modifications, fragmentation of ecosystems, or pollution of water and sediment), an integrated approach towards infrastructure development and maintenance is found to be crucial. This requires the holistic consideration of all functions of waterway systems, including economic development, water supply, energy generation and biodiversity. In addition to inland waterway infrastructure, inland ports act as logistics and transport nodes that are expected to become zero-emission nodes: hubs for sustainable mobility and industry, clean energy and circular economy development. Therefore, inland ports will have to identify and implement new, environmentally-friendly and sustainable solutions – including energy efficiency, environmental strategies and monitoring tools – supporting the transition to renewable energy and zero-emission operations. Like for inland waterway infrastructure, inland ports themselves can also have a negative impact on the environment and the local residents. The same kind of integrative development approach, balancing a variety of interests will have to be applied to the development of the inland port

network. Additionally, the role of inland ports for intermodal urban logistics is considered a main challenge which needs to be addressed in more sustainable urban mobility planning procedures.

3.3 Other relevant European policies and legislative initiatives

The TEN-T Regulation Revision

TEN-T revision aims at **four main objectives**:

- making transport greener by providing appropriate infrastructure and more transport by more sustainable transport modes;
- facilitating seamless and efficient transport, fostering multimodality and interoperability between the TEN-T transport modes and better integrating the urban nodes into the network;
- increase the resilience of TEN-T to climate change and other natural hazards or human-made disasters;
- improving the efficiency of the TEN-T governance tools, at streamlining the reporting and monitoring instruments and at reviewing the TEN-T network design.

The completion of the network remains to be finalized by 2050 with intermediate **deadlines** in 2030 and 2040: the core network by 2030, the extended core network by 2040 and the comprehensive network by 2050. It also supports the uptake of recharging/refuelling infrastructure depending on synergies with - among others - the deployment of alternative fuels infrastructure (**AFIR** proposal).

Of the two horizontal priorities in TEN-T, one is the European Maritime Space. There are also numerous provisions dedicated to the IWT sector, which include: the deployment of alternative fuels' infrastructure (by 2030 and 2050) in compliance with AFIR, the introduction and promotion of new technologies and innovation for zero-carbon energy fuels and propulsion systems, stimulate energy efficiency, etc.

The EU Taxonomy

The EU Taxonomy is a tool to help financial institutions and investors evaluate whether an economic activity can be classified as sustainable. To qualify as sustainable, an investment would need to contribute substantially to at least one of these six objectives without doing significant harm to the other objectives.

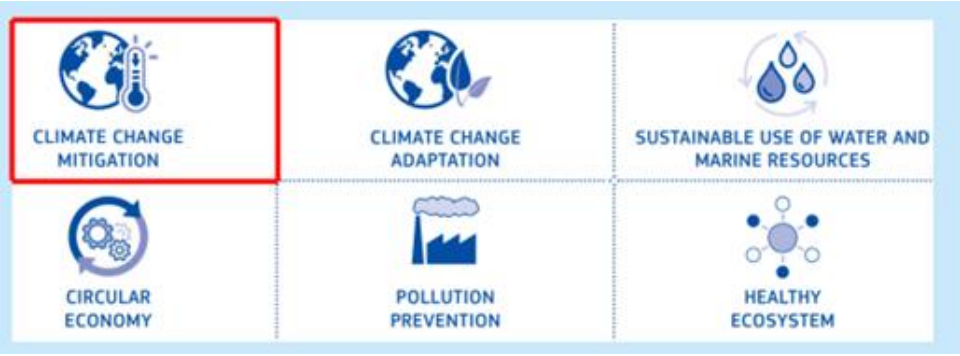


Figure 1 The six objectives of the EU Taxonomy

Technical screening criteria for each of these goals are defined through delegated acts,. The first delegated act, published in December 2021, focuses primarily on Climate Change Mitigation & Climate Change Adaptation.

A new version of the taxonomy for climate mitigation is expected to be adopted in the course of 2023, in particular revising the requirements post year 2025 and introducing a well-to-wake reduction pathway for CO_2 emissions, as alternative to the zero-emission tailpipe approach which is in the current version in case zero-emission tailpipe is not feasible to apply by vessel owners. The report made by the Platform Sustainable Finance presents their latest proposals in the publication from October 2022 for the technical screening criteria for climate change mitigation for both inland and seagoing vessels, including also manufacturing and retrofitting[12].

Thus, it is expected that after the year 2025, also combustion engines using fuels with significantly lower carbon intensity could be in scope to fulfil the technical screening criteria as defined in the delegated act for climate change mitigation. Furthermore, the Taxonomy criteria may possibly be expanded with technical screening criteria on topics for air pollution and water pollution and there may be more specific criteria for cruise vessels.

Corporate reporting requirements sustainability

Not only large industry players but also shippers and larger transport operators will be more and more obliged by means of EU legislation to make formal reports on their environmental performance and plans on how to reduce emissions.

On 21 April 2021, the Commission adopted a proposal for a Corporate Sustainability Reporting Directive (CSRD)[13] which would amend the existing reporting requirements of the Non-Financial Reporting Directive (NFRD). This proposal extends the scope to all large companies and all companies listed on regulated markets (except listed micro-enterprises). The proposal requires an audit (assurance) of reported information, introduces more detailed reporting requirements, and a requirement to report according to mandatory EU sustainability reporting standards. All these added elements in the reporting will increase transparency and will have an impact on loan conditions and access to finance for the companies. Therefore, larger shipping companies and cargo owners in Europe need to be more and more transparent on the sustainability performance. This includes not only their own direct production processes, but also the logistic services which they contract.

The CountEmissions EU[14] initiative of the European Commission DG MOVE also supports this transparency towards transport users for both passenger and freight sector. It can be concluded that also inland waterway transport operations will become more transparent and visible regarding climate

[12] See chapter 6 of the following report (page 275 onwards): https://finance.ec.europa.eu/system/files/2022-11/221128-sustainable-finance-platform-technical-working-group_en.pdf

[13] See also: https://finance.ec.europa.eu/capital-markets-union-and-financial-markets/company-reporting-and-auditing/company-reporting/corporate-sustainability-reporting_en

[14] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13217-Count-your-transport-emissions-CountEmissions-EU_en

change and air pollution emission performance (NOx, PM). For the short term, this brings opportunities as IWT has still a benefit in terms of CO2 emissions per ton transported.

Technology Partnerships

The abovementioned policy and legislative developments at the EU level are accompanied with additional activities and funding opportunities for the IWT. These opportunities concern both the market roll-out and implementation of innovative technologies, as well as the support for further RD&I activities. During the current Multi-Annual Financial Framework (MFF) 2021-2027, the EC is offering an unprecedented support for the waterborne transport sector in terms of RD&I funding. Testament to this aspect is the creation in the HEU framework of the ZEWT Partnership, with an allocation of up to €530 million, but also other opportunities, such as the Clean Hydrogen and BATT4EU Partnerships. Funding for both RD&I and deployment is also available via other relevant EU-level mechanisms such as Interreg, LIFE or CEF. In addition, the Innovation Fund is a growing funding instruments that offers the possibility of bridging the gap between high-TRLs and deployment in terms of the zero-emission transition, even if waterborne transport is not yet listed as one of the main sectors that it addresses.

Initiatives by river commissions

The whole framework cannot be complete without mentioning the river commissions' work towards a stronger IWT sector in their regions, namely the Rhine (CCNR) and the Danube (Danube Commission - DC) basins. These organizations are important actors in their own regions, working on regulatory, technical and operational aspects with the EU institutions and other relevant public and private stakeholders at various legal and policy levels. For example, in the Declaration signed in Mannheim in 2018, the inland navigation ministers of the Member States of the Central Commission for the Navigation of the Rhine (CCNR) defined similar target of largely eliminating GHG by 2050, but also largely eliminating other pollutants by 2050. CCNR adopted in 2021 a dedicated roadmap[15] including two transition pathways for the fleet by 2050 as well as policy measures. Other measures developed by the CCNR address the development of automation in the IWT, and both CCNR and the DC are also a dealing with infrastructure-related aspects.

[15] CCNR, "CCNR Roadmap for reducing inland navigation emissions", Resolution 2021-II-36, December 2021, https://www.ccrzkr.org/files/documents/Roadmap/Roadmap_en.pdf

4. Inputs from RD&I Roadmaps from related initiatives

The roadmap consists of areas of intervention related to key topics such as infrastructural developments, digitalisation as well as zero-emission IWT. It presents the priorities to be addressed and had been developed in synergy with relevant initiatives, the most important ones being:

1) the Co-Programmed Partnership Zero-Emission Waterborne Transport (cPP ZEWT) in Horizon Europe;
2) the outcomes of the Structuring Towards Zero Emission Waterborne Transport (STEERER) project, in particular the feedback received from its Green Shipping Expert Group (GSEG);
3) the activities of the Waterborne TP;
4) the Strategic Transport Research and Innovation Agenda (STRIA) for Transport Infrastructure[16], for Connected and Automated Transport[17].

Strong coordination with the Waterborne Technology Platform and further initiatives, for instance CESNI, H2020 and HEU had been ensured, to avoid duplication of previously identified RD&I topics.

4.1 WaterborneTP and ZEWT Partnership Synergies (including STEERER project)

The Waterborne Technology Platform has been set up as an industry-oriented Technology Platform to establish a continuous dialogue between all waterborne stakeholders, such as classification societies, shipbuilders, shipowners, maritime equipment manufacturers, infrastructure and service providers, universities or research institutes, and with the EU Institutions, including Member States.

The strategic objectives of the WATERBORNE TP are:

- Establish a continuous dialogue between all stakeholders in the waterborne transport sector and in other waterborne-related sectors on R&D;
- Contribute to the widest possible consensus regarding R&D and to focusing of efforts and resources;
- Develop a common medium- and long-term R&D Vision and a Strategic Research Agenda (SRA);
- Contribute to the appropriate mobilisation and allocation of the necessary financial resources (private/regional/national/EU sources);
- Contribute to the social expectations regarding clean, competitive and safe waterborne transport as well as regarding other waterborne-related activities, including education and training.

[16] https://trimis.ec.europa.eu/roadmaps/transport-infrastructure-inf
[17] https://trimis.ec.europa.eu/roadmaps/connected-and-automated-transport-cat

The guidance regarding Research, Development and Innovation priorities for the waterborne sector is included in Strategic Research and Innovation Agenda's (SRIAs), one for each of the working groups of the Waterborne TP, notably:

- Ships & Shipping
- Ports & Logistics
- Blue Growth

These SRIAs are centred around a mission and vision for 2030 and 2050, to be achieved by means of RD&I. For PLATINA3, and specifically the Inland Waterway Transport sector, two SRIAs are of particular importance, notably Ships & Shipping and Ports & Logistics.

Currently, the SRIAs of the Waterborne TP (Figure 2) are undergoing an update, to be finalised towards the end of 2023, and thereby the input from PLATINA3 to the Waterborne TP is very timely.

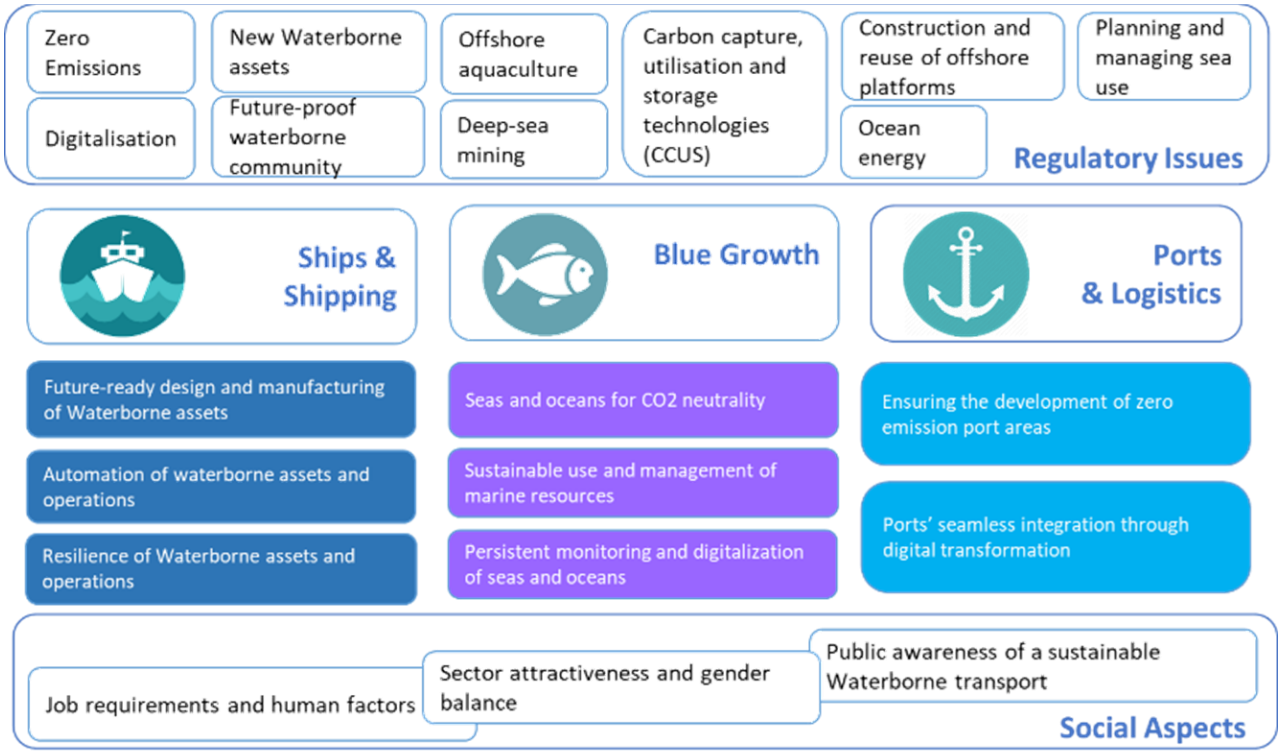


Figure 2: Strategic Research and Innovation Agenda's of the Waterborne TP

SRIA Ships & Shipping

One element of the SRIA Ships & Shipping is the "Automation of Waterborne Assets and Operations". In order to achieve this objective, RD&I will have to be exploited along the following lines of activities:

- First, there are some pre-requisites for automation that are necessary for efficient digitization of ships/platforms, dealing with technical or non-technical aspects that will be developed to achieve services and functionalities. These pre-requisites are sensorization and data management, connectivity and security (concerning cybersecurity and physical systems);
- A second phase will consist of system integration of functionalities and solutions, preparing for increased automation levels and operational solutions, some of them based in particular on digital twin. They may be considered as technical modules to be (re)used for different applications, following an adaptation to the specific cases (i.e. type of waterborne assets such as ship/platform, for maritime/short sea/inland navigation)
- Finally, based on previous innovative solutions, some product applications and business models will be derived and validated through demonstrators. Specific product applications will deal with Unmanned Vehicles for all Domains or UxVs (as an extension of ship sensors) and with automatic processes onboard.

Currently, the Waterborne TP is mapping which steps have already been taken, and what the gaps are to be able to achieve the objectives set (Figure 3). The conclusion from PLATINA3 regarding RD&I can be transferred to the Waterborne TP timely to be considered.

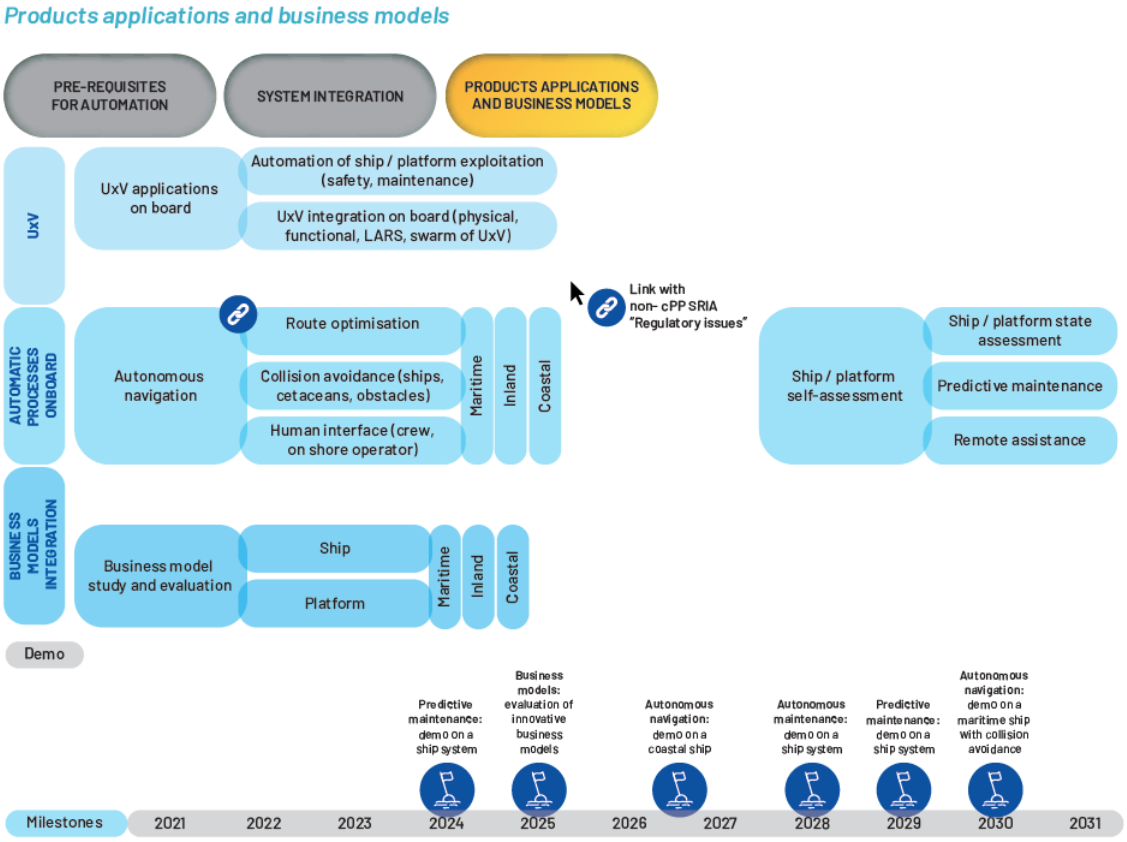


Figure 3: Strategic roadmap Product Applications and Business Models (Waterborne TP)

Ports and Logistics

In the area of Ports & Logistics, the activity "The seamless integration of ports through digital transformation" (Figure 4) is one of the most relevant activities in relation to the roadmap in this deliverable.

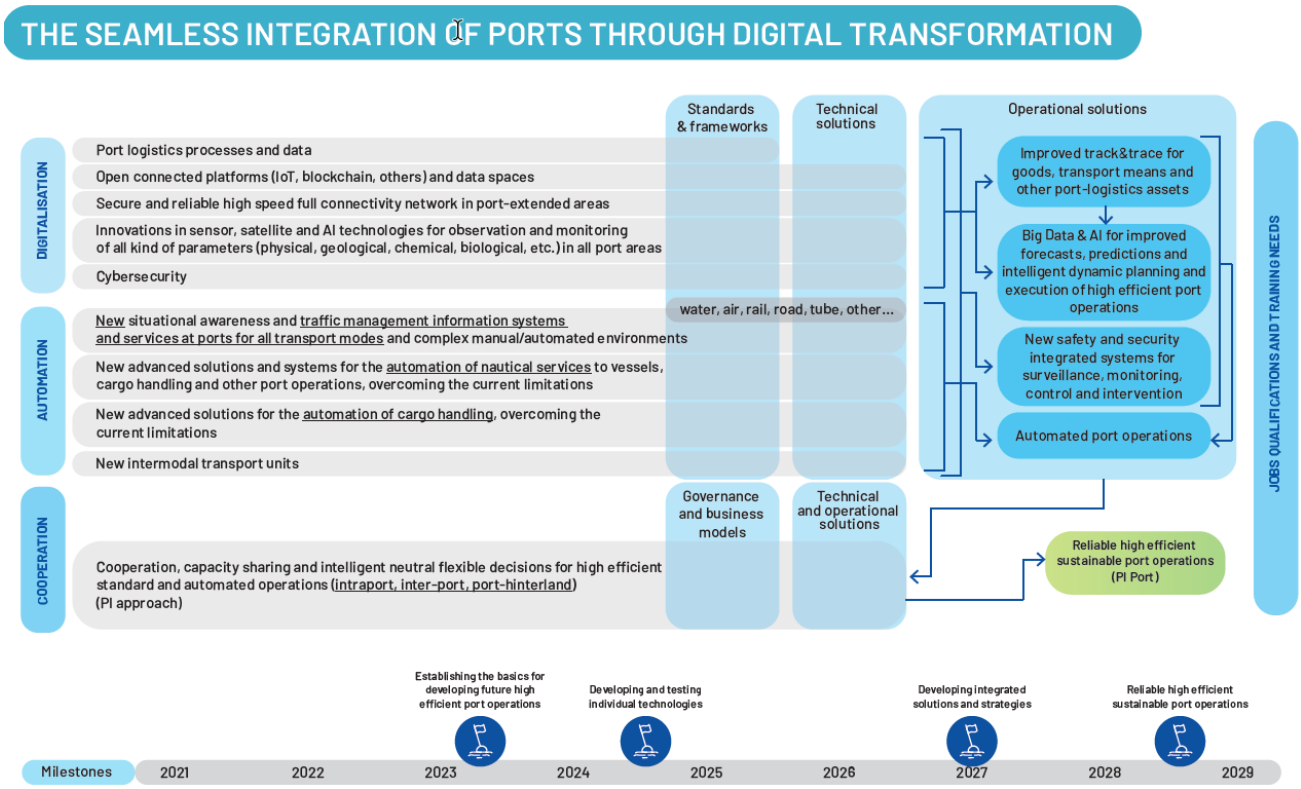


Figure 4 Concept of seamless integration of ports through digital transformation

The milestones set in this SRIA, are linked to the further integration of inland waterway transport in the logistics chain, where digitalisation plays a crucial role as illustrated in figure 4.

As shown, some of the topics identified in the framework of this deliverable could fit into the work of other initiatives, where other topics will have to be put forward to be included in the work programme(s) 2025, 2026 and 2027 of Horizon Europe.

The ZEWT cPP

Besides the activities of the Waterborne TP as outlined above, the Waterborne TP is coordinating the private side of the Co-Programmed Partnership on Zero-emission Waterborne Transport (cPP ZEWT) In the framework of Horizon Europe.

The Partnership is one of the main instruments in transforming waterborne transport into a net zero-emission mode of transport, through the research to and demonstration of deployable zero-emission solutions suitable for all main ship types and services before 2030. It will contribute to maintaining and reinforcing Europe's global leadership in innovative, green waterborne transport solutions. The objective is to provide and demonstrate zero-emission solutions for all main ship types and services, on

both existing and newbuilds, before 2030, which will enable zero-emission waterborne transport before 2050.

The SRIA of the cPP ZEWT has been developed in close cooperation with the STEERER project, and the results of the STEERER project fed into the update of the SRIA, which is currently ongoing and expected to be finalised towards December 2023. The same counts for the input from PLATINA3.

In order to ensure solutions for all main ship types and services, it was necessary to have a more systematized approach of the different ship types in waterborne transport, followed by the analysis and planning of how the decarbonisation challenges for these ship types needs to be addressed.

All this resulted in the development of implementation pathways for six different types of vessels, with a broader description in the Partnership SRIA. Thereby the results of the deliverable will easily feed in the process of updating the ZEWT SRIA. Figure 5 presents the main ship types, as defined for the scope of the Partnership.

Figure 5 Types of vessels for the development of implementation pathways

The technical content of the cPP on Zero-Emission Waterborne Transport is divided into six parallel activities, called Intervention Areas, each of them with several subsections. These are outlined in Figure 6. The recommendations in this deliverable can be transferred as input to the process of updating the SRIA of the cPP on Zero-Emission Waterborne Transport, of which the finalisation is foreseen for the end of 2023. In Deliverable 2.1, actions have been proposed per activity of the SRIA of the cPP on ZEWT.

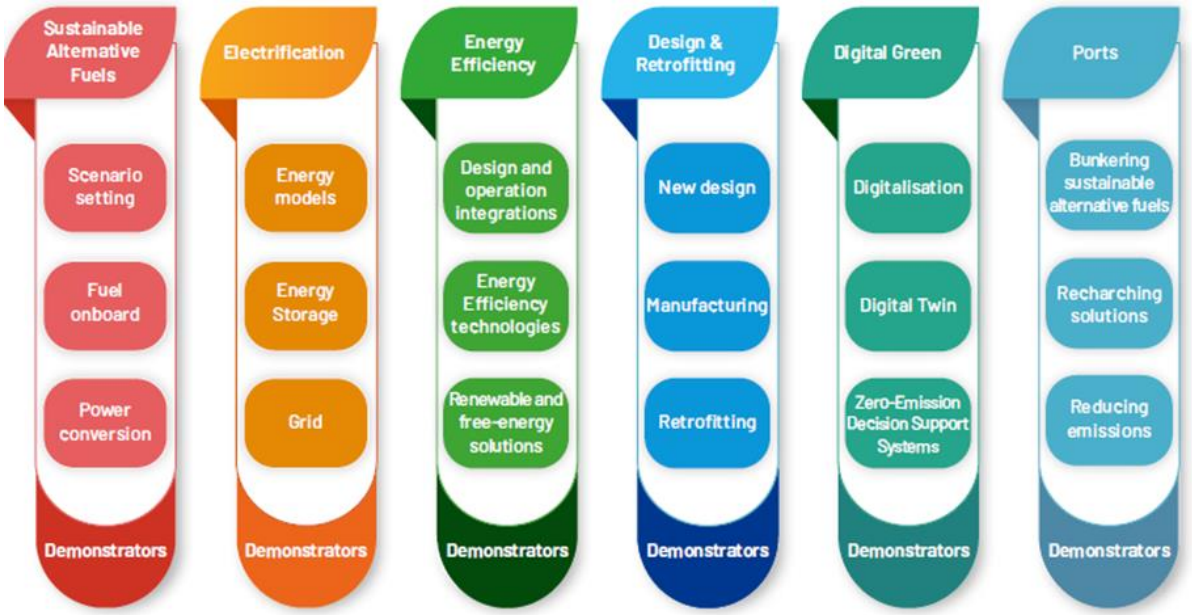


Figure 6 Activities of the Co-Programmed Partnership on Zero-Emission Waterborne Transport

4.2 Connected and Automated Transport SRIA Synergies (STRIA)

A few years ago, the European Commission developed a Strategic Transport Research and Innovation Agendas (STRIA). It sets out the areas where the EU needs to act in concertation with EU countries and stakeholders to radically change transport.

Seven roadmaps describe how to speed up work and deliver in the short and long term. They cover the following priorities:

- Electrification
- Alternative fuels
- Vehicle design and manufacturing
- Connected and automated transport (CAT)
- Infrastructure
- Network and traffic management systems
- Smart mobility and services

The priorities infrastructure and connected and automated waterborne transport will be explained in more detail in the following paragraphs.

According to the summary of the report, ship automation is well advanced with most modern ships and vessels being equipped with systems such as target detecting radars, autopilots and track pilots using satellite positioning. Some autonomous ship demonstrations have been made, but technology is still on a low readiness level. Safety is a main area where automation is expected to provide improvements, such as further addressing the human factor. Better data integration and improved monitoring will allow CAT to contribute to a competitive European shipping industry and improve security in the transport systems. However, digital connectivity is a prerequisite for further improvements to increase capacity

and coverage". In order to be able to achieve these objectives, nine key research and innovation pathways have been defined, notably:

- In-vessel enablers
- Condition and operational monitoring
- Validation and large-scale demonstration to enable deployment
- Electronic information exchange and certification
- Socio-economic impact of CAT
- Changed working conditions
- Physical and digital infrastructure
- Big data, artificial intelligence and their applications
- Secure connectivity

Since the publication of the report, RD&I has significantly progressed, either by means of co-financing via Horizon 2020 and Horizon Europe, or via RD&I financed by the sector. Therefore, the Connected and Automated Transport SRIA would need a significant update, to which the input of PLATINA3 would make an essential contribution.

4.3 Transport Infrastructure SRIA Synergies (STRIA)

According to the summary of the report, the roadmap identifies several key challenges for EU transport infrastructure, the most significant of which are: governance; pricing, taxation and finance; the syncromodality, intermodality, interoperability and integration of transport systems; life-cycle optimisation; construction; operation; safety; and security. Although the development of the first STRIA roadmap on transport infrastructure in 2016-2017 was mainly focused on the goal of decarbonisation, the updated version (2019) adopts a wider approach.

The STRIA roadmap for transport infrastructure aims to:

- map out plans for RD&I in these key areas
- test new methodologies
- pave the way for future transport infrastructure policies

The following challenges have been identified for waterborne transport:

- Integrating shipping and inland navigation into seamless port and logistics operations
- Ensuring zero emissions from inland navigation vessels by 2050
- Dealing with insufficient port capacity and efficiency
- The deployment of smart shipping.
- Addressing the need for comprehensive and interoperable flows of digital information.
- Building smart port infrastructure that is well connected to other modes of transport
- Creating a network of multimodal transport corridors connecting industrial, peripheral, and island areas with modern transhipment facilities
- Innovating, including the use of advanced technologies and the monitoring of automation trends

- Ensuring safe, competitive and eco-friendly shipyards and production sites
- Ensuring the sector has zero accidents, zero loss-of-life and zero pollution, while ensuring cybersecurity

Equally as for connected and automated waterborne transport, since the publication of the report, RD&I has significantly progressed, either by means of co-financing via Horizon 2020 and Horizon Europe, or via RD&I financed by the sector. Therefore, the Infrastructure STRIA would need a significant update, to which the input of PLATINA3 would make an essential contribution.

4.4 The CCNR Roadmap for Emissions Reduction in Inland Navigation

In accordance with the mandate given by the Mannheim Ministerial Declaration of 17 October 2018the CCNR developed a roadmap18 aimed at largely eliminating GHG emissions and air pollutants in the inland navigation sector by 2050, a long-term vision also shared by the EU. Specifically, the Declaration tasked the CCNR with:

- reducing GHG emissions by 35% by 2035 compared to 2015 levels,
- reducing pollutant emissions by at least 35% by 2035 compared to 2015 levels,
- largely eliminating GHG and other pollutants by 2050.

Building upon the CCNR study on pathways towards a zero-emissions inland navigation sector19, the roadmap is the primary CCNR instrument for mitigating climate change and accelerating the energy transition. In addition to a business-as-usual scenario, the roadmap outlines two transition pathways for the fleet by 2050, for both existing vessels and newbuilds. The more conservative pathway, based on mature technologies, is cost-efficient in the short-term but fraught with uncertainties about the availability of certain fuels in the long term, while the more innovative pathway relies on technologies still in their infancy stage but providing more promising emission reduction potential. Both transition pathways are sufficiently ambitious to achieve the emission reduction objectives of the Mannheim Declaration, but no “one size fits all" technology solution is adapted to all vessel types and navigation profiles. A technologically neutral approach appears therefore best suited to achieve the energy transition. The next figure describes the pathways in detail.

[18] CCNR, “CCNR roadmap for reducing inland navigation emissions”, March 2022, https://ccr-zkr.org/12090000-en.html.

[19] CCNR, “Study on energy transition towards a zero-emission inland navigation sector”, October 2020, https://ccr-zkr.org/12080000-en.html.

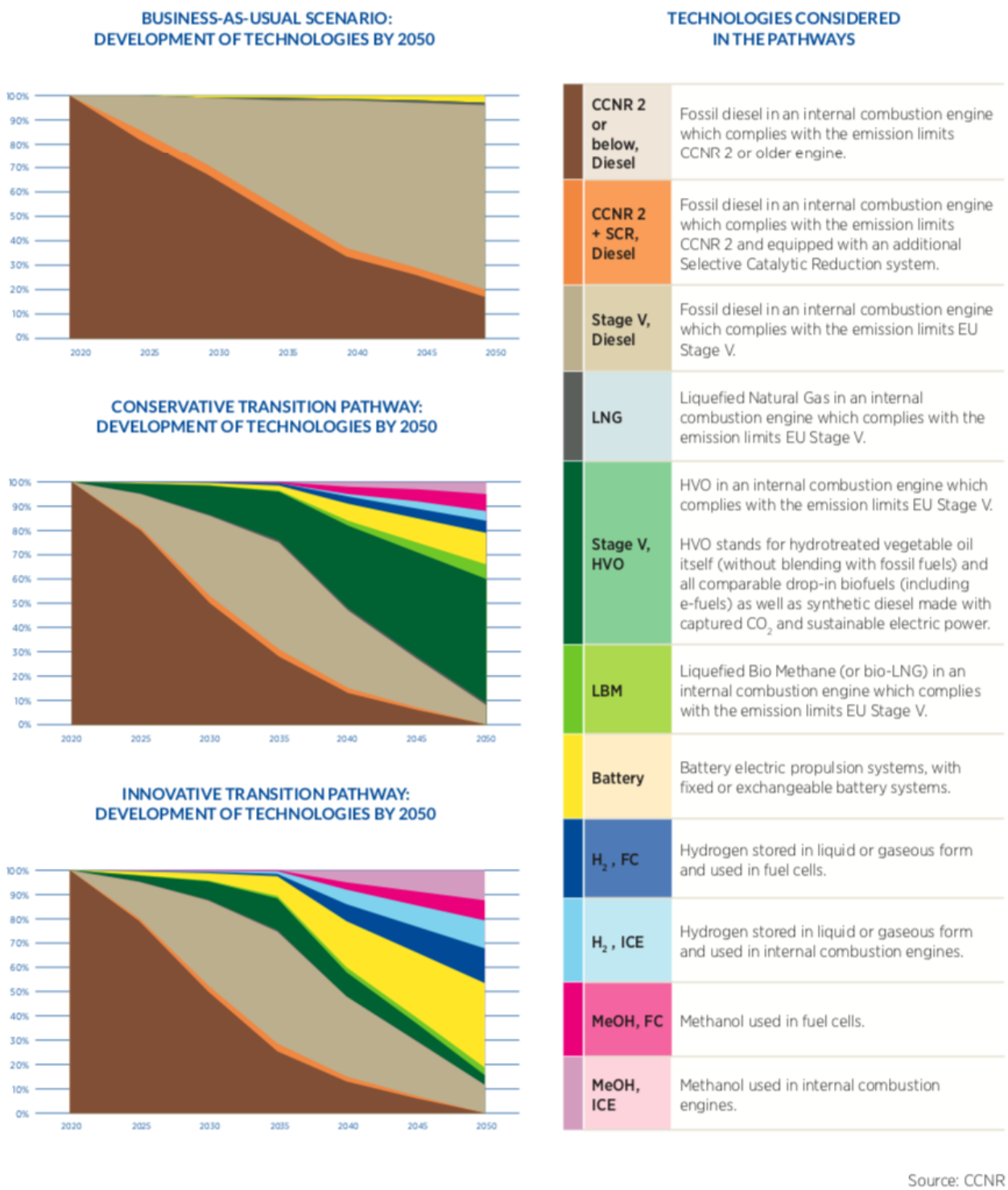


Figure 7 Transition pathways for the fleet and considered technologies

Looking ahead, the CCNR undertakes to, among others:

- at the latest in 2025 evaluate whether it is opportune to revise the CCNR's study, especially on the economic and technical evaluation of the technologies;
- evaluate by 2025 whether it is opportune to extend the scope of the roadmap, for example to other greenhouse gases such as N_2O or to emissions associated with other aspects of the vessel's life cycle, to the manufacturing and disposal of propulsion systems, to other types of vessels, or even to the technologies' safety;
- revise, if necessary, by 2030 the roadmap and the corresponding action plan.

By supporting the transition towards a zero-emissions fleet, the CCNR roadmap will be a valuable tool to promote the development of clean energy infrastructure. This includes shoreside power supply and charging facilities, and alternative fuels bunkering infrastructure. These themes were the subject of in-depth consultations during expert workshops held under the aegis of the CCNR.

5. Destination of this R&D Roadmap

The destination and vision for this R&D Roadmap is to contribute to achievement of the main European policy goals towards the strategy for long-term EU greenhouse gas emissions reductions, to climate adaptation and to reach seamless transport, mobility and logistics towards 2050 (as defined by the Smart and Sustainable Mobility Strategy and the NAIADES III Action Programme). This R&D Roadmap identifies the supporting steps that need to be taken to reach this destination, by concentrating on the thematic fields markets, fleet, jobs & skills and infrastructure.

The main focus is on providing input for the calls to be planned in Horizon Europe working programmes for the period 2025-2027. However, not only attention needs to be paid to the RD&I but also to the deployment of the developed innovations and concepts. Therefore the topics identified from the 4 PLATINA3 Work Packages and their Tasks also provide relevant information for future calls in programmes such as Connecting Europe Facility and Innovation fund which do focus more on the roll-out of innovations.

6. RD&I needs related to Market

6.1 RD&I recommendations from Task 1.1: Increased Modal Shift and Decarbonisation

IWT possesses both advantages and disadvantages with respect to new and growing markets. On the one hand, its large carrying capacity, the high energy efficiency performance and relatively low cost make it an attractive option for some specific markets. On the other hand, low reliability, high and low water events occurring more frequently due to climate change, and a rapid adaptation to climate and air pollutant objectives by other transport modes (especially road) limit IWT's development and modal share.

The following recommendations relating to RD&I are made aiming at increasing IWT's modal share in the coming years:

RD&I Topic 1.1.1	**Identification and analysis of how new markets can be captured and of how IWT can be integrated into urban logistics**
Explanation	Increased participation of IWT in urban logistics supply chains (deliveries, transhipment of urban waste, recycling goods) has a number of environmental and societal benefits, including, inter alia, reduced CO2 emissions, accidents, road congestion and cost of transport. The issues to be considered comprise supportive public procurement procedures, effectiveness of temporary financial support and subsidies, specific solutions for increased urban deliveries (e.g. pallets, food, beverages) and passenger transport on urban waterways, development and use of suitable smaller and competitive vessels, analysing automation potential, as well as dedicated multi-annual urban planning considering IWT.
RD&I Topic 1.1.2	**Development of IWT transport solutions supporting the energy transition**
Explanation	The IWT sector can contribute to the energy transition as a reliable and cost-effective transport carrier of renewable energies and related components for the generation of alternative energies such as biofuels, wind turbines and hydrogen. Issues to be considered comprise new vessel and transhipment solutions and operational concepts, as well as adaptations of logistics chains and relevant framework conditions. In addition to the transport of renewable energies, the transport of CO2 can become a new market for inland navigation. Feasibility studies and pilot projects along the main IWW axes can provide first results with respect to the commercial viability and potential of CO2 transport.
RD&I Topic 1.1.3	**Implementation and analysis of pilot projects**
Explanation	Higher market shares for IWT can be captured by case studies and specific studies. Continued financial support must be provided to fund such studies and pilot projects testing the impact and economic viability of transport, technological and logistic innovations. For example, before choosing to operate modal shift to IWT, many shippers first check if IWT fits their shipping needs in an affordable way. In the case of CO2 transport, significant experimentation and studies would have to be performed

	at scale prior to its full implementation to determine its feasibility in real conditions. Similarly, testing trials will have to be organized to ascertain the viability and reliability of inland navigation vessels for the transport of new cargo. With regards to the energy transition, pilot projects are also essential to gain knowledge of new technologies, identify and address economic, financial, technical and regulatory obstacles to their deployment.
RD&I Topic 1.1.4	**Improvement of seaport operations and IWT interconnections to global trade**
Explanation	In order to stimulate modal shift to IWT, improving the handling of inland waterway cargo in seaports and the performance of the container logistics chain overall must be addressed. Research items relate to reduction of congestion, efficient slot management of logistics activities, supply chain visibility by digitalisation and information sharing, development of common platforms for improved situational awareness, improved predictability of arrival and departure times, as well as the consideration of new trading routes, e.g. involving Short Sea Shipping (SSS), intra-European trade, Artic routes.
RD&I Topic 1.1.5	**Raising resilience of IWT supply chains to low water events**
Explanation	The success of IWT in multimodal supply chains heavily depends on its supply chain reliability. This in turn is dependent on the quality and predictability of the waterway infrastructure, which occasionally suffers from low water events. Adaptation of transport concepts and logistical chains to account for increased probability of low water scenarios, including, but not limited to, the use of smaller vessels in platoons or coupled formations. Alternatively, the increased use of buffer stocks, through expansion of the handling and storage capacities of ports next to industrial sites, could be analysed in specific cases.
RD&I Topic 1.1.6	**Increase the awareness relating to the advantages of IWT as an alternative mode of transport**
Explanation	The competitiveness of IWT could be further strengthened by the development and implementation of communication and marketing activities displaying the advantages of IWT. This could take the form of a social media campaign, or a centralised and up-to-date webpage containing all relevant information on IWT success stories and practical information. Moreover, such a repository could also contain information on available funding opportunities at European, national, regional and local levels to lower the barriers for new industrial customers. A similar repository for all relevant IWT regulations would also be desirable, to be able to efficiently check which specific regulations would be applicable if IWT were to be integrated in logistics supply chains. Additionally, guidance and support in setting up national or regional modal shift aid schemes, in line with the EU exemption regulation, would be desirable for national or regional authorities.

6.2 RD&I recommendations from Task 1.2: Standardised Transport Units (modularity), Transhipping Infrastructure & Vessel design

Intermodal transport is the movement of freight from an origin to a destination relying on at least two modes of transportation. Each carrier is issuing its own contract. Transfers from one mode of transport to another are commonly taking place at specifically designed terminals. Therefore, intermodal transportation refers to an exchange of freight between two transportation modes. The key elements of intermodal transportation are therefore:

- composition;
- transfer;
- interchange;
- decomposition.

The vision is that inland waterway vessels shall sail in between hubs, which are fully or partially equipped to operate the smooth transport of freight using the best suitable mode of transport. Due to optimised data flows, shippers and vessel owners should have permanent access to data showing where the freight is located and when it will arrive. Rerouting due to unforeseen events should be possible at any time, providing alternative routes in real time. In addition, the congestion problem in container handling in seaports should be solved so that container transport on inland vessels is no longer hampered by this issue.

The following recommendations relating to RD&I are made with a focus on loading units, modal shift, and vessel adaptation:

RD&I Topic 1.2.1	**Development of a roadmap for IWT-related modal shift and decarbonisation**
Explanation	A Roadmap for Modal Shift and Decarbonisation needs to specify which loading units to build on, which transport modes to use for which type of transport, which infrastructures to develop, which incentives to put in place, with a time horizon towards 2050. Without such a roadmap, there is a risk that too many technologies will be developed in parallel (and many of them abandoned later) and that the overall (policy) objectives are not reached. The roadmap will have to consider any inland vessel adaptation to new/modified loading units, vessel equipment, as well as infrastructure requirements. Innovative design and optimisation of cargo units should facilitate modularity, system interoperability and overall capacity, as well as intermodal handling. Moreover, infrastructure means the transhipment infrastructure which is needed for the composition of the freight (from the first mile), for the interchange at certain hubs, and for the de-composition of freight to the last mile transport. This also includes storage capacity of loading units once they are not in use. It also refers to any installations needed for batteries (charging stations, exchange of batteries, storage, etc.) or alternative fuels (bunkering). Depending on the roadmap and the vessel adaptations proposed, this infrastructure needs to be adapted at the central hubs which are planned without ignoring that there is still a significant freight transport (at least for inland waterway transport) through traditional forms of transportation e.g. bulk transport or (chemical) liquids. The development process of a consolidated roadmap for modal shift towards IWT shall engage and bundle initiatives of important potential supply chain partners.

6.3 RD&I recommendations from Task 1.3: Synchromodal logistics chains

Creation of a seamless waterborne transport chain and integration of maritime and port-hinterland transport requires the development of an improved synchronisation of waterborne transport with other modes of transportation. Synchromodality of the transport chain requires stakeholder to actively interact within a cooperative network to flexibly plan transport processes and to be able to switch in real-time between transport modes. This topic of establishing synchromodal transport was elaborated in Task 1.3.

The following recommendations relating to RD&I are made aiming at establishing synchromodal logistics chains in the coming years:

RD&I Topic 1.3.1	**Development of technologies and regulations that allow seamless switch of cargo**
Explanation	Technologies related to keeping track of cargos are fundamental to effectively promote an integrated approach for freight flows within the port and hinterland framework (reliable, highly efficient sustainable port operations). In this regard, seamless tracking and tracing devices need to be improved to enhance goods connections with transport networks along the supply chain. Seamless and improved track and trace technology will connect the individual goods with the means of transportation along the supply chain. Moreover, separate regulations for different transport modes create a high level of fragmentation in terms of the development of multimodal transport and creates additional administrative barriers. Road, rail, and IWT establish different regulatory frameworks requiring the submission of a large number of different documents with specific cargo details. This limits the possibilities of switching to another modality, affecting, in particular, the utilization of IWT. This means that research for the development of transport regulations addressing multimodality to provide uniform requirements regarding transport documents is needed. RD&I actions shall therefore be considered in terms of the revision of RIS Directive together with Combined Transport Directive, both of them being important legal tools to promote IWT as an innovative and competitive transport mode. During the revision of both directives it is important to foresee further steps towards their alignment, as well as to consider development of service integration in the logistic chains with the support of Intelligent Transport Systems.

6.4 RD&I recommendations from Task 1.4: Reducing economic/financial barriers to modal shift

Not applicable.

6.5 RD&I recommendations from Task 1.5: Policy and regulatory actions encouraging and facilitating the use of IWT

D1.5 provides recommendations and good practices for regulatory bodies, policymakers and key stakeholders in the sector on what has to be foreseen to increase a modal shift. The recommendations consider all the findings from a regulatory point of view and from the perspective of on-going national and international initiatives.

RD&I Topic 1.5.1	**Developing clear legal framework for energy transition**
Explanation	Clarity on a regulatory level is necessary for shipowners to take further steps towards energy transition. A clear framework in terms of which propulsion system to invest in for future decades is also related to the issue of the availability of future low- and zero-emission energy sources on the corridor level and beyond. At the current moment several technologies of different maturity level exist, however, it is not defined yet, which will be dominant and approved for the next decades. In comparison with road transport, investments in low- or zero-emission vessels are rather long-term commitments (40–60 years of ship engines life cycle), meaning that, to undertake such investments future security from the side of regulatory framework is needed. This also relates to the low uptake of the existing opportunities in terms of available EU funding and the low number of pilot projects with respect to fleet modernization. Aforementioned relates to further steps, which has to be considered in terms of RD&I for inland fleet to ensure modal shift to “green” IWT.

7. RD&I needs related to Fleet

7.1 RD&I recommendations from Task 2.1: Zero-emission strategy for the fleet: SRIA, co-programmed partnership

The recommendations for RD&I coming from the work executed in Task 2.1 in view of the ZEWT co-programmed partnership have been presented in detail in the deliverable D2.1, specified for the six intervention areas. These recommendations for Task 2.1 were already filtered, considering the expected results from ongoing projects as well as calls in the Horizon Europe working programme 2023/2024. The recommendations are summarised below and categorised into sub-topics:

- Transition towards zero-emission
- Climate resilience
- Automation of vessels

Both the recommendations for RD&I as well as the recommendations for deployment support are presented.

RD&I Topic 2.1.1	**Support transition of the inland fleet towards zero-emission**
Explanation	The transition of the inland fleet towards zero-emission by 2050 should be supported by a series of RD&I efforts: • Engines need to be certified and tested for the (blends) with biofuels as alternative for fossil diesel, e.g. Stage V engines to be certified for blends of fatty acid methyl ester (FAME) higher than 8%. • Fuel specifications need to be made stricter, including the measurement and enforcement due to fuel instability, corrosion, susceptibility to microbial growth, and poor cold-flow properties of certain biofuels. Also, proper government measures need to be more widely known and clear to the users and fuel providers. • Investigate and demonstrate the maintenance needs of methanol as well as types of storage systems. • Investigate and demonstrate the maintenance needs of different hydrogen carriers as well as types of storage systems, interoperability and safety of mobile hydrogen storage systems. • Demonstration of the battery design life in operational conditions. • Further develop ES-TRIN to consider new battery types, ease battery handling and prevent standardisation issues • Investigate and develop cost-effective, widely applicable and standardised bunkering/charging solutions, considering various potential bunkering/charging locations in different ports and the different types of vessels. • Studies to making onshore power supply (OPS) points future ready so they can be utilized for (rapid) charging of batteries on board used for propulsion of the vessel.

	• Development of standardized components on vessel side for OPS and fast-charging (e.g. connections, length of cables). • Development and harmonisation of standards & procedures (both of technical and financial-administrative nature) for OPS and (fast) charging at seaports and inland ports (the ship-to-shore interfaces).
RD&I Topic 2.1.2	**Support transition of the inland fleet towards zero-emission – deployment**
Explanation	The transition of the inland fleet towards zero-emission by 2050 should be supported by solving a series of deployment issues: • Investigate the development of new types of fuel cells and their reliability (tilting, acceleration, vibrations, etc.) and cost in the waterborne transport environment. • Development/ further optimization of engines systems (including aftertreatment systems) to (nearly) eliminate all types of air pollutants (focus on the most harmful ones first) for traditional fuels, as well as for some technologies converting sustainable alternative fuels. Therefore, new Stage V engines need to become further available and certified for usage of higher blends of biofuels, methanol and hydrogen, either dual fuel or single fuel. (HEU) • Further upscaling of demonstrator projects to identify benefits/push the limits of the different fuels. (Priority for both HEU and the Innovation Fund) • Demonstration of the battery design life in operational conditions (HEU & Innovation Fund). • Research to bring down the volumetric and gravimetric density of battery modules and pack integration, making onboard storage modular and standardised, and thus competitive with conventional fossil diesel. This could result in other types of hydrogen carriers and convertors and new types of electricity storage technology than the ones used today. (HEU) • Retrofitting existing vessels by the (optimal) integration of sustainable available solutions, including solutions using renewable energies. • Development and implementation of new vessel designs that support multi-fuel engines and fuel cells, including aft-ship replacement for existing vessels. (HEU) • Investigate and demonstrate the benefits of using multiple (smaller) main engines to optimize engine load distribution and increasing energy management flexibility. (HEU) • Demonstrator projects on bunkering sustainable alternative fuels at inland and sea ports, including energy providers. (Innovation Fund) • Availability, feasibility and use of swappable battery containers. • Further development of fast charging infrastructure.

7.2 RD&I recommendations from Task 2.2: Options for shallow water & climate resilient vessels

Innovative inland vessel concepts can contribute to the reduction of the vulnerability of inland waterway transport to low-water events, but they will not solve the entire problem. For that, additional measures with respect to climate resilient infrastructure, provision of reliable information on navigation conditions, as well as logistics and vessel operations are required. While measures for adaptation of existing vessels are relatively limited, aiming largely at increasing the cargo capacity at low water, new buildings show a greater potential. This for instance includes lightweight solutions, multiple propulsion devices, hull-form optimisation, variation of main parameters, etc., resulting in improved shallow-water performance and competitive performance at normal water levels.

RD&I Topic 2.2.1	**Raise climate resilience of inland vessel designs**
Explanation	Inland vessel designs with a higher degree of climate resilience can be supported by a series of RD&I efforts: • Develop new materials, alloys, composites, etc. for shipbuilding and retrofitting. The new solutions need to offer similar technical characteristics and safety levels (fire resistance) while at the same time achieving a weight reduction at a reasonable price. • Develop new bow thrusters that allow operations in extreme shallow waters with equal or increased energy efficiency. The proposed solutions also need to prevent the accumulation of sediments in the thrusters. • Investigate the adaptation of existing vessels from local-to-local modifications to the replacement of the aft ship, aiming largely at increasing the cargo capacity at low water while maintaining or improving energy efficiency. • Research on the determination of framework conditions for design (navigation, operational profile) as well as shallow water hydrodynamics: ship performance, manoeuvring models, interaction ship-river bed, including the reliable prediction of ship operation with ventilation: scaling (model tests), CFD. • Execute research also on the impact of the energy density and weight of new energy carriers (e.g. batteries, hydrogen) on ship design and operation, in particular looking at the performance at low water conditions. • Reliable and efficient prediction of ship operation with ventilating propellers is to be further investigated. In general, model tests and numerical methods can be used for this purpose. Challenges of model tests relate to the assessment of scaling effects, correct propeller loading and application of proper friction deduction force. Numerical simulations are associated with high computational costs for large-Reynolds-number simulations and propeller modelling. • Finally, the impact of the introduction of new low-emission or zero-emission solutions (e.g. full-electric sailing or usage of hydrogen and fuel cells) on weight and size of vessels has to be considered with respect to proper operation during low-water events.

RD&I Topic 2.2.2	Improved forecasting of climatic framework conditions
	Research is needed with respect to the provision of reliable data on and forecasting of climatic framework conditions as a precondition for the proper retrofitting and design of inland waterway vessels. Future vessel adaptation measures shall thereby not negatively affect the operation of vessels at normal navigation conditions, e.g. increase the energy demand during normal conditions.
RD&I Topic 2.2.3	**Better understanding of real sailing profiles**
	Better understanding of the real sailing profiles allows the vessels to be designed more in line with the real conditions, which is also required for the energy transition. The ship design has to be optimised for the real operating conditions, considering rising OPEX with sustainable energy carriers, new ship main dimensions, structures, drivetrains, hull forms and the associated hydrodynamics. Investigations of extreme shallow water conditions require further research with respect to interaction with river beds and squat effects in combination with small under-keel clearance.

7.3 RD&I recommendations from Task 2.3: Roadmap for on-board systems allowing automation of inland navigation vessels

Task 2.3 resulted into 12 recommendations to international and national policymakers (such as CCNR, EU, UNECE), standardisation bodies (such as CESNI), and classification societies. They refer to both pilot projects, RD&I needs as well as to regulations and standards. This for instance pertains to the facilitation of cross-border pilot projects in IWT corridors, information sharing on pilot tests, as well as to financial support for 4/5G connectivity along main European waterways.

The main RD&I needs and deployment needs from Task 2.3 are summarised as follows:

RD&I Topic 2.3.1	Pilot projects and outstanding development needs for automation of vessels
Explanation	Techniques and systems needed for high automation (CCNR levels 4-5) have comparatively low TRL levels. The most advanced systems (collision avoidance, AI, neural networks, sensor fusion and integration, etc.) need additional technical development to move from TRL 5-6 to TRL 9 in the next 10 years. Administrations in charge of IWT, in collaboration with River Commissions, should therefore facilitate cross-border pilot projects to test automated navigation, including on major European waterways such as the Rhine or the Danube, by giving the proper derogations to the existing regulatory framework. Appropriate and enhanced safety mechanisms should be included to ensure equivalent levels of safety compared to conventional navigation during the tests. The European Commission should make more funding mechanisms available to bridge the financial gap regarding the outstanding RD&I needs of onboard systems. Specifically, the European Commission should focus its RD&I funding and financing activities to accelerate the achievement of technological maturity in particular for collision avoidance technology, but also for AI and neural networks, machine learning, human-machine and machine-to-machine communication, sensor fusion, and better

	integration of RADAR and LIDAR technologies within automated systems. Human-machine interface (HMI) considerations must also be considered. Finally, encryption, data integrity, and cybersecurity systems and protocols still need additional testing and improvements to become fully mature. This remains critical for the safe deployment of most high automation applications. Publicly funded pilot projects should supply accurate, timely, and up-to-date information and data on the most critical variables recorded during the tests. This information should be exchanged internationally, e.g. at the EU/CCNR/DC levels, to support policy making activities.
RD&I Topic 2.3.2	**Develop regulations and standards for automation of vessels - deployment**
Explanation	Standardisation and regulatory bodies (EU, CCNR, CESNI, CEN, ETSI) should amend the rules which reflect a human-centred vessel design to facilitate the development of alternative designs for automated inland vessels, with reduced or no crew onboard, by enabling the execution of the safety functions even in the absence of the human operator, provided that an equivalent level of safety compared to conventional navigation is ensured. In light of best practices from the sector, CESNI should develop • technical, phraseology, and redundancy requirements allowing automated vessels to ensure proper vessel-to-vessel and vessel-to-shore communications functions, including to and from a rescue coordination centre. • recommendations or minimal requirements for the achievement of route planning, route execution and emergency immobilization functions to be performed by automated vessels, including a fall-back capability to ensure the automated vessel and surrounding navigation's continued safety in case of major disruptions of the automated system. • safety requirements tailored to the specificities of automated vessels in terms of fire safety, cybersecurity, collisions, and water ingress management functions, as well as their corresponding safety procedures. • requirements for sensors and positioning systems to be able to ensure and verify data integrity, provide metadata, and determine whether information produced and/or received is accurate enough for automated inland navigation.

7.4 RD&I recommendations from Task 2.4: Input for roadmap for accurate European fleet data

To ensure safe operation a vessel has to obtain an inland navigation certificate issued in accordance with Directive (EU) 2016/16291 by a competent authority. The certificate contains data identifying the vessel (name of the vessel, type of the vessel, dimensions of the vessel etc.). The European Hull Database (EHDB) is a database kept by the European Commission in which the data of the vessels operating on European inland waterways is collected. The EHDB is notably used to verify the history of pending applications for inland navigation certificates and information on certificates already issued to the vessel. The EHDB is also used to support the proper functioning of river information services (RIS) in accordance with Directive 2005/44/EC and the access to the EHDB may be granted also for RIS authorities.

The key development needs pertaining to fleet data seems not to be relevant for a Horizon Europe initiative or a deployment action. Recommendations for actions to be taken up by the European Commission DG MOVE include following:

- The accuracy, the completeness and timeliness of each record for each vessel in EHDB should be monitored to continuously improve data quality.
- Refactoring EHDB should anticipate the extension of data fields (future-proof).
- Further explore and prepare the practical execution of interconnections between existing databases such as IVR, CDNI and EHDB.
- Facilitate access to EHDB for other database administrators, especially CDNI, considering the existing legal frameworks. Such cooperation would help demonstrate the opportunities of interconnections and create added value by combining data.
- Some important data fields should be harmonised and better defined (e.g. country of vessel, vessel types, vessel activity, etc.).
- Explore the possibility of publication of minimum fleet data (available online in aggregated and anonymised form without special user authorisation to answer the most needed queries).
- Investigate further the legal feasibly as well as possible acceptance (especially by the shipping industry) of collection of dynamic data on the voyage of vessels.

7.5 RD&I recommendations from Task 2.5: Funding and financing for energy transition European IWT fleet

The funding conditions for vessel owners to invest in powertrain solutions which match the transition towards zero-emission transport should generally be improved, as most innovative technologies do not provide business cases by themselves. The key RD&I needs derived from Task 2.5 therefore focus on establishing coordination and support actions for setting up a European financial instrument to support the inland navigation energy transition.

RD&I Topic 2.5.1	**Coordination and support action to set up European financial instrument to support the inland navigation energy transition**
Explanation	Regarding the creation of a European financial instrument to support the IWT energy transition, task 2.5 delivered following deployment recommendations: • Providing significant amounts of deployment funding for the transition of the fleet towards a near zero-emission fleet: - making best use of existing financial instruments (at EU, national and regional levels) on short term (e.g. Innovation Fund, CEF, national or reginal funding schemes) - as well as setting up new financial instruments dedicated to support the energy transition of inland vessels under the next Multiannual Financial Framework. • Enquiring about the willingness, barriers and opportunities of customers to contract low/zero-emission vessels, even if this implies additional costs, and whether arrangements, standards and commitments could be made in that regard, considering level playing field issues as well as competition law. • Developing a European strategy between the EU, national governments and IWT sector representatives regarding the funding and financing of the energy transition in order to: - ensure sufficient financial resources are available to enable the transition; - assess whether the burden set on different actors is fairly distributed; - avoid that some vessel owners are side-lined (for instance, because of the lack of available national funding) • developing a European action plan to overcome the related financial challenge. A first proposal was made in the Task 2.5, the implementation of which requires monitoring and development. The Horizon Europe call “Towards the implementation of the inland navigation action programme with a focus on Green and Connected Inland Waterway Transport” (TOPIC ID: HORIZON-CL5-2023-D5-01-17) is expected to elaborate on this topic (“Building of viable financial engineering instruments to support investments in zero emission, digitalised and connected vessels”). The call underlines that the industrial commitment in terms of investments will need to be leveraged with additional resources, which might be available in the next Multiannual Financial Framework, aiming for a dedicated financial instrument for co-financing the deployment of zero-emission, automated vessels with innovative public-private collaboration models for deployment.

7.6 RD&I recommendations from Task 2.6: EU wide implementation of emission label / energy index for vessels / GLEC

In order to promote low/zero emission vessels, an instrument is needed to recognise and reward such vessels. Task 2.6 therefore developed options for an EU label or indexing method to express the energy and emission performance of vessels. It concludes that a big step can be made by implementing a system addressing the type of energy consumed by the vessel and the emission performance per kWh (greenhouse gasses and air pollutants). This requires a solid base of data and information. Further synergies and functions can be added via inclusion of vessel design indicators and the productivity of the vessel (e.g. tonkilometres). The key RD&I needs derived from Task 2.6 focus on establishing coordination and support actions to establish a EU label that reflects the energy and emission performance of inland vessels.

RD&I Topic 2.6.1	**Coordination and support action to facilitate EU wide implementation of emission label**
Explanation	Regarding the creation and establishment of a European emission label for inland vessels, task 2.6 delivered following deployment recommendations: • Further elaboration of the objectives to be achieved with the envisaged instrument and the first main users and applications (with EC, CCNR, national governments, regional and port authorities, shippers, banks and other incentive providers). • Select the appropriate methodology and the reliable indicators to be used. • Develop and set references values or threshold values for labelling/indexing to rate the emissions and energy performance. Also for this required follow-up, the Horizon Europe call “Towards the implementation of the inland navigation action programme with a focus on Green and Connected Inland Waterway Transport” (TOPIC ID: HORIZON-CL5-2023-D5-01-17) is expected to address the continuation of this research work done in Task 2.6. One of the expected outcomes thereby is to create a “Proposal of a European labelling system for EU waterways”.

7.7 RD&I recommendations from Task 2.7: Regulatory aspects supporting the transition towards zero-emission for the fleet

The current European regulatory framework for inland navigation is considered incomplete to provide the necessary legal certainty to ensure investment, encourage players and create sufficient incentives for alternative technologies. Furthermore, since several technologies are still at an experimental stage, pilot applications in inland vessels are considered critical to address the technical barriers to the deployment of technologies and feed in the regulatory work at an early stage. The gap analysis carried out in the framework of Task 2.7 enables to identify possible improvements of the regulatory frameworks along three axes:

- Vessel design and propulsion systems (V)
- Fuel sources and characteristics (F)
- Vessel operation and police requirements (P)

A substantial number of RD&I-related recommendations was made in the work of Task 2.7 and presented in the deliverable D2.7:

- facilitate the financing and commissioning of pilot vessels using alternative technologies, subject to the sharing of the experience collected for the regulatory work (V)
- investigate the opportunity to introduce efficiency and greenhouse gas emission limits, possibly both for existing vessels and newly built vessels, in line with emission reduction target (V)
- review opportunity to further reduce exhaust emission limits for inland navigation vessels, taking account of existing related Union and international standards and propose any necessary legal changes (V)
- review the extent to which the engine emissions measured during type-approval tests using corresponding test cycles reflect engine emissions in real operating conditions and propose any necessary changes (V)
- evaluate the need to lower the factor A of emission limits for gas engine in NRMM to increase the climate performance of LNG propulsion systems (V)
- develop guidelines for the implementation of Articles 34 and 35 of NRMM for engines using hydrogen as fuel (pending a revision of NRMM) (V)
- start the development of safety requirements for hydrogen in internal combustion engine (V)
- develop guidelines for the implementation of Articles 34 and 35 of NRMM for engines using methanol as fuel (pending a revision of NRMM) (V)
- start policy research/development and impact assessment study for a proposal of “FuelEU IWT” based on the FuelEU Maritime proposal in Fit for 55, aligned with EU Taxonomy technical screening criteria and methodology (F)
- start policy research/development and impact assessment study for a proposal about IWT to be included in ETS (based the approach for road transport in ETS) (F)
- investigate need for more strict fuel quality standards for FAME and their blends as well as quality checks in the supply chains of these fuels and enforcement (F)

Several projects are already ongoing or planned which are expected to address these recommendations. Examples of ongoing projects which can be mentioned are projects SYNERGETICS, RH2IWER, FLAGSHIPS, CURRENT DIRECT. In additional, calls in the Working Programme 2023/2024 are also expected to address the topics, in particular Horizon Europe call “Demonstrations to accelerate the switch to safe use of new sustainable climate neutral fuels in waterborne transport (ZEWT Partnership)” (HORIZON-CL5-2023-D5-01-12).

The key RD&I needs and deployment needs from Task 2.7 are summarised as follows:

RD&I Topic 2.7.1	**Proposals for regulations and standards supporting the transition towards zero-emission for the fleet**
Explanation	Based on the work in Task 2.7, analysis of regulatory aspects to support the transition to zero-emission should be elaborated. These analyses should contain following aspects: • Facilitate the financing and commissioning of pilot vessels using alternative technologies, subject to the sharing of the experience collected for the regulatory work. • Investigate the opportunity to introduce efficiency and greenhouse gas emission limits, possibly both for existing vessels and newly built vessels, in line with emission reduction target • Policy research on feasibility and impact of additional instruments to promote usages of energy carriers with low carbon intensity (such as a ETS or FuelEU IWT) • Technical advice for the development of guidelines for the implementation of Articles 34 and 35 of NRMM for engines using methanol and hydrogen as fuel. • Review opportunity to further reduce exhaust emission limits for inland navigation vessels, taking account of existing related Union and international standards and propose any necessary legal changes. In this regard, review the extent to which the engine emissions measured during type-approval tests using corresponding test cycles reflect engine emissions in real operating conditions and propose any necessary changes. • Improve the understanding of safety issues with hydrogen for the development of requirements for hydrogen in internal combustion engine • Investigate need for stricter fuel quality standards for FAME and their blends as well as quality checks in the supply chains of these fuels and enforcement.

8. RD&I needs related to Job & Skills

Work Package 3 of the PLATINA3 project deals with various aspects of the IWT training and careers topics, in particular:

- Providing input for competence standards related to the use of zero or low emission propulsion systems
- Identifying knowledge and skills needed for greener vessel operation in refresher classes
- Preparing input for competence standards related to onboard systems allowing automation of IWT vessels
- Supporting the use of modern techniques such as simulators, virtual reality (VR) and augmented reality (AR) in training schemes for greener and highly automated vessel operation
- Provide input to a roadmap on standards for examination of new competences in the EU regulatory framework

8.1 RD&I recommendations from Task 3.1: Standards for competence on zero or low emission propulsion systems

Task 3.1 on required competence for operation of vessels with zero or low emission identifies competences (knowledge and skills) dealing with alternative fuels, propulsion technology and exhaust gas after treatment that could be proposed to update the European Standard of Qualifications in Inland Navigation (ES-QIN), adopted by CESNI. Potential technologies that have been targeted include vessels with electric power supply, being vessels which use electric power from – at least one – energy source (generators, batteries, fuel cells) , use of fuel cells, cryogenic gaseous fuels (liquid hydrogen), pressurised gaseous fuels (hydrogen in bottle racks), liquid fuels (methanol), solid fuels, reaction products. As a "competence" should always be regarded as the proven ability to carry out a specific task, Platina3 also proposed draft standards for the practical examination of the above-mentioned competences. These drafts should be taken further by CESNI in line with the NAIADES III action programme and the CESNI work programme.

RD&I Topic 3.1.1	**Update of CESNI standards with a view to alternative fuels competence**
Explanation	CESNI shall focus on the definition of the competence of specific experts following the timing developed for the update of the European Standard on Technical Requirements in Inland Navigation (ES-TRIN) to establish technical requirements for the storage, bunkering and maintenance procedures for the relevant fuels and energy carriers. International or national legislators could still wish to decide for which tasks the expert really needs to be present onboard. For some alternative fuels or energy sources, like batteries, CESNI will examine if the experts need to be present at all times during vessel operation or if the presence is only required during bunkering/(re-)placing of accumulators on board and during maintenance. Once the standards for competences will have been updated, it will be possible to develop standards for practical examinations and for the requirements on simulators.

8.2 RD&I recommendations from Task 3.2: Input for refresher classes for environmentally friendly vessel operation

CESNI will examine standards for eco-efficient navigation with traditional fuels on 20 April 2023. IWT training institutes could be encouraged to offer training according to these standards. In general, CESNI took good note of the PLATINA3 report on the need for refresher classes for alternative fuels and agreed to adopt competence standards as well as standards for practical examination for experts for alternative fuels depending on the specific dangers of methanol, batteries and hydrogen in line with the update of the standards for these fuels and energy carriers in ES-TRIN.

8.3 RD&I recommendations from Task 3.3: Standards for competence for on-board systems for automation

Task 3.3 was developed to identify the competences (knowledge and skills) related to the remote operation of vessels in IWT from remote control centers. The report and competence framework should be seen as a first step towards establishing standards in this field. The report D3.3 also refers to Track Guidance Assistant systems for Inland Navigation (TGAIN) as an important element of support to the boatmaster towards more automated vessel operation on the level of automation 2 according to the CCNR definition of level of automation. These drafts should be taken further by CESNI in line with the NAIADES III action programme and the CESNI work programme.

RD&I Topic 3.3.1	**Update of CESNI standards with a view to competence related to automation**
Explanation	Discussions on draft competences for remote operation operators (ROCO) and crew members on board vessels that are remotely controlled have raised important questions of principle that the CESNI/QP working group will have to deal with. These questions will need to be considered as a whole, as there are strong cross-cutting issues and as feedback from other bodies will be required. As an example, competences for persons who remain on board of a remotely operated vessels can only be designed when it has been clarified if this person will have to be able to bring the vessel in a safe state in case of a failure of communication with the remote operation center of if such a person will have to be able to continue sailing even beyond the completion of the vessel operation that had started when connection between the remote control centre and the vessel was impaired or lost. The draft standards delivered in Platina3 deliverable D 3.3 for ROCO and personnel on board a remotely controlled craft have already fed the reflections for the working group that is working on the manning standards and that will also have to integrate these new roles in the manning tables. Once the standards for competences will have been updated, it will be possible to develop standards for practical examinations and for the requirements on simulators.

8.4 RD&I recommendations from Task 3.4: Input for refresher classes for operation of systems of automation

CESNI will develop specific content for the competence standards for management level (boatmasters) using track guidance assistants in inland navigation as addressed in the PLATINA3 report. It may also wish to work on the good practice for manufacturers who make boatmasters who are already using these devices familiar with the appropriate use and limitations of track guidance assistants.

8.5 RD&I recommendations from Task 3.5: Integration of competence in CESNI on zero or low emission propulsion systems

Not applicable.

8.6 RD&I recommendations from Task 3.6: Integration of competence in CESNI for on-board systems for automation

Not applicable.

9. RD&I needs related to Infrastructure

The next subchapters are dedicated to the relevant infrastructure-related information from the initiatives with whom the Roadmap should create synergies: the ZEWT Partnership, WaterborneTP, STEERER, the SRIA for Transport Infrastructure and the SRIA for Connected and Automated Transport. This information will not only add content and value to the Roadmap, but will also show the linkages and/or complementary activities that are needed in order to create with WP4 input a coherent and stronger Roadmap.

With respect to digitalisation (Task 4.3) there is a link as well with the CEF funded project DIWA Masterplan and also with the Common Expert Group DINA where a holistic vision on digitalisation for inland navigation will be developed, to be supported by a CEF Technical Assistance project.

9.1 RD&I recommendations from Task 4.1: Inland waterway and port infrastructure ready for a changing climate

With regard to policy needs, it is noticed that the amount of research and pilot work needed to test new solutions for inland waterways to adapt to the changing climate is underestimated and under-represented when it comes to research and development. The conduction of single research projects, or the consideration of only inland waterways in the direct hinterland of maritime ports is not sufficient in order to arrive at a climate resilient inland waterway infrastructure, although it constitutes one important step forward. Moreover, a continuous consideration of the topic is necessary as the framework conditions are subject to continuous changes, new critical locations evolve, as well as new approaches adapted to local conditions can be developed.

As already shown for the year 2018, the economic impact on the industry relying on inland waterway transport can be dramatic with significant negative impacts on the productivity of an entire country e.g. Germany, reducing the competitivity of inland waterway transport, and resulting in a modal shift away from waterways with lowest external costs not to be restored again. These impacts occur now and they are projected to become worse in the future. Therefore, it is of great urgency to act now, starting with dedicated infrastructure measures relating to proper maintenance and management of waterways on short and longer term.

If infrastructure measures are neglected, the navigation conditions will become worse as a consequence, and the vulnerability of inland waterway transport to climate change will increase, reducing thereby the service quality of inland waterway transport, which cannot be compensated by newly built vessels or modified logistics concepts, e.g. modified ship operation. Meanwhile, some research and development has been carried out. However, this mostly on a local level, e.g. the KLIWAS programme for the German waterways, the Climate Resilient Networks for the Dutch waterways or the Horizon Europe projects CRISTAL, PLOTO, ReNEW. A comprehensive picture with a common climate modelling basis is still missing, in particular for the Danube region, calling for climate change projects on European level involving all relevant representatives of member states concerned.

The following RD&I items shall be considered in detail and where possible more in detail on a local level:

RD&I Topic 4.1.1	**Creating data basis containing short and long term climate change projections**
Explanation	• Creation of a common data basis with respect to climate projections (temperature, precipitation, discharge, water depth, water temperature, …) and impacts relevant to inland waterway transport, the environment and possible users of waterways, as well as local economies, e.g. the Danube region which has not been considered yet; • Forecasting for improved utilisation and management of the waterway: extension of existing lead-times and improvement of reliability by deterministic short-term predictions, as well as probabilistic mid-term and seasonal predictions (e.g. 3 month);
RD&I Topic 4.1.2	**Further development of integrative planning procedures for inland waterway infrastructure projects**
Explanation	• Promotion of integrative planning of infrastructure projects, including a dialogue between the industry, logistics, politics, and environmental organisations, as well as regulations and funding for modernisation on European and national level. Proper cooperation between the different stakeholders and an integrated approach for coping with climate change is essential. • Investigation of interrelations between developments of surroundings of waterways, land-borne activities and the ones on waterways, e.g. impact of water withdrawal for agriculture, or sealing of land in the vicinity of waterways, etc. • Develop methods for integrative water management, extension of existing water reservoirs and implementation of new water reservoirs. • Elaboration and initiation of measures for the reduction of administrative efforts with respect to permissions requested for the implementation of infrastructure projects.
RD&I Topic 4.1.3	**Develop innovative methods for waterway maintenance and management**
Explanation	• Research on river engineering and waterway management options for provision of reliable and predictable navigation conditions. • Development and testing of innovations e.g. flexible waterway infrastructure, eventually considering lessons from the past. • Review, elaboration and testing of maintenance approaches with respect to their appropriateness and how they can be improved. • Review of fairways and navigation channels, as well as evaluation where relocation of fairways and marking are meaningful. • Application of Nature Based Solutions: evaluation of which and where they can be applied, e.g. creation of natural canals in a river delta with a lot of sedimentation.
RD&I Topic 4.1.4	**Develop innovative methods for waterway surveying and measuring**
Explanation	• Further development of information systems providing relevant information to operation of waterways and navigation conditions to users of inland waterways. • Usage of aquatic and flying drones for collection of information on developments in fairways and wide waterways at low water for determination of e.g. new routes suitable for navigation.

	• Implementation of the floating-ship-data approach, supporting waterway management, as well as providing improved information on navigation conditions (water depth).

These topics can be combined in one or more comprehensive projects on EU level, involving all relevant actors and member states and which shall be launched in such a way that a continuous consideration of climate change and adaptation to it can take place. The approach has to be a multi-disciplinary one considering integrative planning in relation to navigation, the environment as well as other water users like industries with a need for water extraction or even land borne activities having an impact on the water regime of a river, e.g. sealing of wider areas impacting the ground water level or sudden discharge of rain into a river.

9.2 RD&I recommendations from Task 4.2: Alternative energy infrastructure along the waterway and in ports

In general, there is a consensus on the need for a transition to cleaner inland waterway transport. The existing bunkering infrastructure does not seem suitable for supplying clean energy and hence requires new infrastructure for the inland waterway transport fleet that aims at transition towards zero-emission by 2050.

However, there are differences in the details of the vision and gaps and challenges that lie in its path. Based on all the insights gathered in PLATINA 3, it can be concluded that the greatest challenge for the clean energy infrastructure for inland waterway transport has an economic nature and concerns the currently lacking demand from vessel operators for clean energy. This poses an economic challenge for producers of clean energy and operators of the energy infrastructure. With the very first initial uptake and small number of vessels running on clean energy, supply can be provided with, for example, flexible truck-to-ship deliveries. However, demand and supply should develop in a balanced way. Policies and incentives (i.e. grants) should stimulate combined projects that will ensure a first critical mass of demand for clean energy, considering a corridor approach. This will help ensuring an initial consumption of clean energy which is large enough for suppliers of clean energy to invest in the required energy infrastructure. When the right conditions are there, clean energy suppliers can move relatively easily, as compared to small individual vessel owners, and invest in infrastructure once there is a prospect of a market.

With respect to technical developments, the following R&D needs are listed in the following:

RD&I Topic 4.2.1	**Utilisation of the existing bunker infrastructure to store and deliver clean energy to vessels**
Explanation	Existing bunkering stations and bunker boats are not technically suitable to store and deliver clean energy; there are also legal bottlenecks due to safety rules and permits. For instance, existing bunker boats are not allowed to carry H2 stacks. A detailed analysis shall be carried out showing how the existing bunker infrastructure can be utilised for the storage and delivery of clean energy to inland vessels.

RD&I Topic 4.2.2	**Analysis and development of clean energy infrastructure for dedicated cases and routes**
Explanation	For suppliers of clean energy, it is technically challenging to provide (full) geographic coverage for their customers, since a large proportion of vessels operate on the spot market and will have varying sailing trajectories and may not be able to bunker and charge clean energy always at the same location. This will imply, especially in the deployment phase, that the development of the clean energy infrastructure for specific cases and dedicated routes (e.g. container vessels, ferries, etc.) on limited parts of a corridor will be necessary.
RD&I Topic 4.2.3	**Development of containerised energy storage systems**
Explanation	Containerised energy storage for e.g. batteries and hydrogen (and possibly also other forms of clean energy) appears to be a suitable option to reach a necessary degree of geographical coverage with swapping energy containers at existing container terminals. However, there are technical challenges both on the vessel and ashore. Not all (existing) vessels will be suited to carry containers and large parts of the sector never call on container terminals. Furthermore, many inland terminals are still operated by one crane only and may not be able to take on the additional handling of clean energy-containers. However, swapping locations could also be at shore-side locations along waterways and not necessarily at container terminals. The feasibility of this swapping concept would need to be investigated.
RD&I Topic 4.2.4	**Development of proper Onshore Power Supply (OPS)**
Explanation	For OPS, it is important to have the necessary electricity infrastructure in place. The grid should reach the quay side (in an effective manner), meet the demand (also from inland cruise vessels) and there should be a uniform concept for the operation of the shoreside power connections and a commonly accepted payment method. Looking into the future, it is also essential to set up OPS points in such a way that they can also be utilised for (rapid) charging of batteries on board used for propulsion of the vessel. However, it does appear that this is technically very complex and requires many infrastructural modifications to make a regular OPS point ready to serve as a charging point to charge batteries on board of vessels used for their propulsion.
RD&I Topic 4.2.5	**Monitoring of the availability of clean energy for inland waterway transport**
Explanation	An overarching technical challenge is whether there will be enough supply of clean energy in all European inland waterway transport countries to meet the 55 % GHG reduction targets by 2030. This is not yet entirely clear, and it is also going to depend on the demand from other modes of transportation and industries. This should be monitored closely and it should be made clear what the prospects are for inland waterway transport in the various European countries and regions.
RD&I Topic 4.2.6	**Raising awareness for a mind shift relating to the use of clean energy**
Explanation	Clean energy such as H2 is not the same as fossil diesel and requires a significant mind shift in the supply and bunkering of the fuel as well as the operation of a vessel. The stakeholders who are going to be affected should become aware of this need for a mind shift in a timely manner, which can be achieved by the conduction of dedicated feasibility studies, investigation of use cases and analysis of pilots implemented.

RD&I Topic 4.2.7	Utilisation of learnings from the development and implementation of infrastructure projects (e.g. relating to LNG)
Explanation	This especially concerns the operation of the bunkering infrastructure, i.e. with operating the bunkering station in Cologne, bunkering pontoons and the truck-to-ship supplies. Lessons can be learned from the technical difficulties in construction and initial operations relevant to the future (liquid) H2 infrastructure.

9.3 RD&I recommendations from Task 4.3: Smart waterway and port infrastructure and management

Digitalisation of waterways and ports in general

Intelligent solutions, including digitalisation and automation, will play an important role in improving the efficiency and reliability of inland navigation and traffic management. They will also help to better integrate inland navigation into logistics processes and multimodal chains, reduce the administrative burden or the costs related to regulatory compliance.

A reliable, safe, efficient and smart waterway network is needed to enable smart vessels to navigate Europe‘s waterways. Therefore, PLATINA 3 had a look at the requirements that future autonomous and remotely controlled vessels will place on infrastructure and infrastructure operators. Shipping operations such as voyage planning; navigation on rivers, canals or navigation in ports; passing locks and movable bridges; or docking operations can be improved by digital solutions. PLATINA3 partners collaborated with the DIWA Masterplan to develop conclusions and recommendations. Furthermore, PLATINA3 prepared a plan to develop the holistic vision on digitalisation in inland navigation which was handed over to the DINA Common Expert Group for further elaboration and preparation of a technical assistance study to be financed by CEF.

Automation requires reliable and high-quality data, reliable communication facilities and a cybersecurity framework in order to provide the confidence needed to remove humans from processes. Future communications will need to be digitally encoded, automatically transmitted and machine-readable. Vessels will need to communicate with each other and with the infrastructure. Therefore, connectivity is one of the key elements of smart shipping. Adding connectivity brings with it a number of other requirements, such as latency, privacy and data security.

Not all navigational tasks will and should be replaced at once, nor does it seem feasible at this stage. Vessel operations such as voyage and route planning, navigation and sailing on rivers and passing locks are already the focus of research projects and, in some cases, commercial deployments. Other operations that would require the changes to the physical infrastructure, such as docking of autonomous vessels at locks, at movable bridges waiting for passing; or in ports for loading and unloading, may take longer on the way to (fully) autonomous inland shipping.

Irrespective of the speed and direction of automation in inland navigation, it is important for the sector to know which waterways and which of their sections are ready to provide information and services essential for different levels of automation. The classification of the waterway network in terms of its readiness for automation should help autonomous and remotely controlled vessels to operate in a more

predictable environment. To prepare such a classification, activities in road transport such as ISAD (Infrastructure Support for Autonomous Driving) can be further explored and used as a basis.

Starting with an overview of the current state, looking for example at the existing information exchange between vessels and infrastructure within addressed shipping operations and describing the possible future state, which foresees autonomous and remotely controlled vessels, the existing gaps were identified and recommendations for a future smart infrastructure were formulated.

The respective R&D needs regarding to smart waterway infrastructure are listed in the following.

RD&I Topic 4.3.1	**Improve the reliability of data provided by authorities and waterway users**
Explanation	• Further development of communication standards, data sets to be exchanged and interfaces for sharing data in a machine-readable way; • Elaboration of rules on exchange of information between vessels and with the on-shore authorities for a mixed navigation situation (co-existence of autonomous and conventional vessels); • Investigation and testing of novel technologies and solutions replacing the voice communication in a mixed navigation situation (co-existence of autonomous and conventional vessels); • Improvement of the quality of data by investing in quality of existing data rather than on sharing new types of data; • Ensuring easy & user-friendly feedback loops from the sector concerning the quality of data provided by authorities; • Increase awareness for digitalisation and automation in the inland navigation sector, in particular referring to vessel operators; • Provision of support to digitalisation efforts of inland vessels (through financial support and other incentives, creation of favourable regulatory framework, …); • Continuation of the standardisation and harmonisation processes, which started with RIS, with requirements of autonomous and remotely controlled navigation in mind; • Continuation of the development of EuRIS as the default digital information platform for inland waterway transport with respect to real-time and forecasted fairway-, infrastructure-, traffic and transport information, covering the entire European fairway network relevant for inland waterway transport.
RD&I Topic 4.3.2	**Increase readiness of waterway network for automation**
Explanation	• Conduction of research regarding how the classification of waterways can be done, providing the insight into the readiness (maturity) of the European waterway network for automation.
RD&I Topic 4.3.3	**Investigate improved communication, networks and systems & connectivity**
Explanation	• Investigation, research and pilot deployment of novel technologies providing improved correction data. Project SciPPPer with testing PPP (Precise Point Positioning), RTK (Real Time Kinematic) and more recently their hybridisation, PPP-RTK); • Investigation of novel precise positioning solutions; • Investigation of alternative solutions for critical infrastructure objects and urban areas;

	• Investigation of further standardisation and adaptation of the VHF Data Exchange System (VDES) to the needs of inland navigation; • Primary consideration of (critical) bottlenecks and infrastructure like bridges, locks, waterway section difficult to navigate due to high traffic of geographical conditions.

RD&I Topic 4.3.4	**Ensure cybersecurity**
Explanation	• Creation of an awareness in inland navigation sector through e.g. information campaign or dedicated trainings for administrations, authorities and waterway users; • Establishment of a coordination platform bringing the main inland navigation players together with cybersecurity experts (this is an outcome of the 1st Cybersecurity workshop in Bonn, Sep 2019: CCNR who organised the workshop was asked to play a central role in the cybersecurity domain in inland navigation); • Elaboration of standards – what is required for onboard as well as onshore systems; • Elaboration of guidance – examples on how to proceed in application of cybersecurity measures (while standards may state what must be achieved without too much regard to the methods used, guidance should address not only the outcome and applicable metrics but suggest suitable methods); • Consideration of cybersecurity requirements in the design of digital and automation solutions for infrastructure and vessels (by applying e.g. multiple layers of mechanism, functions and barriers aiming at hindering, detecting and limiting the damage of a security breach); • Application of "building-in redundancy" principles, both in design and deployment of critical systems; • Integration of redundancy of the critical systems principle into relevant standards; • Application of cybersecurity requirements in the design of digital and automation solutions in all new emerging application areas; • Raising awareness in the inland navigation sector; • Raising awareness at the competent authorities (NIP directive); • Development of various preparatory steps, mitigation actions and responses to threats.
RD&I Topic 4.3.5	**Ensure data privacy**
Explanation	• Application of the "privacy-by-design" principle, meaning "data protection through technology design (at the outset of data processing practices); • Application of agreements on sharing certain kind of data. Sharing privacy related information should only be done with consent of the information owner. For all users it should be clear if data is provided for the use by others as well.
RD&I Topic 4.3.6	**Address regulatory and legal aspects**
Explanation	• Conduction of a regulatory scoping exercise to identify and analyse various legislative acts and assess how smart shipping (autonomous vessels) could be regulated (similar to the IMO scoping exercise);

	• Coordination of the work with CESNI, in particular in case of crew, technical requirements for vessels, etc.; • Integration of the agreed rules into European and national legislations; • On short-term: development of a procedure for the approval of pilot projects derogating from the provisions of the CCNR (work done by the CCNR).

Inland ports

Ports across Europe have different development trends behind them (related to regionalisation, multimodality, innovation, digitalisation, or optimisation of port operations), different operational and ownership models, focussed on different cargoes and offering different services. For example, for most inland ports, digitalization is still a new topic, therefore they find themselves in a position where they need to follow the digitalization examples of major European sea ports and ports from other regions.

The respective R&D needs regarding smart inland port infrastructure are listed in the following.

RD&I Topic 4.3.7	**Development and adoption of port community systems**
Explanation	Development and adoption of a port community system, enabling inland ports to make use of economies of scale splitting the costs of investment and operation between several users (ports), hence avoiding the situation that only one port needs to support the entire financial burden. Besides the financial aspects, aspects in relation to data sharing, data ownership and data protection and security from the point of user rights, liabilities and responsibilities shall be considered. The complexity of these aspects requires strong cooperation, especially if several countries are involved (both EU and non-EU Member States). An enhanced regional cooperation with an outlook to corridor integration shall be achieved for European inland ports.
RD&I Topic 4.3.8	**Integration of both inland and seaports enabling ports to become reliable partners in European and global transport chains**
Explanation	Improvement of the interconnection between ports (inland and sea) and the other (land) transport modes. The (larger) IWT ports, in particular those found on the Rhine, have started to harmonize their systems. However, many of the others are still lagging behind, a fact that will to a significant extent obstruct their development. This will also have an impact on other transport-related aspects, in particular the achievement of a modal shift at the EU level.
RD&I Topic 4.3.9	**Development of a digitalisation roadmap applicable to inland ports**
Explanation	Development of a digitalisation roadmap applicable to inland ports, which identifies practical actions required across several intervention areas addressing a good port governance, ensuring maximal stakeholder involvement, improving cybersecurity and facilitating trade while using smart technologies in the port customers' interests.

Seaports

Seaports are frontrunners in the digitalisation transformation/adoption trend. In Europe, several seaports such as Rotterdam, Amsterdam, Hamburg, Antwerp, Barcelona, Valencia, etc. have already built-up impressive experience in dealing with new technologies. In the area of seaports, the long-term vision is a network of trusted networks - global network of Smart Ports. It is expected to be an informal network of independent Smart Ports, sharing real-time information concerning the maritime supply chain and fostering the development and implementation of innovations. By joining this network of Smart Ports, seaports also benefit from optimised transport flows.

A deep and massive digitalisation process based on new technologies (Internet of Things - IoT, smart sensors, Big Data analytics, Artificial Intelligence, 5G, etc.) will be the trend for sea ports and all its stakeholders in the next 5-10 years. Consequently, forecasts, analysis and predictions will be dramatically improved and assisted port operations will achieve a more efficient use of resources (dynamic optimisation systems, predictive maintenance systems, advanced dredging materials management, just-in-time ship arrivals, etc.).

The respective R&D needs regarding smart seaport infrastructure are listed in the following.

RD&I Topic 4.3.10	**Development of shared frameworks and standards at European level as proposed by DTLF**
Explanation	Establishment of a truly integrated approach for the use of data by the development of shared frameworks and standards at European level (Digital Transport and Logistics Forum - DTLF and European Sustainable and Smart Mobility Strategy). The standards developed for the maritime sector (in waterborne) need to be connected to those already set for logistical and distributional transport networks (in the framework of the Alliance for Logistics Innovation through Collaboration in Europe - ALICE).
RD&I Topic 4.3.11	**Improve safety and security in automated and semi-automated environments and ecosystems**
Explanation	Development of innovative strategies to guarantee safety and security in automated and semi-automated environments and ecosystems. The integration of cybersecurity and physical systems related to port infrastructure is critical, particularly given the increased and frequent threats. In this regard, active cooperation between ports and countries and effective and resilient threat identification systems are urgently required. The improvement and development of new technologies, equipment and devices allowing intelligent, passive and active interactions with passengers and goods have to be considered with the aim of fostering a completely safe and secure environment.
RD&I Topic 4.3.12	**Development of new collaborative solutions and the corresponding tools and business models**
Explanation	Development of new collaborative solutions and the corresponding tools and business models, facilitating capacity sharing along the supply chain and considering all the different transport flows (e.g. people and cargo movements; intercontinental flows; short-sea flows; hinterland transport network, port clusters, etc.). The maritime sector is characterised by the high degree of interactions of intermediaries along the supply chain, where the ports are vital players representing the primary interface between the sea/river and the hinterland, through the transportation and movement of goods.

RD&I Topic 4.3.13	**Develop pathway towards fully connected and automated ports**
Explanation	Addressing automation and robotisation, enhancements and developments shall be carried out with respect to new situational awareness systems for multiple functions, combining physical and digital assets. In this regard, a wide range of solutions (e.g. cutting-edge Vessel Traffic Service - VTS; modern control towers; innovative vehicle traffic management services; equipment control systems, autonomous and remote-controlled port services ships; automated mooring; etc.) needs to be defined and assessed for the implementation of an effective pathway towards a fully connected and automated port.
RD&I Topic 4.3.14	**Support progressive automation of nautical services for vessels**
Explanation	Development of new advanced solutions and systems to support the progressive automation of nautical services for vessels (piloting, tugging, mooring, underwater maintenance, etc.), cargo handling and other port operations overcoming the current limitations. Improved solutions for human-machine interactions, including the application of new technologies such as artificial intelligence, predictive analytics, big data and augmented reality.
RD&I Topic 4.3.15	**Adapt job qualifications and training needs for port automation**
Explanation	Modification of traditional job qualifications and training needs, matching the new technological developments. Human factor aspects, including ethical issues, will have to be thoroughly assessed and addressed, especially with regards to automation technologies (e.g. the dockworker of the future; remote working; cobotics and mobile robotics; etc.).

9.4 RD&I recommendations from Task 4.4: Barriers to infrastructure implementation and proposed solutions

Not applicable.

10. RD&I topics already addressed in Horizon Europe 2021-2024

In order to be able to conclude on the priority topics to be addressed in future research and development programmes, it is required to (double) check whether the topics identified in the previous chapters for the thematic pillars "Market", "Fleet", "Jobs & Skills" and "Infrastructure" are already covered in the Horizon Europe (HEU) Working Programme 2021-2024.

For the thematic area "Fleet", specifically as regards the sub-theme on Zero Emission Waterborne Transport (ZEWT), this check was already done in the D2.1. Additionally, the call topic HORIZON-CL5-2023-D5-01-17 "*Towards the implementation of the inland navigation action programme with a focus on Green and Connected Inland Waterway Transport*" is expected to follow up the coordination and support work on the Tasks 2.5 and 2.6 for financing of the energy transition of the fleet, as well as on the label/index for energy and emission performance of vessels.

Regarding the thematic area "Jobs & Skills" the analyses showed that there are no specific RD&I actions in the Horizon Europe Work Programme 2021-2024, but the topic of Jobs & Skills (specifically in relation to automation and zero-emission technologies) is to be addressed in calls for these technologies (e.g. HORIZON-CL5-2023-D5-01-16, HORIZON-CL5-2022-D5-01-05).

Therefore, the assessment as to what extent the PLATINA3 RD&I topics have been covered already in the Horizon Work Programmes between 2021 and 2024 will be focused on the thematic areas of "Market" and "Infrastructure" in the remainder of this chapter.

10.1 Coverage of "Market" RD&I topics in Horizon Europe 2021-2024

RD&I Topic	PLATINA3 RD&I topic	Horizon Europe Call ID, title and link to call and/or granted projects	Partial	Full
1.1.1	Identification and analysis of how new markets can be captured and of how IWT can be integrated into urban logistics	HORIZON-CL5-2023-D5-01-16 Developing small, flexible, zero-emission and automated vessels to support shifting cargo from road to sustainable Waterborne Transport	X	
1.1.2	Development of IWT transport solutions supporting the energy transition	No direct link with HEU 2021-2024		
1.1.3	Implementation and analysis of pilot projects	No direct link with HEU 2021-2024		
1.1.4	Improvement of seaport operations and IWT interconnections to global trade	HORIZON-CL5-2022-D5-01-05 Seamless safe logistics through an autonomous waterborne freight feeder loop service Project: SEAMLESS	X	
		HORIZON-CL5-2022-D6-02-03 Smart enforcement for resilient, sustainable and more efficient transport operations	X	
		HORIZON-CL5-2023-D5-01-13	X	

RD&I Topic	PLATINA3 RD&I topic	Horizon Europe Call ID, title and link to call and/or granted projects	Partial	Full
		Integrated real-time digital solutions to optimise navigation and port calls to reduce emissions from shipping (ZEWT Partnership)		
		HORIZON-CL5-2021-D6-01-09 Climate resilient and environmentally sustainable transport infrastructure, with a focus on inland waterways Projects: CRISTAL, PLOTO, ReNEW	X	
		HORIZON-CL5-2022-D6-02-07 New concepts and approaches for resilient and green freight transport and logistics networks against disruptive events (including pandemics)	X	
1.1.5	Raising resilience of IWT supply chains to low water events	HORIZON-CL5-2023-D6-01-09 Climate resilient and safe maritime ports	X	
1.1.6	Increase the awareness relating to the advantages of IWT as an alternative mode of transport	No direct link with HEU 2021-2024		
1.2.1	Development of a roadmap for IWT-related modal shift and decarbonisation	No direct link with HEU 2021-2024		
1.3.1	Development of technologies and regulations that allow seamless switch of cargo	HORIZON-CL5-2023-D5-01-13 Integrated real-time digital solutions to optimise navigation and port calls to reduce emissions from shipping (ZEWT Partnership)	X	
1.5.1	Developing clear legal framework for energy transition	No direct link with HEU 2021-2024		

It can therefore be concluded that Market RD&I topics 1.1.1, 1.1.4, 1.1.5 and 1.3.1 are already **partially** covered, while Market RD&I topics 1.1.2, 1.1.3, 1.2.1 and 1.5.1 have no direct link to a RD&I call in the Horizon Europe Work Programme 2021-2024.

10.2 Coverage of "Infrastructure" RD&I topics in Horizon Europe 2021-2024

RD&I Topic	PLATINA3 RD&I topic	Horizon Europe Call	Partial	Full
4.1.1 4.1.2 4.1.3 4.1.4	Creating data basis containing short and long term climate change projections Further development of integrative planning procedures for inland waterway infrastructure projects Develop innovative methods for waterway maintenance and management Develop innovative methods for waterway surveying and measuring	HORIZON-CL5-2021-D6-01-09 Climate resilient and environmentally sustainable transport infrastructure, with a focus on inland waterways Projects: CRISTAL, PLOTO, ReNEW	X	
		HORIZON-CL5-2023-D6-01-09 Climate resilient and safe maritime ports	X	
4.2.1	Utilisation of the existing bunker infrastructure to store and deliver clean energy to vessels	No direct link with HEU 2021-2024		
4.2.2	Analysis and development of clean energy infrastructure for dedicated cases and routes	No direct link with HEU 2021-2024		
4.2.3	Development of containerised energy storage systems	No direct link with HEU 2021-2024		
4.2.4	Development of proper Onshore Power Supply (OPS)	No direct link with HEU 2021-2024		
4.2.5	Monitoring of the availability of clean energy for inland waterway transport	No direct link with HEU 2021-2024		
	Raising awareness for a mind shift relating to the use of clean energy	No direct link with HEU 2021-2024		
4.2.6	Raising awareness for a mind shift relating to the use of clean energy	No direct link with HEU 2021-2024		
4.2.7	Utilisation of learnings from the development and implementation of infrastructure projects (e.g. relating to LNG)	No direct link with HEU 2021-2024		
4.3.1	Improve the reliability of data provided by authorities and waterway users	No direct link with HEU 2021-2024		
4.3.2	Increase readiness of waterway network for automation	No direct link with HEU 2021-2024		
4.3.3	Investigate improved communication, networks and systems & connectivity	No direct link with HEU 2021-2024		
4.3.4	Ensure cybersecurity	HORIZON-CL5-2024-D6-01-10 Ensuring the safety, resilience and security of waterborne digital systems	X	

RD&I Topic	PLATINA3 RD&I topic	Horizon Europe Call	Partial	Full
4.3.5	Ensure data privacy	No direct link with HEU 2021-2024		
4.3.6	Address regulatory and legal aspects	No direct link with HEU 2021-2024		
4.3.7	Development and adoption of port community systems	No direct link with HEU 2021-2024		
4.3.8	Integration of both inland and seaports enabling ports to become reliable partners in European and global transport chains	HORIZON-CL5-2021-D6-01-07 More efficient and effective multimodal freight transport nodes to increase flexibility, service visibility and reduce the average cost of freight transport Project: MultiRELOAD HORIZON-CL5-2023-D5-01-13 Integrated real-time digital solutions to optimise navigation and port calls to reduce emissions from shipping (ZEWT Partnership)	X	
4.3.9	Development of a digitalisation roadmap applicable to inland ports	No direct link with HEU 2021-2024		
4.3.10	Development of shared frameworks and standards at European level as proposed by DTLF	No direct link with HEU 2021-2024		
4.3.11	Improve safety and security in automated and semi-automated environments and ecosystems	No direct link with HEU 2021-2024		
4.3.12	Development of new collaborative solutions and the corresponding tools and business models	No direct link with HEU 2021-2024		
4.3.13	Develop pathway towards fully connected and automated ports	No direct link with HEU 2021-2024		
4.3.14	Support progressive automation of nautical services for vessels	No direct link with HEU 2021-2024		
4.3.15	Adapt job qualifications and training needs for port automation	No direct link with HEU 2021-2024		

Based on this table it can be concluded that Infrastructure RD&I topics 4.1.1 – 4.1.4, 4.3.4 and 4.3.8 are already (partially) covered, while Infrastructure RD&I topics 4.2.1-4.2.7, 4.3.1-4.3.3 and 4.3.5 – 4.3.7 and 4.3.9 – 4.3.15 have no direct link to a RD&I call in HEU WP 2021-2024.

However, it is noted that the efforts underway through the calls listed above for the topics 4.1.1 up to 4.1.4 are not sufficient to achieve a climate resilient waterway system covering e.g. the relevant parts of the Rhine-Danube axis with the majority of goods transported in Europe on inland waterways.

A detailed assessment took place on the scope and expected outcomes of projects CRISTAL, PLOTO and ReNEW, see also in the Annex. It was concluded that even after completion of these projects, it can be expected that a comprehensive picture with a common climate modelling basis will be still missing, in particular for the Danube region, calling for climate change projects on European level involving all relevant representatives of member states concerned. Referring to the projects mentioned above, river-engineering and maintenance works are almost completely neglected, while most effort is put on monitoring of water levels and digital applications for provision of some information on waterways without the inclusion of all relevant waterway authorities responsible for e.g. RIS, raising also the question how realistic the promised integration in the existing RIS will be.

The projects underway do not give a full picture on the climate change impacts on available water depths for the entire inland waterway network in Europe. For example the Rhine-Danube axis is important as it includes many free-flowing sections which are sensitive to climate change effects. However, from the analyses on projects underway it became obvious that not all relevant waterway administrations owning the necessary specific knowledge are involved, e.g. the Federal Institute of Hydrology of Germany. The implementations, e.g. on water level forecast, are locally limited and would demand further developments for all critical locations at the Rhine-Danube axis where necessary. Further, interrelations between developments of surroundings of waterways, land-borne activities and the ones on waterways, e.g. impact of water withdrawal for agriculture, or sealing of land in the vicinity of waterways, etc. are not considered. The call on “Climate resilient and safe maritime ports” is promising, and allows also for the development of river engineering measures. However, it is interlinked mainly to sea ports, neglecting thereby the adaptation of inland ports as well as parts of waterways farther away from the seaport. The outcomes, their applicability and local impacts are not clear yet. The topics 4.1 up to 4.1.4 are partially covered by the latest developments. However, major research items, in particular on a corridor level e.g. the Rhine-Danube axis, are not tackled yet. The call on “Climate resilient and safe maritime ports” can provide a valuable step forward. Even in this case, further RD&I activities will be necessary.

Therefore, seen the fragmentation and gaps, it is recommended to keep the topics 4.1 up to 4.1.4 valid for further research and to prepare a large dedicated project for IWT in Europe to address all geographic areas and types of waterways (rivers, canals).

11. Conclusions and Recommendations

Across the four thematic work packages “Market”, “Fleet”, “Jobs & Skills” and “Infrastructure” four horizontal topics have been distinguished in the PLATINA3 project:

- Climate resilience
- Climate change mitigation and air quality improvement
- Digitalisation
- Modal shift

Climate resilience is understood as readiness to deal with worst case scenarios resulting from a progressively changing climate. Here, direct impacts, e.g. caused by droughts leading to low-water conditions or sudden events like severe precipitation leading to flooding can play an important role. In addition, indirect impacts in particular in association with water scarcity have to be considered too. E.g. the extraction of water for agricultural purposes caused by insufficient precipitation may result in conflicts of interests between the different stakeholders of waterways what for the inland waterway transport sector has to become prepared, demanding an integrative approach involving all relevant stakeholders.

The topic of **climate change mitigation and air quality improvement** concerns the transition to low or zero-carbon intensity energy usage by inland vessels and the reduction of the air pollutant emissions (NOx, PM) of vessels. This was addressed in Tasks 1.5, 2.1, 2.5, 2.6, 2.7, 3.1 and also 4.2. In Task 1.5 it was concluded that for a successful modal shift from road towards inland waterway transport, the vessels need to be competitive with the emission performance of the trucks, which are expected in the near future. In Tasks 2.1, 2.5-2.7 detailed conclusions and recommendations have been made in terms of the actions needed for the fleet to enable this transition. In Task 3.1 attention was paid to the requirements for the jobs&skills in terms of the competences of the workforce. In Task 4.2 attention was paid to the energy supply infrastructure along waterways and in ports, which also requires a drastic development to be able to supply the vessels with low/zero- carbon energy.

The topic of **digitalisation** is not a goal in itself but an important supporting development required to remain competitive and to improve the connectivity to ports, other transport modes and the clients (e.g. to keep the direct costs low and to allow synchromodal solutions). As was made clear in the Task 1.3, digitalisation as well as digital integration is crucial to increase the modal share of IWT and to be able to significantly contribute to the modal shift goals as presented in the EU Green Deal. Moreover, automation may also support to sail even safer and more efficiently. It may also overcome problems with shortage of personnel and is expected to increase the attractiveness of working in the IWT sector. The latter came clear from the Tasks 2.3, 3.3 and 4.3.

Last but not least, there are specific RD&I recommendations from the tasks on achieving **modal shift**. However, it shall be noted that the modal shift opportunities do heavily rely on the first three topics. Without climate resilience, vessels will not be able to sail economically while green vessels and digitalisation will be required by the future clients. For modal shift some specific RD&I actions are required. These have been specifically addressed in Task 1.1 and 1.2 and partially in Task 1.3, discussing for example the actions needed to unlock the potential of new markets, the subject of new loading units and transhipment systems.

11.1 Conclusions

The following table presents the conclusion on the identified RD&I topics based on the tasks executed in the PLATINA3 project within the four thematic work packages “Market”, “Fleet”, “Jobs & Skills” and “Infrastructure”. The topics which have not been sufficiently addressed as yet in the Horizon Europe Working Programme 2021-2024 (see chapter 10) are marked by means of **red texts** in the following table. These topics require particular attention in the elaboration of future Horizon Europe Work Programmes such as the programme for the years 2025-2027.

RD&I Topic	Climate resilience	Climate mitigation and air quality improvement	Digitalisation	Modal Shift
RD&I Topic 1.1.1				Identification and analysis of how new markets can be captured and of IWT can be integrated into urban logistics
RD&I Topic 1.1.2				Development of IWT transport solutions supporting the energy transition
RD&I Topic 1.1.3				Implementation and analysis of pilot projects
RD&I Topic 1.1.4				Improvement of seaport operations and IWT interconnections to global trade
RD&I Topic 1.1.5	Raising resilience of IWT supply chains to low water events			
RD&I Topic 1.1.6				Increase the awareness relating to the advantages of IWT as an alternative mode of transport
RD&I Topic 1.2.1				Development of a roadmap for IWT-related modal shift and decarbonisation
RD&I Topic 1.3.1				Development of technologies and regulations that allow seamless switch of cargo

RD&I Topic	Climate resilience	Climate mitigation and air quality improvement	Digitalisation	Modal Shift
RD&I Topic 1.5.1		Developing clear legal framework for energy transition		
RD&I Topic 2.1.1		Support transition of the inland fleet towards zero-emission		
RD&I Topic 2.1.2		Support transition of the inland fleet towards zero-emission – deployment		
RD&I Topic 2.2.1	Raise climate resilience of inland vessel designs			
RD&I Topic 2.2.2	Improved forecasting of climatic framework conditions			
RD&I Topic 2.2.3			Better understanding of real sailing profiles	
RD&I Topic 2.3.1			Pilot projects and outstanding development needs for automation of vessels	
RD&I Topic 2.3.2			Develop regulations and standards for automation of vessels - deployment	
RD&I Topic 2.5.1		Coordination and support action to set up European financial instrument to support the inland navigation energy transition		
RD&I Topic 2.6.1		Coordination and support action to facilitate EU wide implementation of emission label		
RD&I Topic 2.7.1		Proposals for regulations and standards supporting the transition towards zero-emission for the fleet		

RD&I Topic	Climate resilience	Climate mitigation and air quality improvement	Digitalisation	Modal Shift
RD&I Topic 3.1.1		Update of CESNI standards with a view to alternative fuels competence		
RD&I Topic 3.3.1			Update of CESNI standards with a view to competence related to automation	
RD&I Topic 4.1.1	Creating data basis containing short- and long-term climate change projections			
RD&I Topic 4.1.2	Further development of integrative planning procedures for inland waterway infrastructure projects			
RD&I Topic 4.1.3	Develop innovative methods for waterway maintenance and management			
RD&I Topic 4.1.4	Develop innovative methods for waterway surveying and measuring			
RD&I Topic 4.2.1		Utilisation of the existing bunker infrastructure to store and deliver clean energy to vessels		
RD&I Topic 4.2.2		Analysis and development of clean energy infrastructure for dedicated cases and routes		
RD&I Topic 4.2.3		Development of containerised energy storage systems		
RD&I Topic 4.2.4		Development of proper Onshore Power Supply (OPS)		
RD&I Topic 4.2.5		Monitoring of the availability of clean		

RD&I Topic	Climate resilience	Climate mitigation and air quality improvement	Digitalisation	Modal Shift
		energy for inland waterway transport		
RD&I Topic 4.2.6		Raising awareness for a mind shift relating to the use of clean energy		
RD&I Topic 4.2.7		Utilisation of learnings from the development and implementation of infrastructure projects (e.g. relating to LNG)		
RD&I Topic 4.3.1			Improve the reliability of data provided by authorities and waterway users	
RD&I Topic 4.3.2			Increase readiness of waterway network for automation	
RD&I Topic 4.3.3			Investigate improved communication, networks and systems & connectivity	
RD&I Topic 4.3.4			Ensure cybersecurity	
RD&I Topic 4.3.5			Ensure data privacy	
RD&I Topic 4.3.6			Address regulatory and legal aspects	
RD&I Topic 4.3.7			Development and adoption of port community systems	
RD&I Topic 4.3.8			Integration of both inland and seaports enabling ports to become reliable partners in European and global transport chains	
RD&I Topic 4.3.9			Development of a digitalisation roadmap applicable to inland ports	

RD&I Topic	Climate resilience	Climate mitigation and air quality improvement	Digitalisation	Modal Shift
RD&I Topic 4.3.10			Development of shared frameworks and standards at European level as proposed by DTLF	
RD&I Topic 4.3.11			Improve safety and security in automated and semi-automated environments and ecosystems	
RD&I Topic 4.3.12			Development of new collaborative solutions and the corresponding tools and business models	
RD&I Topic 4.3.13			Develop pathway towards fully connected and automated ports	
RD&I Topic 4.3.14			Support progressive automation of nautical services for vessels	
RD&I Topic 4.3.15			Adapt job qualifications and training needs for port automation	

11.2 Recommendations

The following sections present the recommended RD&I actions from the side of PLATINA3, for each of the four horizontal topics.

11.2.1 Climate resilience

Reference	Title	Summarising explanation
RD&I Topic 4.1.1	Creating data basis containing short- and long-term climate change projections	Creation of a common data basis with respect to climate projections and impacts relevant to inland waterway transport, the environment and possible users of waterways, as well as local economies. Forecasting for improved utilisation and management of the waterway: extension of existing lead-times and improvement of reliability by deterministic short-term predictions, probabilistic mid-term and seasonal predictions;
RD&I Topic 4.1.2	Further development of integrative planning procedures for inland waterway infrastructure projects	Promotion of a multi-disciplinary approach with resepct to integrative planning of infrastructure projects, including a dialogue between the industry, logistics, relevant water users, politics, and environmental organisations, as well as regulations and funding for modernisation on European and national level. Proper cooperation between the different stakeholders and an integrated approach for coping with climate change. Investigation of interrelations between developments of surroundings of waterways (e.g. extraction of water), land-borne activities (e.g. sealing) and the ones on waterways. Develop methods for integrative water management, extension of existing water reservoirs and implementation of new water reservoirs. Elaboration and initiation of measures for the reduction of administrative efforts with respect to permissions requested for the implementation of infrastructure projects.
RD&I Topic 4.1.3	Develop innovative methods for waterway maintenance and management	Research on river engineering and waterway management options for provision of reliable and predictable navigation conditions. Development and testing of innovations. Review, elaboration and testing of maintenance approaches with respect to their appropriateness and how they can be improved. Review of fairways and navigation channels, as well as evaluation where relocation of fairways and marking are meaningful. Application of Nature Based Solutions: evaluation of which and where they can be applied.
RD&I Topic 4.1.4	Develop innovative methods for waterway surveying and measuring	Further development of information systems providing relevant information to operation of waterways and navigation conditions to users of inland waterways. Usage of aquatic and flying drones for collection of information on developments in fairways and wide waterways at low water. Implementation of the floating-ship-data approach, supporting waterway management, as well as providing improved information on navigation conditions.
RD&I Topic 2.2.1	Raise climate resilience of inland vessel designs	Inland vessel designs with a higher degree of climate resilience can be supported by a series of RD&I efforts. Efforts in the field of: development of new materials, new bow thrusters, adaptation of existing vessels, research on framework conditions for vessel design, impact of new energy carriers and zero-emission solutions on vessel draft in view of low water events, prediction of ship operation and model tests.

Reference	Title	Summarising explanation
RD&I Topic 2.2.2	Improved forecasting of climatic framework conditions	Research is needed with respect to the provision of reliable data on and forecasting of climatic framework conditions as a precondition for the proper retrofitting and design of inland waterway vessels. Future vessel adaptation measures shall thereby not negatively affect the operation of vessels at normal navigation conditions, e.g. increase the energy demand during normal conditions.

11.2.2 Climate mitigation and air quality improvement

Reference	Title	Summarising explanation
RD&I Topic 1.5.1	Developing clear legal framework for energy transition	Clarity on a regulatory level is necessary for shipowners to take further steps towards energy transition as well as for energy suppliers and related stakeholders on corridor level. At the current moment several technologies of different maturity level exist and it is not defined yet which will be dominant and approved for the next decades. This creates reluctance to invest.
RD&I Topic 2.1.1	Support transition of the inland fleet towards zero-emission	The transition of the inland fleet towards zero-emission by 2050 should be supported by a series of RD&I efforts. This concerns: engines to be certified and tested for biofuels, elaboration of (bio)fuel specifications, maintenance needs for methanol, new types of hydrogen carriers (e.g. LOHC), demonstration of the battery design life in operational conditions, further development of ES-TRIN to consider new battery types, bunkering/charging solutions, onshore power supply (OPS) for (rapid) charging of batteries.
RD&I Topic 2.1.2	Support transition of the inland fleet towards zero-emission - deployment	The transition of the inland fleet towards zero-emission by 2050 should be supported by solving a series of deployment issues: development of new types of fuel cells and their reliability (tilting, acceleration, vibrations, etc.), development/ further optimization of engines systems to (nearly) eliminate all types of air pollutants, further upscaling of demonstrator projects to identify benefits/push the limits of the different fuels, demonstration of the battery design life in operational conditions, bring down the volumetric and gravimetric density of battery modules and pack integration, retrofitting existing vessels by the (optimal) integration of sustainable available solutions, including solutions using renewable energies, development and implementation of new vessel designs that support multi-fuel engines and fuel cells, including aft-ship replacement for existing vessels, investigate and demonstrate the benefits of using multiple (smaller) main engines, demonstrator projects on bunkering sustainable alternative fuels at inland and sea ports, availability, feasibility and use of swappable battery containers, further development of fast charging infrastructure.
RD&I Topic 2.7.1	Proposals for regulations and standards supporting the transition towards zero-emission for the fleet	Analysis of regulatory aspects to support the transition to zero-emission. These analyses should contain: facilitate the financing and commissioning of pilot vessels using alternative technologies, investigate the opportunity to introduce efficiency and greenhouse gas emission limits, policy research on feasibility and impact of additional instruments to promote usages of energy carriers with low carbon intensity, technical advice for the development of

Reference	Title	Summarising explanation
		guidelines for the implementation of Articles 34 and 35 of NRMM for engines using methanol and hydrogen as fuel, review opportunity to further reduce exhaust emission limits for inland navigation vessels, review the extent to which the engine emissions measured during type-approval tests using corresponding test cycles reflect engine emissions in real operating conditions and propose any necessary changes, improve the understanding of safety issues with hydrogen for the development of requirements for hydrogen in internal combustion engine, investigate need for stricter fuel quality standards for FAME and their blends as well as quality checks in the supply chains of these fuels and enforcement.
RD&I Topic 3.1.1	Update of CESNI standards with a view to alternative fuels competence	CESNI shall focus on the definition of the competence of specific experts following the timing developed for the update of the European Standard on Technical Requirements in Inland Navigation (ES-TRIN) to establish technical requirements for the storage, bunkering and maintenance procedures for the relevant fuels and energy carriers.
RD&I Topic 4.2.1	Utilisation of the existing bunker infrastructure to store and deliver clean energy to vessels	Existing bunkering stations and bunker boats are not technically suitable to store and deliver clean energy; there are also legal bottlenecks due to safety rules and permits. A detailed analysis shall be carried out showing how the existing bunker infrastructure can be utilised for the storage and delivery of clean energy to inland vessels.
RD&I Topic 4.2.2	Analysis and development of clean energy infrastructure for dedicated cases and routes	A large proportion of vessels operate on the spot market and will have varying sailing trajectories and may not be able to bunker and charge clean energy always at the same location. This will imply, especially in the deployment phase, that the development of the clean energy infrastructure for specific cases and dedicated routes on limited parts of a corridor will be necessary.
RD&I Topic 4.2.3	Development of containerised energy storage systems	Containerised energy storage appears to be a suitable option to reach a necessary degree of geographical coverage with swapping energy containers at existing container terminals. However, there are technical challenges both on the vessel and ashore. The feasibility of this swapping concept would need to be investigated.
RD&I Topic 4.2.4	Development of proper Onshore Power Supply (OPS)	For OPS, it is important to have the necessary electricity infrastructure in place. The grid should reach the quay side (in an effective manner), meet the demand (also from inland cruise vessels) and there should be a uniform concept for the operation of the shoreside power connections and a commonly accepted payment method. Looking into the future, it is also essential to set up OPS points in such a way that they can also be utilised for (rapid) charging of batteries on board used for propulsion of the vessel. However, it does appear that this is technically very complex and requires many infrastructural modifications to make a regular OPS point ready to serve as a charging point to charge batteries on board of vessels used for their propulsion.
RD&I Topic 4.2.5	Monitoring of the availability of clean	An overarching technical challenge is whether there will be enough supply of clean energy for IWT. This is not yet clear and depends also on demand from

Reference	Title	Summarising explanation
	energy for inland waterway transport	other transport modes and industries. This should be researched and monitored closely.
RD&I Topic 4.2.6	Raising awareness for a mind shift relating to the use of clean energy	Clean energy bunkering and operation is not the same as fossil diesel and requires a significant mind shift. The affected stakeholders should become aware of this need for a mind shift in a timely manner, which can be achieved by the conduction of dedicated feasibility studies, investigation of use cases and analysis of pilots implemented.
RD&I Topic 4.2.7	Utilisation of learnings from the development and implementation of infrastructure projects (e.g. relating to LNG)	This especially concerns the operation of the bunkering infrastructure, bunkering pontoons and the truck-to-ship supplies. Lessons can be learned from the technical difficulties in construction and initial operations relevant to the future (liquid) H2 infrastructure.

11.2.3 Digitalisation

Reference	Title	Summarising explanation
RD&I Topic 2.2.3	Better understanding of real sailing profiles	Better understanding of the real sailing profiles allows vessels to be designed more in line with the real conditions, which is required for the energy transition as well as for climate resilience. Therefore, data needs to be collected on the operation of vessels and the actual waterway conditions using digital measurement and storage systems on board as well as sources from waterway managers.
RD&I Topic 2.3.1	Pilot projects and outstanding development needs for automation of vessels	Techniques and systems needed for high automation have comparatively low TRL levels. The most advanced systems (collision avoidance, AI, neural networks, sensor fusion and integration, etc.) need additional technical development to move from TRL 5-6 to TRL 9 in the next 10 years. In parallel the regulatory framework needs to evolve while safeguarding safety and security to enable the economic added value of automation.
RD&I Topic 2.3.2	Develop regulations and standards for automation of vessels – deployment	Standardisation and regulatory bodies (EU, CCNR, CESNI, CEN, ETSI) should amend the rules which reflect a human-centred vessel design to facilitate the development of alternative designs for automated inland vessels, with reduced or no crew onboard, by enabling the execution of the safety functions even in the absence of the human operator, provided that an equivalent level of safety compared to conventional navigation is ensured.
RD&I Topic 3.3.1	Update of CESNI standards with a view to competence related to automation	Discussions on draft competences for remote operation operators (ROCO) and crew members on board vessels that are remotely controlled have raised important questions of principle that the CESNI/QP working group will have to deal with. These questions will need to be considered as a whole, as there are strong cross-cutting issues and as feedback from other bodies will be required.

Reference	Title	Summarising explanation
RD&I Topic 4.3.1	Improve the reliability of data provided by authorities and waterway users	This concerns a number of actions: further development of communication standards, investigation and testing of novel technologies and solutions replacing the voice communication, improvement of quality of existing data, ensuring easy & user-friendly feedback loops from the sector concerning the quality of data provided by authorities, awareness for digitalisation and automation in the inland navigation sector, continuation of the development of EuRIS as the default digital information platform for IWT.
RD&I Topic 4.3.2	Increase readiness of waterway network for automation	Conduction of research regarding how the classification of waterways can be done, providing the insight into the readiness (maturity) of the European waterway network for automation.
RD&I Topic 4.3.3	Investigate improved communication, networks and systems & connectivity	This concerns the actions such as: investigation, research and pilot deployment of novel technologies providing improved correction data, investigation of novel precise positioning solutions, investigation of alternative solutions for critical infrastructure objects and urban areas, investigation of further standardisation and adaptation of the VHF Data Exchange System to the needs of inland navigation.
RD&I Topic 4.3.5	Ensure data privacy	Address application of the “privacy-by-design” principle. Sharing privacy related information should only be done with consent of the information owner.
RD&I Topic 4.3.6	Address regulatory and legal aspects	This concerns the execution of a regulatory scoping exercise to identify and analyse various legislative acts and assess how smart shipping could be regulated, coordination of the work with CESNI, integration of the agreed rules into European and national legislations.
RD&I Topic 4.3.7	Development and adoption of port community systems	Development and adoption of a port community system, enabling inland ports to make use of economies of scale and joint investments. Besides the financial aspects, aspects in relation to data sharing, data ownership and data protection and security, liabilities and responsibilities shall be considered. The complexity of these aspects requires strong cooperation.
RD&I Topic 4.3.9	Development of a digitalisation roadmap applicable to inland ports	Development of a digitalisation roadmap applicable to inland ports, which identifies practical actions required across several intervention areas addressing a good port governance, ensuring maximal stakeholder involvement, improving cybersecurity and facilitating trade while using smart technologies in the port customers’ interests.
RD&I Topic 4.3.10	Development of shared frameworks and standards at European level as proposed by DTLF	Establishment of an integrated approach for the use of data by the development of shared frameworks and standards at European level (DTLF and European Sustainable and Smart Mobility Strategy). The standards developed for the maritime sector need to be connected to those for logistical and distributional transport networks (in the framework of the Alliance for Logistics Innovation through Collaboration in Europe - ALICE).
RD&I Topic 4.3.11	Improve safety and security in automated and semi-automated	Development of innovative strategies to guarantee safety and security in automated and semi-automated environments and ecosystems. The integration of cybersecurity and physical systems related to port infrastructure is critical. The improvement and development of new

Reference	Title	Summarising explanation
	environments and ecosystems	technologies, equipment and devices allowing intelligent, passive and active interactions with passengers and goods have to be considered with the aim of fostering a completely safe and secure environment.
RD&I Topic 4.3.12	Development of new collaborative solutions and the corresponding tools and business models	Development of new collaborative solutions and the corresponding tools and business models, facilitating capacity sharing along the supply chain and considering all the different transport flows. The maritime sector is characterised by the high degree of interactions of intermediaries along the supply chain, where the ports are vital players.
RD&I Topic 4.3.13	Develop pathway towards fully connected and automated ports	Addressing automation and robotisation, enhancements and developments shall be carried out with respect to new situational awareness systems for multiple functions, combining physical and digital assets. In this regard, a wide range of solutions needs to be defined and assessed for the implementation of an effective pathway towards a fully connected and automated port.
RD&I Topic 4.3.14	Support progressive automation of nautical services for vessels	Development of new advanced solutions and systems to support the progressive automation of nautical services for vessels, cargo handling and other port operations overcoming the current limitations. Improved solutions for human-machine interactions, including the application of new technologies such as artificial intelligence, predictive analytics, big data and augmented reality.
RD&I Topic 4.3.15	Adapt job qualifications and training needs for port automation	Modification of traditional job qualifications and training needs, matching the new technological developments. Human factor aspects, including ethical issues, will have to be thoroughly assessed and addressed, especially with regards to automation technologies (e.g. the dockworker of the future; remote working; cobotics and mobile robotics).

11.2.4 Modal shift / increase the use of inland waterways

Reference	Title	Summarising explanation
RD&I Topic 1.1.2	Development of IWT transport solutions supporting the energy transition	The IWT sector can contribute to the energy transition as a reliable and cost-effective transport carrier of renewable energies and related components for the generation of alternative energies. Issues to be considered comprise new vessel and transhipment solutions and operational concepts, as well as adaptations of logistics chains and relevant framework conditions. Also transport of CO_2 can become a new market for IWT.
RD&I Topic 1.1.3	Implementation and analysis of pilot projects	Higher market shares for IWT can be captured by case studies and specific studies. Continued financial support must be provided to fund such studies and pilot projects testing the impact and economic viability of transport, technological and logistic innovations. Similarly, testing trials will have to be organized to ascertain the viability and reliability of inland navigation vessels for the transport of new cargo. With regards to the energy transition, pilot projects are also essential to gain knowledge of new technologies, identify and address economic, financial, technical and regulatory obstacles to their deployment.
RD&I Topic 1.1.6	Increase the awareness relating to the advantages of IWT as an alternative mode of transport	The competitiveness of IWT could be further strengthened by the development and implementation of communication and marketing activities. This could take the form of a social media campaign, or a centralised and up-to-date webpage containing all relevant information on IWT success stories and practical information and available funding opportunities. A repository for all relevant IWT regulations would also be desirable for integration in logistics supply chains. Additionally, guidance and support in setting up national or regional modal shift aid schemes, in line with the EU exemption regulation is desirable for national or regional authorities.
RD&I Topic 1.2.1	Development of a roadmap for IWT-related modal shift and decarbonisation	A Roadmap for Modal Shift and Decarbonisation needs to specify which loading units to build on, which transport modes to use for which type of transport, which infrastructures to develop, which incentives to put in place, with a time horizon towards 2050. This also includes storage capacity of loading units once they are not in use. It also refers to any installations needed for batteries or alternative fuels. Depending on the roadmap and the vessel adaptations proposed, this infrastructure needs to be adapted at the central hubs which are planned without ignoring that there is still a significant freight transport through traditional forms of transportation e.g. bulk transport or (chemical) liquids. The development process of a consolidated roadmap for modal shift towards IWT shall engage and bundle initiatives of important potential supply chain partners.

Annex – assessment of resilience projects (4.1.1-4.1.4)

In view of the PLATINA3 consortium, none of the projects PLOTO, CRISTAL and ReNEW below does consider the Rhine and the Danube fully (in Germany no pilot is carried out, in the Netherlands an App is developed), some systems for RIS can be observed for Hungary and Romania.

Also for the call HORIZON-CL5-2023-D6-01-09 : **Climate resilient and safe maritime ports** with a (total) budget of 14 mln euro (2 projects expected, 7 mln euro EU contribution each) it is concluded that it is rather unlikely that the research needs will be sufficiently covered. It is uncertain if there will be successful projects for IWT which do cover the Rhine and Danube rivers. It may also be that less relevant waterways will be addressed (e.g. Douro, Elbe). Ideally, the entire Rhine and Rotterdam and the entire Danube and Constanta would be selected, this could result in a proper outcome. As there are too many options open, it cannot be said that this call will produce suitable solutions. Therefore, we have to keep open that further calls relating to the inland waterway infrastructure will become available.

Therefore, it was concluded that the RD&I topics 4.1.1 - 4.1.4 will not be sufficiently covered and there is a need for additional R&D which is reflected in the recommendations and summary of this document.

With respect to infrastructure research, further developments of topics already implemented in FAIRway Danube und RIS COMEX were found and not much more. In the following, more information is available relating to the 3 projects:

The CRISTAL project with pilots in France, Italy and Poland:

Note: based on http://www.cristal-project.eu/pilot-sites-2/

Objective area 1: Development of pathway towards 20% market share increase and 80% reliability

- *Key result 1:* Roadmaps for needed developments and related administrative and regulatory framework, including the development of business and governance models, to achieve the targeted 20% market share growth – identification of information and infrastructure needs as well as data exchange and operational management requirements.
- *Key result 2:* A synchro/multi-modal corridor management system for the use of all involved actors (public authorities, logistics/mobility operators, passengers) and especially those parties responsible for crisis management and civil protection, for ensuring on-time shipments (and continuity of passenger transport) via IWT even in calamities situations in a minimum of 80% of cases.

- *Key result 3*: Governance, business models and finance structures, technological developments and organizational models to ensure sustainable improvements for a successful implementation of the Good Navigation Status

Objective area 2: Use of state-of-the-art technologies, including digitalization, to increase the operability and resilience of infrastructure, and assure 50% capacity during extreme weather situations

- *Key result 4*: Real-time monitoring system of water levels, hydrological conditions, infrastructure maintenance and resilience level, including a River Information Services (RIS)-Layer in which the collected data will be made available to the barge and surveillance operators.
- *Key result 5:* A digital twin incorporating real-time data (key result 4) and weather data for an infrastructure early warning and infrastructure maintenance system, as well as to support corridor management.
- *Key result 6:* Exploitation of existing platform networks (e.g. https://fenix-network.eu/) to facilitate the interoperability among systems and the secured data and information exchange for supporting synchro/multimodality along a corridor. Governance, business models and finance structures, technological developments and organizational models to ensure sustainable improvements for a successful implementation of the Good Navigation Status

Objective area 3: Implementation of state-of-the-art technologies (objective area 2) and market share increase strategy (objective area 1) in the pilots` regions as basis for further Europe-wide roll-out for increased market share of IWT

- *Key result 7:* Applications to measure, in real time, the actual water levels and the IWT infrastructure maintenance and resilience by using novel subsurface inspection data to plan predictive maintenance and improving their resilience implemented, tested and validated in the three pilot regions.
- *Key result 8:* Completed implementation, testing and validation of the corridor management system, governance and technology innovations in the three pilot areas.
- *Key result 9:* Completed implementation, testing and validation of the digital twins of the three pilot regions: Poland, Italy and France. Governance, business models and finance structures, technological developments and organizational models to ensure sustainable improvements for a successful implementation of the Good Navigation Status

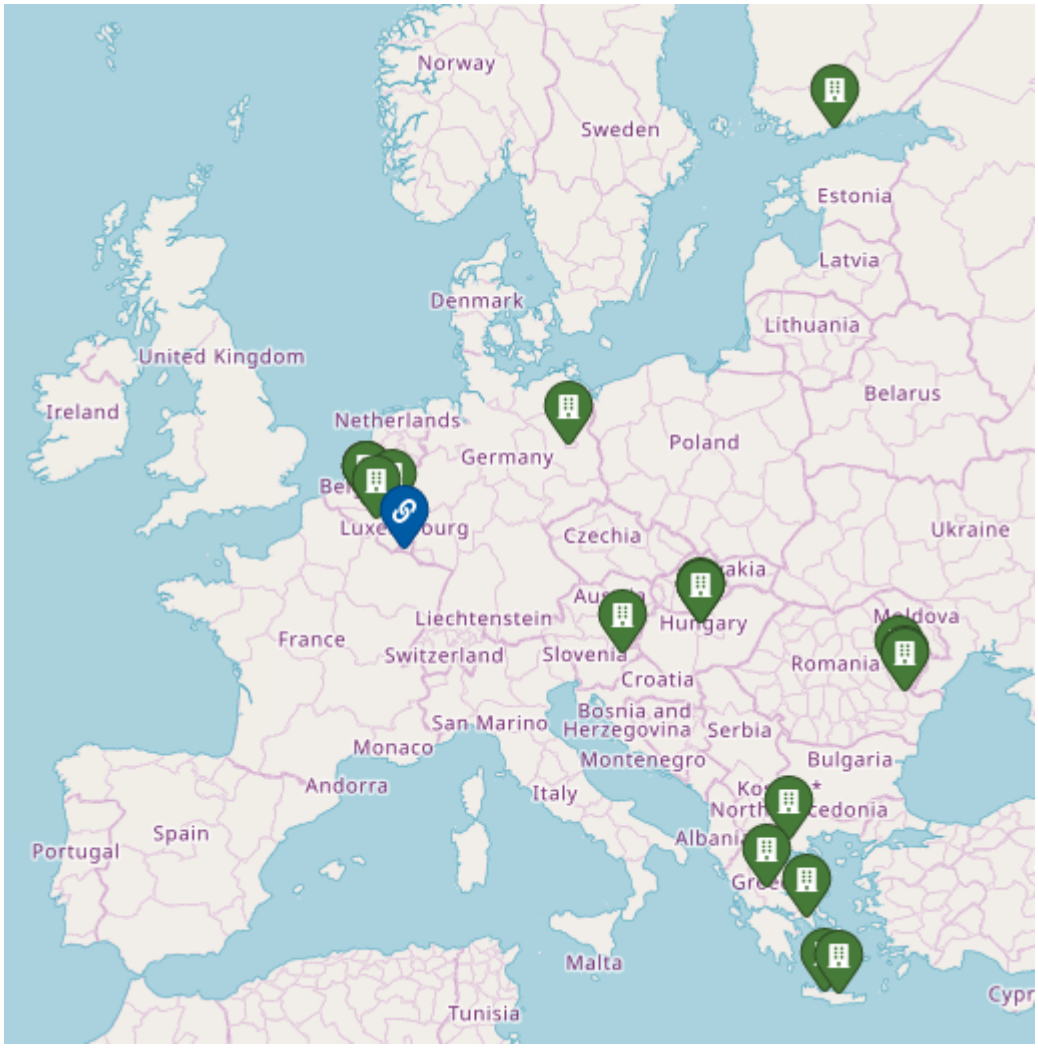
Objective area 4: Exploitation on local as well as European level and beyond

- *Key result 10:* Roadmap for the improvement of IWT towards realization of (EC IWT Transaction Plan 2021-2027 and EC Digital Inland Waterway Area flagship developments on a strategic level (European level).
- *Key result 11:* Roadmap for individual pilot regions towards realization of flagship developments (pilot level).
- *Key result 12*: Roadmap for individual stakeholders (engineers, environmentalists, assets and risks managers, logistic & fleet professionals and trainers, procurement managers, organization

managers, transport/logistic and land planning managers, policy makers) towards realization of flagship developments (individual organization level).

- *Key result 13*: Roadmap for financial sector towards realization of flagship developments (individual organization level), in line with the EC Taxonomy, taking into account the results of the "Maritime taxonomy.

The PLOTO project with pilots in Belgium/Wallonien, Hungary and Romania



Note: based on https://ploto-project.eu/pilot-sites/

Objectives:

• Use high-resolution modelling data for the determination and assessment of the climatic risk of the selected transport infrastructures and associated expected damages.

• Use existing data from various sources with new types of sensor-generated data (computer vision) to feed the used simulator.

• Utilise tailored weather forecasts (combining seamlessly all available data sources) for specific hot spots, providing early warnings with corresponding impact assessment in real-time.

• Develop improved multi-temporal, multi-sensor UAV- and satellite-based observations with robust spectral analysis, computer vision and machine learning-based assessment for diverse transport infrastructures.

• Design and implement an integrated Resilience Assessment Platform environment as an innovative planning tool that will permit a quantitative resilience assessment through an end-to-end simulation environment, running "what-if" impact/risk/resilience assessment scenarios. The effects of adaptation measures can be investigated by changing the hazard, exposure and vulnerability input parameters.

• Design and implement a Common Operational Picture (COP), including an enhanced visualisation interface and an Incident Management System (IMS).[20]

Deliverables

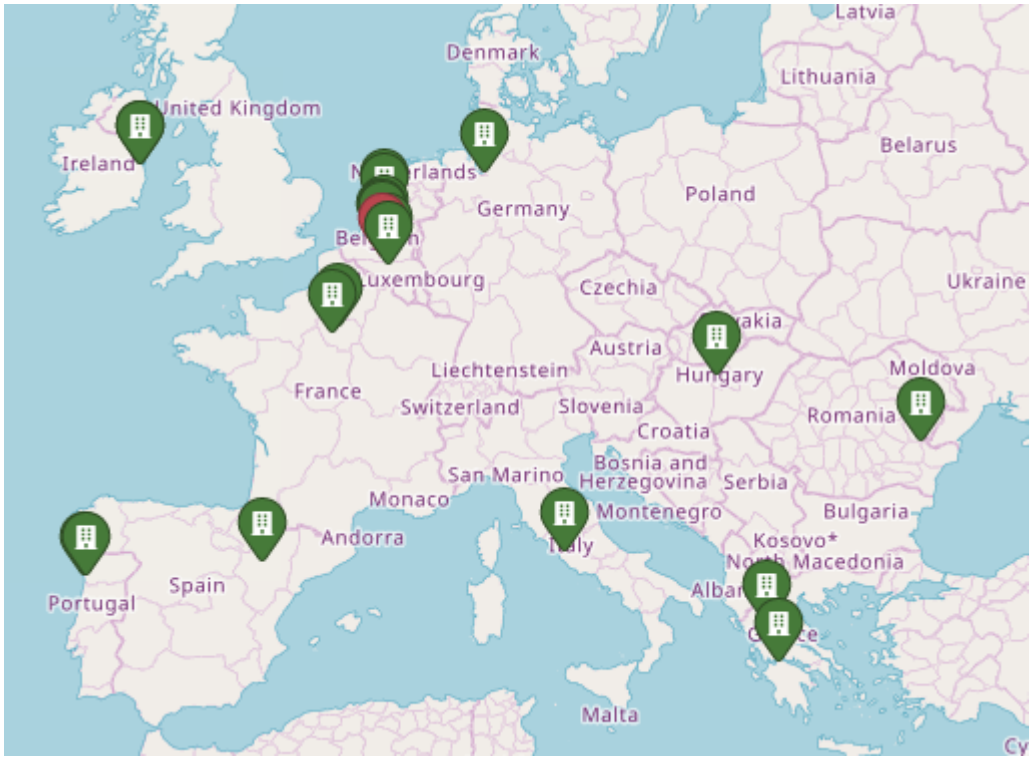
Deliverable Number	Deliverable Title	Dissemination level
D1.2	Data Management Plan	PU - Public
D1.3	Data Management Plan version 2	PU - Public
D2.1	Definition of the Requirements, Use Cases and System Specifications 1st version	PU - Public
D2.2	Definition of the Requirements, Use Cases and System Specifications final version	PU - Public
D3.2	Report on the dynamical downscaling of climate and atmospheric impacts 1st version	PU - Public
D3.3	Report on the dynamical downscaling of climate and atmospheric impacts final version	PU - Public
D3.4	Report on Dynamic Data Assimilation methodology and site-specific risk parameters and stressor indicators	PU - Public
D4.3	Multi-Hazard Vulnerability Modules for IWW and connected hinterland infrastructures 1st version	PU - Public
D4.4	Multi-Hazard Vulnerability Modules for IWW and connected hinterland infrastructures final version	PU - Public

[20] PLOTO_D2.1_Definition-of-the-Requirements-Use-Cases-and-System-Specifications-1st-version_v1.0.pdf (ploto-project.eu)

D4.5	Impact Assessment Model and Overall Organisational Resilience	PU - Public
D5.1	Assessment along the IWW corridor and a surrounding disaster affected area, using multi-source remote sensing data	PU - Public
D5.2	Dynamic link to hazard and resilience assessment	PU - Public
D6.3	Bussiness Continuity Models, Adaptation Strategies Standard Response Procedures	PU - Public
D7.1	The PLOTO Integrated System and Acceptance tests 1st version	PU - Public
D7.2	The PLOTO Integrated System and Acceptance tests final version	PU - Public
D7.3	Reports on pilot testing, assessment and recommendations, plus training report 1st version	PU - Public
D7.4	Reports on pilot testing, assessment and recommendations, plus training report final version	PU - Public
D8.1	Project Website, Corporate identity and general templates for dissemination material	PU - Public
D8.2	Dissemination, Communication and Exploitation Strategy 1st version	PU - Public
D8.3	Dissemination, Communication and Exploitation Strategy 2nd version	PU - Public
D8.4	Dissemination, Communication and Exploitation Strategy final version	PU - Public

The ReNEW project with four living labs:

- Ghent's Multifunctional Synchromodality Resilient City Logistics Hub
- Smart Douro Inland Waterway Infrastructure Resilience Management
- Netherlands / EU IWT Network Resilience Mitigation DT App
- Resilience promoting Autonomous Zero-emissions Barges



Note: based on https://renew-waterways.eu/living-labs/

Deliverables:

1. A decision-support framework including Resilience and Sustainability Quantification supporting the strategic planning and operational optimisation of Green Resilient IWT (GRIWT).
2. Innovative infrastructure resilience and sustainability solutions targeting rapid deployment after disruptive events to create new provisional links to other transport modes and building on autonomy developments and maturing green energy options.
3. A Green Resilient IWT Dataspace and Digital Twin providing data sharing between infrastructure monitoring, RIS and traffic management and emergency systems and climate solutions primarily.
4. Four Living Labs, out of which three LLs focusing on integrated IW and hinterland infrastructure [Gent-urban, Douro-corridor, Netherlands–national/EU network perspectives] and a LL addressing specifically inland waterway resilience.
5. ReNEW Outreach and Upscale program designed to maximise impact pathways spearheaded by the European Inland Waterways (IWT) Transport Platform and industry clusters as well as leading industry innovators.

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