

ReNEW

White Paper

Capacity Building Strategy Roadmap
and Key Policy Recommendations



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Acronyms and Abbreviations	Meaning
5G/6G	5 th and 6 th generation of mobile technologies
AI	Artificial Intelligence
AIS	(Inland) Automatic Identification System
ALICE	Alliance for Logistics Innovations through Collaboration
Blue Wave Platform	Information and optimization platform for IWT
CBA models	Cost-Benefit Analysis models
CCNR	Central Commission for the Navigation of the Rhine
CEMT class	Conférence Européenne des Ministres de Transport classification
CO ₂	Carbon Dioxide
CONOPS	Concept of Operations
DT	Digital Twins
EBSI	The European Blockchain Services Infrastructure
eIDAS	Electronic Identification and Trust Services
ES-TRIN	European Standard - Technical Requirements for Inland Navigation Vessels
EURIS	European River Information System(s)
EV	Electric Vehicle(s)
'Fit for 55' NECP	'Fit for 55' National Energy and Climate Plans
GAIA-X	Community propagating a federated secure data structure
GHG	Green House Gases
IoT	Internet of Things
IWT	Inland Water Transport
KPI	Key Performance Indicator(s)
LL	Living Lab(s)
NIS	Network and Information Systems
RCCS	Remote Control Centres
ReNEW	Resilience-centric smart, green, Networked EU Inland Waterways
SME	Small and Medium Enterprise(s)
VTS	Vessel Traffic Services

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1 Introduction

1.1 Overview project

The resilience of the Inland water transport (IWT) system depends on the reliability of the infrastructure and the IWT fleet. Furthermore, due to the increasing dynamics, heterogeneity, and complexity of inland waterway systems, it is becoming increasingly difficult for the system to cope with serious predictable and, in particular, unexpected events.

The European Commission views the digitalisation of the transport sector as a key enabler for smart solutions that can support the resilience and sustainability of inland water transport (IWT) and deliver economic, environmental, and societal benefits. Industrial data spaces, simulation and digital twins (DTs) have gained importance in recent years in various fields (e.g. Industry 4.0, smart manufacturing, intelligent transport and smart cities). Simulation and Digital Twins (DT) are used to predict outcomes and evaluate what-if scenarios. This leads to better real-time optimisation of processes and operations. Thus, DTs can serve as a decision support system for industry to achieve resilience and system decarbonisation based on cross-domain modelling standards and innovative architectures.

Furthermore, it is essential to have the proper infrastructure that can flexibly handle unexpected events and provide a link between IWT and other transport modes, allowing proposed solutions resulting from simulations and DT to be effectively implemented.

The ReNEW (Resilience-centric smart, green, Networked EU Inland Waterways) project aims to study and demonstrate how this digitalisation of the IWT sector and the current or new infrastructure (including vessels) could go hand in hand. The aim is to make the sector a smarter, greener, more sustainable and climate-resilient sector.

After studying and demonstrating various innovations, the question arises as to how the sector will implement these innovations. This brings us to the purpose and scope of this deliverable: capacity building and policy recommendations.

1.2 Methodology

One of ReNEW's objectives is to develop key policy recommendations based on assessments of responses to hazardous situations in inland waterways, whether caused by natural disasters or human activities. This includes understanding the societal impacts of the ReNEW initiatives and the innovations introduced by autonomous barges (WP2). These efforts will lead to the reorganisation of human resources and foster interactions in policy-making with project stakeholders based on the project's results.

This white paper aims to outline a roadmap of actions and compile a comprehensive list of key policy recommendations. To support the impact of ReNEW's capacity building and policy recommendations,

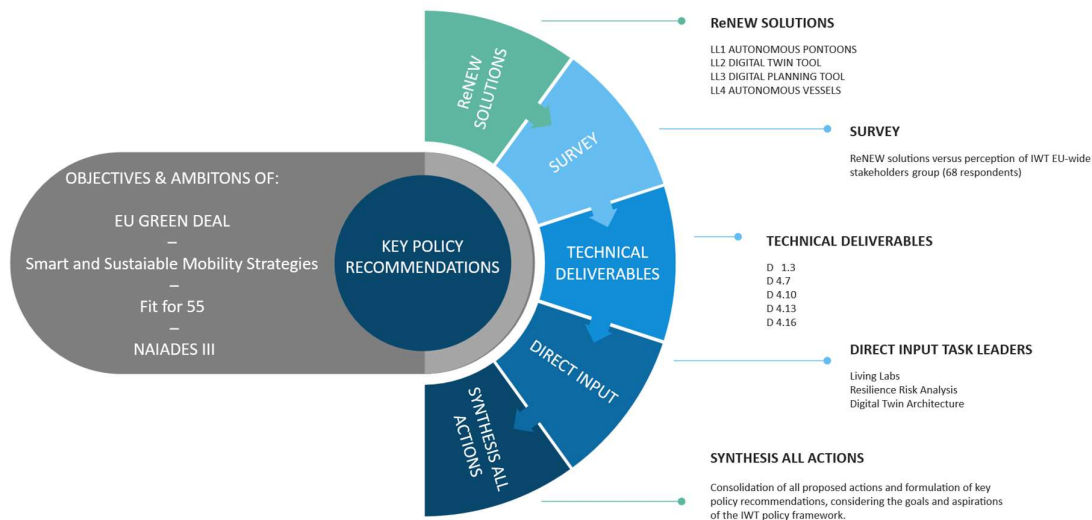
a survey was conducted to explore the responses of a wide range of categorised stakeholders regarding the proposed solutions, fields of application, implementation rates, acceptance and support, as well as the incorporation of resilience strategies into company and governmental frameworks. The survey also aimed to clarify the perceived roles of various stakeholders, including government entities.

A separate white paper provides detailed insights into this survey and presents an initial set of categorised recommendations for action.

To strengthen the foundation for the final list of key policy recommendations, an additional analysis was conducted on the ReNEW technical deliverables: D 1.3, D 4.7, D 4.10, D 4.13, and D 4.16. Moreover, we reached out individually to the task leaders of all living labs, as well as those involved in the structured hazard and vulnerability assessment and the developers of the digital twin solution in ReNEW. This collaboration provided valuable insights and lessons learned from the ReNEW project, resulting in an additional layer of recommendations and actions to be pursued.

Finally, the key policy recommendations were evaluated against the backdrop of the EU's policies. In this regard, we considered the European Green Deal (published on December 11, 2019), the EU's Sustainable and Smart Mobility Strategy (published on December 9, 2020), Fit for 55, and NAIADES III "Boosting Future-Proof European Inland Waterway Transport" (published on June 24, 2021).

Table 1 1: Graph "capacity building strategy roadmap and key policy recommendations methodology"



2 Roadmap of Key Actions

2.1 Foundational Layer 1: Survey: categorised recommendations for action

The survey assessed the relevance and acceptance of the ReNEW solutions, identified barriers to adoption, explored the drivers that promote their development, and examined the impacts of implementing these solutions.

. The solutions developed in ReNEW are:

- Modular pontoons for resilient logistics hubs
- Waterway infrastructure resilience management
- Digital transport planning tool
- Resilience-promoting autonomous barges

Based on the findings, necessary actions were outlined. This analysis served as the foundation for tailored recommendations, supporting EU policies that aim to promote inland waterway transport as a sustainable and resilient option in today's increasingly disrupted environment.

These recommendations, based on the survey findings, aim to address the identified barriers and leverage the drivers to promote the adoption of innovative solutions for climate-resilient and environmentally sustainable inland waterways.

2.1.1 Modular Pontoons Solutions

- **Promote Flexibility:** Encourage the use of modular pontoons to enhance the flexibility of inland water transport (IWT), making it more adaptable to various conditions and needs.
- **Address Barriers:** Tackle high infrastructure investment needs, restrictive regulations, and potential job losses by developing supportive policies and providing financial incentives.
- **Leverage Drivers:** Utilise the benefits of modular pontoons, such as staff shortage solutions, flexible vessel sizes and environmental advantages, to promote their adoption.

2.1.2 Waterway Infrastructure Resilience Management

- **Implement Digital Twin Solutions:** Advocate for the adoption of digital twin solutions to improve the resilience and sustainability of waterway infrastructure.

- **Overcome Barriers:** Address issues like a lack of digitised ship data, high investment requirements, and reluctance to share data by fostering collaboration and providing funding for necessary technologies.
- **Enhance data-driven Decision-Making:** Use digital twin solutions to enable more efficient decision-making, better planning options, and automatic information flow.

2.1.3 Digital Transport Planning Tool

- **Adopt Planning Tools:** Encourage the widespread adoption of digital transport planning tools to enhance the efficiency, reliability, and resilience of inland shipping operations.
- **Mitigate Barriers:** Overcome data security concerns, resistance to new methods, and lack of funding by ensuring data privacy, providing training, and securing financial support.
- **Boost Competitiveness:** Use planning tools to enhance the competitiveness of inland shipping relative to other modes, improve terminal efficiency, and drive sustainable growth in the sector.

2.1.4 Autonomous Barges

- **Promote Autonomous Barges:** Support the development and deployment of autonomous barges to advance IWT as a climate-resilient and environmentally sustainable solution.
- **Address Infrastructure Needs:** Ensure suitable waterway infrastructure and reinvestment policies to support the operation of autonomous barges.
- **Leverage Technological Advances:** Utilise the benefits of autonomous freight transport, such as 24/7 operation, reduced carbon footprint, and enhanced resilience to climate disruptions.

2.1.5 Role of Authorities

- **Develop Supportive Policies:** Authorities should develop policies that support and enable innovative solutions for climate-resilient and environmentally sustainable inland waterways.
- **Encourage Voluntary Compliance:** While some stakeholders favour a compulsory approach, the majority support a voluntary approach to policy development.

2.2 Foundational Layer 2: Technical deliverables and direct input task leaders: categorised recommendations for action

To enhance the foundation for the final compilation of key policy recommendations, a supplementary analysis was conducted on the ReNEW technical deliverables, specifically D1.3, D4.7, D4.10, D4.13, and D4.16.

Additionally, individual outreach was conducted with the task leaders of all living labs, as well as with those involved in the structured hazard and vulnerability assessment, and with the developers of the digital twin solution within the ReNEW initiative.

This collaborative effort yielded valuable insights and lessons learned from the ReNEW project, leading to further enhancements of recommendations and actions to be pursued.

2.2.1 Modular Pontoons Solutions

1. Harmonise Regulatory Frameworks Across Europe

The current legal landscape for remote and autonomous inland waterway vessels is fragmented, with varying exceptions and regional regulations. To foster innovation and attract investment, a unified European regulatory framework is essential. This framework should:

- Standardise operational requirements for autonomous and remotely operated vessels.
- Align with initiatives from bodies like the Central Commission for Navigation on the Rhine (CCNR).
- Include provisions for liability in automated operations, updating legacy legal codes to reflect modern technological realities.

2. Modernise Liability and Insurance Structures

The shift toward remote shipping and automated cargo handling necessitates a rethinking of liability frameworks. Policymakers should:

- Develop new legal instruments that assign responsibility in cases involving autonomous systems.

- Encourage insurance models that reflect the shared and distributed nature of risk in automated logistics.

3. Support Infrastructure for Digital and Physical Resilience

To ensure operational continuity during crises, investment in both digital and physical infrastructure is critical. Recommendations include:

- Expand 5G/6G and satellite communication networks to support uninterrupted vessel operations.
- Promote the development of Smart Terminals with remote-controlled mooring, loading, and unloading systems.
- Encourage the deployment of Floating Modular Platforms (FMPs) for emergency logistics and energy supply.

4. Incentivise Modal Shift and Consolidation Platforms

To reduce road congestion and emissions, policies should:

- Support business models that consolidate cargo volumes for waterborne transport.
- Provide incentives for logistics hubs that integrate barge, truck, and last-mile delivery systems (e.g., cargo bikes, EVs).
- Set measurable targets, such as a 20% increase in modal shift, as demonstrated in LL1 Ghent.

5. Embed Climate Resilience in Urban Waterway Planning

Given the increasing frequency of extreme weather events, urban waterway infrastructure must be climate-resilient. Policymakers should:

- Mandate the integration of environmental alert systems and IoT-based monitoring for water levels and quality.
- Require resilience assessments for logistics hubs, including simulations of staff loss and infrastructure failure.
- Promote the use of digital twins and data spaces for real-time situational awareness and decision-making.

6. Promote Innovation Through Public-Private Partnerships

The success of LL1 Ghent illustrates the value of collaborative innovation. To replicate this model:

- Establish funding mechanisms that support Living Labs and pilot projects.
- Facilitate knowledge transfer between cities and regions through EU-wide platforms.

- Encourage co-development of technologies such as autonomous vessels, drones, and floating energy systems.

7. Align with European Green Deal and Fit for 55 Objectives

All policy initiatives should be aligned with broader EU sustainability goals. This includes:

- Prioritising zero-emission propulsion systems and floating battery platforms.
- Supporting the development of off-grid energy solutions for critical infrastructure.
- Integrating biodiversity and water management strategies into transport planning.

2.2.2 Waterway Infrastructure Resilience Management

1. Establish Legal Recognition for Blockchain-Based Evidentiary Systems

To support the use of blockchain in monitoring and enforcement, EU policymakers should:

- Develop a harmonised legal framework that explicitly recognises blockchain-stored data (e.g., sensor logs, vessel positions, environmental parameters) as admissible evidence in administrative and judicial proceedings.
- Align this framework with the European Blockchain Services Infrastructure (EBSI) and eIDAS 2.0 to ensure interoperability, trust, and readiness for the public sector.

2. Enable Public Authorities to Adopt Blockchain for Environmental Monitoring

To empower authorities like APDL and APA:

- Create EU-level technical guidance and reference architectures for blockchain-based data logging systems.
- Ensure these systems are compatible with existing digital identity and trusted service infrastructures.
- Promote the use of smart contracts for automated rule enforcement, such as detecting illegal wastewater dumping and issuing fines.

3. Mandate Real-Time Environmental Data Integration for Inland Waterways

To improve resilience and emergency preparedness:

- Require waterway authorities to integrate real-time meteorological and hydrological data into digital twin models.
- Encourage the use of predictive analytics and simulation tools to support emergency planning and navigation safety during extreme weather events.

4. Incentivise Voluntary Compliance Through Transparent Monitoring

To foster ecological responsibility among vessel operators:

- Promote voluntary adoption of smart monitoring systems by offering incentives (e.g., reduced port fees, public recognition).
- Utilise blockchain to transparently record vessel wastewater management behaviour, enhancing public trust and accountability.

5. Support Cross-Sector Collaboration and Data Sharing

To ensure effective implementation:

- Facilitate stakeholder engagement across port authorities, environmental agencies, vessel operators, and technology providers.
- Develop standardised data-sharing agreements that protect privacy while enabling real-time monitoring and enforcement.

6. Fund Infrastructure and Capacity Building

To scale these innovations:

- Allocate EU and national funding for the deployment of sensors and blockchain infrastructure.
- Provide training and technical support to public authorities and vessel operators on the use of digital twins and blockchain systems.

7. Integrate Digital Twins into Emergency Response Protocols

To enhance operational resilience:

- Mandate the integration of digital twin outputs into inland waterway emergency plans.
- Use these models to simulate “what-if” scenarios and optimise response strategies for floods, droughts, and infrastructure failures.

2.2.3 Digital Transport Planning Tool

1. Improve Data Accuracy and Availability for Disruption Management

To enable effective real-time planning and mitigation:

- Mandate the consistent and accurate reporting of disruption data across all national and regional platforms, including EURIS.
- Establish a European standard for disruption data formats and update frequencies to ensure interoperability and reliability across borders.
- Encourage integration of inland terminal data with deep-sea terminal systems to support seamless multimodal planning.

2. Embed Digital Infrastructure in Alternative Fuel Projects

As infrastructure for alternative fuels is developed:

- Require that all new inland waterway infrastructure projects include digital communication capabilities (e.g., sensor networks, data feeds).
- Ensure that these infrastructures are mapped and integrated into digital planning tools like EURIS and the ReNEW route planner.

3. Promote Awareness and Adoption of Digital Planning Tools

To maximize the impact of tools like the ReNEW route planner and Blue Wave platform:

- Launch EU-wide awareness campaigns targeting skippers, terminal operators, and logistics providers to promote the benefits of digital transport planning.
- Provide training and incentives for early adopters, especially SMEs, to integrate these tools into their operations.

4. Support Real-Time Planning and Mitigation Capabilities

To enhance resilience and reduce emissions:

- Fund the development and deployment of planning modules that allow skippers and terminals to adjust operations in real time based on disruptions, weather, and terminal congestion.
- Encourage the use of predictive algorithms that recommend mitigation strategies based on historical disruption data.

5. Enable Multimodal Integration and Modal Shift

To support the EU's climate goals:

- Stimulate digital planning platforms to include multimodal routing options (e.g., rail, road, IWT) and simulate modal shift impacts.
- Use these tools to identify and promote the most sustainable and cost-effective transport combinations.

6. Standardise and Share Environmental and Operational KPIs

To track progress and inform policy:

- Define a standard set of KPIs for IWT performance, including emissions, energy use, reliability, and disruption resilience.
- Require digital platforms to collect and report these KPIs to national and EU-level transport authorities.

7. Foster Cross-Border Data Sharing and Governance

To ensure cohesive European inland waterway operations:

- Develop governance frameworks for cross-border data sharing, especially for real-time traffic, infrastructure status, and weather data.
- Align national systems with EU-level platforms, such as EURIS and the ReNEW dataspace.

2.2.4 Autonomous Barges

1. Harmonize and Modernize ES-TRIN for Autonomous and Zero-Emission Vessels

To enable the safe and scalable deployment of autonomous inland vessels:

- Introduce a dedicated "Category C" within the ES-TRIN framework for unmanned vessels, covering requirements for dynamic positioning, lighting, ventilation, and pumping systems.
- Update ES-TRIN to actively promote alternative energy systems, including battery-electric and hydrogen propulsion, by embedding technical standards and safety protocols.

- Ensure that ES-TRIN adaptations are aligned with the operational realities of autonomous vessels, such as remote control centres (RCCs) and modular energy systems.

2. Streamline Permitting for Alternative Energy Infrastructure

To accelerate the deployment of battery-swapping and charging infrastructure:

- Establish a unified EU-level permitting framework for zero-emission energy infrastructure at inland ports and terminals.
- Simplify and harmonise the permitting process across member states to reduce administrative burdens and attract private investment.
- Encourage modular and interoperable infrastructure designs to support future energy technologies beyond batteries.

3. Standardise Local Traffic Regulations Across Jurisdictions

To ensure seamless cross-border navigation:

- Develop a harmonised set of baseline traffic rules for autonomous and remotely operated vessels, applicable across EU inland waterways.
- Allow for local exceptions but require mutual recognition of core safety and operational standards.
- Use the experience of Belgium, the Netherlands, and France as a foundation for broader EU-wide regulatory alignment.

4. Support Regulatory Sandboxes and Transitional Testing Frameworks

To enable safe experimentation and learning:

- Encourage national authorities to adopt regulatory sandboxes for autonomous inland vessels, allowing phased testing from crewed to fully unmanned operations.
- Provide guidance for conducting GAP analyses and defining CONOPS (Concept of Operations) for new vessel types.
- Promote cross-border coordination through the Central Commission for Navigation on the Rhine (CCNR) and other supranational bodies.

5. Incentivise Modal Shift Through Zero-Emission Vessel Deployment

To reduce road congestion and emissions:

- Offer financial incentives (e.g., tax credits, green shipping subsidies) for logistics operators that adopt zero-emission inland shipping solutions.

- Prioritise infrastructure investments that support Class IV vessels, which are more resilient to low water levels and can access a broader network of waterways.
- Track modal shift impacts using KPIs such as increased IWT share, reduced GHG emissions, and improved energy efficiency.

6. Ensure Consistent Enforcement and Social Acceptance

To build trust and ensure compliance:

- Develop clear enforcement protocols for both existing and new regulations governing autonomous and zero-emission vessels.
- Launch public awareness campaigns to improve societal understanding of the safety and environmental benefits of autonomous shipping.

Collaborate with educational institutions to develop training programs for RCC operators and port personnel.

2.2.5 Resilience Risk Analysis

1. Strengthen Workforce Resilience and Attractiveness

- Invest in workforce development: Launch EU-supported training programs focused on digital skills, automation, and remote operations to address the ageing workforce and skill shortages.
- Promote sector attractiveness: Develop campaigns to improve the image of IWT careers, emphasising innovation, sustainability, and work-life balance.
- Support automation transition: Encourage adoption of AI-driven navigation and autonomous vessels (e.g., X-Barge) to mitigate labour shortages.

2. Enhance Climate Adaptation and Infrastructure Resilience

- Mandate climate-resilient infrastructure: Require new IWT infrastructure to incorporate adaptive features such as elevated quays, modular terminals, and flood-resistant designs.
- Fund predictive digital tools: Support the deployment of digital twins and hydrological models to forecast and manage climate-induced disruptions, such as droughts, floods, and heatwaves.
- Standardise emergency protocols: Develop harmonised EU-wide emergency response frameworks for extreme weather events, including drought, flooding, and storms.

3. Establish Robust Cybersecurity and Digital Governance

- Implement cybersecurity standards: Develop and enforce EU-wide cybersecurity protocols for IWT infrastructure, aligned with NIS2, including AIS (Automatic Identification Systems), lock systems, automated vessels, and digital twins.
- Promote cyber hygiene training: Require regular cybersecurity awareness and response training for IWT personnel.
- Support secure digital infrastructure: Invest in resilient communication systems (e.g., VTS, satellite redundancy) to ensure continuity during cyber incidents.

4. Improve Operational Continuity and Risk Management

- Mandate real-time data integration: Require integration of real-time data (e.g., lock status, water levels, vessel positions) into traffic management systems to reduce delays and improve safety.
- Support redundancy and backup systems: Encourage investment in backup energy, navigation, and communication systems to mitigate operational disruptions.
- Develop cost-benefit frameworks: Promote the use of standardised CBA models to evaluate resilience investments and justify funding decisions.

5. Promote Environmental Compliance and Monitoring

- Enforce anti-dumping regulations: Strengthen enforcement against illegal wastewater dumping through blockchain-based monitoring and smart contracts.
- Incentivise green retrofits: Provide financial incentives for retrofitting vessels with low-emission technologies and waste management systems.
- Expand environmental KPIs: Require operators to report on emissions, energy efficiency, and ecological incidents using harmonised indicators.

6. Foster Cross-Border Coordination and Regulatory Harmonisation

- Harmonise IWT regulations: Align national rules on unmanned shipping, safety, and environmental standards under ES-TRIN and CCNR frameworks.
- Create shared data platforms: Support interoperable data spaces (e.g., EURIS, RIS) for cross-border traffic and infrastructure coordination.

2.2.6 Digital Twin Architecture

1. Create Governance of a decentralised Data Space & Digital Twin Infrastructure

- Establish transparent governance for the decentralised data-sharing infrastructure and its day-to-day operations. This will ensure clear consensus on topics such as terms and conditions, validated participation, technical and data standards, addressed use cases, as well as ownership and liability.

2. Establish Business Models for Commercial Players

- Create robust business models to facilitate the onboarding of commercial services onto the Data Space. This will allow partners to recognise the value of their contributions to the infrastructure, scale services effectively (as demonstrated in the ReNEW testing with the 4Shipping route planner), and attract potential clients.

3. Invest in Training & Upskilling

- Invest in specialised training programs for logistics operators, skippers, terminal staff, and other essential personnel to enhance digital maturity and equip the workforce for more AI-driven and data-centric operations, including remote-controlled and automated vessels.

4. Install Inclusive Monetary Incentives

- Implement more varied incentive mechanisms that include small players and engage the many minor actors. This enables their involvement in digital and sustainable transitions through equitable data value sharing and accessible entry points..

5. Impose Physical-Digital Infrastructure Integration

- Ensure that during the tendering or license renewal process, any new or renovated physical infrastructure (such as docks, locks, and terminals) includes embedded sensors and digital interfaces from the beginning.

3 Advancing resilient and sustainable IWT Key Policy Recommendation

To finalise the key policy recommendations, all recommended actions were evaluated against the backdrop of the EU's policies. In this regard, we considered the European Green Deal (published on December 11, 2019), the EU's Sustainable and Smart Mobility Strategy (published on December 9, 2020), Fit for 55, and NAIADES III "Boosting Future-Proof European Inland Waterway Transport" (published on June 24, 2021)..

3.1 Modernise Regulation for a Green, Smart and Autonomous IWT

1. Update ES-TRIN for Autonomous and Zero-Emission Vessels

To support the deployment of autonomous and zero-emission vessels, it is essential to update the ES-TRIN standards to include a new category for unmanned and remotely operated vessels. This update should define technical requirements for dynamic positioning, automated mooring, and remote control protocols. Harmonising local traffic regulations across Member States will prevent operational fragmentation and ensure consistent enforcement mechanisms. This recommendation aligns with NAIADES III Flagship 3 and Fit for 55's zero-emission mobility goals.

Action: Introduce a new "Category C" in ES-TRIN for unmanned and remotely operated vessels.

Alignment: Supports NAIADES III Flagship 3¹ and Fit for 55's zero-emission mobility goals.

Details: Include dynamic positioning, automated mooring, and remote-control protocols.

2. Legal Recognition of Blockchain-Based Evidence

Establishing a legal framework that recognises blockchain-stored data as admissible evidence will support the Green Deal's digital transformation and NAIADES III's smart governance. This framework should align with the European Blockchain Services Infrastructure (EBSI) and eIDAS 2.0 to ensure

¹ Flagship 3: Speeding up certification procedures for innovative and low-emission vessels

interoperability and trust. Blockchain technology can be used for environmental monitoring, vessel tracking, and automated compliance, providing a secure and transparent method for logging data.

Action: Amend EU digital evidence laws to accept blockchain-logged data.

Alignment: Supports the Green Deal's digital transformation and NAIADES III's smart governance.

Use Case: Environmental infractions, vessel tracking, and automated compliance.

3.2 Accelerate Infrastructure Adaptation for Climate Resilience

1. Mandate Smart Infrastructure in TEN-T and Urban Nodes

To enhance the resilience and efficiency of IWT infrastructure, it is crucial to mandate the inclusion of embedded sensors and digital interfaces in all new or renovated infrastructure projects. This requirement should be part of public tenders and align with the Green Deal's "Renovation Wave" and NAIADES III Flagship 1. Real-time data on water levels, lock occupancy, and emissions must be standardised and shared to enable predictive maintenance, traffic optimisation, and environmental monitoring.

Action: Require embedded sensors and digital interfaces in all new or upgraded IWT infrastructure.

Alignment: Green Deal's "Renovation Wave" and NAIADES III Flagship 1².

Details: Real-time data on water levels, emissions, and lock status must be standardised and shared.

2. Support Redundant Communication Systems

Funding hybrid communication systems that combine 5G/6G and satellite connectivity will ensure operational continuity for modular pontoons and autonomous vessels. This recommendation supports Fit for 55's digital infrastructure goals and ReNEW's modular pontoon needs. Prioritising resilience in remote or high-traffic areas will enhance the reliability and efficiency of IWT operations.

Action: Fund hybrid 5G/satellite systems for resilient vessel operations.

Alignment: Fit for 55's digital infrastructure goals and ReNEW's modular pontoon needs.

² Flagship 1: Helping waterway managers to ensure a high level of service (Good Navigation Status) along EU inland waterway corridors by 31 December 2030

3.3 Strengthen Data Governance and Interoperability of Digital Ecosystems

1. Establish a Federated Data Space for IWT

Creating a governance model for decentralised digital twin infrastructure will ensure interoperability, trust, and scalability of digital services. This model should define onboarding criteria, data standards, and use case prioritisation, aligning with GAIA-X and EU Data Act principles. Representation from SMEs, public authorities, and logistics providers is essential to ensure inclusive and effective governance.

Action: Develop a governance model for a federated data space to support decentralised digital twin infrastructure.

Alignment: Green Deal's digital transformation and NAIADES III Flagship 6³.

Details: Define onboarding rules, data standards, and use case priorities.

2. Incentivise Secure Data Sharing

Introducing EU-wide standards and incentives for secure data exchange will address reluctance to share data and mitigate cybersecurity risks. Providing grants or tax incentives for compliance with cybersecurity protocols and developing certification schemes for trusted data providers will support the digital resilience of Fit for 55 and the harmonisation of RIS under NAIADES III.

Action: Introduce EU-wide cybersecurity standards and incentives for data exchange.

Alignment: Fit for 55's digital resilience and NAIADES III's RIS harmonisation.

3.4 Invest in Workforce Transition and Social Inclusion

1. Launch a Digital Skills Agenda for IWT

Launching an EU-wide IWT Digital Skills Initiative will prepare the workforce for AI-driven, remote-controlled, and automated operations. This initiative should focus on training in AI, blockchain, and digital twin technologies, partnering with vocational schools, universities, and industry. Including

³ Flagship 6: A roadmap for digitalisation and automation of IWT

reskilling programs for traditional crew roles will support the Green Deal's Just Transition Mechanism and NAIADES III Flagship 7⁴.

Action: Fund training in AI, blockchain, and remote vessel operations.

Alignment: Green Deal's Just Transition Mechanism and NAIADES III Flagship 7.

Details: Include reskilling for traditional crew roles and support for SMEs.

2. Support SMEs

Creating a Digital Inclusion Fund for small IWT operators will ensure broad participation in the digital transition. Offering low-barrier access to digital tools and platforms, promoting fair data value-sharing models, and encouraging participation in pilot projects and Living Labs will support the Green Deal's inclusive growth and NAIADES III's SME focus.

Action: Create a Digital Inclusion Fund for small IWT actors.

Alignment: Green Deal's inclusive growth and NAIADES III's SME focus.

3.5 Push Fleet Modernisation and Energy Transition

1. Accelerate Deployment of Zero-Emission Vessels

Updating ES-TRIN and the Energy Taxation Directive to support battery-electric and hydrogen propulsion systems will accelerate the deployment of zero-emission vessels. Simplifying permitting processes for alternative energy infrastructure, providing technical guidance and safety standards, and prioritising battery-electric systems for short-haul and urban routes will support Fit for 55's CO₂ standards and NAIADES III Flagship 3⁵ & 5⁶.

Action: Update ES-TRIN and Energy Taxation Directive to support battery-electric and hydrogen vessels.

Alignment: Fit for 55's CO₂ standards and NAIADES III Flagship 3 & 5.

⁴ Flagship 7: Smart and flexible EU crewing rules

⁵ Flagship 3: Speeding up certification procedures for innovative and low-emission vessels

⁶ Flagship 5: Developing inland ports as multimodal alternative fuels infrastructure hubs

Details: Provide tax incentives and fast-track certification for clean vessels.

2. Enable Scalable Modular and Autonomous Fleets

Harmonising permitting and operational protocols across Member States will enable the scalable deployment of modular and autonomous fleets. Developing EU-wide guidelines for remote operation centres, encouraging modular vessel designs for flexible deployment, and supporting pilot corridors for autonomous navigation will align with the Green Deal's modal shift and NAIADES III Flagship 2⁷.

Action: Harmonise permitting and operational protocols across Member States.

Alignment: Green Deal's modal shift and NAIADES III Flagship 2.

Use

Case: Urban logistics, last-mile delivery, and climate-resilient corridors.

3.6 Enact an Implementation and Monitoring Strategy

1. Propagate a 'Voluntary First, Binding Later' Approach

Beginning with enabling policies and incentives and transitioning to binding regulations by 2030 will support the Green Deal's "do no harm" principle and Fit for 55's phased approach. Utilising Horizon Europe and CEF funding to support early adopters and monitoring progress through key performance indicators (KPIs) on emissions, resilience, and digital adoption will ensure effective implementation.

Action: Initiate incentives and pilot corridors, transitioning to binding rules by 2030.

Alignment: Green Deal's "do no harm" principle and Fit for 55's phased approach.

2. Co-invest in Public-Private Partnerships

Fostering co-investment in infrastructure, digital platforms, and training programs will support the Green Deal's Sustainable Europe Investment Plan and NAIADES III Flagship 8⁸. Creating joint ventures for digital twin development and encouraging industry consortia to co-develop standards will enhance collaboration and innovation.

⁷ Flagship 2: Updating the EU's legal framework for intermodal transport to stimulate IWT

⁸ Flagship 8: Supporting the sector and Member States in the transition to zero-emission vessels

Action: Co-invest in digital twins, smart ports, and training programs.

Alignment: Green Deal's Sustainable Europe Investment Plan and NAIADES III Flagship 8.

3. Real-Time Monitoring via Digital Twins

Using ReNEW's digital twin tools to track emissions, resilience, and modal shift KPIs will support the Green Deal's data-driven governance and the integration of the Fit for 55's National Energy and Climate Plan (NECP). Establishing a central EU dashboard for IWT performance and integrating with TEN-T and Green Deal monitoring frameworks will ensure real-time policy feedback and continuous improvement.

Action: Use ReNEW's digital twin tools to track emissions, resilience, and modal shift KPIs.

Alignment: Green Deal's data-driven governance and Fit for 55's NECP integration.

Table 1 2: Overview graph “ReNEW Key Policy Recommendations”

ReNEW KEY POLICY RECOMMENDATIONS	
MODERNISE Regulation for a Green, Smart and Autonomous IWT	UPDATE ES-TRIN for Autonomous and Zero-Emission Vessels
	Action: Introduce a new “Category C” for unmanned and remotely operated vessels.
	ESTABLISH Legal Recognition of Blockchain-Based Evidence
	Action: Amend EU digital evidence laws to accept blockchain-logged data.
ACCELERATE Infrastructure Adaptation for Climate Resilience	MANDATE Smart Infrastructure in TEN-T and Urban Nodes
	Action: Require embedded sensors and digital interfaces in all new or upgraded IWT infrastructure.
	SUPPORT Redundant Communication Systems
	Action: Fund hybrid 5G/satellite systems for resilient vessel operations.
STRENGTHEN Data Governance and Interoperability of Digital Ecosystems	ESTABLISH a Federated Data Space for IWT
	Action: Develop a governance model for a federated data space to support decentralised digital twin infrastructure.
	INCENTIVISE Secure Data Sharing
	Action: Introduce EU-wide cybersecurity standards and incentives for data exchange.
INVEST in Workforce Transition and Social Inclusion	LAUNCH a Digital Skills Agenda for IWT
	Action: Fund training in AI, blockchain, and remote vessel operations.
	SUPPORT SME's
	CREATE a 'Digital Inclusion Fund' for small IWT actors.
PUSH Fleet Modernisation and Energy Transition	ACCELERATE Deployment of Zero-Emission Vessels
	Action: Update ES-TRIN and Energy Taxation Directive to support battery-electric and hydrogen vessels.
	ENABLE Scalable Modular and Autonomous Fleets
	Action: Harmonise permitting and operational protocols across Member States.
ENACT an Implementation and Monitoring Strategy	PROPAGATE a 'Voluntary First, Binding Later' Approach
	Action: Initiate incentives and pilot corridors, transitioning to binding rules by 2030.
	CO-INVEST in Public-Private Partnerships
	Action: Co-invest in digital twins, smart ports, and training programs.
	INTEGRATE Real-Time Monitoring via Digital Twins
	Action: Use ReNEW's digital twin tools to track emissions, resilience, and modal shift KPIs.

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