D1.3 Report on scenarios

Synergetics | Synergies for Green Transformation of Inland and Coastal Shipping

GRANT AGREEMENT NO.	101096809
DURATION OF THE PROJECT	42 months
DELIVERABLE NUMBER	D1.3
DISSEMINATION LEVEL	Public
DELIVERABLE LEADER	SPB
STATUS	FINAL
SUBMISSION DATE	28-02-2025
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Release Approval

1 | Release Approval

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Executive Summary

Introduction

This report presents the inventory of policy strategies, scenarios and legislative initiatives for inland waterway transport and coastal shipping in relation to meeting the emission reduction objectives for the year 2050. It integrates and reflects from the viewpoint of policy strategies and legislative developments on the SYNERGETICS results from the two other tasks, tasks 1.1 and 1.2 in the 1st work package of SYNERGETICS' *Exploration*. This report presents the results of task 1.3 of SYNERGETICS. It provides the groundwork for the further elaboration of scenarios and policy recommendations in the WP5 of SYNERGETICS which is focussed on the acceleration of the roll-out of energy and technological solutions to reduce the overall emissions.

Key points of strategies, policies and assessment

The main strategies come from the European Union by means of the European Green Deal and the Smart Sustainable Mobility Strategy aiming for at least 90% emission reduction by 2050 compared to 1990 levels and a growth of transport by inland navigation and short sea. These strategies resulted into legislative proposals, where mainly the Fit-for-55 policy package is relevant with respect to interventions to bring down the emissions of waterborne transport. Most relevant initiatives for emission reduction stemming from Fit-for-55 are the revision of the Renewable Energy Directive (RED-III), the revision of the directive on the ETS, AFIR and a new regulation FuelEU Maritime. Also, EU Taxonomy is relevant as it provides specific technical criteria for inland vessels and seagoing vessels, to steer investments and capital into these fleets.

The Central Commission for Navigation of the Rhine (CCNR) developed a specific strategy for inland vessels with an action plan for energy transition with the aim to achieve emission reduction levels of at least 90% by the year 2050 compared to 2015. On EU level, the European Commission prepared the NAIADES-III strategy with a clear objective to move towards zero GHG performance. However, the emission reduction goals are less detailed compared to the ones specified in the CCNR targets, in particular for air pollutant emissions.

For maritime vessels (including coastal vessels) the IMO has a prominent role as international body. The IMO developed a specific strategy and targets for GHG reduction and implemented specific regulations such as EEDI, EEOI, EEXI, CII. However, these regulations especially focus on larger vessels (above 5000 GT), but only a minority of coastal vessels is larger than 5000GT.

Key findings from the assessment lead to the conclusion that there are no dedicated emission reduction strategy or target for IWT and coastal vessels in the EU policy strategies. Only the CCNR strategy provides clear targets and two specific scenarios (a conservative scenario and innovative scenario) with different energy types and solutions to reach the defined targets and a dedicated action plan.

Seen from the IWT and coastal shipping sectors, the EU legislation does primarily focus on the energy supply (AFIR, ETS-2 and RED-III) and on measures focussing on the transparency and awareness of larger shipping companies and clients (CSRD, CSRDDD). Furthermore, attention is also paid to financing by means of the EU Taxonomy. However, there are no significant legislative measures which directly address the vessel owner/operators themselves.

Furthermore, there are a few differences in the scope, some are WTW based while others are TTW based. For example, EU RED-III and FuelEU Maritime have a WtW scope, including therefore also the GHG emissions emitted in the Well-to-Tank part of the value chain. However, EU ETS does focus on the TTW GHG emissions while EU Taxonomy has a bias towards zero-direct GHG emission performance, ignoring the WTT emissions.

Another noteworthy conclusion is that there is a clear gap in the legislative framework for inland navigation and coastal vessels in comparison with the framework for larger vessels (> 5000 GT) and road haulage. FuelEU Maritime and EU ETS are applied across Europe by legislation for vessels above 5000GT and ETS2

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applies for all road transport in Europe. Coastal vessels (usually below 5000 GT) are out of scope of FuelEU Maritime and ETS legislation. Moreover, fuel supply to inland vessels is subject to a voluntary 'opt-in' decision by the Member State to transpose the EU ETS directive. Member States can decide for themselves whether or not to include fuel supply to inland navigation in the EU ETS2 and to receive the revenues from such a national expansion of scope of ETS2 in their country.

In the assessment also the EU RED-III directive is marked as a potentially effective legislative measure. However, the implementation provides a great degree of freedom to EU Member States on how to transposition the EU directive into national law. This situation therefore brings a high level of uncertainty towards the extent inland navigation and coastal vessels will be addressed by national implementation of RED-III. Significant differences may occur between EU Member States, resulting in undesired effects such as bunker tourism resulting in emission leakage. The role and possible impact of non-EU Member States needs to be taken into account in this respect.

Concluding views

Several concluding remarks from the first explorative work in SYNERGETICS can be made while taking into account the results and reports of Tasks 1.1 and 1.2 of SYNERGETICS (Deliverables D1.1 and D1.2). These remarks which will be relevant for developing calculation models in WP4 and policy recommendations in WP5:

- The conclusion is that due to EU RED-III and ETS-2 being directives with a large freedom for Member States how to implement them, the EU Member States have a decisive role in setting up the required legal framework to provide an economic incentive for use of renewable energy and clean technologies. It needs to be noted that the vast majority of EU Member States, does not seem to have concrete and elaborated plans for addressing inland navigation and coastal shipping and there seems to be a lack of coordination between countries in this respect.
- The sustainable availability of biological feedstock and infrastructure may be problematic, especially in the medium and long term. If indeed, drop-in solutions such as renewable HVO are not feasible due to limited availability and / or high prices (e.g. through competing aviation sector) of the HVO, there will be a need for other solutions than using current combustion engines. Therefore, it is strongly recommended to work on multiple options in parallel.
- Solutions other than direct drive combustion engines will require more extensive retrofitting of vessels (e.g. converting to electric platforms, batteries, fuel cells on board, more volume needed for storage of energy). Capacity at shipyards for retrofitting works will be needed as well as infrastructure capacity for the renewable energy refuelling / charging along waterways and in ports.
- A bottleneck in the deployment of renewable energy, specifically for e-hydrogen and bio-/e-methanol is the NRMM regulation. The legislation does not recognise hydrogen and methanol as reference fuels for certification, making it close to impossible to bring new combustion engines into the market to be installed on inland vessels. For those options to become viable, it is crucial to eliminate this shortcoming as soon as possible.
- In general, a prerequisite is the internalisation of external costs to allow new business models for uptake of renewable energy and clean technologies. It is seen as an opportunity to use the legal framework for 'opt-in' ETS for inland navigation across Europe and to add coastal vessels into the ETS for seagoing vessels (by lowering the threshold to 400 GT for example). Furthermore, it is recommended to work on a coordinated implementation of RED-III across EU Member States to achieve and effective framework and to avoid undesired cross-country shifting effects ('bunkering tourism').
- A holistic approach is needed to solve the 'chicken-egg' dilemma for the introduction of new technologies, working in parallel on infrastructure for renewable energy and at the same time on a first group of users and legislation to provide economic incentives and to create a market for renewable energy. It is recommended to actively use a combination of EU funding instruments, national funding and well-coordinated national and international plans on TEN-T corridor level (AFIR).
- More focus is needed on the full life-cycle performance of solutions. It appears from the Task 1.1 that a significant amount of GHG emissions still results from manufacturing components (e.g.

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batteries) or processes in the production of e-fuels such as e-methanol (e.g. when using carbon from direct air capture). Also, large volumes of fresh waters will be needed for producing e-hydrogen, while fresh water is scarce.

- Since the energy transition is expected to be very costly and achieving full zero-emission on the full life cycle scope seems to be a highly unlikely scenario today, it seems advisable to avoid usage of energy in the first place. Therefore, attention needs to be paid to energy efficiency measures and to avoiding transport demand.

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1. Introduction

1.1 Background

Mitigating climate change is a major social challenge and requires massive changes, not least in the transport sector. In combination with increasing needs to reduce emissions of air pollutants that are harmful to health and the environment, considerable efforts are still required to increase environmental performance of inland and coastal vessels.

It is well-known that burning fossil fuels are the main cause of global warming. It is therefore without alternative that a transition to renewable energy sources is necessary. A few decades ago, it was assumed that this energy transition would mainly be driven by the scarcity of oil reserves and the associated rise in costs. However, improved extraction methods of fossil energy carriers and the discovery of new fields, partly unconventional deposits, as well as global market conditions and economical perspectives and politics of influential nations are strongly dampening the price development of this fossil fuels. Moreover, external costs have not or only marginally been internalised so far. At the same time the urgency increases to take measures on short term to stay below 1.5 degrees global warming. In order to mitigate climate change effects, the energy transition must take place while large fossil fuel resources are still available.

The current price trajectory of fossil fuels, governed by supply and demand as well as geopolitical policies, is insufficient to rapidly facilitate the transition to sustainable energy sources and technologies necessary to achieve the climate mitigation target.

In today's energy landscape, despite the availability of numerous non-fossil energy technologies, it is unlikely to expect the kind of singular technological dominance that characterised previous industrial transitions, such as the rise of steam engines or the widespread adoption of diesel engines. Currently, environmentally friendly alternative fuels generally come with higher economic costs across most applications, and their implementation introduces additional operational complexities and potential risks. The problem with the novel propulsion technologies is that they do not offer greater productivity, on the contrary. At the same time, there is an increased safety conscience and related reluctance to deal with novel risks. As a consequence, the market parties do not take action by their own to shift to renewable energy and clean technologies.

Therefore, governments must take decisive action to create a supportive environment for clean energy technologies. This means designing smart policies that make renewable fuels and clean technologies economically attractive and competitive and/or making binding regulations to phase out polluting technologies and usage of fossil fuels. A carefully planned transition that gradually phases out polluting fossil fuel power systems while ensuring energy stability and economic continuity, is key.

Promoting the uptake of renewable energy and clean technologies is a complex challenge for the policy makers. Different strategies and scenarios have been developed to ensure that the EU adheres the global environmental targets set in the 2015 Paris agreement. Legislative developments like the EU Green Deal, the Smart Sustainable Mobility Strategy, and the Fit for 55 package provide the main policy framework for the transport sector. The Fit for 55 packages includes specific measures such as the FuelEU Maritime regulation, the revision of the ETS and the Renewable Energy Directive.

1.2 Role of SYNERGETICS

SYNERGETICS is an Innovation Action aiming at the green transformation of the existing inland and coastal fleet by creating synergies. On the one hand, synergies are sought with pilot and demonstration projects that are carried out outside of SYNERGETICS. SYNERGETICS partners are involved in many of these projects assessed within WP2, so that appropriate cross-linking is ensured. On the other hand, the findings from the project's own demonstrators (WP3) are compared and made available to the industry. The results will flow into a catalogue (WP4) which will form the input for decision support tools and scenarios for the industry

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and for policy makes to accelerate (WP5) the uptake of greening technologies in inland waterway transport and coastal operations.

An important part of the SYNERGETICS project is to develop and provide clear recommendations to policy makers on the most effective, efficient and acceptable measures for promoting renewable energy and clean technologies. Making these recommendations is part of WP5 (Acceleration). In order to prepare for this work, in terms of exploration (WP1), a stock taking exercise was carried out to paint the picture of the current policy ambitions, plans and interventions which are in place or being implemented. This picture is compared with the findings from Tasks 1.1 and 1.2 of WP1. Next the question to be answered in WP5 (Acceleration) is to conclude what gaps possibly need to be closed or whether adaptions could be recommended for the sake of effective and efficient policies to reach the objective of mitigation of global warming and fighting pollution.

1.3 Terminology description

The title of the Task 1.3 of WP1 leading to the Deliverable 1.3 is "*Inventory of scenarios up to 2050 in line with the relevant strategies*". This section outlines the definition of the terminology that is commonly used in the document to elaborate the strategies and scenarios.

Policy

A policy is defined by the International Organisation of Standardisation as a set of rules that fall into a defined managed object domain[1] . What is meant by this is that policies are rules and/or criteria that apply to a defined object, where the object can be all sorts of things, like the EU, governments, a company, etc. There are numerous ways of constructing a policy. For example, the lifespan of the policy can vary, the degree of enforcement can differ, or the scope of the policy can deviate. However, in all cases, a policy must define rules and/or criteria to be considered a policy. So as a consequence of the definition of a policy, when the word 'policy' is used in D1.3, it refers to a document that contains a set of rules and/or criteria for a defined managed object domain.

Legislation, regulations, and directives

When talking about legislation the preparation and enacting of laws by legislature is meant[2]. Legislation encompasses a broad definition since it includes both binding and non-binding legal act. This means that when the word 'legislation' is used in D1.3, it refers to a law act that has been implemented or is still in preparation to be enacted. Within the EU, multiple types of legislation exist, which include regulations, directives, decisions, recommendations, and opinions[3]. For D1.3, regulations and directives are the relevant types of legislation. Examples of relevant directives are the Renewable Energy Directive as well as the Directive on the ETS. Examples of relevant regulations are the FuelEU Maritime regulation, EU Taxonomy, Alternative Fuel Infrastructure Regulation and the provisions for Non-Road Mobile Machinery (emission limits for new engines in inland vessels).

In EU terms, a regulation is a binding legislative act that applies to the entire EU. So, when a regulation is implemented, all Member States must adhere to the rules that are included in the regulation. A directive is also a binding legislative act. However, in this case, the EU sets goals that Member States need to achieve. To achieve the goals set in a directive, Member States can decide for themselves how to implement the specific goals into their national legislation. With these definitions, it can be stated that regulations and directives are captured by the definition of a policy.

[1] (PDF) Policy Definition and Classification: Aspects, Criteria, and Examples
[2] Legislation | Definition, Types, & Examples | Britannica
[3] Types of legislation | European Union

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Scenario

When constructing policies, scenarios are used as a tool to deal with the uncertainties of the future[4]. Scenarios can be constructed in different ways, but for all different types of scenarios, the essence is that they describe a future goal that is most likely to occur with the given policies. Relevant for D1.3 are the policies that include specific climate change mitigation targets in combination with legislation to achieve those goals.

Following this terminology, regulations and directives, are part of a broader scenario to reduce emissions. In this case, each regulation or directive contributes to reaching the desired target of the policy scenario. However, this is not the only way to use scenarios. The CCNR roadmap, for example, includes two policy scenarios (a conservative and innovative scenario) sketching different assumptions for energy carriers and technologies to be used to reach the future goal, namely reaching at least 90% reduction of emissions by 2050 compared to 2015.

Strategy

A strategy is, according to literature, a long-term plan or direction that determines how to meet the needs of the market and stakeholders[5]. What this means in D1.3 is that a strategy includes (dynamic) actions that serve the purpose of meeting the goals of the constructed scenarios. It is important to note that in strategies, no rules are defined, but they only contain actions.

Strategies can function at different levels. An example of this is that the EU constructed a strategy for the entire transport sector (Sustainable and Smart Mobility Strategy), and within the transport sector, the EU established a strategy specifically for the IWT sector (NAIADES-III) on a more detailed level. Both are defined as strategies, but the magnitude of their scope differs from each other. The information included in a strategy can also vary, depending on the goal and scope of the strategy. In some cases, a static and detailed strategy is more effective, whereas in other cases, like market-oriented strategies, a more dynamic approach is the better option.

So, in conclusion, the definition of a strategy is that it entails a long-term plan or direction to meet certain requirements by defining a set of actions, where the scope of the strategy and the most effective way of constructing a strategy can vary depending on the application. It can also be stated that when looking at the definition of a policy as described above, a strategy is a distinct concept and does not fall under the definition of a policy, since it does not define any rules. In the EU strategies are generally translated into policies[6].

Roadmap

A roadmap can also be classified as a strategy. A roadmap usually presents specific actions which are planned to be carried out to reach a specified objective. A clear and relevant example is the Roadmap on energy transition for IWT as published by the Central Commission for Navigation on the Rhine. This roadmap presents objectives, possible scenarios on technological pathways and a set of actions to reach the targets.

1.4 About this deliverable

This deliverable "D1.3 Report on scenarios" is the third deliverable of WP1 Exploration. It documents the findings of "Task 1.3 Inventory of scenarios up to 2050 in line with the relevant strategies". This deliverable provides the results of a collection and reflection process concerning the transition scenarios up to 2050 in line with the relevant policy strategies.

[4] Types of scenario planning and their effectiveness: A review of reviews - ScienceDirect
[5] (PDF) What Is Strategy?
[6] Strategy and policy of the European Commission

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The legislative landscape that is designed to foster an environmentally friendly transport sector consists out of a broad range of policy measures, making it a complex task to navigate between the different measures. It was therefore important to compile an overview and to scrutinize the scenarios with the findings from Tasks 1.1 and 1.2, which can be used as a clarification document. For the scenarios and strategies that are discussed within D1.3 the key points and facts have been identified. In the comparison similarities, differences and contradictions have been identified. Particular attention was paid to expected progress with the anticipated infrastructure expansion, technical development, and availability of alternative energy carriers.

This task was led by SPB with support by OST, DST and MARIN. Seen the process of implementation of the Fit-for-55 package the focus until summer 2024 was on monitoring the developments. In Q3 and Q4 2024 the state-of-play was described and compared. Particular attention was also paid to exploring the strategy and scenarios for coastal navigation, as this segment was yet rather unknown.

Chapter 2 of this report presents more details about the task, the scope, and the applied methodology. Next, chapter 3 presents the results of the stocktaking exercise of the overall strategies and scenarios relevant for the overall transport sector and thus also for inland waterway transport and coastal shipping. In chapter 3 also specific attention is paid to the dedicated strategies for inland waterway transport and to dedicated strategies for seagoing transport covering coastal shipping.

In chapter 4 the findings are presented from the assessment and comparison of the overall strategies and scenarios. Chapter 5 subsequently dives into the more specific assessment of the strategies and scenarios for inland waterway transport, while chapter 6 included the specific analysis for the strategies and scenarios related to coastal shipping. Next, chapter 7 presents a summary of the main findings of the tasks 1.1 and 1.2, where the main findings of these deliverables are reflected upon in chapter 8 from the viewpoint of comparing it with the strategies and scenarios. Chapter 9 presents the overall conclusions from this report. In the Annex more detailed information is provided on the strategies and scenarios discussed in chapter 3 .

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2. Methodology

2.1 Scope

In Deliverable 1.3 **general** strategies, policy and regulations and directives have been identified and analysed, which **affect both inland waterway transport and coastal shipping**. This concerns the following:

- European Green Deal (EU strategy)
- Smart Sustainable Mobility Strategy (SSMS) (EU strategy)
- EU Taxonomy revision on screening criteria (EU regulation)
- CountEmissionsEU (EU regulation)
- Fit-for-55 package (EU policy)
- RED revision (RED III) (EU directive)
- Corporate Sustainability Reporting Directive (CSRD) (EU directive)
- Alternative Fuel Infrastructure Regulation (AFIR) (EU regulation)
- Revision of the Emission Trading System (ETS) (EU directive)

The following **specific** strategies and policies **inland navigation** are identified:

- NAIADES III policy of the European Commission (EU strategy)
- CCNR Mannheim Declaration and Roadmap for the energy transition of the fleet (CCNR strategy)
- Green Deal roadmap and implementation of RED-III and ETS-2 for inland navigation in The Netherlands (national strategy, policy and national implementation of EU directives)
- Flemish Green Deal for greening the Belgium IWT fleet (national strategy)
- German funding programme for IWT (national strategy)

The following **specific** strategies and scenarios for **coastal shipping** are identified:

- IMO policy measures (contains both strategies and IMO regulations)
- FuelEU Maritime regulation (EU regulation)
- Green Deal roadmap and implementation of RED-III for seagoing vessels in The Netherlands (national strategy, national policy, national implementation of EU directive)
- German Sustainable Modernisation of coastal vessels funding programme (national strategy)
- Cyprus maritime Tonnage Tax System implementation (national strategy)
- Croatia most relevant maritime sustainable policy implementations (mostly strategies)
- UK most relevant maritime sustainable policy implementations (national strategy and policy)

From the EU point of view the focus has been mainly on greenhouse gas (GHG) emission reduction strategies. There are however also a few relevant policies regarding the air pollutant emissions. For inland waterway transport the Non-Road Mobile Machinery Regulation ((EU) 2016/1628) provides the requirements for new engines to comply with emission limits for air pollutant emissions such as NO_x, SO_x and particulate matter. Moreover, the Air Quality Directive is also revised, resulting in more strict requirements for the air quality in Europe. This concerns limits on the NO_x and particle matter concentration in the air which may not be exceeded. Governments such as municipalities have to make sure that the air quality indicators stay under the limit values. In particular the air quality in cities along major seaports and inland ports can be affected by the emissions from coastal vessels and inland vessels. This may lead to regional/local measures to prevent such emissions. An example of this is the support for using electricity as energy source when a vessel is at berth in a port, or the measures from IMO related to setting NO_x and SO_x limits for specific areas and seaports. It should be noted that although local emissions can be reduced or completely avoided through certain measures (such as using electricity from onshore power supply (OPS) instead of burning a fuel for a generator when a vessel is at berth in a port), this may result in a shift of emissions to other regions (e.g. shifting emissions to locations where electricity is produced).

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2.2 Format for systematic description of strategies and scenarios

A template was developed and applied for a systematic collection of key characteristics of the strategies and scenarios. A structured description enabled a systematic analyses and comparison. The main elements of the format of the description concern the following:

- Organisation and date
- Scope, including a view on other sectors (synergies)
- Adaptation status
- Goals (by year, by percentage and the definition)
- Technologies and energy carriers considered
- Cost analysis and subsidies
- Interventions

The full template is presented in the Annex 1 of this report.

2.3 Applied research methods

Desk research has been the main tool used to analyse the policies, measures, and the legislations. Furthermore, interviews were conducted with policy makers. National policy makers have been contacted to provide information on their national policies for coastal shipping and the corresponding national implementation strategies of EU directives such as ETS and RED-III. Regarding the coastal shipping not much useful information was received, while the general strategies and scenarios are available from desk research (e.g. IMO publications and measures). For the national implementation plans of the EU strategies only information on the Dutch Green Deal and RED-III implementation has been received. Synergies with other projects such as PLATINA4Action were also used to gain more insight into the specific status and issues in inland navigation. For example, the NAIADES implementation Expert Group meeting on 7 November 2024 was valuable regarding the status of the 35 actions and also the work in WP4 of PLATINA4Action to take stock of good practices in zero-emission solutions and their roll-out.

Moreover, internal meetings and workshops took place between WP1 partners to discuss the findings and elaborate the conclusions. The draft final report was reviewed to validate the findings and conclusions.

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3. Main strategies, policies and legislation

The following sections in this chapter provide a detailed overview of key legislative and strategic initiatives addressing sustainability, emissions reduction, and energy transformation.

Main international actors providing the strategies and policies are the European Union, the IMO and the CCNR. Furthermore, national governments developed their national strategies and policies taking into account the overarching strategies and policies on international level.

IWT and coastal shipping are in scope of common legislative and strategic initiatives, arising from sustainability strategies and scenarios focussed on the entire transport sector. However, there are some differences in the legislative landscape for IWT compared to coastal shipping. This is due to the fact the IWT does not fall under the scope of IMO, while coastal shipping does.

coastal shipping in terms is not included in the NAIADES III strategy, since NAIADES III only focusses on IWT. Therefore, this chapter 3 is divided into:

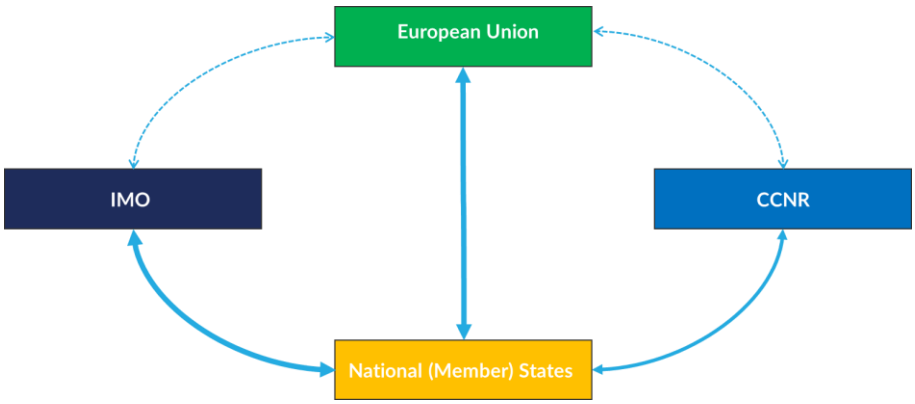
- a section that describes the general strategies, policies and legislations which affect both coastal shipping and IWT
- a section dedicated to specific strategies, policies, and legislations for IWT
- a section dedicated to specific strategies, policies, and legislations for coastal shipping

Both the international and national strategies, policies and legislations are described. For each entry, the main elements are outlined, presenting the (important) information by the mains of a table and by means of summarising text. More details are available by means of Annexes. Annexes 2 to 4 provide comprehensive, detailed elaborations for the sections introduced in chapters 3.1 through 3.3.

Figures 1 and 2present the subdivision of these strategies, policy, and legislations in a schematic graphic way.

This visualization enables readers to quickly comprehend the complex landscape of maritime transportation regulations, clearly delineating the boundaries between EU, IMO, CCNR approaches.

However, of course the strategies from CCNR and IMO are interlinked into some extent since EU Member States are also part of IMO and CCNR. The CCNR however includes also Switzerland, while IMO has a global coverage regarding seagoing transport operations. In the end, the legislation needs to be implemented on national level. Therefore, also the national member states play a crucial role. This is in particular the case for EU legislation like directives where member states have a large degree of freedom do decide how to implement the directive into national law.



1 | Legislative subdivision of the policy makers (EU, IMO, CCNR, national member states)

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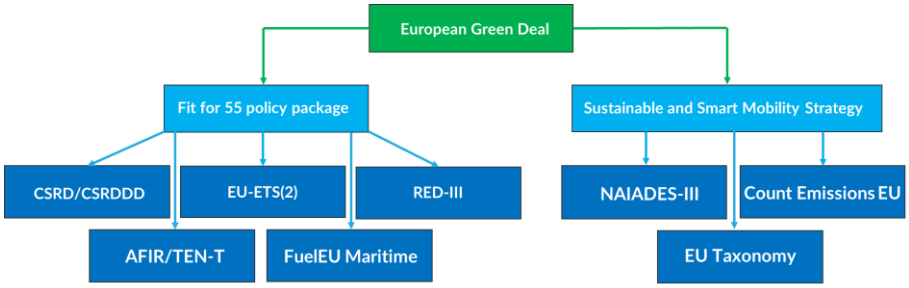

2 | Subdivision of EU initiatives.

3.1 Overall strategies, policies and legislation for waterborne transport

3.1.1 European Green Deal

The European Green Deal (EGD), adopted in December 2019, was developed as response to the Paris agreement in 2015. This is a landmarking strategy as the European Green Deal defines the overall goals and the general approach. It resulted into more specific legislation later on, mainly via Fit-for-55 package and the Smart Sustainability Mobility Strategy. For this reason, the figure 1 was made to make clear what the impact is of the EU Green Deal and what legislation relevant for IWT and coastal shipping resulted from the EGD.

In the Paris agreement it was agreed upon by the United Nations to cap the increase in average global temperature to 2°C, with the ambition to stay below 1.5°C increase. This is to be achieved by the collaborative reduction of GHG emission. The EGD presents the plan of the European Union to take responsibility for reaching the climate targets. The EGD indicates two periods in time with specific reduction targets for GHG emissions. Towards the year 2030 the goal is to reduce the amount of GHG emissions by 55 % compared to the year 1990. For the year 2050 the goal is to achieve net-zero emission in the European Union.

The scope of the EGD goes beyond emission reduction objectives. The EGD strategy also includes boosting the economy, improving people's health and quality of life, caring for nature and leaving no one behind. By setting these goals, the ambition of the EU is to create an environmentally friendly and socially just EU, while striving toward being the global leader in sustainability to maintain a competitive foundation within the global market. These goals are facilitated by several EU strategies and scenarios.

Legislative measures (regulations and directives) from the Fit for 55 package and the Sustainable and Smart Mobility strategy are most relevant for the inland navigation and costal shipping sectors. The Fit for 55 package is a policy that is designed to strengthen the EGD goals. The goal of this policy measure is to ensure that the 55% emission reduction goal is not just an ambition, but something that is actually feasible. Within the ESG transport is an important reduction pillar, since it is responsible for a significant part of the EU pollution. The EGD states that the transport sector needs to reduce their emissions by 90% in 2050. The Sustainable and Smart Mobility strategy is designed to reach this goal.

Besides the necessary policy measures the EU also accommodates multiple financial tools through the EGD, including:

- NextGenerationEU fund
- REPowerEU plan
- Recovery and Resilience Facility (RRF)
- Just Transition Fund in which 55 billion EUR is reserved to support the countries in need, so that these Member States are also able to comply with the Green Deal targets.

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2 | Main features of the European Green Deal.

Scope	Status	Goal	Technologies/ energy carrier considered	Cost (C) /Subsidies (S)
• Eliminating all GHG emissions • Climate adaptation • Conservation and protection • of biodiversity • Sustainable food production (Farmer-to-fork strategy) • Circular economy • Just transition	Implemented	• 55% emission reduction by 2030 • climate neutral by 2050 • 20% of EU land and sea areas restored by 2030 • 3 billion new trees in 2030	Technology neutral	• S: 1.8 billion EUR from NextGenerationEU • S: 55 billion EUR between 2021-2027 from the Just Transition Mechanism (JTM) • S: 2.1 billion EUR from the EU Solidarity Fund • S: close to 300 billion EUR from the REPowerEU plan

3.1.2 EU Taxonomy

Reaching the high level GHG reduction goals as defined in the EGD (see section 3.1.1) requires a significant investment in sustainable activities. The EU Taxonomy regulation was established in 2020 to prevent the abuse of the definition of sustainability (greenwashing) and to steer more capital flow toward environmentally friendly investments.

In 2023 the technical screening criteria regarding seagoing and inland vessels have been revised. This was one of the actions in the Sustainable and Smart Mobility Strategy (more information on the SSMS in section 3.1.3). The EU Taxonomy can be seen as the categorisation of sustainable economic activities.

It subdivides sustainability in six categories, which are:

- Climate change mitigation
- Climate change adaptation
- Protection of water and marine resources
- Transition to a circular economy
- Pollution prevention and control
- Protection and restoration of biodiversity and ecosystems

If an economic activity does not belong to one of these categories it cannot be defended as a sustainable investment. For vessels, both inland and coastal, from 2026 onwards there will be two options to comply with the EU Taxonomy limits. The first option is that vessels have zero direct greenhouse gas emissions (Tank-to-Wake GHG emissions). The second option is only allowed if the first option is both technically and economically not feasible. In this second option the average Well-to-Wake emissions per unit of energy (CO_2e/MJ) used by a vessel need to stay below a certain threshold value[7]. These threshold values subsequently decrease every 5 years, providing a linear decrease of GHG emissions per energy unit (MJ) over time.

[7] See Annex, table A2-II for more details and the table with the specific threshold values

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3 | Main features of the EU Taxonomy.

Scope	Status	Goal	Technologies/ energy carrier considered	Cost (C) /Subsidies (S)
Climate mitigation Climate adaptation Protection of water and marine resources Transition to a circular economy Pollution prevention and control Protection and restoration of biodiversity and ecosystems Option (a): Tank-to-Wake approach Option (b): Well-to-Wake approach	Implemented	Increase of investments in sustainable economic activities Reduction in greenwashing	Technology neutral	n.a.

3.1.3 Sustainable and Smart Mobility Strategy

According to the EGD transition roadmap the transport sector needs to reduce the GHG emissions by 90 % in 2050 compared to the year 1990. In order to comply with this goal, the EU developed the Sustainable and Smart Mobility Strategy (SSMS) in 2020. The SSMS indicates ten main flagship areas to foster the path towards the 90 % emission reduction goal. One of the strategies to achieve reduction of GHG emissions is by means of a modal shift from road transport to more sustainable ways of transport such as transport using inland navigation and rail transport. Growth is expected from shortsea and inland waterway transport. One of the goals as mentioned is to increase waterborne transport by 25 % in 2030 and by 50 % in 2050.

In total the SSMS has set out 82 different actions to reach the flagship goals. Some relevant actions for SYNERGETICS that have been implemented so far are:

- the revision of the EU Taxonomy technical screening criteria for seagoing and inland vessels
- the development of the NAIADES-III policy document and action plan
- the development of the CountEmissionsEU proposal.

Financing is a key factor in achieving the SSMS actions. It has been estimated that the actions regarding the low/zero-emission transport and infrastructure deployment between 2021 and 2030 cost around 130 billion EUR/year, the digitalisation actions around 100 billion EUR/year and the TEN-T development around 30 billion EUR/year.

These actions are, therefore, supported by multiple financial systems, such as:

- REPowerEU
- European Regional Development Fund (ERDF)
- Cohesion Fund
- Innovation Fund
- Connecting Europe Facility (CEF)
- InvestEU (from the Sustainable Infrastructure and Research, Innovation and Digitalisation Windows).

Member States can call upon these funds by delivering a Recovery and Resilience plan to the EU, or by the means of pilot projects with private actors for sustainable transport innovation.

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4 | Main features of the Sustainable and Smart Mobility Strategy.

Scope	Status	Goal	Technologies/ energy carrier considered	Cost (C) /Subsidies (S)
• Emission reduction • Modal shift towards IWT and railroad • Digitalisation • Making transport accessible for everyone	Implemented	• 90% transport emissions reduction in 2050 • 25% more inland waterway and shortsea shipping in 2030 • 50% more inland waterway and shortsea shipping in 2030	• high speed railways • Automated mobility • Electrification/ batteries • Hydrogen • Low-carbon fuels	• C: 130 billion EUR/year for low/zero-emission transport and infrastructure deployment between 2021/2030 • C: 100 billion EUR/year for digitalisation • C: 30 billion EUR/year for TEN-T infrastructure deployment • S: Recovery and Resilience Facility (REPowerEU) • S: ERDF • S: Cohesion Fund, Innovation Fund • S: CEF • S: InvestEU (from the Sustainable Infrastructure and Research, • Innovation and Digitalisation Windows)

3.1.4 Fit for 55 policy package

As mentioned in chapter 3.1.1 the EGD defined the GHG emission reduction goal of 55% to be achieved in the year 2030 compared to the volume of GHG emissions reported for the year 1990. To ensure that this is not just an ambition but becomes reality, the European Commission proposed the Fit for 55 package in 2021. The Fit for 55 package includes:

- multiple new financial tools
- eight specific measures that strengthen and revise existing legislation
- five new measures

Most relevant measures for IWT and coastal shipping that have been resulting from the Fit for 55 package are:

- Corporate Sustainability Reporting Directive (CSRD) / Corporate Sustainability Due Diligence Directive (CSDDD)
- Revision of the ETS directive, including maritime transport in the current ETS and a new EU-ETS-2 for buildings and the road transport sector with optionally other sectors (amongst others fuel supply to inland navigation)
- Revision of the Renewable Energy Directive (RED-III)
- FuelEU Maritime Regulation
- Revision of the Alternative Fuel Infrastructure Directive (AFID), which has been transposed to a regulation (AFIR).

These measures are in coherence with the scope of the EGD strategy, since it includes the reduction of emissions while creating a socially just and competitive EU that the EGD strives to achieve.

This coherence is also shown in the financial support systems that have been develop alongside the Fit for 55, which includes:

- 86.7 billion EUR from the Social Climate Fund
- Innovation Fund
- 30 % of the 2021-2027 Multiannual Financial Framework budget
- 35 % of research and innovation funding under Horizon Europe

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- 37 % contribution from the Member States recovery and resilience plans, which are financed by the Recovery and Resilience Facility.

5 | Main features of the Fit for 55 policy package.

Scope	Status	Goal	Technologies/ energy carrier considered	Cost (C) /Subsidies (S)
• Eliminating all GHG emissions • Increasing the number of natural carbon sinks • Upgrading ETS • Social support system for citizens and small businesses	Several legislative proposals have been or are being processed individually for adoption on EU level (European Parliament, Council, European Commission) and subsequently implementation on EU and/or Member State level	• 55 % emission reduction by 2030 • Natural Carbon sink uptake of 310 Mt in 2030	Technology neutral	• S: 86.7 billion euro from Social Climate Fund • S: Innovation Fund • S: 30 % of the 2021-2027 Multi annual Financial Framework budget • S: 35 % of research and innovation funding under Horizon Europe • S: every Member State needs to dedicate a minimum of 37 % of their recovery and resilience plans, which are financed by the Recovery and Resilience Facility

3.1.5 CSRD and CSRDDD

In 2023 as part of the Fit for 55 policy package the Corporate Sustainable Reporting Directive (CSRD) and the Corporate Sustainable Due-Diligence Directive (CSDDD) were proposed by the European Commission. The main objective for the CSRD is to increase transparency of the environmental and social impact of companies. The detailed reporting obligations for companies subjected to the CSRD are included in the European Sustainable Reporting Standard (ESRS). The CSDDD elevates this transparency by forcing large companies to include their due diligence into the company policy and to actively take responsibility for reducing their environmental and social impact.

The scope of the CSRD and CSDDD includes both environment impacts as well as the social impacts spanning across the full value chain of products and services of companies. Regarding the reporting of GHG emissions this results in the obligation to include scope 1, 2 and 3 emissions into the sustainability reports. This means that not only the direct emissions of own assets need to be reported (scope 1) but also the indirect emissions that are consequences of the activities of the company, but occur from sources not owned or controlled by it. This therefore concerns also the full emissions of transport and logistic operations for sourcing or distributing activities. Since IWT companies and the smaller coastal shipping companies are generally part of the scope 3 emissions of larger companies the consequence of this is the increase in emission data which is demanded from IWT and coastal shipping service providers. It will lead to awareness and insight where large GHG emissions take place and supports assessments and follow-up actions how the GHG emissions can most effectively be reduced within the value chain of companies.

6 | Main features of the CSRD and CSDDD.

Scope	Status	Goal	Technologies/ energy carrier considered	Cost (C) /Subsidies (S)
• All emissions • Environmental impacts of value chain • Social impact of value chain • Well-to-Wake approach	Implemented	• Creating sustainability data transparency • Stimulate investments in sustainable businesses • Reduction of value chain emission	Technology neutral	n.a.

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3.1.6 Revision of the EU-ETS directive

Another measure of the Fit for 55 package is the revision of the Emission Trading System (EU ETS). The revision was adopted on EU level in 2023. As a result, the existing EU-ETS is expanded with seagoing/coastal vessels above 5000 GT and a new EU-ETS2 system will be introduced for energy supply to road transport and buildings with optional relevance for fuel supply to IWT. Where the in section 3.1.5 described CSRD and CSDDD focus on creating transparency and responsibility on company level, the revision of ETS leads to direct limits for the absolute GHG emissions over time in several sectors. Furthermore, it creates a financial incentive to avoid usage of fossil fuels, by means of the price mechanism for GHG emission allowances.

The EU-ETS has already been introduced in 2005 for heavy industry. It is revised to also include the seagoing maritime vessels above 5000 GT into this system. The EU-ETS system works by auctioning a limited number of emission allowances, which will be reduced every year until no emissions allowances are available anymore.

Due to the success and effectiveness of the EU-ETS, a second ETS instrument, referred to as EU-ETS2, has been proposed to expand the scope of sectors to cap and trade the GHG emission allowances. This system includes emissions from buildings, road transport and optionally other sectors which are under the national responsibility of Member States. In contrast to the existing ETS system, the EU ETS-2 is addressing the energy suppliers for these sectors, while the existing ETS system addresses the actors which are directly emitting the GHG emissions (such as factories). Fuel suppliers to IWT can be part of the EU-ETS2 as an "Opt-in" option. Member States can decide whether or not to include the fuel supply to the IWT sector.

The revenues of the emission allowances are used as funding source for the transition towards a sustainable European Union. Regarding the EU-ETS and EU-ETS2, part of the revenue is used to subsidise the Social Climate Fund and the Innovation Fund. The revenue of the ETS-2 "Opt-in" is however to be decided freely by the Member States themselves. The Netherlands decided to put fuel supply to inland navigation under the scope of EU-ETS-2. At the same time, The Netherlands also decided to provide additional financial support linked to the "Opt-in" decision for greening the inland navigation fleet. It concerns a budget of 163.5 million EUR euro for the period 2025-2030.

7 | Main features of the EU-ETS and EU-ETS2.

Scope	Status	Goal	Technologies/ energy carrier considered	Cost (C) /subsidies (S)
• ETS: Maritime vessels >5000 GT included in ETS • ETS2: Eliminating CO_2 emissions in Building, transport and other sectors • tank-to-wheel approach	Implemented, national transposition ongoing regarding ETS2 opt-ins. Will be in force from year 2027	• ETS: 45 % GHG emission reduction in 2030 • ETS2: 42 % GHG emission reduction in 2030 • Total EU-ETS: 61 % GHG emission reduction in 2030 • Total EU-ETS: 100 % GHG reduction in 2044 (tank-wheel)	Technology neutral	• S: Part of the revenue is used for the Social Climate Fund and for Innovation Fund. • S: "Opt-in" revenue is for Member States (e.g. NL: 163.5 million EUR for 2025-2030).

3.1.7 RED-III

Another relevant objective of the EGD and the Fit for 55 package, described in chapter 3.1.4, is to increase the total share of renewable energy within the EU. A measure to contribute to this objective is to revise the Renewable Energy Directive, called the RED-III proposal. The RED-III proposal is addressing Member States to impose specific requirements to energy suppliers for transport and buildings in their country.

Concerning the transport sector, the RED-III offers the Member States two implementation choices. The first option is to ensure that 29 % of Tank-to-Wake (TtW) energy use comes from renewable energy sources. The second option is to force energy suppliers to reach a 14.5 % Well-to-Wake (WtW) GHG emission

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reduction in the energy supply chain by the year 2030. Furthermore, a sub-target on the used renewable energy is included, which states that 5.5 % of the supplied fuel needs to be advanced biofuels. Within this 5.5 % at least 1 % needs to be Renewable Fuel of Non-Biological Origin (RFNBO). In ANNEX 9a and 9b of the EU RED-III legal document it is specified which feedstock can and cannot be used to meet this sub-target.

To financially support the fuel suppliers in their transitioning to supplying renewable energy carrier the Innovation fund can possibly be used and also EU funding can be made available from Connecting Europe Facility (e.g. CEF-AFIF). As mentioned in section 3.1.6 the Innovation fund for the private sector will be partially filled with allowances from the ETS system. Furthermore, Member States that use the ETS2 "Opt-in" will also receive revenues from the additional allowances from the EU-ETS2 system. The available financial resources will depend on the revenues from auctioning the emission allowances, which depend on the market price in future.

8 | Main features of the RED-III.

Scope	Status	Goal	Technologies/ energy carrier considered	Cost (C) /Subsidies (S)
• Relative GHG emission • Reduction in energy supply	Implemented	• 42.5 % renewable energy in 2030 • 29 % increase in renewable energy use (TtW) or 14.5 % reduction (WtW) • 5.5 % advanced biofuel in 2030 of which 1 % is from RFNBO.	• Biofuels (Methane, Methanol, FAME and HVO) • RFNBO (hydrogen, e-methanol, e-diesel) • Electrification/batteries	• S: Innovation Fund • S: Connecting Europe Facility (CEF-AFIF)

3.1.8 AFIR

Another proposed measure included in the Fit for 55 package regarding the increase in renewable energy is the proposed Alternative Fuel Infrastructure Regulation (AFIR). The AFIR replaced the Alternative Fuel Infrastructure Directive (AFID) and was adopted on EU level in 2024.

The AFIR is connected to the Trans-European Transport Network (TEN-T) regulation which was also revised and part of the Fit-for-55 package. Together, the TEN-T and AFIR need to ensure a European transport network with adequate renewable energy infrastructure alongside. The AFIR sets out the requirement for this infrastructure, including measures for vessels such as hydrogen bunker facilities every 200 km and available on-shore power supply (OPS) for moored vessels. The main financial support programme for deployment of alternative fuel infrastructure is the Connecting Europe Facility which contains also a specific instrument for the development of alternative fuel infrastructure (CEF-AFIF) focussing on infrastructure deployment for energy(carriers): hydrogen, methanol, and electricity.

Within the AFIR measures the inland and maritime ports play a prominent role in the policy consideration. The ports are seen as the most suitable connection points between all transport modes, waste management and renewable energy production, energy storage and carbon capture facilities. To facilitate this the revised TEN-T regulation set outs a plan to increase the number of ports and to improve upon short sea routes.

In line with the increased digitalisation of the transport sector the AFIR not only includes measures on the renewable energy itself, but also in optimising the use of the energy. To achieve this, the AFIR states that all renewable energy bunker points need to show comprehensive user information, which includes real time price and bunker availability, and easy payment methods like debit and credit cards are required.

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9 | Main features of the AFIR.

Scope	Status	Goal	Technologies/ energy carrier considered	Cost (C) /Subsidies (S)
Uptake of renewable fuels by providing regulations on the required bunkering and charging infrastructure	Implemented	• Ensure minimum infrastructure to support the required uptake of alternative fuel vehicles across all transport modes and in all EU Member States • Ensure full interoperability of the infrastructure • Ensure comprehensive user information and adequate payment options at alternative fuel infrastructure.	• Electricity charging points • Shore power • Hydrogen fuel points • Methane bunkering points • Smart recharging systems • Easy payment options • Data transparency on costs and waiting times at recharging/refuelling locations	S: Connecting Europe Facility (CEF-AFIF)

3.1.9 CountEmissionsEU

Another measure that influences both the IWT and coastal shipping is the proposed CountEmissionsEU Regulation by the European Commission. As described in section 3.1.3 CountEmissionsEU results from one specific action within the SSMS. CountEmissionsEU, which currently has not yet been adopted by European Parlement, Council and EC, aims for setting a harmonised calculation method for greenhouse gas emissions in transport. The goal of this proposal is to gain knowledge on the emission within the transport in a harmonised way to increase the comparability and transparency of the emission values.

The current proposal of CountEmissionsEU is to follow the EN ISO 14083:2023 methodology, which is a direct copy of the ISO 14083 norm. This norm is a comprehensive calculation method that includes all emission sources within the full transport chain. In this method companies must calculate and report their scope 1, 2 and 3 emissions (Well-to-Wake) in absolute GHG emissions, using the unit carbon dioxide equivalent (CO_2e), and in relative emission based on the transport activity, using the unit carbon dioxide equivalent per transported ton per travelled distance ($CO_2e/t{\cdot}km$).

The CountEmissionsEU proposal does not make it obligatory that all transport operators make these calculations. There is a voluntary basis to do so. However, if companies are making calculations (for example in view of CSRD) and decide to report and disclose the GHG emissions of a transport service they must use the EN ISO 14083:2023.

10 | Main features of the CountEmissionsEU.

Scope	Status	Goal	Technologies/ energy carrier considered	Cost (C) / Subsidies (S)
• Calculation method for accounting all GHG emissions in absolute CO_2e and CO_2e/ton km • Well-to-Wake approach	Approval still in progress	• Gaining knowledge on mission intensive operations within the transport sector	• ISO 14083:2023 norm	n.a.

3.2 Specific strategies, policies and legislation for IWT

3.2.1 NAIADES III strategy

As specified in section 3.1.3 the development of the SSMS lead to the NAIADES-III action plan which was published by the European Commission mid-2021. This strategy is purely focussed on IWT and sets out 35

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specific actions to be achieved between 2021 and 2027. The objectives within the NAIADES-III action plan can be subdivided into two core subjects. The first and most important objective is to facilitate the transition to a zero-emission IWT fleet by 2050. A second objective is to make better use of transport using the inland waterways. This stems from the goal of the SSMS to induce a modal shift towards IWT and thus to reduce GHG emissions by means of modal shift because of the higher energy efficiency per t·km. However, such GHG emission reduction will only be achieved if IWT will keep pace into some extent with the GHG emission reduction of road transport.

Other topics which are identified related to the core objectives are the need for job security and digitalisation in the sector. The available workforce has been decreasing over the last decades, while in order to facilitate the modal shift more workforce is required. A solution to this problem is to ensure proper job security and by increasing the attractiveness of working in the IWT sector. Digitalisation also helps overcome this problem due to optimalisation of the transport and logistic efficiency and possibly also by means of autonomous sailing with reduced crew on board of vessels if the safety and security are guaranteed.

To finance these actions the NAIADES-III programme does not have a specific own budget. However, it links to multiple broader financial programmes and facilities that can also be used be used for reaching the objectives of the NAIADES III programme. This includes for example: Connecting Europe Facility, Horizon 2020 and Horizon Europe, LIFE, Innovation Fund and the Recovery and Resilience Facility.

11 | Main features of the NAIADES-III strategy

Scope	Status	Goal	Technologies/ energy carrier considered	Cost (C) /Subsidies (S)
• Modal shift towards more IWT • Eliminate all GHG emissions • Digitalisation of the IWT • Job security in IWT	On going	• shifting more cargo towards IWT • IWT zero-emission by 2050 • Make IWT jobs more • attractive and sustainable • Speeding up the certification process	• Zero-emission technology • Innovative propulsion systems • Sustainable fuels	• C: 27 billion EUR for IWT TEN-T network • S: 26.2 billion EUR from InvestEU • S: Innovation Fund • S: CEF • S: CEF 2 • S: Horizon 2020 • S: Horizon Europe • S: LIFE programme • S: Recovery and Resilience Facility • S: 21.8 billion EUR in 2021-2027 from Connecting Europe Facility for IWT TEN-T network

3.2.2 CCNR strategy for IWT

In 2018 the Member States of the Central Commission of Navigation on the Rhine (CCNR) signed a declaration, referred to as the "Mannheim declaration", to reduce GHG emission and air pollution of IWT in the Member States of the CCNR. This covers the countries along the Rhine River and therefore also Switzerland as non-EU Member State.

In this declaration two timeframes with corresponding reduction targets where established compared to 2015. For the year 2030 the goal is to reduce 35 % of both GHG emissions and air pollution while in 2050 the total GHG emissions and air pollution must be near zero emission.

To achieve these reduction goals the CCNR developed a roadmap based on extensive studies. In the roadmap the CCNR applied the following scope:

- Cargo and passenger transport are included (so no recreational vessels, service vessels and floating equipment),
- Both GHG and air pollutant emissions from the propulsion and auxiliary systems are included

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- A Tank-to-Wake approach is used according to the IPCC method for national accounting of transport emissions.

In the studies and in the CCNR roadmap for the energy transition of IWT, two different transition pathway scenarios are included to reach the emission reduction goals. It presents a 'conservative scenario' with more focus on drop-in biofuels (combustion engines) and an 'innovative scenario' with more focus on methanol, hydrogen and battery electric technologies to be deployed in IWT. These pathways were compared to a 'business as usual' scenario.

Within this scope two key conclusions were drawn from the study. One is that there is no "one-size-fits-all" solution that can be applied by all vessel types. There are still many uncertainties and each technology has its pros and cons, depending on vessel type and operational profile. The second one is that a significant financial gap must be closed compared to the 'business as usual' scenario. The energy transition related cost exceeds the current available financial resources of vessel owner/operators. It has been estimated that in the conservative scenario between 2020 and 2050 2.4–6.4 billion EUR is required while the innovative scenario would require 5.3–10.2 billion EUR to deploy and operate the required technologies. Clearly funding instruments are needed as well as measures to internalise external costs to close the financial gap.

12 | Main features of the CCNR Strategy: Mannheim declaration and CCNR roadmap.

Scope	Status	Goal	Technologies/energy carrier considered	Cost (C) / Subsidies (S)
• Reducing all GHG emissions • Reducing air pollution • IWT is defined as transport of goods and passengers by IW vessels. • Currently uses Tank-to-Wake approach until Well-to-Wake approach is developed	Implemented	• 35% reduction of GHG emissions and air pollution in 2035 • near zero-emission, meaning at least 90% reduction of GHG emissions and air pollutant emissions in 2050	• Diesel CCNR 2 or below • Diesel CCNR2 + SCR 3 • Diesel stage V • LNG stage V • Stage V HVO • LBM • Electrification/Batteries • H_2 Fuel Cell • H_2 ICE • Methanol fuel Cell • Methanol ICE	• C: estimated 2.4 to 6.4 billion EUR in the period 2020-2050 for conservative scenario • C: estimated 5.3 to 10.2 billion EUR in the period 2020-2050 for innovative scenario • S: European funding and financing instrument in collaboration with: EU, EIB, CCNR, MS

3.2.3 National policies for IWT

In the analysis of the different national policies regarding IWT three national strategies significant and relevant for European inland waterway transport were identified. These come from The Netherlands, Belgium, and Germany.

Mainly the Netherlands has showed ambitious policy measures to reduce emissions of IWT. A clear example is the national implementation of the RED-III by The Netherlands, which plans specific targets for fuel suppliers to inland vessels. Moreover, The Netherlands also decided to include these fuel suppliers under the scope of the EU-ETS-2 system by means of the 'opt-in' opportunity. Revenues from the additional allowances are planned to be used to feed a fund for greening the fleet of inland vessels (with first budget of 164 million EUR between 2025 and 2030).

3.2.3.1 The Netherlands

In 2019 The Dutch Ministry of Infrastructure and Water Management developed together with a broad group of stakeholders the Dutch Green Deal on Maritime shipping, Inland hipping and Ports. This joint policy of stakeholders sets out the specific goals for the Netherlands to reduce GHG and air pollutant emissions. For inland navigation it refers to the Mannheim declaration of the Member States of the CCNR. In the Dutch

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Green Deal, a separate chapter is dedicated to IWT in which three timeframes are included, each with a corresponding reduction goal compared to the year 2015. In 2030 the Netherlands aims to have 150 zero-emission (tailpipe) vessels and 40-50 % CO_2 emission reduction, in 2035 the aim is to have a reduction of 35 %-50 % for both GHG emissions and air pollution and in 2050 the fleet must be near zero-emission, in-line with the ambition of the Mannheim declaration of the CCNR.

Budgets have been planned to stimulate the update of engines with less air pollutant emissions. Furthermore, research was done on setting up an international fund for greening the inland fleet of vessels. Furthermore, to monitor the emission progress of the Dutch fleet a Dutch emission label has been developed, of which a new improved concept can be found in PLATINA3 D2.6[8]. However, it was investigated that legally it is not possible to mandate this label on a national scale. Therefore, the Dutch ministry does now focus on the development and implementation of an international emission label system, which is currently being prepared by CCNR in view of the CESNI work programme and further being supported and developed in the Horizon Europe funded PLATINA4Action project.

A hurdle that slows down the energy transition in every stage is the higher energy cost of renewable energy. To tackle this problem by creating a more level playing field the Netherlands has decided to implement the EU-ETS2 "Opt-in" for the IWT. As mentioned in section 3.1.6 the revenue of this can be used by the Member States themselves. The Netherlands has decided that all revenue from the EU-ETS2 allowances from the IWT sector will be used for the IWT energy transition. From a first revenue estimation of the EU-ETS2 a 163.5 million EUR fund for the IWT has been established and corresponding stakeholders are currently in conclave on how to use this fund. From another climate related fund, the Dutch Growth fund, a 50 million EUR grand has been given to the ZES company, which is part of the SYNERGETICS consortium, for developing their swappable battery packs.

13 | Main features of the Dutch policy on IWT.

Scope	Status	Goal	Technologies/ energy carrier considered	Cost (C) / Subsidies (S)
• Eliminating all GHG emissions • Eliminating all air pollutant • Well-to-Wake approach	Implemented	• 150 emission free vessels in 2030 • Implementation of international label system • 40 %-50 % CO_2 reduction in 2030 • 35 %-50 % GHG emission and air pollution reduction in 2035 • virtually climate neutrality in 2050	• ZES battery packs • Hydrogen • Methanol • Biodiesel (HVO/FAME)	• S: 163.5 million EUR from the Dutch Climate Fund between 2025 and 2030 • S: 50 million EUR from the Dutch Growth fund for project ZES

Following the adoption of the revised Renewable Energy Directive (RED-III) by the EU, the Member States need to transpose this into national law before mid of 2025. The Dutch policy proposal for transposition of RED-III regarding IWT is to include specific reduction targets for fuel supply to inland navigation. As mentioned in section 3.1.7 the EU gives the Member States two options for the RED-III implementation on national level. The Netherlands has decided to use the 14.5% Well-to-Wake reduction option. The 14.5%

[8] Towards implementation of a label system for EU inland vessels

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reduction is not evenly spread within the Dutch RED-III strategy due to difficulties in electrification of the aviation and Maritime sectors, for example.

For the IWT a reduction target has been set to 14.5 %, however, 2.9 % of that can be achieved by purchasing emissions credits from other transport sectors that have reduced more emission then required.

Even though there will be funding from the Dutch government the RED-III implementation of the Netherlands will have an impact on the energy price. Since the Netherlands is the largest energy supplier of the IWT sector in Europe this can have a major economic impact if other countries will not follow. Collaboration between Member States resulting in a coordinated / harmonised approach is key for a stable market and effective policy to reduce GHG emissions. To prevent phenomena like bunker tourism the Netherlands signed an agreement with Belgium in which it is states that both countries will implement the RED-III in similar ways.

14 | Main features of the Dutch RED-III implementation into national law.

Scope	Status	Goal	Technologies/ energy carrier considered	Cost (C) / Subsidies (S)
• Reducing GHG emissions in gram CO_2e/MJ • Well-to-Wake approach	Implemented	• 2026: 3.8 % total reduction • 2027: 5.1 % total reduction • 2028: 7.6 % total reduction • 2029: 10.2 % total reduction • 2030: 14.5 % total reduction	• Biofuels (Methane, Methanol, FAME and HVO) • RFNBO (hydrogen, e-methanol, e-diesel) • Electrification/batteries	• S: 163.5 million EUR from the Dutch Climate Fund between 2025 and 2030 • S: 63.5 million EUR for the Dutch project CONDOR from RH2INE

3.2.3.2 Flanders

As mentioned in the introduction of this section Belgium has also established a Green Deal for the IWT sector in the Flanders region. This Green Deal can be seen as a strategy which is supported and undersigned by a public private group of stakeholders dedicated to green Flanders' IWT fleet. In total the group consists of more than 100 stakeholders. This Green Deal is coordinated organised by the Flemish part of Belgium and is, therefore, denoted as the Flemish Green Deal. The Flemish Green Deal, referred to on national level as "015 Binnenvaart", consists out of fifteen strategic objectives clustered into four domains:

- Domain 1: Technology for green inland shipping
- Domain 2: Financial solutions for green inland shipping
- Domain 3: Policy to support green inland shipping
- Domain 4: Implementation of green inland shipping

The Flemish Green Deal itself does not specify any concrete reduction targets. However, their national climate policy does include some quantifiable targets for the IWT. For CO_2 reduction the goal is the have a 23 % reduction in 2030, where for air pollution it only states that they need to be reduced. A strategy to meet the objective is to induce a modal shift of 6.3 billion t·km, which is a 30 % increase, from road traffic to rail and inland navigation transport.

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15 | Main features of the Flanders Green Deal.

Scope	Status	Goal	Technologies/ energy carrier considered	Cost (C) / Subsidies (S)
• Eliminating all GHG emissions • Reduction of air pollution • Induce modal shift	Ongoing	• 23 % GHG emission reduction in 2030 • climate neutrality in 2050 • 6.3 billion t·km or 30% of freight from road to rail/IWT • 600 on-shore power supply points (achieved already)	• Alternative fuels • Electricity from grid	n.a.

3.2.3.3 Germany

The German government is following the European Union's climate targets. However, there is a special funding programme for inland shipping with several funding calls per year to support the transformation to a more climate-friendly mode of transport. Small companies are a particular focus here, as they can achieve particularly high funding rates. The latest programme from 2023 is divided into:

- Infrastructure: maintenance and expansion
- Environmental friendliness and fleet structure: more efficient and lower-emission vessels and promotion of alternative drive systems in inland navigation
- Digitalisation: networking of ports, digitalisation of locks and ships, automation of transhipment points, 5G mobile communications standard
- Strengthening the multimodal transport chain: increase the share of inland waterway transport in the modal split to 12 percent
- More skilled personnel: recruiting young talent, promoting training for inland waterway and port professionals

In May 2024, the Federal Ministry for Digital and Transport and Federal Ministry for Economic Affairs and Climate Action initiated a broad stakeholder process to develop measures as the basis for a 'National Action Plan for Climate-Friendly Shipping' (NAPS). The NAPS will cover maritime and inland shipping as well as maritime industrial policy. It is intended to support the sector on its transformation path towards climate neutrality and strengthen its competitiveness and innovation expertise. Numerous stakeholders from the fields of shipping and ports, the environment, the energy sector, the maritime industry, the financial sector, science, and representatives from state and federal ministries took part in the NAPS stakeholder process. The stakeholders submitted, critically discussed and prioritised proposed measures in several workshop rounds. Written feedback from stakeholders was also considered throughout the process. The departmental coordination is currently still pending.

16 | Main features of the German IWT policy and funding programme

Scope	Status	Goal	Technologies/ energy carrier considered	Cost (C) / Subsidies (S)
• Reduction of greenhouse gas • Reduction of air pollution • Induce modal shift • More skilled personnel	Ongoing	• 12% IWT in the modal split	• Alternative fuels • Electrification • Hydrodynamic measures • Digitalisation	• 40 million EUR in 2025 then declining every year

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3.3 Specific strategies, policies, and legislation for coastal shipping

3.3.1 IMO

Even though the exact definition of coastal shipping is unclear and subject of further investigation within SYNERGETICS, the seagoing vessels fall under the IMO regime. The IMO, which stands for International Maritime Organisation, is an organisation assigned by the UN that develop the international policies for the Maritime industry. In 2018 the IMO published the initial roadmap "IMO Strategy on reduction of GHG emissions from ships" which was revised in 2023. However, it does not address SOx, NOx, and PM. These air pollutant emissions have been already addressed by the MARPOL regulations.

The IMO regulations focus on the following four distinct aspects:

- GHG emission reduction in absolute emissions (CO_2e) and in emission intensity ($CO_2e/t \cdot km$)
- Air pollution reduction (specifically NO_x and SO_x)
- Increasing the energy efficiency
- Increasing the use of renewable energy

For the GHG emission reduction three timeframes have been established, where in 2030 the reduction goal of absolute GHG emission is 20 % and striving to 30 %, while for the emission intensity is a 40 %, in 2040 it is 70 % and striving to 80 % and in 2050 the IMO want the Maritime sector to be virtually climate neutral with a 70 % emission intensity reduction compared to 2008.

For air pollutant emissions the IMO has chosen to focus on the reduction of SO_x, NO_x, and particulate matter. The limits that have been established for the different air pollutants differ per sea area[9]. IMO has defined Emission Control Areas (ECAs). An IMO regulatory instrument that already had been developed before the GHG reduction roadmap is the Energy Efficiency Design Index (EEDI). This value quantifies the relative efficiency of a vessel compared to a reference efficiency. This strategy is based on the prevention of emissions, which is an effective way of climate change mitigation. Therefore, the IMO GHG reduction strategy forces vessels build in 2025 that are >400 GT to be 30 % more efficient then vessels build in 2014. Vessels with a high EEDI will of course still require energy for transportation. For this reason, the IMO has set the goal to increase the share of renewable energy in the total energy mix by at least 5 %, but they are striving to 10 %.

The financial support for the IMO funded projects has been mostly relying on contributions from individual countries and the EU. Some funds that are directly from the IMO are the:

- Voluntary multi-Donor Trust Fund
- IMO GHG TC-Trust Fund
- Integrated Technical Cooperation Programme

[9] https://wwwcdn.imo.org/localresources/en/OurWork/Circulars/Documents/MEPC.1-Circ.778-Rev.4%20-%20Special%20Areas%20and%20Emission%20Control%20Areas%20(ECAs)%20under%20MARPOL%20(Secretariat).pdf

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17 | Main features of the IMO strategy.

Scope	Status	Goal	Technologies/ energy carrier considered	Cost (C) / Subsidies (S)
• Eliminating all GHG emissions • Reduction of carbon emission intensity (CO_2/ton km) • Reduction of air pollution • Improve energy efficiency • Well-to-Wake approach	Implemented	• 40 % reduction of carbon emission intensity in 2030 • 70 % reduction of carbon emission intensity 2050 • 20 % reduction of GHG emissions in 2030 • 70 % reduction of GHG emissions in 2040 • 100 % reduction of GHG emissions in 2050 • Ships ≥400 GT build in 2025 need to be 30% more efficient than those build in 2014 • 0.5 % Sulphur content limit outside ECAs and 0.1 % - 0.5% inside ECAs (depending on the ECA) • NO_x emissions below ECA Tier zone limit • At least 5 %, but striving at 10 %, of energy comes from zero or near zero-emission sources	• On-shore power supply • Mandatory data collection systems for fuel oil consumption • Exhaust gas water washing for SO_x filtration • Gas and other low flash point fuels • NO_x reduction technologies (SCR)	• S: 11 million USD in the period 2016-2022 from EU for GMN project • S: 7.1 million USD in the period 2019-2023 from Norway for the Green Voyage 2050 project • S: 2.5 million USD in the period 2020-2025 from the Republic of Korea for the GHG-SMART Programme • S: 7 million USD in the period 2018-2025 for the GloFouling Partnerships project • S: 4 million USD in the period 2022-2025 from Norway for the TEST Biofouling project • S: 1.5 million USD in the period 2022-2024 from Saudi Arabia for the IMO CARES project • S: 1.2 million USD in the period 2022-2024 from Republic of Korea and IMO for the FFT project • S: 650,000 USD for IMO-UNEP-Norway Innovation Forum • S: Voluntary multi-Donor Trust Fund • S: IMO GHG TC-Trust Fund • S: Integrated Technical Cooperation Programme

3.3.2 FuelEU Maritime regulation

The EU first developed the MRV regulation (Monitoring, Reporting and Verification of ships' emissions) as base for the FuelEU Maritime regulation. The FuelEU Maritime regulation aims to support and force greenhouse gas emission reduction of seagoing vessels. The FuelEU regulation sets maximum limits for the yearly average GHG intensity of the energy used by seagoing ships >5000 GT. In 2025 the goal is set to a 2 % GHG intensity decrease, reaching up to an 80 % reduction by 2050. FuelEU Maritime covers not only CO_2 emissions, but also other greenhouse gases such as CH_4 and N_2O emissions, using a Well-to-Wake (WtW) approach for fuels (not for electricity). Besides defining the emission limits the Regulation also introduces additional zero-emission requirements for moored vessels, mandating the use of onshore power supply or alternative zero-emission technologies in ports.

Due to the exclusion of vessels below 5000 GT the impact of FuelEU Maritime on the coastal shipping sector will be limited. However, MRV will be expanded from January onwards to vessels above 400 GT. It may be an option to also expand the scope of FuelEU Maritime and also ETS to include these vessels between 400 GT and 5000 GT. This would therefore increase the coverage of coastal vessels.

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18 | Main features of the FuelEU Maritime regulation.

Scope	Status	Goal	Technologies/ energy carrier considered	Cost (C) / Subsidies (S)
• Reduction of CO_2, CH_4 and NO_x emission • cargo and passenger vessels >5000 GT • Well-to-Wake approach	Implemented	• 2 % reduction in 2025 • 80 % reduction in 2050 • Mandatory on-shore electric power or zero emission energy available at big ports in 2030	All (see Annex of Regulation)	n.a.

3.3.3 National policies for coastal shipping

An analysis has been conducted as well regarding the national implementation of coastal shipping policies related to the energy transition. This analysis indicated that in contrast with IWT a broader scala of countries have implemented policies regarding the maritime sector, including coastal shipping. The countries of which policy information has been obtained and analyses include the Netherlands (section 3.3.3.1), Germany (section 3.3.3.2), Cyprus (section 3.3.3.3), Croatia (section 3.3.3.4) and the UK (section 3.3.3.5).

3.3.3.1 The Netherlands

The Dutch Green Deal, also mentioned in section 3.2.3.1, includes a separate chapter on policy for seagoing vessels. The scope in terms of GHG emissions and air pollution are equal when compared to the IWT sector, however, the specific reduction goals are less strict. For seagoing vessels, the goal is to have at least one zero-emission seagoing vessel and an emission reduction of 70 % in 2050 with climate neutrality ASAP after 2050, but at least before 2100. To set an example for other seagoing shipping companies it is also included in the Dutch Green Deal that the I&W's Government Shipping Company will use fuel containing at least 30 % biofuel in 2030. For air pollution the Dutch Green Deal uses the same limits as set in the IMO strategy described in section 3.3.1.

Funding that has been assigned to facilitate the Dutch seagoing policy goals are:

- 52.9 million EUR from the Dutch Ministry of Economic Affairs and Climate Policy, which has been divided over three consortia, including Maritime companies and knowledge institutes.
- 210 million EUR from the National Growth Fund
- 926 million EUR from private and public actors

Besides the already assigned funding the Dutch government is discussing a potential extra 111.3 million EUR from the national Climate Fund that ships can use to invest in innovative CAPEX related technological developments.

19 | Main features of the Dutch policy for seagoing vessels

Scope	Status	Goal	Technologies/ energy carrier considered	Cost (C) / Subsidies (S)
• Reduction all GHG emissions • Reduction air pollutant (NO_x, SO_x and PM) • Well-to-Wake approach	Implemented	• At least 1 zero-emission seagoing vessel in 2030 • 70 % CO_2 reduction in 2050 and climate neutrality ASAP after 2050, but at least before 2100	• On-shore power • Electrification/Batteries • Wind Assisted Ship Propulsion (WASP) • Hydrogen • Methanol • Carbon Capture	• S: 52.9 million EUR from Dutch Ministry of Economic Affairs and Climate Policy, divided over three consortia. • S: 210 million EUR from the National Growth Fund (Nationaal Groeifonds) • S: 926 million EUR from private and public actors. • S: potential extra 111.3 million EUR from national Climate Fund

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The implementation approach of the RED-III for the seagoing industry, referred to as the Maritime industry in the Dutch RED-III implementation strategy, is similar to the implementation of the RED-III for the IWT sector as described in section 3.2.3.1. However, as also explain in section 3.2.3.1 different transport modes have different reduction targets in the Dutch RED-III implementation strategy. The Maritime sector must reduce their Well-to-Wake emissions by 8.2 %, compared to the 14.5 % reduction goal of the IWT sector. Of that 8.2 % the Maritime sector is allowed to purchase 2.5 % emission credits from other sectors to comply with the 8.2 % reduction goal.

20 | Main features of the Dutch RED-III implementation.

Scope	Status	Goal	Technologies/ energy carrier considered	Cost (C) / Subsidies (S)
• Reducing GHG emissions in gram CO_2e/MJ • Well-to-Wake approach	Implemented	• 2026: 3.6 % total reduction • 2027: 4.8 % total reduction • 2028: 5.9 % total reduction • 2029: 7.1 % total reduction • 2030: 8.2 % total reduction	• Methanol • Hydrogen • LNG with Carbon Capture	n.a.

3.3.3.2 Germany

In Germany, the "Sustainable Modernisation of Coastal Vessels" funding programme has been in place for coastal shipping since 2020.

To promote the sector, there was the "ShortSeaShipping Inland Waterway Promotion Centre" in Bonn until the end of 2024. The aim of this association was to promote coastal and inland waterway transport, particularly in the context of intra-European multimodal transport chains. Based on the public-private partnership model, the SPC was financially supported by the maritime industry and trade associations as well as public funding bodies (Federal Ministry for Digital and Transport, eleven federal states).

The aim of the German government's 'Sustainable modernisation of coastal vessels' (NaMKü) funding guideline is to provide innovative stimuli and financial incentives for the modernisation of coastal vessels to

- reduce air pollutants such as nitrogen oxides (NO_X) or particulates;
- reduce greenhouse gases (GHG) such as CO_2, methane, and nitrous oxide from ships;
- improve energy efficiency.

21 | Main features of the German coastal funding programme

Scope	Status	Goal	Technologies/ energy carrier considered	Cost (C) / Subsidies (S)
• Reducing GHG emissions • Reducing air pollutants • Increase energy efficiency	Implemented	n.a.	• Alternative fuels • Hydrodynamic measures	From January 2025, 53 new projects with a total funding of 26.6 million EUR

3.3.3.3 Cyprus

As of April 2024, Cyprus exercises a modification of its Tonnage Tax System, which provides the possibilities for reduction of up to 30% of the Annual Tonnage Tax levied on owners of Cyprus ships (and foreign-flagged ships under certain conditions) if the ships use "mechanisms-equipment for the environmental preservation of the marine environment and the reduction of the effects of climate change".

Annual Tonnage Tax reduction is decided based on the performance attained in operation (see Annex A4-III-3) whereby use is made of the existing IMO instruments: Energy Efficiency Existing Ship Index (EEXI), fuel consumption recorded in the IMO Data Collection System (DCS), and Carbon Intensity indicator (CII).

The reductions can be considered cumulatively, but the total reduction for a single ship cannot exceed 30%.

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22 | Main features of Cyprus Tonnage Tax System

Scope	Status	Goal	Technologies/ energy carrier considered	Cost (C) / Subsidies (S)
• Reducing GHG emissions • Increase energy efficiency	Implemented	Climate mitigation by the means of financial incentive through tax reduction	n.a.	S: maximum of 30% tax reduction

3.3.3.4 Croatia

The most important initiatives and policy documents relevant for greening of shipping in the Republic of Croatia are the following:

- **Transport Development Strategy of the Republic of Croatia for period 2017–2030** (published in 2017)
- **Croatian Hydrogen Strategy until 2050** (adopted by the Croatian Parliament in 2022) which addresses inter alia domestic shipping, in particular the possibilities for the use of hydrogen in the inter-island ferry transport.
- **Integrated National Energy and Climate Plan of the Republic of Croatia for period 2021–203010** (published in 2023).

23 | Main features of the Integrated National Energy and Climate Plan of the Republic of Croatia for period 2021–2030

Scope	Status	Goal	Technologies/ energy carrier considered	Cost (C) / Subsidies (S)
• Reducing GHG emissions • Reducing air pollutants	Ongoing	• 80MVA of installed OPS • installed infrastructure in seven seaports and four inland ports.	• Onshore power supply (OPS) • Hydrogen • LNG • Ammonia	For period 2021–2030, 51.5 million EUR for OPS, infra-structure for alternative fuels, and acquisition of ships using alternative fuels

[10] https://mingo.gov.hr/UserDocsImages/KLIMA/NECPdraftUpdateHRv1EC.pdf

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3.3.3.5 United Kingdom

The most important initiatives and policy documents relevant for greening of shipping in United Kingdom are the following:

- **British energy security strategy**[11] (published in period 2019–2022, with the last update in 2022) which inter alia addresses expansion of production of green hydrogen and lists allocation of £23 million for green ships as part of the Clean Maritime Demonstration Competition.
- **Clean maritime plan: Maritime 2050 environment route map**[12] (published in 2019) which contains the expectations for 2025 and 2035, and addresses port air quality, economic opportunities from low and zero emission shipping, identifies maritime emission reduction options and market barriers to commercial deployment of such measures, and evaluates demands on the UK energy system from port and shipping electrification. Furthermore, the Clean maritime plan presents the scenarios for take-up of emissions reduction options and their impacts on emissions and costs and discusses the role of targets and economic instruments.
- United Kingdom is a signatory to **COP 26: Clydebank Declaration for green shipping corridors**[13] (published in period 2019–2022, with the last update in 2023) which aims to facilitate creation of green shipping corridors.
- **Decarbonising Transport** (published in 2021) is a policy document which includes the goal of net-zero shipping in UK until 2050. (Decarbonising Transport indicates that 5% of domestic GHG emissions or 6.1 MtCO2e come from domestic shipping in UK.) It also addresses the possibilities for extension of Renewable Transport Fuel Obligation (RTFO) – which requires that a certain share of fuel used in road applications comes from renewable sources – from road to maritime.
- **Maritime 2050** (published in 2019) is a high-level strategy document which indicates the ambitions of the UK government with respect to seven topics: the UK's competitive advantage, environment, infrastructure, people, security, technology and trade.
- **The Ten Point Plan for a Green Industrial Revolution** (published in 2020) which addresses greening of shipping in Point 6: Jet Zero and Green Ships by allocating funds into the Clean Maritime Demonstration Programme (see **British energy security strategy**) to develop clean maritime technology. A reference is made to hydrogen ferry trials in Orkney and launching of a hydrogen refuelling port in Teesside.
- **UK Hydrogen Strategy** (published in 2021) which makes another reference to £20 million made available for the Clean Maritime Demonstration Competition, to accelerate the design and development of zero emission marine vessels in the UK.

[11] https://www.gov.uk/government/publications/british-energy-security-strategy/british-energy-security-strategy
[12] https://www.gov.uk/government/publications/clean-maritime-plan-maritime-2050-environment-route-map
[13] https://www.gov.uk/government/publications/cop-26-clydebank-declaration-for-green-shipping-corridors/cop-26-clydebank-declaration-for-green-shipping-corridors

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24 | Main features of the Clean maritime plan: Maritime 2050 environment route map

Scope	Status	Goal	Technologies/ energy carrier considered	Cost (C) / Subsidies (S)
• Reducing GHG emissions • Reducing air pollutants • Increasing energy efficiency	Ongoing	• By 2035: The UK has built a number of clean maritime clusters. These combine infrastructure and innovation for the use of zero emission propulsion technologies. Low or zero emission marine fuel bunkering options are readily available across the UK. The UK Ship Register is known as a global leader in clean shipping. • By 2025: All vessels operating in UK waters are maximising the use of energy efficiency options. All new vessels being ordered for use in UK waters are being designed with zero emission propulsion capability. Zero emission commercial vessels are in operation in UK waters. The UK is building clean maritime clusters focused on innovation and infrastructure associated with zero emission propulsion technologies, including bunkering of low or zero emission fuel.	• Hydrogen • Ammonia • Methanol • Energy efficiency techniques (including wind assisted propulsion)	£20 million to accelerate the design and development of zero emission marine vessels.

3.3.3.6 Finland

The main legal instrument which could be of relevance for the greening initiatives in Finland is the Act on Environmental Protection in Maritime Transport 1672/2009 (with amendments up to version 1537/2019) which applies to international ships in Finnish waters and domestic vessels both within and outside of the Finnish waters. The Act also applies to fishing vessels. In essence, the Act implements the MARPOL convention requirements on the national level.

Apart from that, there are no specific national targets for reduction of air pollutants or greenhouse gases, nor there are any financial instruments in support of greening of the Finnish coastal vessels. The implementation of RED-III is still ongoing.

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4. Overall findings from comparing strategies, policies, and legislation

When analysing the various strategies, policies and legislative measures as presented in chapter 3, it is evident that many are interconnected. From the European Green Deal the overarching SSMS and Fit-for-55 packages resulted in specific measures which have or can have relevant impact for the waterborne transport sector. Each specific measure addresses a distinct element in the overall waterborne transport ecosystem along with the incorporation of the different types of stakeholders and processes involved.

Some legislative measures, for example, aim specifically at the energy supply process in the regulations for energy supply and use, while other measures are more directed to the financing process and related stakeholders. Moreover, some measures make sure that attention is paid to awareness at the demand side for (waterborne) transport services to trigger a higher level of responsibility to choose for more environmentally friendly services. Each measure is complementary and synergies are expected from the package of measures resulting from the European Green Deal strategy.

Clearly the policies are mainly goal oriented, aiming for emission reduction as output. Most measures are technologically neutral in nature, although there seems to be a bias to use of electricity and deployment of hydrogen (e.g. from EU Taxonomy technical screening criteria, FuelEU Maritime and CEF-AFIF conditions). The overall aim is to create an inclusive technological pathway towards climate neutrality by 2050. The European Commission acknowledges that the green transition is a costly (and time-consuming) process especially for the economically vulnerable Member States, industries, and citizens. The European Commission therefore plans mitigation measures such as specific funding programmes to relief the financial impact of the energy transition for these vulnerable groups.

4.1 Fuel supply directives

A set of measures that are intertwined in a complimentary way are the **RED-III and the EU-ETS2** directives. Both RED-III and ETS2 target the GHG emissions related to **fuel supply** and address fuel suppliers. As explained in Annex 2 the revised ETS directive limits the amount of GHG that can be emitted and puts a price tag on the remaining GHG emission, while the RED-III forces the fuel suppliers to reduce their final or full chain GHG emissions. ETS results in an increase of the price of fossil fuels. Therefore, fuel users are stimulated to switch to more sustainable energy types. This push towards renewable energy by pricing GHG emissions makes it more likely that Member States will comply with the RED-III targets set for 2030. It also works the other way around. The fact that RED-III fuel suppliers will be forced by regulations to supply more renewable energy to clients leads to less demand for fossil fuels, resulting in a better balance between supply and demand of ETS emission allowances for the supply of fossil fuels. This ensures that the demand and price of the available GHG emission allowances is relatively reduced to some extent.

4.2 Measures focussing transparency and awareness of clients

As second set of complementary legislations that is distinguished both aim at higher awareness and transparency of emission data, in particular for larger companies in the EU. The measures that addressing this topic are the proposed **CountEmissionsEU** regulation**, EU Taxonomy** regulation **and CSRD/CSRDDD** (directives). All these legislations focus on creating harmonization in defining sustainable economic activities and create transparency regarding the emission performance of economic activities. The measures each encompass a different aspect, but together they increase the overall impact. Where for example CountEmissionsEU is planned to define a harmonized methodological framework for transport companies to reporting GHG emissions, CSRD/CRSDDD requires a wider group of companies to report their emissions for which the CountEmissionsEU is planned to provide the methodological framework to calculate the GHG emissions properly. By establishing a harmonized and transparent framework different economical activities can be directly compared with each other, making it possible to accurately define the economic activities that comply with the criteria defined in the EU Taxonomy regulation.

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4.3 Measures focussing on available energy infrastructure

Another set of complementary legislations are the **RED-III** directive and the **AFIR**. They both support and set requirements to have sufficient availability of the **required renewable energy recharging and refuelling infrastructure in ports and along inland waterways**. The RED-III requires fuel suppliers to reduce their GHG emissions and to supply a higher share of renewable fuel. The revised AFIR, which stems from AFID and the revised TEN-T regulation, sets requirements for the development of an alternative fuel infrastructure. In order to comply with the RED-III targets, Member States need to develop infrastructure to supply the renewable energy. The AFIR forces Member States to develop this infrastructure. As a result, both the Member States and the fuel supply companies are pushed to reduce the GHG emissions and to supply more renewable energy. At the same time, the ETS and also the transparency and reporting measures are designed to reduce the demand for fossil fuels and to increase the use of renewable energy. As a result, the investments in renewable energy infrastructure along ports and waterways will increase faster due to the combined strength of the measures.

4.4 Measures focussing on providing the required financial support

The revenues of the ETS resulting from auctioning of GHG emission allowances are used to invest in projects related to reaching the RED-III and AFIR targets through the Innovation Fund. The Innovation Fund supports the deployment of innovative solutions which drastically reduce the GHG emissions. Besides providing financial support to cover for the capital investments, the Innovation Fund can also provide support to compensate for higher operational costs. Typically, the price of renewable energy is higher than the price of fossil fuel. The Innovation Fund can, therefore, in some extent help to bridge this gap in the operational costs. This legislative setup to earmark revenues from ETS to the Innovation Fund therefore increases the feasibility of GHG emission reduction and the use of renewable energy.

Moreover, with the social climate fund (SCF), it also provides an instrument to support vulnerable groups to make the energy transition. The SCF is created alongside the ETS2 for emissions from fossil fuel combustion in buildings, road transport and additional sectors. It provides EU Member States with dedicated funding so that the most affected vulnerable groups, such as households in energy or transport poverty, are directly supported, and not left behind during the green transition. Member States may use the SCF to support structural measures and investments in energy efficiency and renovation of buildings, clean heating and cooling and integration of renewable energy, as well as in zero- and low-emission mobility solutions. Moreover, Member States will have the option of spending part of the resources on temporary direct income support.

4.5 Differences between measures and possible risks

There also exist **differences** between the policies and measures. These differences emerge from the types of emissions included in the scope and the targets to achieve. Although all measures come from the European Commission, some measures apply the **Tank-to-Wake (TTW)** scope while others apply the broader **Well-to-Wake (WTW)** scope. ETS directive and EU Taxonomy regulation primarily focus on the **TTW** approach while other measures such as RED-III apply the full **WTW** scope.

EU Taxonomy prefers vessels having zero direct GHG emissions. This would be vessels using either hydrogen or electricity as energy source[14]. This implies that it ignores where the electricity and hydrogen come from. This could still be electricity made from fossil fuels (e.g. coal fired power plants) or hydrogen made from fossil natural gas. This TTW approach may lead to the increase in producing hydrogen and electricity in a GHG emission intensive way, especially in the situation when there is not yet sufficient green hydrogen or

[14] In theory ammonia (NH3) would also be a fuel with zero-emission GHG emission, but ammonia is not yet seen in IWT by policy makers as a feasible energy carrier due to the severe safety risks.

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electricity available. It needs to be noted that producing and using grey hydrogen results in much more GHG emissions on WTW level compared to using fossil diesel. This is therefore a risk for reaching the climate neutrality ambition in 2050. Moreover, FuelEU Maritime regulation dictates that the GHG emissions from electricity use shall be noted as zero, therefore discarding possible WTT emissions from the electricity generation. This also could result in inefficiencies seen from the full well-to-wake perspective.

The EU Green Deal, Fit for 55, SSMS, CSRD/CSRDDD and Count Emission EU address also the upstream emissions (WTW). In particular the RED-III measure addresses the development of green hydrogen (RFNBO). Renewable Fuels of Non-Biological Origin (RFNBO) are synthetic fuels mostly derived from electricity that can cover part of the EU's demand renewable fuels in the coming years. Production is still limited by upstream hydrogen supply and carbon capture solutions.

Other differences in scope are found in the EU Green Deal and Fit for 55, which both include targets for reducing **all types of air pollution**, and the RED-III and ETS2, which **only address GHG emissions**. The result of this is that fuel supplier might switch to fuels that have a low GHG emission value but may have no or even negative reduction on air pollution emissions. An example of this is the use of FAME fuel as drop-in solution for diesel engines. While FAME can reduce the WTW emissions of GHG significantly, there are cases that the use of FAME will lead to higher NO_x emissions. For example, this was the result of measurements done in France on inland vessels of vessel operator Sogestran[15].

The final differences that have been found are the different reduction targets. The ETS2 legislation, for example, has a target of reducing 42 % of the Tank-to-Wake GHG emissions for fuel suppliers whereas for RED-III a reduction of 14.5 % is required on a Well-to-Wake basis. Because the scope and the targets are rather different, it is not clear how these relate to each other.

4.6 Substantial differences can occur between Member States

It can be concluded that several measures are revised directives, which gives a large degree of freedom to Member States to decide how to exactly implement the measure on national level. Clear examples are the revision of the Renewable Energy Directive (RED-III) and also the revision of the ETS.

In this process of implementation there seem to be delays at Member State level in the implementation process of RED-III. One country can go faster than the other, leading possibly to substantial differences between countries, simply because one country has the law in force earlier than the other country. Furthermore, there is a high risk of diverging types of implementations which may result in a market disruption. For RED-III for example, the country may opt for applying a single general target for fuel supply to all transport modes or may choose for differentiated targets per mode of transport. Moreover, Member States can also decide for themselves whether or not to apply the opt-in for ETS-2 and to add additional sectors to the system such as inland navigation.

A patchwork of different national regulations can hamper the purpose of the EU Green Deal to reach the EU targets. Seen the large share of cross-border operating inland and coastal vessels, legislation works effectively through a combined effort of all the Member States and having a harmonised approach. Large implementation differences can, besides not meeting the EU Green Deal targets, also have other negative consequences. An example is 'bunker tourism' where vessel operators will choose to purchase fossil fuel in countries which have not included fuel supply under ETS2 regime and therefore still emit GHG emissions. On longer term it may result in the loss of the environmentally friendly image that IWT and coastal shipping currently poses, while road transport is already being forced across Europe to reduce GHG emissions by means of ETS2 and by means stricter requirements for new vehicles (Euro 7).

[15] Source: presentation by Sogestran at Technology Transfer Workshop Antwerp, 4 December 2024, see https://platina4action.iwtprojects.eu/2nd-technology-transfer-workshop-antwerp/

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Moreover, after researching and analysing the different EU Green Deal implementations of the Member States it was concluded that only a few countries (the Netherlands, Belgium/Flanders) actually implemented a national Green Deal for coastal shipping and/or IWT. At the moment, for the RED-III regulation it is currently only the Netherlands which published a comprehensive proposal for implementation. It is not known yet if other EU Member States will also propose specific differentiated targets for GHG intensity reductions in the maritime and inland navigation sectors.

Finally, regarding the ETS-2 opt-in for domestic navigation, only The Netherlands made a clear decision to utilise this option and to use the additional resources to support the inland navigation sector in the energy transition. It is yet unknown how other Member States will deal with this, while especially here there is a risk of bunker tourism if neighbouring countries along major IWT corridors make different political choices.

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5. Comparison of inland waterway transport strategies and policy framework

5.1 NAIADES-III strategy and actions by Member States

For the IWT sector specifically, the main policy support stems from the 2021-2027 NAIADES-III action plan, which takes into account the EU Green Deal and SSMS objectives. This NAIADES-III strategy program is a follow-up of the previous NAIADES-II communication program (2013). The 35 actions listed in the NAIADES-III strategy strive to accomplish the first steps towards emission and air pollution neutrality by 2050. It is synergetic to the targets set in the CCNR strategy 'Declaration of Mannheim' (2018) and the Dutch IWT climate goals (2019).

The NAIADES-III strategy comes with a set of 35 action. These actions refer to planned revisions of legislation, in combination with both financial and non-financial support programmes to contribute to the overall objectives of the EU Green Deal, Sustainable Smart Mobility Strategy and the NAIADES III goals. These 35 actions result in a complimentary connection between the different IWT legislation.

An example of this complementarity is that by means of EU funded projects from Horizon Europe, for example, and though national grants, innovations and pilot projects are enabled to develop and demonstrate zero-emission vessels (e.g. hydrogen fuel cell and battery-electric commercial freight vessels). Furthermore, revisions of legislation, such as the revision of TEN-T, as a result of the 35 action leads to obligations for Member States to invest in infrastructure for renewable fuels and on-shore power in inland ports. Another example of the complementary nature of the NAIADES-III strategy is the connection to the Dutch Green Deal. As a result of the implementation of the Dutch Green deal a voluntarily Dutch emission label system has been established while PLATINA3 (from Horizon 2020) made a study on possible instruments on EU level. Both The Netherlands and European Commission with NAIADES-III share the goal to increase transparency regarding emission performance of vessels and introducing a kind of emission monitoring system. Due to the combined efforts of both legislation the first step towards this goal has been achieved.

The NAIADES III document clearly mentions under the header "*Transitioning to zero-emission inland waterway transport*" (section 2.2) the following (quote) "*Despite its strong environmental record compared to other transport modes, it is nonetheless crucial that inland waterway transport quickly embarks on a pathway to zero greenhouse gas emissions by 2050, if it is to remain competitive and sustainable*".

This gives a specific quantitative target (zero GHG emissions) for a specific time horizon (2050). It remains, however, unclear if this target for 2050 concerns the well-to-wake scope or the tank-to-wake scope and how this needs to be seen in comparison with the scope and emission reduction goals in the Mannheim Declaration and the CCNR roadmap which was subscribed also by major EU Member States for IWT in Europe.

5.2 Comparison between NAIADES III and CCNR strategies

Even though the NAIADES-III is complimentary and synergetic to the CCNR's Mannheim declaration there are also a few differences. This arises from the fact that the NAIADES-III strategy covers a broader range of themes for the IWT sector. The Mannheim declaration and Dutch Green Deal mainly focus on setting specific targets for both GHG emission reduction and air pollution emission reduction. This results in a scope difference between NAIADES-III and the Mannheim Declaration. For example, the Mannheim declaration and the national Green Deal in The Netherlands do not have specific ambitions regarding modal shift or modal share, whereas in the NAIADES-III this is one of the main strategies.

Another difference is that the Mannheim declaration, which resulted in the CCNR Roadmap, refers to a **Tank-to-Wake approach following the IPCC method for national accounting of transport GHG emissions.** The CCNR roadmap presents also two scenarios (conservative and innovative) reaching these targets with different assumptions for the technologies and energy carriers used. The document presenting

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the NAIADES-III strategy does not specific what scope is applied in terms of the objective to reach zero GHG emissions by 2050.

Moreover, a pertinent question from the EU documents is whether a pre fixed trajectory to 2050 should be adopted and if yes, what are the appropriate intermediate emission reduction targets for this trajectory? The CCNR Roadmap gives some direction with the two scenarios (conservative and innovative) for the transition pathway figures along with setting intermediate targets for 2035 compared to 2050.

Furthermore, the NAIADES-III strategy lacks clear definitive targets for air pollutant emissions like NO_x and particulate matter. The following question can therefore be raised: Is the current legalisation NRMM Stage V sufficient to cap such air pollutant emissions over the next decades, or is a revision needed (e.g. NRMM Stage VI) to implement more strict limits for air pollutant emissions? And what levels of air pollutant emissions could be set as targets for 2030, 2040, 2050? Here also the development of emission reduction of road haulage may play a role, seen the motivation for the modal shift ambitions to reduce external costs by modal shift and thus to remain environmentally competitive to road haulage in the EU.

5.3 Decisive role for Member States

In the context of the NAIADES-III target for 2050, it can be remarked that a European ETS2 opt-in implementation for IWT by all EU Member States would already lead to zero greenhouse emissions by 2044 seen from the tank-to-wake perspective according to the IPPC methods for national accounting. If all countries apply this for IWT (such as planned by The Netherlands) the Mannheim Declaration target for 2050 can already be reached within the current legal framework by 2045.

It must be stressed however, that it is optional for Member States to decide whether to apply the ETS2 opt-in also to fuel supply for inland navigation or not. ETS2 revenues may subsequently be used to financially support (e.g. via grant schemes) the inland navigation sector to make the energy transition. It must also be pointed out that there can still be a significant amount of emissions from the well-to-tank part of the value chain which need to be reduced or avoided by means of complementary measures.

The Renewable Energy Directive (RED-III) complementary to the ETS2 "Opt-in" addresses the well-to-tank emission performance and it also regulates the feedstocks used to produce fuels. As a result, RED-III can be seen as complementary to ETS2 if the Member States decide to implement both simultaneously. A limitation of RED-III is, however, that the path is defined until the year 2030. As of yet it is not been defined how it will further develop from 2030 onwards. Moreover, it is yet unclear how the EU Member States will exactly transpose the RED-III into national law. It can be concluded that the Fit-for-55 package resulted in a legal framework which can be effectively applied by Member States to boost the usage of renewable fuels in inland navigation. However, a clear risk is the degree of freedom which the Member States have in the implementation of the revised ETS directive and revised RED. A patchwork of different national implementations may lead to bunker tourism and large share of the IWT fleet still using fossil fuels at low prices (e.g. when excluding ETS-2 and with low RED-III requirements). An element to take into account is the **role of non-EU Member States**, which can play a role in case the energy becomes much cheaper in non-EU Member States compared to EU Member States if non-EU Member States do not implement measures which make fossil energy more expensive (such as ETS and RED-III). For example, on the Danube Corridor such situations may take place. Such risk may play a role, leading to regional differentiated approaches in the EU to mitigate risks of ' bunker tourism'.

To steer towards an effective framework, it is important for the short term that Member States and non-EU Member States **try to align their climate related legislative landscape for inland navigation as much as possible, especially if these are neighbouring countries with intensive cross border waterborne traffic (such as countries along the Rhine).** This is needed to ensure that the price fluctuations of fossil and renewable fuels between countries remain within the acceptable margin. Moreover ETS-2 "Opt-in" can provide significant financial resources to support the inland navigation sector in the energy transition.

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6. Comparison of coastal shipping strategies and policy framework

6.1 IMO compared with EU strategy for maritime transport

For coastal shipping the IMO GHG reduction action plan is the foundation of climate target goals. The scope of the IMO includes both GHG emissions and air pollution. The IMO uses a Well-to-Wake approach, due to which it captures a wide range of targets set in the other legislations related to the coastal shipping industry.

It can be seen that the targets set in the updated 2023 IMO GHG reduction action plan are not always in line with targets from the EU or national Member States. For example, IMO 2023 is stricter compared to the Dutch green deal for seagoing transport. However, the Dutch Green Deal dates already from 2019 and climate agreements have been set at higher ambition levels since 2019 as result of global United Nations agreements. In this respect, the goal of the EU Green Deal is to be a global leader in sustainability, while at the same time remain competitive in the global market.

The FuelEU Maritime is besides complementary to the IMO GHG reduction action plan also complementary to the AFIR and to ETS. Both the AFIR and FuelEU Maritime have as a goal to develop an energy carrier infrastructure and sufficient market demand for renewable fuels. ETS creates a synergy by limiting the allowances to CO_2 emissions and by adding costs to the usage of fossil fuels, which reduces the price gap with renewable fuels.

Even though the AFIR is more general for all transport sectors and the FuelEU Maritime is more focused on the maritime industry, by pursuing one of the two regulations automatically the other one is also pursued. The AFIR relies on the development of the TEN-T network. The development of ports as multimodal areas is a large aspect in the TEN-T regulation, meaning that pursuing the AFIR will increase the renewable fuel present at ports, while simultaneously ETS reduces the demand for fossil fuels. The other way around — when pursuing the FuelEU Maritime — the available renewable energy at ports will be increased and subsequently the goals of the AFIR are also reached. At the same time, due to the AFIR and FuelEU Maritime, there will be less demand for fossil fuels which makes it possible to stay within the volume of emission allowances according to ETS. Due to this interconnection between the three regulations, they are complementary to each other.

6.2 ETS for maritime, but what about the vessels below 5000 GT?

A strong limitation of the MRV, FuelEU Maritime and ETS is that **they only address seagoing vessels above 5000 GT**. The reasoning behind this is to reduce the administrative burden of the smaller vessels. They rationalise this by concluding that roughly 90 % of the worldwide marine GHG emissions comes from seagoing vessels above 5000 GT. However, many vessels operating in coastal waters will be smaller than 5000 GT and are therefore not in scope of these European legislative requirements. Furthermore, some other specific sectors are excluded like navy vessels, fishing vessels, fish-processing vessels and vessels with a public service.

When looking specifically to coastal shipping, the vessels below 5000GT are a significant part of the coastal shipping sector. This means that a quite large share of the coastal shipping industry is not affected by FuelEU Maritime and ETS, which significantly reduces the incentive for the coastal shipping sector to green their fleet.

The Dutch Green Deal states that the government needs to take the lead in greening their fleet to set an example for the rest of the maritime industry. This is, as mentioned before, also the goal of the EU Green Deal which states that the EU wants to be the Global leader in sustainability.

So, when comparing the ETS and FuelEU Maritime with the goals and ambitions of the EU and the Dutch Green Deal **it can be concluded that there is a clear gap**. The legal framework currently falls short because **vessels below 5000 GT are not (yet) included in the legislation**. However, the possibility to

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include vessels between 400-5000 GT under ETS and FuelEU Maritime will be reviewed within a few years which may lead to filling the gap. The EU MRV obligation also used to only be for vessels >5000 GT, however, is has been decided that the EU MRV will become mandatory for vessels between 400 and 5000 GT from 2025 onwards. This shows signs of possible expansion for the scope of the ETS and FuelEU Maritime regulation.

The DNV published a report in 202416 in which it was concluded that there will not be enough renewable fuels available to meet the IMO reduction targets. It was calculated that the maritime industry requires 10 % to 100 % of the total available alternative fuels for all transport sectors. Three solutions to this problem were offers, which are making use of Carbon Capture and Storage (CCS), using shore power for propulsion for short range shipping and increasing the energy efficiency to reduce fuel consumption. The increase of energy efficiency is already captured by IMO regulations and making use of onshore power is included in the FuelEU Maritime. However, CCS is not part of the legislative solutions. For larger coastal vessels this could be a viable solution provided that the large CAPEX cost is worth the investment. A viable lesson that can be learned from this report for SYNERGETICS is that besides renewable fuel, onshore electricity and CCS are also key pillars in order to meet the climate targets set in the EU Green Deal and in the IMO GHG reduction action plan.

6.3 Lack of concrete plans by Member States

A survey by SYNERGETICS among Member States led to the conclusion that there is a general lack of specific plans on national level regarding the maritime sector. Only a few countries did provide a concise overview of activities. However, the coastal shipping segment is not addressed specifically. This is a major conclusion which is relevant for the work in WP5 Acceleration. This results in the conclusion that there is still a lot of work to do in this respect. Further insights are expected from WP4 on the specific representative coastal vessel types, in addressing their operational profiles and the operational costs.

[16] Strategies for meeting the earliest decarbonization targets

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7. Main findings from Tasks 1.1 and 1.2 in SYNERGETICS

Deliverable 1.3 is the last deliverable in WP1 'Exploration' of the SYNERGETICS project. One of the goals of this deliverable is to analyse upon the correlation between the analysis on the current available renewable technologies of D1.1, the techno-economical study on the feasible technical solutions in D1.2 and the exploration of the relevant strategies and policies for both IWT and coastal shipping. For clarification purposes this chapter outlines the main conclusions of D1.1 (section 7.1) and D1.2 (section 7.2) and these findings together with the findings of D1.3 are analysed and discussed in chapter 8.

7.1 Main conclusions deliverable 1.1

In D1.1 an inventory of the different technological renewable energy solutions that can be used for the waterborne sector has been established. The research for D1.1 did not just stay within the boundaries of the waterborne sector but is also encompasses solutions form other (transport) sectors to create synergies between the waterborne sector and other sectors in terms of technological solutions. The focus of this deliverable has been on high TRL solutions, excluding solutions like ammonia, solid-state batteries, and redox-flow batteries for example, while using a Tank-to-Wake approach.

From the report it became clear why shipping is categorised as a hard-to-abate sector. The business case for application of renewable fuels and clean technologies is not there, and there are still many risks and uncertainties. All in all, this results in lack of market demand and uptake of these solutions.

Reasons are that vessels require increased safety measures, investment cost are high, vessel life spans are large, bunkering renewable energy is time consuming, renewable energy is expensive, bunker facilities are scarce, and the required certification processes for alternative fuels are not always in place yet. Moreover, techniques like kinetic energy recovery when braking road and rail vehicles, the relatively simple provision of overhead lines on tracks, and special cases such as "perpetual motion electric trucks", for example, are not applicable for inland and coastal vessels.

Inland and coastal shipping as a sector is not a development driver in the true sense of the word. It can, therefore, be more efficient to adapt technologies with already relatively high TRL and market availability to the requirements on board.

In addition to the introduction of renewable energy and new propulsion systems, the continuous increase in energy efficiency by means of hydrodynamics is a relevant measure next to other approaches to increase efficiency (e.g. logistic optimisation, trip planning). All ships, independent of type, size, transport task or even their energy system will directly benefit from a reduced ship resistance. Primarily, less power means that less energy is required to drive the vessel. While labelling of the energy efficiency is already mandatory for large seagoing ships, such indicators are still being developed for inland navigation. Secondary or indirect effect is, that reduced power demand will lead to smaller engine sizes, hence less engine weight, as well as smaller drive trains and smaller energy storages which supports the transition costs.

All in all, in freight transport in particular, no technology is yet within striking distance of conventional drives in economic terms. High costs, technical and regulatory hurdles and disadvantages in ship operation stand in the way of commercial viability. Holistic strategies comprising technology development, increased awareness, incentive schemes and regulations must be developed and rolled out in order to achieve rapid decarbonisation.

7.2 Main conclusions deliverable 1.2

Building on Deliverable 1.1, Deliverable 1.2 offers a techno-economic assessment of selected renewable energy carriers (Well-to-Tank and Tank-to-Wake) that were deemed feasible. This includes an evaluation of their production, availability, and various generic supply pathways for the total energy needed for Inland Waterway Transport (IWT) in Europe. Specific criteria were established to define a feasible renewable energy carrier.

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The criteria for an energy carrier to be considered renewable is that it has to be produced fully from sustainable sources within Europe, in North Africa or in the Middle East (EUMENA), it has to be an additional energy source to prevent energy deficit in other sectors, there has to be an abandoned capacity available, and the TRL level of the energy carrier needs to be high. In the case of bioenergy, the biomass that meet the feasible renewable energy carrier criteria are sources that have a low indirect land use change impact (ILUC), and they must be useable after 2030 according to the renewable energy directive (RED II/III). To assess the European technical biomass capacity the assumption is made that biomass that would be considered sustainable should be centralised around Rotterdam within a radius of 500 km.

As a result of the techno-economical assessment of renewable energy sources, which include electricity, e-Hydrogen, e-Methanol/bio-Methanol and Biomass, it can be concluded that all energy sources must be fully renewable as well as the additional required processes in order to minimise burden-shifting.

The D1.2 notes that for the long-term Bio-based energy carriers (biofuels) possibly only can play a minor role in the greening efforts of the European coastal and inland shipping fleet, since the biomass capacities are limited. However, they can be applied for specific regions where infrastructure for e-fuels is difficult to implement, or as an add-on for e-fuels to reduce the effect of production fluctuations and/or the necessity of larger interim storage capacities. To mitigate the dependency on biomass, the focus needs to be put on deployment of battery electric propulsion solutions and usage of e-hydrogen and e-methanol.

Furthermore, it was outlined that the current electricity production capacity is not sufficient to also power the European coastal and inland shipping fleet. When expanding the capacity is has been found that onshore wind energy has the lowest GWP (Global Warming Potential) but in case China will reduce their emissions, or the photovoltaic industry is moved to Europe, solar panels can also become a low GWP solution. Regarding the GWP for the energy carriers considered, there will be a shift from Tank-to-Wake emissions (today) to Well-to-Tank emissions (future) when more renewable energy carriers are used. Well-to-Wake emissions will not be emission free for any of the energy carriers neither in the near-term future nor in the long-term future as there will always remain upstream emissions (WTT). This emphasises the relevance of avoiding the use of energy where possible and thus the attention to energy efficiency measures and avoiding transport demand in the first place.

From a Well-to-Wake perspective for the best-case scenarios in terms of emission and cost, battery-electric and e-hydrogen show the most promising result. When including air pollution emissions and overall efficiency, the battery-electric solution outperforms all other energy carriers. E-methanol performs the worst in all the before mentioned categories. On the other hand, the required on-board storage space and infrastructure development for e-methanol is the most beneficial compared to battery-electric and e-hydrogen. Due to this e-methanol remains an interesting energy carrier for further elaboration.

In terms of the business case for sustainable IWT and coastal shipping it can be concluded, also through CCNR and Prominent or NEEDS calculations, that it is highly challenging to reduce the disadvantages in Total Cost of Ownership (TCO). This is due to the many uncertainties regarding the development of fuel costs, technology-pathways, and policy development. Variables such as loss of cargo space, payload, availability of the necessary infrastructure and costs and ease of refuelling/recharging will become increasingly relevant to look at going forward.

Discussions with stakeholders indicated that there is currently no perceived first-mover-business advantage for companies seeking to transition to sustainable fuels. Options like combining business level and policy framework conditions such as polluter pays, pay-per-use or insetting schemes can lead to earmarked contributions for fleet-renewal and retrofitting. Due to this these solutions are considered interesting contributions to a faster greening of the industry. Closing the current gap in cost data availability also plays a crucial role in boosting the incentive of vessels owners to participate in the transition. Furthermore, the role of non-EU countries and stakeholder from the Danube-region should be put under further consideration.

The D1.2 report showed that there are feasible renewable energy carriers expected for retrofitting that meet the criteria set in the report. However, the Well-to-Tank pathways need to be carefully looked at. Due to the lack of level playfield between renewable energy carriers and fossil diesel in terms of the market price for the energy, it remains a quite big challenge to obtain a viable business case for technological solutions

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using renewable energy. Furthermore, more research is needed for an in-depth assessment of storages (limited data available) as well as of Tank-to-Wake costs and of further impacts of the energy carrier paths (outside the scope of this report).

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8. Initial views on technology, feedstock and infrastructure and business model

Upon analysing the WP1 results from deliverables D1.1, D1.2, and D1.3, a clear key takeaway emerges, which is that **a one-size-fits-all technical solution will not be feasible to reach the 2050 targets** of the EU Green Deal. Different renewable energy carriers and solutions are needed in parallel. With this some other findings have been identified in the analysis, which are outlined and discussed in this chapter. The initial view that presented in this chapter is based on the analysis using the obtained information in WP1. WP5 will build upon this reflection and may, therefore, contain different outcomes in case new information and insight is developed during the SYNERGETICS project.

8.1 Availability of feedstock and infrastructure may be problematic

In the current stage of technological development some solutions like **electrification and drop-in biofuels** (e.g. HVO) are in a relatively high TRL stage and will be more feasible solutions in the short term to reduce emissions. However, to realise the GHG reduction targets for IWT and coastal shipping, **it is inconclusive if there is sufficient feedstock available**. It needs to be remarked that there will be competition in terms of energy supply for deep sea vessels and also with transport modes like aviation which also require the feedstocks for producing sustainable aviation fuel (SAF). In D1.2 it was shown that in order to produce enough renewable fuel such as green hydrogen and e-methanol there will **probably be a deficit in the amount of available fresh water**. Seen the uncertainties and possible bottlenecks affecting the availability and prices of renewable fuels, it is too early to conclude on specific pathways and energy carriers to be applied for the IWT and coastal shipping sectors. It is therefore recommended to follow a broader approach and to work in parallel on different types of technical solutions and energy carriers. It is too risky to focus on the development of one silver bullet for all and thus better to **keep multiple options open in parallel**. A 'technology lock-in' shall be avoided. A general recommendation is however that avoiding using of energy is a general solution to contribute to the reduction of emissions. And seen the costs of the energy transition and concerns about availability and (high) energy prices, it will become increasingly important to save energy where possible.

From D1.3 it is shown that this capacity and availability problem has been integrated in the policies from the EU. The regulatory policies are **technology-neutral**, which is positive to keep all technological options open. The EU legislation leaves also much **freedom for Member States** to decide for themselves on how to reach the targets. Taking the RED-III legislation as an example, here the Member States can choose whether they go for a 29 % increase of physical share in renewable energy or a 14.5 % Well-to-Wake GHG emission reduction. They can also decide for themselves if there will be specific targets for individual modes of transport, e.g. anticipating to the ability of a mode of transport to accommodate the required technology and extra costs, **taking into account the specifics of the Member State regarding the transport sector and the energy supply**.

This freedom in implementation, however, also has drawbacks. Especially the ETS2 "Opt-in" option for IWT can be mentioned here. When looking at the Netherlands, Belgium and Germany, for example, if the strictness in policy implementation differs from each other this can lead to market issues like **bunker tourism**. The Netherlands has chosen to include the ETS2 "Opt-in" into their policy for fuel supply to IWT. However, in case Belgium and Germany decide not to use the "Opt-in", it will be much cheaper for many ship owners to bunker in Belgium or Germany instead of bunkering fuel in The Netherlands. And since the Netherlands currently have a market share of over 50% of the European fuel delivery to IWT vessels, this will probably lead to problems in the bunkering market in the Netherlands, but may also lead to capacity issues and congestion in Belgium and Germany. Furthermore, if operators avoid in this way the ETS2, the GHG reduction in IWT will effectively not be reached, fossil fuel will remain available at competitive prices and large volumes of fossil fuels may be used after 2044 resulting in GHG emissions. So, where freedom in zero-emission technologies for the different Member States is essential to meet the 2050 targets, for a stable IWT and coastal shipping market, which in its turn is necessary to stay competitive as a sector, policies

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between Member States need to be comparable in their goals and scope, especially between neighbouring countries along important TEN-T corridor.

8.2 Infrastructure and capacity needed for retrofitting of vessels

Capacity and availability are not only a problem for renewable energy supply, but also in terms of workforce in the shipbuilding sector. During the last decades there is a consistent decline in the amount of people working in IWT and coastal shipbuilding. However, the goal is to induce a modal shift towards IWT and coastal shipping which will require more vessels and more people on board of vessels. For the latter, on the longer term, automation and autonomous navigation of vessels may bring relief to the required workforce to man the vessels.

When looking at the construction timescales retrofitting a vessel takes multiple weeks to months and building a new vessel can take up to a few years. Therefore, converting the existing fleet of vessels, that consist out of roughly 12000 motorised inland vessels and 7200 coastal vessels, is not feasible with the current number of shipyards and workforce. **A rapid increase in work force and shipyard capacity is therefore required**. This will also **provide competitiveness, turnover, and jobs for Europe, which is in-line with the priorities for the development of Europe**.

The pace in which the Member States are implementing policies to increase the development of their renewable energy infrastructure is lacking. Currently only for the Netherlands and Flanders it seems clear what can be expected from their implementation of RED-III while only the Netherlands has decided to apply the ETS2 "Opt-in" for fuel supply to inland navigation. This lack in policy implementations is going to cause a low uptake of renewable energy infrastructure, resulting in a capacity deficit of renewable energy carrier throughout the EU. In turn this will decrease the incentive for shipowners to retrofit their vessels, which consequently slows down the increase in shipyard infrastructure and capacity.

8.3 Bottlenecks in the regulations for methanol and hydrogen pathways

Besides the required increase in capacity and availability, in combination with the increased economic cost there are also other barriers which hamper the transition to renewable energy usage in inland vessels. In particular the relatively new fuels such as hydrogen and methanol can be mentioned in this respect. From D1.1 it has been shown that a wide range of zero-emission techniques are already available and in their deployment phase. However, due to fact that the fuel and engine regulations for hydrogen and methanol are not fully integrated in the ES-TRIN and NRMM regulation they cannot be used for commercial inland waterway transport yet. Especially **the situation for methanol as fuel for combustion engines is problematic seen from the side of engine certification (NRMM Regulation) and will take at least a few years**, while for hydrogen mono-fuel combustion engines the barrier in the NRMM regulation may be solved within a relatively short period.

The consequence of this is that the process of getting a certificate for using hydrogen and methanol combustion has to go through exemption rules, making it a time-consuming process with a lot of risks and costs for the market parties. This reduces the incentive for the engine suppliers and shipowners to invest in alternative fuel engines slowing down the sustainability of the fleet. Due to this **a high priority for policy makers has to be on developing a complete set of legislation for using these alternative fuels to increase the fleet greening process**.

8.4 Internalisation of external costs as a prerequisite for business model

The main reason the market itself lacks incentive to green is because currently **a viable business cases for renewable alternatives does not exist due to the attractive business case of using fossil diesel**. Most business to business consumers are not willing to pay extra for renewable transport, but want to have the lowest possible price. They do not give a value to the sustainability of transport yet. Most funding programmes focus on reducing the initial investment cost of the systems (CAPEX costs). However, a significant hurdle for ship owners to use alternative fuels are the additional operational cost (OPEX cost)

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that come with these new techniques and energy carriers (like hydrogen). The renewed EU-ETS, as already mentioned above, is a good first solution towards internalising the external costs, providing a more levelled playfield in OPEX cost between renewable energy and conventional fossil fuel. Nevertheless, the positive impact on the level playfield will only be reached for inland navigation if important neighbouring Member States along the TEN-T corridors (e.g. Rhine and Danube) include the ETS2 "Opt-in" option into their policies. An important sidenote to this is that even though the ETS2 will contribute to a better levelled playfield it does not decrease the OPEX cost, on the contrary. This means that inland navigation and coastal shipping will overall becomes more expensive if external costs are internalised.

Efficiency measures therefore will help to reduce the additional OPEX costs, especially in case of expensive fuels such as green hydrogen and methanol. Furthermore, due to the increased OPEX cost some stakeholders point towards the risk of a 'reverse modal shift' as road transport may become more competitive. Despite this potential risk it needs to be kept in mind that also **road transport is becoming more expensive and is already being addressed in ETS2 across Europe**, while the **sustainability of transport is becoming an increasingly important** criterium for companies on the medium and long term. The impact of **CountEmissionsEU and CSRD/ESRS will lead to more transparency and awareness** on the GHG footprint. It is therefore very important that also coastal vessels and inland vessels make the step towards GHG reductions to **anticipate on the expected increase of willingness to pay for environmentally friendly transport**.

8.5 Solving the chicken – egg dilemma requires a holistic approach

A problem that the inland and coastal vessels are facing in the energy transition is the famous chicken and egg problem. Vessels need the development of robust renewable infrastructure in order to make the transition, but the required infrastructure will only be developed if there is a sufficient number of vessels which will use the renewable energy. The private sector is reluctant to step into this market because of the high risks and the uncertainties. Therefore, the development needs to be steered heavily by means of public support from governments. For example, the funds established in the Recovery and Resilient Facility includes a large amount of funding to help deal with this problem. The main issue seems that most Member States are possibility lacking the human resources and are not taking sufficient action. The governments are not taking the lead as most of them wait for the market interest.

From experience is it known that the market sees sustainability more as a policy problem instead of a market problem, especially since the **external costs are not (yet) reflected in the market prices of energy and inland waterway and coastal transport.** Increasing the pace of the IWT and coastal shipping sector to become sustainable can be solved by altering the EU policies, by means of **providing certainty on the internalising of external costs** (e.g. by ETS and REDIII) and by means of a bigger push to Member States to develop the required infrastructure. The role of non-EU Member States on international transport corridors needs to be taken into account here as well, seen the risk of bunker tourism.

8.6 Increasing energy efficiency

In Deliverable D1.1 it has been indicated that **increasing energy efficiency** will automatically reduce the OPEX cost and, therefore, increase the business case. This because it will lower the required energy consumption. The IMO has adapted the Energy Efficiency Design Index (EEDI) which sets rules for sea going vessels on increasing their energy efficiency. For IWT this type of regulation does not exist (yet). When looking at the already possible energy efficiency increase by only optimising the aft-ship, as calculated in D1.1, there is much to gain when including this in EU policies. The implementation of **energy efficiency targets** is not only favourable for the business case of renewable energy, but it will also reduce the required renewable energy volume. This will result in better competitiveness and will help to cope with high energy costs. Furthermore, it leaves more room for use of scarce feedstocks and resources to produce renewable fuels for more hard-to-abate sectors like aviation, ensuring a faster energy transition over the full transport sector.

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8.7 More focus on life-cycle-performance of solutions

From the results obtained in D1.2 it became clear that by increasing the amount of renewable energy there will be **a shift towards the Well-to-Tank part becoming increasingly important as well as the full life cycle performance**, including the required (scarce) materials, the energy required to produce hardware components (e.g. batteries, fuel cells) and the costs for recycling. When using electricity directly for propulsion via batteries, for example, the TtW emissions are zero, and around 50 % onboard energy efficiency can be gained compared to using internal combustion engines. However, when using fossil fuels to generate electricity the overall WtW emissions are far from zero, while the life cycle costs of lithium batteries may also remain a relevant point of concern.

The EU-ETS and RED-III directives are incentives for fuel producers and fuel supplier to obtain fuels that are produced in a sustainable way. However, in a further stage of developing the renewable energy infrastructure other problems arise, like the before mentioned deficit of **fresh water for producing green hydrogen**. Since not all Member States have the same amount of access to renewable energy resources it is key for the EU to develop the necessary resource facilities alongside the TEN-T network.

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9. Conclusions

It is concluded that there are two key take-away messages from WP1 as input for the further work in SYNERGETICS regarding the energy transition scenarios and strategies. These are:

- A **one solution fits all is not possible** and **several low-emission solutions** as indicated in D1.1 and D1.2 **need to be further developed in parallel** to meet the EU Green deal targets. The reason is that there are severe uncertainties about the availability and prices of energy carriers, in combination with the variety in fuel characteristics. From the assessment it was concluded that HVO made from renewable feedstocks may not be sufficiently available. Therefore, other solutions will be needed as well, especially for the longer term. Moreover, the requirements and possibilities are rather diverse. For example, container vessels operating on fixed routes may well be positioned to use swappable battery containers as the infrastructure can be developed and containers can be swapped efficiently. However, dry cargo vessels operating on the spot market with varying destinations and sailing areas would probably benefit from energy carriers which have a higher energy intensity and thus provide a larger autonomy for the vessel. In such cases, usage of renewable diesel, bio- or e-methanol or e-hydrogen seem more appropriate.
- It is also clear that **further work is needed to provide the full picture on the total cost of ownership, including the operational impacts and price scenarios**. This concerns the additional time needed to replenish the energy and the possible loss of cargo space and payload. Furthermore, the risks of selecting one specific technology need to be taken into account. Seen the uncertainty in availability and prices, it is probably better to have some flexibility on board of the vessel to use different solutions in parallel. Dual fuel combustion engines as well as hybrid approaches on electrified vessels could be a smart way to mitigate these risks. The economics need to be further investigated.
- A **wide range of techniques for retrofit towards green shipping is more or less ready for deployment.** There is also appropriate available funding from the EU and from some Member States (for example The Netherlands and Germany). However, there is still a gap in the business case. The main bottleneck is that **policy regulations are lacking for the actual uptake of these solutions. This is a disadvantage compared to road transport modes and the larger seagoing vessels (>5000 GT) which have binding regulations in place in the EU**. The bottleneck in the NRMM regulation regarding the gap in reference fuels (methanol and hydrogen are not recognised) needs to be solved as soon as possible. Furthermore, Member States, River Commissions and the European Commission together need to ensure a coordinated policy framework focussing on creating incentives and financial support for green vessels and retrofitting. It is crucial that **external cost need to be internalised** to close the gap in the business case and thus to enable the deployment of zero-emission solutions. ETS seems to be a suitable and available instrument to be applied for both coastal vessels below 5000 GT and to inland vessels via the fuel supply (ETS2). Revenues from ETS can effectively be used to feed a greening fund for IWT and coastal vessels. With the revised ETS, the legal framework is already in place at EU level. It is therefore now primarily a task for **Member States to use this opportunity and to align their national implementation policies to create an effective legal framework synergetic to that of the EU. Moreover, deployment projects using the revenues from ETS need to focus on a holistic approach by including both economic incentives (addressing both CAPEX and OPEX), infrastructure and vessel retrofitting to ensure the competitivity of the IWT and coastal shipping sector.** By addressing these bottlenecks, the incentives for the market uptake to green the IWT and coastal shipping fleet will increase, resulting in the desired energy transition rate.

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| Annex 1: Template description strategies and scenarios

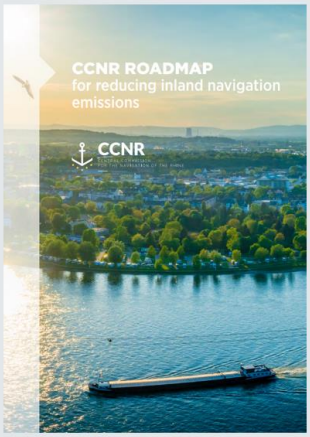
Illustration of applied template for the CCNR Strategy (CCNR Roadmap)

CCNR Roadmap: https://www.ccr-zkr.org/files/documents/Roadmap/Roadmap_en.pdf

1. **Organisation and date**:
Central Commission for the Navigation of the Rhine, March 2022

This roadmap aims primarily to deliver on the mandate conferred by the Mannheim Declaration in 2018 and to help address the crucial challenge of the energy transition for Rhine and European inland navigation.

Built on the CCNR study on the energy transition towards a zero-emissions inland navigation sector ("the CCNR study"), this roadmap should be understood as the primary CCNR instrument for climate change mitigation and for giving effect to the energy transition.



CCNR Roadmap: https://www.ccr-zkr.org/files/documents/Roadmap/Roadmap_en.pdf

1. **Organisation and date**:
Central Commission for the Navigation of the Rhine, March 2022

The objective is to reduce Rhine and inland navigation emissions by:

» setting transition pathways for the fleet (new and existing vessels),
» suggesting, planning, and implementing measures directly adopted or not by the CCNR,
» monitoring intermediate and final goals set by the Mannheim Declaration

The CCNR hopes that this roadmap will help develop a shared vision of the energy transition and associated challenges within the inland navigation sector, while also generating support and acceptance for related policy measures. This roadmap could serve to coordinate decisions at the political level, namely decisions of the Member States but perhaps even more so of the EU. For this reason, it is of the utmost importance to design such a roadmap in full collaboration with as many involved players as possible, taking into account and creating synergies with existing initiatives.

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CCNR Roadmap: https://www.ccr-zkr.org/files/documents/Roadmap/Roadmap_en.pdf

2. **Scope**:
Roadmap aiming at largely eliminating greenhouse gas emissions and air pollutants of the inland navigation sector by 2050.
- lays focus on inland navigation meaning the transport of goods and the carriage of passengers by inland waterway vessels. Recreational crafts, service vessels and floating equipment were not included at this stage;
- define emissions as atmospheric pollutants and greenhouse gases arising from the operation of an inland navigation vessel's propulsion and auxiliary systems
- adopt a "tank-to-wake" (TTW) approach (with IPCC method for accounting GHG emissions), as an interim solution, until a "well-to-wake" (WTW) approach is available for the relevant energy carriers. Application of this approach however implies making assumptions concerning the upstream chains (emissions produced and fuel availability) which are idealised.

CCNR Roadmap: https://www.ccr-zkr.org/files/documents/Roadmap/Roadmap_en.pdf

2. **Scope**:

CCNR Roadmap: https://www.ccr-zkr.org/files/documents/Roadmap/Roadmap_en.pdf

3. **Status:**
Active implementation ongoing. The CCNR will undertake, to report, by 2025, on the progress in the implementation as well as the need to update and, if necessary, revise the roadmap by 2030, the roadmap and the corresponding action plan

4. **Goals (by year and by percentage and what definition?):**
following the Mannheim Declaration "to further improve the environmental sustainability of navigation on the Rhine and Inland waterways, the same Mannheim Declaration tasked the CCNR to develop a roadmap for:

» reducing GHG emissions by 35% compared with 2015 by 2035
» reducing pollutant emissions by at least 35% compared with 2015 by 2035
» largely eliminating GHG and other pollutants by 2050.

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4. **Goals (by year and by percentage and what definition?):**
   More specific goals:
   1. **Climate change**: at least 90% reduction by 2050
   2. **Air pollutant emissions**: at least 90% reduction by 2050
   3. **Energy consumption:** no direct goals but executed calculations (RQ C) point towards certain energy consumption reductions assumed between 2020-2050 in transition pathway scenarios

CCNR Roadmap: https://www.ccr-zkr.org/files/documents/Roadmap/Roadmap_en.pdf

5. **Technologies and energy carriers considered**:

   The roadmap aims to outline two transition pathways for the fleet (new and existing vessels).

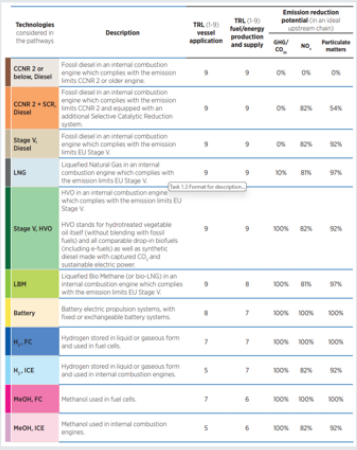
   A more conservative transition pathway, based on technologies that are already mature, cost efficient in the short-term but with uncertainties on the availability on certain fuels, and a more innovative one, relying on technologies still in their infancy stage but providing more promising emission reduction potential on the long run.

   The transition pathways also address the role which the different technological solutions will play in the energy transition challenge, assess their suitability according to the different fleet families in Europe and the sailing profiles of the vessels.

CCNR Roadmap: https://www.ccr-zkr.org/files/documents/Roadmap/Roadmap_en.pdf

5. **Technologies and energy carriers considered:**

- Diesel, 3 variants: 1) CCNR 2 or below 2) CCNR2+SCR 3) Stage V
- LNG (with Stage V emission limit performance)
- Stage V HVO
- LBM
- Battery
- H2 Fuel Cell
- H2 ICE
- Methanol Fuel Cell
- Methanol ICE



Technologies considered in the pathways	Description	TRL (1-9) vessel application	TRL (1-9) fuel/energy production and supply	Emission reduction potential (in an ideal upstream chain): GHG/CO_2	NO_x	Particulate matters
CCNR 2 or below, Diesel	Fossil diesel in an internal combustion engine which complies with the emission limits CCNR 2 or older engine.	9	9	0%	0%	0%
CCNR 2 + SCR Diesel	Fossil diesel in an internal combustion engine which complies with the emission limits CCNR 2 and equipped with an additional Selective Catalytic Reduction system.	9	9	0%	82%	54%
Stage V, Diesel	Fossil diesel in an internal combustion engine which complies with the emission limits EU Stage V.	9	9	0%	82%	92%
LNG	Liquefied Natural Gas in an internal combustion engine which complies with the emission limits EU Stage V.	9	9	10%	81%	97%
Stage V, HVO	HVO in an internal combustion engine which complies with the emission limits EU Stage V. HVO stands for hydrotreated vegetable oil itself (without blending with fossil fuels) and all comparable drop-in biofuels (including e-fuels) as well as synthetic diesel made with captured CO_2 and sustainable electric power	9	9	100%	82%	92%
LBM	Liquefied Bio Methane (or bio-LNG) in an internal combustion engine which complies with the emission limits EU Stage V.	9	8	100%	81%	97%
Battery	Battery electric propulsion systems, with fixed or exchangeable battery systems.	8	7	100%	100%	100%
H_2, FC	Hydrogen stored in liquid or gaseous form and used in fuel cells.	7	7	100%	100%	100%
H_2, ICE	Hydrogen stored in liquid or gaseous form and used in internal combustion engines.	5	7	100%	82%	92%
MeOH, FC	Methanol used in fuel cells.	7	6	100%	100%	100%
MeOH, ICE	Methanol used in internal combustion engines.	5	6	100%	82%	92%

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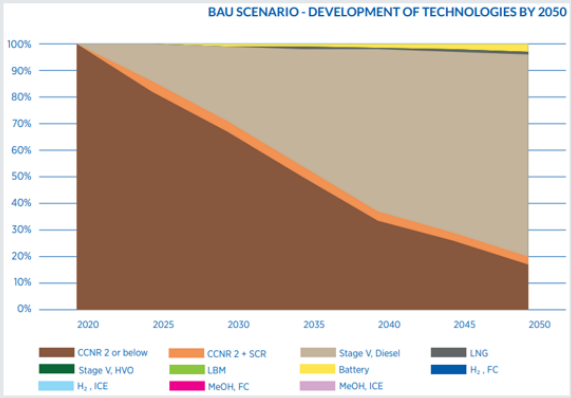
5. **Technologies and energy carriers considered:**



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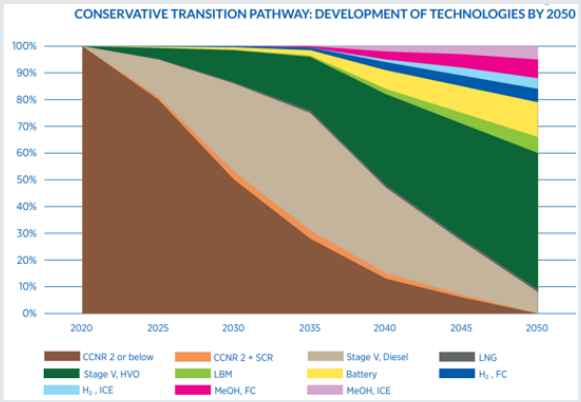
5. **Technologies and energy carriers considered:**



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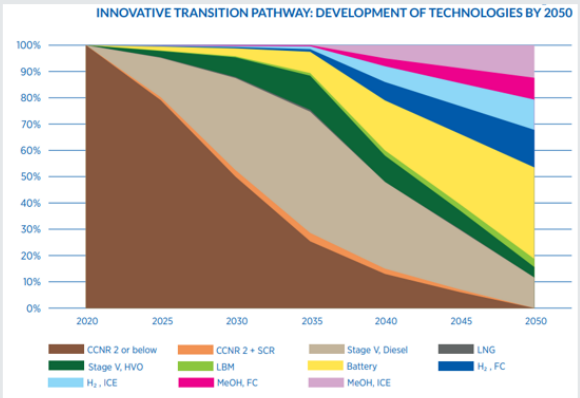
5. **Technologies and energy carriers considered:**



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CCNR Roadmap: https://www.ccr-zkr.org/files/documents/Roadmap/Roadmap_en.pdf

6. **Costs**

The total financial gap in the conservative transition pathway, covering the period 2020-2050 is approximately:
» €2.43 bn in the minimum price scenario
» €2.65 bn in the average price scenario
» €6.38 bn in the maximum price scenario

The total financial gap in the innovative transition pathway, covering the period 2020-2050 is approximately:
» €5.26 bn in the minimum price scenario
» €7.80 bn in the average price scenario
» €10.19 bn in the maximum price scenario

CCNR Roadmap: https://www.ccr-zkr.org/files/documents/Roadmap/Roadmap_en.pdf

7. **Interventions and subsidies**

The implementation plan of the CCNR Roadmap contains different type of measures:

- Regulatory measures

- Voluntary measures

- Financial measures

- Implementation plan Regulatory measures (1/2)

No.	Measures	Required actions (What)	Players (Who)	Methodology, tools and the CCNR's possible contribution and calendar (when available) (How and when)
R1a	Appropriate regulatory framework for the use of alternative fuels and batteries (vessel construction)	Develop standards and requirements applicable to the construction of inland navigation vessels to allow the use of alternative fuels and batteries on board these vessels	CESNI,[20] Member States of the CCNR, River Commissions,[21] UNECE,[22] EU, CEN, GERC[23]	Standards and regulations developed based on experience gained with pilot projects as well as existing standards from maritime as well as other industrial sectors. Timeline CESNI: CESNI work programme 2022-2024 includes several tasks regarding alternative fuels.
R1b	Appropriate regulatory framework for the use of alternative fuels and batteries (crew)	Develop crew-related standards and requirements for allowing the use of alternative fuels and batteries on board inland vessels	CESNI, Member States of the CCNR, River Commissions, UNECE, EU	
R1c	Appropriate regulatory framework for the use of alternative fuels and batteries (vessel operation)	Develop standards and requirements for operating vessels (navigation authority regulation) for allowing the use of alternative fuels and batteries on board inland vessels	Member States of the CCNR, River Commissions, UNECE	The vessel technical requirements for fuel cells and methanol should be adopted by end 2022. Those for the storage of hydrogen would follow shortly thereafter.
R1d	Appropriate regulatory framework for the use of alternative fuels and batteries (transport of dangerous goods)	Develop standards and requirements for allowing the carriage of alternative fuels	UNECE, CCNR	The development of competence standards for the use of relevant alternative fuels, batteries and electric propulsion systems will start in 2022-2023.
R1e	Appropriate regulatory framework for the use of alternative fuels (definition, fuel characteristics, blending and supply)	Develop standards and requirements to ease the use of alternative fuels (definition, fuel characteristics, blending and supply), notably biofuels Coordination on implementation of instruments such as EU Renewable Energy Directive	Member States of the CCNR, EU	CCNR work program 2022-2023 includes to start the work on regulatory framework for vessel operation.

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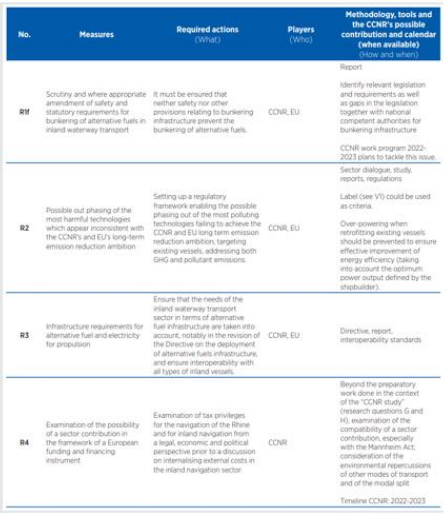
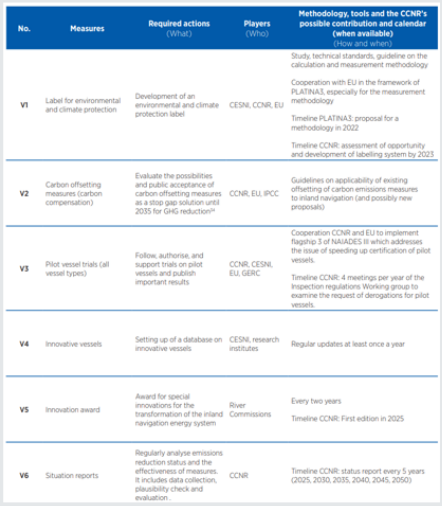
- Implementation plan Regulatory measures (2/2)



No.	Measures	Required actions (What)	Players (Who)	Methodology, tools and the CCNR's possible contribution and calendar (when available) (How and when)
RM	Scrutiny and where appropriate amendment of safety and statutory requirements for bunkering of alternative fuels in inland waterway transport	It must be ensured that neither safety nor other provisions relating to bunkering infrastructure prevent the bunkering of alternative fuels.	CCNR, EU	Report Identify relevant legislation and requirements as well as gaps in the legislation together with national competent authorities for bunkering infrastructure CCNR work program 2022-2023 plans to tackle this issue.
R2	Possible out phasing of the most harmful technologies which appear inconsistent with the CCNR's and EU's long-term emission reduction ambition	Setting up a regulatory framework enabling the possible phasing out of the most polluting technologies failing to achieve the CCNR and EU long term emission reduction ambition, targeting existing vessels, addressing both GHG and pollutant emissions.	CCNR, EU	Sector dialogue, study, reports, regulations Label (see V1) could be used as criteria. Over-powering when retrofitting existing vessels should be prevented to ensure effective improvement of energy efficiency (taking into account the optimum power output defined by the shipbuilder).
R3	Infrastructure requirements for alternative fuel and electricity for propulsion	Ensure that the needs of the inland waterway transport sector in terms of alternative fuel infrastructure are taken into account, notably in the revision of the Directive on the deployment of alternative fuels infrastructure, and ensure interoperability with all types of inland vessels.	CCNR, EU	Directive, report, interoperability standards
R4	Examination of the possibility of a sector contribution in the framework of a European funding and financing instrument	Examination of tax privileges for the navigation of the Rhine and for inland navigation from a legal, economic and political perspective prior to a discussion on internalising external costs in the inland navigation sector	CCNR	Beyond the preparatory work done in the context of the "CCNR study" (research questions G and H), examination of the compatibility of a sector contribution, especially with the Mannheim Act; consideration of the environmental repercussions of other modes of transport and of the modal split Timeline CCNR: 2022-2023

- Implementation plan Voluntary measures



No.	Measures	Required actions (What)	Players (Who)	Methodology, tools and the CCNR's possible contribution and calendar (when available) (How and when)
V1	Label for environmental and climate protection	Development of an environmental and climate protection label	CESNI, CCNR, EU	Study, technical standards, guideline on the calculation and measurement methodology Cooperation with EU in the framework of PLATINA3, especially for the measurement methodology Timeline PLATINA3: proposal for a methodology in 2022 Timeline CCNR: assessment of opportunity and development of labelling system by 2023
V2	Carbon offsetting measures (carbon compensation)	Evaluate the possibilities and public acceptance of carbon-offsetting measures as a stop gap solution until 2035 for GHG reduction[24]	CCNR, EU, IPCC	Guidelines on applicability of existing offsetting of carbon emissions measures to inland navigation (and possibly new proposals)
V3	Pilot vessel trials (all vessel types)	Follow, authorise, and support trials on pilot vessels and publish important results	CCNR, CESNI, EU, GERC	Cooperation CCNR and EU to implement flagship 3 of NAIADES III which addresses the issue of speeding up certification of pilot vessels. Timeline CCNR: 4 meetings per year of the Inspection regulations Working group to examine the request of derogations for pilot vessels.
V4	Innovative vessels	Setting up of a database on innovative vessels	CESNI, research institutes	Regular updates at least once a year
V5	Innovation award	Award for special innovations for the transformation of the inland navigation energy system	River Commissions	Every two years Timeline CCNR: First edition in 2025
V6	Situation reports	Regularly analyse emissions reduction status and the effectiveness of measures. It includes data collection, plausibility check and evaluation.	CCNR	Timeline CCNR: status report every 5 years (2025, 2030, 2035, 2040, 2045, 2050)

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| Annex 2: Detailed description of the general policies relevant for both IWT and Coastal shipping

A2-I EU Green Deal strategy

The European Green Deal (EGD), published on 11 December 2019, is the implementation strategy of the EU of the goals set in the Paris agreement of 2015. The EGD included strategies and scenarios on how to make the EU the first climate-neutral continent by 2050, with an intermediate target of 55 % GHG reduction by 2030 compared to 1990. The EGD captures strategies for challenges related to boosting the economy, improving people's health and quality of life, caring for nature, and leaving no one behind in the energy transition. The health, quality of life and nature conservation goals require more than just the reduction of GHG emissions. Due to this, the scope of the EU Green Deal also includes the reduction of air pollution, like NO_x, SO_x, PM and noise pollution for example, and the restoration of biodiversity and ecosystems. For the reduction of air pollution, the EU Commission developed the Zero Pollution Action Plan[17], which includes targets and strategies to reduce all forms of air pollution until they no longer have an impact on the environment. For the restoration of biodiversity and ecosystems the EU Green Deal requires that 20 % of EU land and sea areas are restored and 3 billion new trees are planted by 2030. The Member States are granted flexibility in deciding how to implement the EGD targets into their own policies. This is done due to the diverse energy mix landscape (e.g. availability of electricity from waterpower, geographic location, availability of large seaports) and resource availability between the Members States making it not feasible to implement a single one-size-fits-all strategy.

To reach the ambitions of the EGD the EU established multiple financial tools. The NextGenerationEU fund, comprised out of 1.8 billion euros, is used to subsidise National climate mitigation projects. As part of the emission reduction targets the REPowerEU plan lays down a roadmap to increase the total amount of renewable energy and to phase out the energy bought from Russia. This plan comes with financial support close to 300 billion EUR where most of the funding comes from the Recovery and Resilience Facility (RRF). As mentioned before, the Green Deal does not only focus on establishing a climate neutral economy, it also strives towards equality and justice throughout Europe. Facilitating the green transition can be difficult for the vulnerable and less fortunate Member States. To make sure that no one is left behind the EU founded the Just Transition Fund in which 55 billion euro is reserved to support the countries in need, so that these Member States are also able to comply with the Green Deal targets. Finally, the EU provides funding to countries that are in the wake of a disaster, where since 2019 2.1 billion EUR have been allocated.

The transport sector is an important segment in the EGD plans, since it is responsible for almost a quarter of the EU greenhouse gas (GHG) emissions and it is the main cause of air pollution in cities. To achieve the EGD reduction targets Inland Navigation and Coastal Shipping will become vital transport modalities towards a climate neutral EU. For the transportation sector not only emission and pollution reduction are considered in the EGD, but also solutions to make transportation affordable and accessible for everyone. The main strategy to achieve these goals are incorporated in the Sustainable and Smart Mobility Strategy (SSMS)[18] (more on this in chapter A2-III) and the TEN-T regulation[19].

[17] Zero Pollution Action Plan - European Commission (europa.eu)
[18] SSMS: Sustainable and Smart Mobility Strategy including an action plan, see for more information: https://transport.ec.europa.eu/transport-themes/mobility-strategy_en
[19] Regulation - EU - 2024/1679 - EN - EUR-Lex (europa.eu)

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A2-II EU Taxonomy regulation

The EU Taxonomy[20] regulation is a cornerstone of the EU's sustainable finance framework and an important market transparency tool. It helps direct investments to the economic activities most needed for the transition, in line with the EGD objectives. The EU Taxonomy is a classification system that defines criteria for economic activities that are aligned with a net-zero trajectory by 2050 and the broader environmental goals other than climate.

In order to meet the EGD objectives, it is vital that we direct investments towards sustainable projects and activities. To achieve this, a common language and a clear definition of 'sustainable' is needed. This is why the action plan on financing sustainable growth called for the creation of a common classification system for sustainable economic activities, or an "EU taxonomy".

The EU taxonomy allows financial and non-financial companies to share a common definition of economic activities that can be considered environmentally sustainable. In this way, it plays a pivotal role in helping the EU scale up sustainable investment, by creating security for investors, protecting private investors from greenwashing, helping companies become more climate-friendly and mitigating market fragmentation.

The Taxonomy Regulation entered into force on 12 July 2020. It establishes the basis for the EU taxonomy by setting out the four overarching conditions that an economic activity has to meet in order to qualify as environmentally sustainable.

Under the Taxonomy Regulation, the Commission had to come up with the actual list of environmentally sustainable activities by defining technical screening criteria for each environmental objective through delegated and implementing acts.

The SSMS also points towards the role of EU Taxonomy regarding transport modes:

"26. Public and private investment in local renewable energy production, in more sustainable multimodal access and in fleet renewals in aviation and waterborne transport must increase. ***Some of these investments would benefit from the establishment of relevant sustainable taxonomy criteria that covers the specificities of each mode, including during transition to zero emissions****. The revised lending policy to be decided by the European Investment Bank (EIB) can equally be expected to be helpful.*

[…]

76. Investment in the recovery of the transport sector should be accompanied by investments by businesses in more sustainable and digital mobility. ***The technical screening criteria based on the Taxonomy Regulation52 should be defined for all transport modes while recognising the specific investment needs. Financing sustainable transport investment could also build on the upcoming European Green Bonds Standard anchored on the EU taxonomy****. The upcoming revision of the transport relevant State aid rules must also be used to drive the sector's transition to sustainability, giving all modes an increasing opportunity to compete on equal terms for a subsidy."*

Therefore, one of the actions[21], action number 17 in the SSMS[22], specifically addresses the establishment of sustainable taxonomy technical screening criteria for all modes. This action is important for Flagship 1 of the SSMS "Boosting the uptake of zero-emission vehicles, renewable and low-carbon fuels and related infrastructure".

[20] REGULATION (EU) 2020/852 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL (europa.eu)
[21] https://eur-lex.europa.eu/resource.html?uri=cellar:5e601657-3b06-11eb-b27b-01aa75ed71a1.0001.02/DOC_2&format=PDF
[22] https://eur-lex.europa.eu/resource.html?uri=cellar:5e601657-3b06-11eb-b27b-01aa75ed71a1.0001.02/DOC_1&format=PDF

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In 2022 and 2023 work has been done accordingly to redefine the technical screening criteria for both maritime transport for the situation from 2025 onwards.

Specific criteria for Inland Waterway Transport (IWT) and seagoing vessels can be derived from the latest updates to the EU Taxonomy delegated regulation23. In principle, the EU Taxonomy aims for zero direct (tailpipe, or Tank-to-Wake) CO_2 emissions. However, if achieving zero direct CO_2 emissions is not technologically and economically feasible, the EU Taxonomy refers to the methodology for calculating CO2e/MJ values based on FuelEU Maritime methodology (Well-to-Wake) and provides threshold values which can be used to be Taxonomy compliant.

If it is technologically and economically not feasible for vessels to achieve zero direct (tailpipe, or Tank-to-Wake) CO_2 emissions, the criteria from the EU Taxonomy Regulation, effective from 2025 onwards for vessels, are presented in the following table in comparison to the fossil diesel baseline:

25 | EU Taxonomy criteria , effective from 2050 onwards for vessels when direct zero-emission is neither economically nor technically feasible.

Time period (y)	2025-2029	2030-2034	2035-2039	2040-2044	2045-2049	2050
Gram CO2e/MJ Inland vessels	76.4	61.1	45.8	30.6	15.3	0
eduction inland vessels mpared to fossil diesel	20%	36%	52%	68%	84%	100%
Gram CO2e/MJ seagoing vessels	76.4	61.1	45.8	30.6	15.3	
duction seagoing vessels mpared to fossil diesel	20%	36%	52%	68%	84%	

Furthermore, seagoing vessels will also need to show that their efficiency (EEXI) is 10% better compared to the baseline.

Regarding air pollutant emissions, it is defined that engines in inland vessels need to comply with emission limits outlined in Annex II to Regulation (EU) 2016/1628 (including vessels meeting those limits without type-approved solutions such as through after-treatment).

Seagoing vessels need to comply with the IMO MARPOL convention regarding the sulphur and NO_x emissions.

A2-III Sustainable and Smart Mobility Strategy (SSMS)

To reach the transport GHG emission reduction goals, described in chapter 3.1.1, the EU Commission published the SSMS in December 2020. The SSMS acknowledges that waterborne transport faces great decarbonisation challenges in the next decades, due to current lack of market-ready zero-emission technologies, long development and life cycles of vessels, the required significant investments in refuelling equipment and infrastructure, and international competition in these sectors. EU emissions from navigation and aviation have grown by more than 50 % since 1990. Action in these sectors is urgently needed, including as they recover from the current crisis. These modes must have priority access to additional renewable and low-carbon liquid and gaseous fuels, since there is a lack of suitable alternative powertrains in the short term. FuelEU Maritime will boost the production and uptake of sustainable maritime fuels and address this issue. Furthermore, the Commission established the Renewable and Low-Carbon Fuels Value Chain Alliance, within which public authorities, industry, and civil society devote their time to boost the supply and deployment of

[23] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L_202302485

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the most promising fuels, complementing the actions under the European Clean Hydrogen Alliance and building on the success of the European Battery Alliance.

Moreover, in order to improve the energy efficiency and reduce the emissions of vessels, ambitious standards for their design and operation must be promoted. The EU must continue working closely with all international organisations, such as the International Maritime Organisation (IMO), on concrete measures aimed at reaching science-based global emission reduction goals consistent with the Paris Agreement. Significant efforts are also needed to develop disruptive technologies to bring zero-emission vessels to the market. "The Union should create the enabling environment to achieve this, including through adequate carbon pricing policies and research and innovation (R&I), in particular through the partnerships that could be put in place under Horizon Europe (such 'Zero Emission Waterborne Transport' and 'Clean Hydrogen')". These activities are essential items in the 'basket of measures' needed to decarbonise aviation and maritime transport, where global actions remain critical.

The European Commission is emphasizing with regards to the transportation sector that "substantial part of the 75 % of inland freight carried today by road should shift onto rail and inland waterways. Short-sea shipping and efficient zero-emission vehicles can also contribute to greening freight transport in Europe." This is a challenging mission given the fact that the modal share of IWT and rail show a persistent long-term decline. To ensure successful implementation of its key targets, the EGD envisages a set of actions bringing into practice sustainable and cost-efficient environmental solutions, setting up standards, establishing binding regulations for emissions reductions and coordinating international efforts towards building a coherent financial system that supports these solutions.

With the adoption of the EGD and the SSMS (December 2020) it became possible to draw up a path for a set of the EU defining regulations in the field of transport and, in particular, in the field of IWT. Moreover, as the EGD states: *"new measures on their own will not be enough to achieve the European Green Deal's objectives. In addition to launching new initiatives, the Commission will work with the Member States to step up the EU's efforts to ensure that current legislation and policies relevant to the Green Deal are enforced and effectively implemented"*.

The role of IWT as an efficient, safe, and sustainable transport mode is described in the ambitious actions of the EGD foreseen for decarbonization of the energy systems and is critical for reaching climate objectives in 2030 and 2050. To bring these objectives into reality it is essential to ensure that IWT becomes not only "greener", but also fully integrated, interconnected and digitalised. Smart infrastructure, together with the energy transition and the digital transformation of the sector, shall constitute a sustainable model of inclusive economic growth. Specific attention of the EGD is given to digital technologies as a critical enabler for attaining the sustainability goals of the Green Deal in many different sectors. Regarding the IWT sector automation and a connected multimodal mobility play a pivotal role in this.

Among the key actions of the EGD roadmap for Sustainable and Smart Mobility, which address IWT and promote its further development, are strong incentives to increase and better manage the capacity of inland waterways. SSMS (see A2-III Sustainable and Smart Mobility Strategy (SSMS)) is putting a strong and clear focus on making the transportation sector more sustainable, relying on an interconnected multimodal transport system and setting an Action Plan subdivided in 10 flagship areas. It identifies main measures to reach the aim of 90 % emissions reduction in the transport sector by 2050. Among other priorities, it is indicated that ***by 2030 zero-emission vessels will become ready for market***, while by 2050 "the multimodal Trans-European Transport Network (TEN-T) equipped for sustainable and smart transport with high-speed connectivity will be operational for the comprehensive network". With regards to modal shift, SSMS is setting up the following milestone:

"Transport by inland waterways and short sea shipping will increase by 25% by 2030 and by 50% by 2050 in comparison with 2015."

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3 | SSMS main objectives and set of actions. Source: European Commission

Claiming to lower the sector's dependence on fossil fuels, SSMS is giving a priority to renewable and low-carbon energy sources. Together with this, SSMS foresees the deployment of inland ports potential for production and transportation of low and zero-emission energies (Flagship 1 – "Boosting the uptake of zero-emission vehicles, renewable & low-carbon fuels and related infrastructure").

Flagship 2 – "Creating zero-emission airports and ports" aims to turn maritime and inland ports into green multimodal transport nodes serving as clean industrial clusters and waste recycling centres as integral parts of the circular economy. At the same time, a need for sustainable and modern infrastructure for new fuels and low- and/or zero-emission vessels have to be considered for the whole IWT network. This includes the total upgrade of the existing infrastructure of the TEN-T network to enable modal shift.

SSMS clearly emphasizes that in comparison with road and railway transport, IWT is facing greater challenges regarding the energy transition due to the range of well-known issues such as the comparatively low technological readiness level (TRL) of existing innovations and availability of certified equipment for the inland fleet and the need for large long-term investments and therefore longer transition period to be considered. This allows to conclude that to ensure a level-playing-field for IWT and to promote modal shift, differentiation on the level of policy measures and regulatory actions has to be considered. This has to be taken into account especially with regards to the EU Taxonomy Regulation and corresponding Delegated Acts, described in chapter A2-II, and the Fit for 55 package [24] (more on this regulation in chapter A2-IV).

To help IWT overcome the aforementioned challenges, SSMS describes the strong intentions of the EC to incentivise the development of the IWT market not only by means of the implementation of binding regulations, but also by putting into practice revised lending policies for banks and other financial institutions.

The particular role is given to the enhancement of the logistic performance and making freight traffic management more sustainable without empty runs and avoiding idle times and congestion. As regards to the future of the sustainable and efficient performance of IWT, the SSMS puts focus on development of smart

[24] 'Fit for 55': delivering the EU's 2030 Climate Target on the way to climate neutrality (europa.eu)

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solutions and utilization of digital data exchange, automated and unmanned auxiliary value-added services and deployment of artificial intelligence. In accordance with the Flagship 4 – Greening freight transport, rail & waterborne intermodal, IWT will be able to compete on an equal footing with road only with paperless freight transport, which can be implemented by the implementation of e-tools initiative (eIWT) [25], Regulation on electronic freight transport information (hereinafter – eFTI) [26], future development of RIS services and harmonization of RIS standards across the European IWT network, implementation of inland ports community systems, well-functioning of European Hull Database (hereinafter – EHDB), European Crew Database (ECDB), etc.

Flagship 5- Pricing carbon and providing better incentives for users of the SSMS deals with carbon pricing where it was stated that 'polluter pays' and 'user pays' principles need to be implemented without delay in all transport modes. The Commission therefore pursues a comprehensive set of measures to deliver fair and efficient pricing across all transport modes. Emission trading, infrastructure charges, energy and vehicle taxes must come together in a mutually compatible, complementary, and coherent policy.

The EU-ETS is seen as the most important instrument of carbon pricing to internalise the cost of CO_2 emissions. The Commission proposed under the Fit-for-55 package to extend the EU Emission Trading System (EU-ETS) to the maritime transport sector for vessels over 5000GT. And as was announced in the European Green Deal, the expansion of the emission trading system includes emissions from road transport (called ETS2). In EU-ETS2 Member States may decide whether or not to include inland waterway transport under this framework. EU-ETS revenues can be invested in EU R&I to decrease emissions further. At the IMO, the EU does push to advance discussions on market-based instruments as a medium-term measure to implement in the greenhouse gas reduction strategy. Moreover, it was announced as well in the SSMS that fossil-fuel subsidies should end. When revising the Energy Taxation Directive, the Commission aimed at aligning taxation of energy products and electricity with EU energy and climate policies. The taxation of energy content for various fuels should be better aligned, and the uptake of sustainable transport fuels better incentivised.

The European Climate Law[27] (ECL) became a central element of the overall EU regulatory framework targeting climate neutrality and emissions reduction. Based on the provisions of the Paris Agreement, ECL established "a binding objective of climate neutrality in the Union by 2050" and "binding Union target of a net domestic reduction in greenhouse gas emissions for 2030" serving to compel Member States (MS) to fulfil their obligations according to the Paris Agreement.

The ECL does not reflect direct impact on modal shift and transport sustainability, yet this impact takes place by means of subsequent legislation based on the ECL (such as the Fit for 55 package, EU Taxonomy Regulation, Guidelines on State aid for climate, environmental protection and energy 2022) establishing main preconditions for future actions to support sustainable economic activities. The ECL addresses all sectors of economic activities generating GHG emissions and other air pollutant emissions. Together with the subsequent legislation, ECL is standing for setting up a framework based on a broad use of "polluter pays" principles established in the Treaty on the Functioning of the European Union (TFEU)[28], the "energy efficiency first" principle of the Energy Union and the "do no harm" principle of the EGD.

A2-IV Fit for 55 policy package

Besides the in chapter A2-III mentioned SSMS, the in 2021 established Fit for 55 policy package is also a crucial pillar within the EU sustainability plans for transport. The Fit for 55 consists out of a package of legislative actions (proposing new or revised regulations and directives) developed to strengthen the in

[25] eIWT: Electronic tool for Inland Waterways Transport (europa.eu)
[26] REGULATION (EU) 2020/1056 on electronic freight transport information (europa.eu)
[27] European Climate Law (europa.eu)
[28] Treaty on the Functioning of the European Union

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chapter A2-I and A2-III described climate-related legislations. This package aims to ensure that a 55 % emission reduction by 2030 is not just an ambition but becomes a goal that will be obeyed by the EU. The measures are designed in such a way that the transition towards 2030 is not only as environmentally friendly as possible, but also fair for everyone and globally competitive. In this context, a fair policy means that the measures should prevent the emergence of greater inequality, reduce the number of people living in energy poverty, and ensure that Member States with a higher GDP per capita contribute more to climate funds compared to less affluent Member States. This is incorporated in the package by increasing solidarity among the Member States, based on the "leave no one behind" principle.

The competitive aspect is reflected in the fact that the policy aims towards stimulating innovation in the green energy sector and infrastructure. The innovation funds included in this package are intended to initiate and maintain the EU's global leadership role in developing clean energy and infrastructure technologies. To remain innovative and thus competitive, education and training are important components. Therefore, the Fit for 55 package also includes necessary education plans, investments aimed at education, and collaborations between Member States.

The Fit for 55 package contains eight measures that strengthen existing legislation and five new measures. For IWT and coastal shipping the most relevant ones are the revision of the ETS directive (more on this in chapter A2-VI), the measures related to the increase in renewable energy use, the regulations on the allowed feedstock for biofuels and the Carbon Border Adjustment Mechanism (CBAM)[29]. A large segment of the total GHG emission in the EU comes from energy consumption, which accounts for 75 % of the total GHG emissions. The in 2018 implemented RED-II required that in 2030 32 % of the energy used in the EU should arise from renewable energy sources. The Fit for 55 package increased this target to 40 %. The 40 % renewable energy target will directly influence the fuel price and the allowed energy carrier used on board. In order to drive IWT and coastal shipping companies towards renewable energy sources the AFID/AIFR has been implemented (more on this in chapter A2-IX).

Additionally, to the plans for increasing the amount of renewable energy, a goal of the Fit for 55 package is to enhance Europe's natural carbon sinks to achieve a net greenhouse gas removal of 310 million tons of CO_2 equivalent by 2030. These measures are primarily connected to the agriculture, forestry, and land classification sector, which is referred to as the land use, land-use change, and forestry (LULUCF) sector. The measures concerning the LULUCF sector are strongly influenced by biofuel production, as currently, 60 % of the existing biofuel production comes from biomass. To ensure that the AFID/AFIR will not interfere with the LUCUF goals, the Fit for 55 package includes stricter regulations that prohibit the use of certain biomass products and specify areas that cannot be used for biomass production. These biomass regulations will have an impact on the total amount of biofuel that can be produced for the IWT and Coastal shipping sector.

The European Commission recognised that the EU only accounts for 8 % of the Global GHG emissions. Therefore, the European Commission included a measure into the Fit for 55 package that will incentivise third countries to reduce their emissions as well, which is called the CBAM regulation. This regulation imposes a tax on emission-intensive products imported into the EU. This regulatory construction does not only incentivise third countries to reduce their GHG emissions, but it also aims to ensure that companies within the EU actually reduce their emissions rather than shifting them outside of the EU to third countries with less strict GHG emission legislations.

To reach the Fit for 55 targets, multiple financial funds have been established. The largest financial contribution comes from the 2021-2027 Multiannual Financial Framework (MMF) budget[30], from which many different EU plans, like increasing the cohesion between EU Member States and EU agricultural policy plans for example, are financed. On 21 July 2020 the European Council adapted a 1,074.3 billion EUR budget

[29] Carbon Border Adjustment Mechanism (CBAM) | Access2Markets (europa.eu)
[30] Multiannual financial framework | Fact Sheets on the European Union | European Parliament (europa.eu)

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ceiling for the 2021-2027 MMF budget. This budget includes the NextGenerationEU Fund and the Just Transition Fund that are part of the EGD as discussed in chapter A2-I. 30 % of this budget is reserved for funding the climate targets set in the Fit for 55 packets. Another part of the MMF budget goes to the Horizon Europe programme, of which 35 % is used to educate, conduct research and for innovation regarding climate neutral solutions.

Another fund that is established within the Fit for 55 is the Social Climate Fund (SCF)[31], which will be filled using part of the revenue of the ETS2 regulation, a 50 million allowance from the ETS regulation and a mandatory 25% contribution from the Members States to their specific Social Climate Plans. All these contributions should mobilise at least 86.7 billion euro.

The SCF can be used by Member States for investments in increasing energy efficiency, renovation of buildings, clean heating and cooling and integration of renewable energy and for zero- and low-emission mobility solutions. The goal of the SCF is to ensure that Member States support vulnerable groups, like those that live in energy poverty and those who cannot afford transportation for example, so that no one is left behind. Member States can only obtain funds from the SCF if their Social Climate Plans, which has to be submitted before June 2025, comply with the environmental targets and plans set by the EU Commission.

Furthermore, two final financial support systems included in the Fit for 55 are the Innovation fund that can be used by businesses and research facilities for innovation projects, and every Member state needs to dedicate a minimum of 37 % of their recovery and resilience plans to meet the Fit for 55 targets. The Innovation Fund is, just like the SCF, filled using the revenue of the ETS2 system and the recovery and resilience plans of the Member States are financed by the Recovery and Resilience Facility.

A2-V CSRD and CSRDDD

Due to the implementation of the EGD and the corresponding Fit for 55 package the European Commission recognised that corporate emission transparency is essential in order to reach the sustainability targets. Larger companies where already obligated to report their no-financial Environmental, Social and Governance (ESG) goals according to the Non-Financial Reporting Directive (NFRD) 2014/95/EU[32]. However, with the revised climate goals it was deemed necessary to revise the NFRD. This revision let to the implementation of the Corporate Sustainability Reporting Directive (CSRD)[33]. The CSRD was developed to assess the environmental impact and work conditions of companies in a clear and harmonized manner. At the same time, it is also aiming to steer more capital flows towards sustainable investment.

The CSRD specifies which companies have to comply with the CSRD, it mandates the reporting of their environment and social impact and it also specifies that these CSRD reports must be publicly published to enhance transparency regarding the sustainability and work conditions of companies include in de CSRD. The required reporting details that the CSRD reports have to encompass are denoted in the European Sustainability Reporting Standard (ESRS) ((EU) 2023/2772). Connected to the CSRD legislation the EU Commission developed the CSDDD, which stands for "Corporate Sustainability Due Diligence Directive." The CSDDD mandates larger companies to include their due diligence into company policy and requires them to report publicly publish this. It also obligates the companies that fall under the CSDDD to actively participate in reducing the environmental and social impact of their value chain.

The CSRD and CSDDD are intended for large companies and thus do not apply to SMEs. The reason for this is because the burden of that these two regulations bring with them might be financially and time consuming wise unbearable for SMEs. Companies that fall under the CSRD and CSDDD include large companies, and

[31] Social Climate Fund - European Commission (europa.eu)
[32] Directive - 2013/34 - EN - ifrs - EUR-Lex (europa.eu)
[33] Directive - 2022/2464 - EN - CSRD Directive - EUR-Lex (europa.eu)

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all undertakings, except for micro undertakings, whose securities are admitted to trading on the regulated market in the EU. Companies that are defined as large have to meet two of the three set criteria, which are:

- ≥250 employees
- ≥40 million EUR turnover
- ≥20 million EUR of assets

To create a level playing field the CSRD also required undertakings from third countries that have a net turnover of more than 150 million EUR in the EU and which have a subsidiary undertaking on EU territory, or undertakings from third countries that have a net turnover of more than 40 million euro in the EU who only have a branch on EU territory, or undertakings from third countries whose securities are admitted to trading on the regulated market in the EU to annually publicly publish a report including the requirements specified in the CSRD and CSDDD.

In IWT and Coastal shipping both large undertakings and SMEs are part of the transport chain. This means that the IWT and Coastal shipping sectors deals with companies that are both included and not included in the CSRD. However, larger companies, such as shippers, ports, and banks, are obligated to report their due diligence across their entire chain (including scope 3/logistics emissions), which often consists of various stakeholders. Some of these scope 3 emissions within the IWT and Coastal shipping chain may be generated by SMEs that are not subject to the CSRD regulation. These SMEs may still be approached by large companies to report their CSRD/CSDDD. To reduce the burden on these undertakings in such cases, provisions are exempted (both financial and non-financial), and large undertakings are required to provide support to the SMEs that are part of their scope 3 emissions.

A2-VI Specification revision ETS directive

On 14 July 2021, as part of the 'Fit for 55' package, the Commission published a legislative proposal for a revision of the directive on the EU Emissions Trading System (ETS), to align it with the target of a 55 % reduction of the EU net GHG emissions by 2030, compared to 1990 levels.

The EU-ETS was launched in 2005 and covers about 45 % of EU GHG emissions. The latest revision of the EU-ETS Directive, adopted in 2018, sets the total quantity of emission allowances for phase 4 (2021-2030), in line with the previous EU emission reduction target (40 % reduction below 1990 levels by 2030). The Commission proposal to amend Directive 2003/87/EC concerns the ongoing phase 4 of the ETS (2021-2030). It consists of five main elements:

- a reduced cap and more ambitious linear reduction factor for GHG emissions,
- revised rules for free allocation of allowances and the market stability reserve
- extension of the ETS to maritime transport
- a separate new ETS for buildings and road transport
- increase of the Innovation and Modernisation Funds and new rules on use of ETS revenues

To align the EU-ETS directive with the increased GHG emission reduction targets set in the European Climate Law, the Commission proposed to reduce the emissions from the EU-ETS sectors (including the extension to the maritime sector) by 61 % by 2030, compared to 2005 levels. To achieve this target, the revision increases the linear emissions reduction factor from 2.2 % per year to 4.2 %.

The revision extends the EU-ETS to cover CO_2 emissions from maritime transport (seagoing vessels under IMO), specifically from large ships above 5 000 GT. The requirement to surrender allowances would be gradually phased-in during 2023-2025.

Protection against carbon leakage will still be in place through allocation of free allowances. However, the number of the free allowances will gradually be reduced with a decreasing emissions cap and the proposed introduction of a Carbon Border Adjustment Mechanism (CBAM).

Decision (EU) 2015/1814 establishing the ETS market stability reserve (MSR) would be amended to enable a smoother intake of allowances to the reserve. From 2023, allowances above the level of auction volumes

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of the previous year would be invalidated, and the number of allowances in the MSR would be limited to 400 million EUR.

A separate self-standing emissions trading system for fuel distribution for road transport and buildings (ETS2) is being established starting from 2027. The regulated entities (fuel distributors) would need to report the amount of fuels placed on the market starting from 2024. From 2027, they would have to surrender a corresponding number of allowances. The cap on emissions would be set in 2026 and would gradually decrease to a 42 % reduction of emissions in 2030 compared to the 2005 levels for these sectors. All allowances would be auctioned and none provided for free. Indirect social impacts from rising prices of road transport and heating fuels are addressed through a legislative proposal for a Social Climate Fund. By 2044 no new emission rights will be auctioned anymore. IWT is one of the sectors which can be added to the scope of ETS2 as "Opt-in", which is a decision of a Member State to do so, or not. All revenues from the "Opt-in" flow back to the Member State.

The Commission presented separate legislative proposals for strengthening the ETS Market Stability Reserve and including aviation in the ETS. In December 2021, the Commission presented a legislative proposal for a Council Decision amending the system of own resources of the EU by adding new sources of revenue, including the EU-ETS and the CBAM, complemented in March 2022 by a proposal for a Council Regulation on the methods and procedure for making own resources available based on ETS and CBAM.

A2-VII Specification revision Renewable Energy Directive (RED-III)

Given the need to speed up the EU's clean energy transition, the Renewable Energy Directive EU/2018/2001 was revised in 2023. The amended Directive EU/2023/2413 entered into force on 20 November 2023. There is an 18-month period ongoing to transpose most of the directive's provisions into national law (deadline 21 May 2025), with a shorter deadline of July 2024 for some provisions related to permitting for renewables. It sets an overall renewable energy target of at least 42.5 % binding at EU level by 2030 - but aiming for 45 %.

Permitting procedures will be easier and faster under the new law. Renewable energy will be recognised as an overriding public interest, while preserving a high level of environmental protection. In areas with high renewable energy potential and low environmental risks, Member States will put dedicated acceleration areas for renewables in place, with particularly short and simple permitting processes. The provisional agreement also enhances cross-border cooperation on renewables.

The agreement includes targets and measures to support the uptake of renewables across various sectors of the economy. The revised Directive strengthens the annual renewable energy targets for the heating and cooling sector and for renewable energy used in district heating systems. It introduces a specific renewable energy benchmark of 49 % for energy consumption in buildings by 2030 to complement EU buildings legislation and guide Member States efforts.

As a key energy-consuming sector, industry is included for the first time in the Renewable Energy Directive. The agreement establishes indicative targets (1.6 % of annual increase in renewable energy use) as well as a binding target to reach 42 % of renewable hydrogen in total hydrogen consumption in industry by 2030.

The agreement also reinforces the regulatory framework for renewable energy use in transport: 14.5 % greenhouse gas intensity reduction or 29 % share of renewable energy in final energy consumption. It includes a combined sub-target of 5.5 % for advanced biofuels, including a minimum level of 1 % for renewable fuels of non-biological origin (RFNBO). These targets support the EU's ambitions on renewable hydrogen roll-out. A revision is also that **all fuel supply to transport is now in the primary scope of the requirements**. Therefore, **also energy/fuel supply to maritime and inland waterway transport are directly counted in the volume of energy** for which greenhouse gas intensity reduction targets or minimum shares of renewable energy needs to be achieved.

The agreement also contains provisions to support energy system integration via electrification and waste heat uptake as well an enhanced system of guarantees of origin to improve consumers' information.

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The agreement strengthens the bioenergy sustainability criteria, in line with the increased climate and biodiversity ambition of the EGD. In the future, these criteria will apply to smaller installations (equal or above 7.5 MW) rather than the 20 MW threshold under the current directive. The agreement includes provisions to ensure that forest biomass is not sourced from certain areas with a particular importance from a biodiversity and carbon stock perspective. In addition, the agreed rules establish that woody biomass will have to be used according to its highest economic and environmental added value (so-called cascading use). Financial support will be banned for energy produced using saw logs, veneer logs, industrial grade roundwood, and stumps and roots.

A2-VIII proposal for CountEmissionEU regulation

In order to achieve the EU climate targets, in combination with the reporting obligations of emissions for companies due to the CSRD and CSDDD, it is essential to gather knowledge on the different emissions sources within transport chains. To determine this, there is a need for harmonized emission calculation framework to assess the total emission values of all components within the transport chain.

Between 2011 and 2019, two funded projects where released, which are the Carbon Footprint of Freight Transport (COFRET), under the seventh framework program (FP7), and the Logistics Emissions Accounting & Reduction Network (LEARN), under Horizon 2020, in order to establish a methodological framework for harmonization of emission accounting in the transport sector[34]. These initiatives led to the foundation of the Global Logistics Emissions Council (GLEC) Framework who dedicated their time to develop a comprehensive and tailor-made International Organization for Standardization (ISO) standard, where the most resent published version is the ISO 14083:2023 norm.

The EU Commission adopted the ISO 14083:2023 standard in the CountEmissionEU (2023/0266 (COD)) regulation proposal as their methodology framework for harmonized emission accounting, requiring that if an entity decides to report their emissions it has to be according to the emission accounting guidelines documented in the EN ISO 14083:2023. The EN ISO 14083:2023 is the CEN approved document that follows the ISO 14083:2023 text without any modification and supersedes the previously published EN 16258:2012 emission accounting guidelines. The ISO 14083:2023 method in the CountEmissionEU regulation proposal was chosen as the methodology framework because it provides a harmonized and transparent emission dataset while identifying the various emission sources across the entire transport chain.

Currently, this regulation is still under discussion, as the European Commission has not yet decided on the exemption strictness for Small- and Medium-sized Enterprises (SMEs) regarding the use of primary data and calculation method validation. In the version that has been send to the European parlement, SMEs are not mandatory to use primary data and validate their calculation method, because these entities may lack the capacity and finances to do so. The CountEmissionsEU proposal is on a voluntary basis and regulations that obligate the reporting of climate emissions, like the CSRD for example, take precedence over the CountEmissionsEU proposal. For larger companies the most recent version of the proposal mandates the use of primary data and the validation of their calculation method.

In the CountEmissionEU proposal seven goals are defined to optimize the outcome of this regulation. The first goal is to develop a standardized emission calculation method for the entire transport sector, for which the ISO 14083:2023 methodology has been selected, so that emission values can be compared fairly and accurately. The second goal is to promote the use of primary data (data that is measured directly in real time conditions), or for SMEs use representative emission factors to reduce national and regional discrepancies. The third goal is to investigate what policy implementation method is most effective, which is currently still under discussion. The fourth goal is to increase transparency and communication regarding emission values among different entities. The fifth goal is to provide support to enhance the clarity of the calculation methodology to ensure optimal use of the implemented harmonized calculation framework. The sixth

[34] EUR-Lex - 52023PC0441 - EN - EUR-Lex

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goal is to develop a verification system for available calculation tools and used company estimates to yield accurate values. The final goal is to increase the number of entities using available verified calculation tools to enhance the reliability of the GHG emission values.

One project that arose from this legislation is the CLEVER project, which is currently an ongoing initiative. In this project, a consortium is working on updating current emission factors of fuels, developing missing emission factors, and creating a method to achieve reliable emission factors. This project, in combination with CountEmissionEU, will ensure an accurate and reliable emission calculation method.

A2-IX Alternative Fuels Infrastructure Regulation (AFIR)

One of the measures in the EGD and Fit for 55 package, described in chapter A2-I and A2-IV respectively, is to establish an adequate infrastructure for renewable energy and climate neutral transportation. To achieve this goal the EU Commission developed the trans-European network for Transport (TEN-T) Regulation (EU) 2024/1679 [35]. The TEN-T regulation defines a cross European transport and energy provision network to ensure that all Member States possess a high quality, affordable and low emission infrastructure.

One of the TEN-T goals is to establish a high-quality alternative fuel infrastructure across the TEN-T network. This led to the revision of the Alternative Fuels Infrastructure Directive (AFID)[36] published in 2014, which is transposed into the Alternative Fuels Infrastructure Regulation (AFIR)[37]. The reason for changing the AFID to AFIR stems from the EU Commission recognizing the need for a harmonized policy regarding alternative fuels to achieve the TEN-T goals.

The AFIR and TEN-T regulation outline strategies and scenarios for objectives like the construction of high speed railways, the installation of charging points and the development of sustainable fuel stations along the TEN-T network. To ensure that the TEN-T network becomes reality all 432 big cities that are part of the TEN-T network are required to hand in a Sustainable Urban Mobility Plan (SUMP), including a strategy on how the city is going to implement a zero- to low-emission infrastructure. The AFIR and TEN-T regulations are primarily focused on road and railway transport, but also impact IWT and Coastal shipping.

One regulation that will have an impact on IWT and Coastal shipping is that by 2030 a hydrogen refuelling point must be installed every 200 km along the TEN-T network with data transparency, including current waiting times and transparent payment systems. According to the AFID, cars must be able to refuel hydrogen at or near their destination. This is often in urban areas, so in the AFIR it is recommended to place hydrogen refuelling points at urban logistics hubs, which are often multimodal logistics points, so that vessels can also refuel hydrogen from there.

Besides fuel locations also ports have a prominent role in the developments of the TEN-T network. Ports have been indicated as the most suitable multimodal connection points as they are suitable for energy production and storage, environmentally friendly waste management location, a connection point between all modalities and a location for Carban Capture and storage facilities. Part of the TEN-T policy is to increase the number of ports and to improve the short sea shipping routes. A more detailed plan on how the EU want to achieve this is described in the European Maritime Space.

Additionally, for Ports along the TEN-T network regulations have been established for installing shore power points for moored vessels. Since Member States have different policies for making their Ports more sustainable, it has been decided to allow Member States to determine how they integrate shore power into their infrastructure. However, there are some minimum requirements to which the infrastructure has to comply.

[35] Regulation - EU - 2024/1679 - EN - EUR-Lex (europa.eu)
[36] Directive 2014/94/EU
[37] Alternative Fuels Infrastructure - European Commission (europa.eu) , Regulation (EU) 2023/1804

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The AFIR specifies that Ports welcoming a frequent number of large container ships and passenger ships must provide shore power for large moored container ships and passenger vessels. Large container ships and passenger ships are defined as those with a gross weight over 5000 GT. Ports that handle more than 100 large moored container ships, more than 40 moored ro-ro and/or high-speed passenger ships, or 25 large moored passenger ships that are neither ro-ro nor high-speed vessels per year (calculated as an average over three years) must ensure that at least 90 % of the required energy is available through shore power.

In calculating the frequency of moored large container and passenger ships, short-term moored vessels, vessels using emission-neutral technologies, and vessels that must unexpectedly moor (such as for life-saving operations) do not need to be included. Islands and remote locations within Europe where there is insufficient electricity capacity to establish shore power at ports are exempt from this rule until a connection to the electricity grid from the mainland is established.

In addition to Ports for large vessels, inland ports along the TEN-T network are also required to install shore power points. The requirement from the AFIR is that inland ports must have at least one shore power point per port by 2025. The main ports along the TEN-T network are also required to establish an appropriate number of methane bunkering stations by 2025, based on market demand. Each Member State is required to submit a policy plan by 31 December 2024 regarding the current status, perspective, and installation of the necessary infrastructure for alternative sustainable fuel points, including for IWT and Coastal shipping.

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| Annex 3: Detailed description of the policies relevant for IWT

A3-I EU Strategy for IWT: NAIADES III

In June 2021, the EC released its communication "NAIADES III: Boosting future-proof European inland waterway transport"[38] for the period 2021-2027. It is designed to deliver the main objectives of the EGD and SSMS for the IWT sector and to draw up the pathway to the future energy transition of the sector. The core objectives are the following two:

1) shifting more cargo over Europe's rivers and canals
2) facilitating the transition to zero-emission vessels by 2050

In order to facilitate these core objectives, the NAIADES-III action plan indicated 10 flagship measures and encompasses 35 actions to incorporated these flagship measures. Relevant flagship measures related to meeting the energy transition challenge are:

- Speeding up of the certification process for innovative and low emissions vessels (ES-TRIN)
- The development of multimodal alternative fuel infrastructure hubs
- The need to support the sector and Member States in the transition towards zero-emission particularly regarding funding and financing

To meet this challenge, support for the initial deployment of zero-emission vessels and the related recharging/refuelling infrastructure was proposed through the Alternative Fuels Infrastructure Facility under the 2021-2023 work programme of the Connecting Europe Facility 2. Where possible, funding under the CEF 2 could be combined with other sources of funding to achieve greater impact. Such a new instrument will partially contribute to closing the Total Cost of Ownership (TCO) gap. In addition, this action plan indicates that the European Commission will facilitate the efforts by stakeholders and Member States to create a fund to complement EU and national financial instruments for the deployment of zero-emissions vessels.

Based on the 2019 document 'Strategic Inland Waterway Transport agenda for Europe'[39] it focuses on four main priority areas: infrastructure, inland fleet, digitalisation, and job force in the IWT sector to boost decarbonisation, energy efficiency, resilience, sustainability, and modal shift.

The success of the previous programs (NAIADES and NAIADES II) was delivered in various areas, which are the establishment of the European Committee for drawing up standards in the field of inland navigation (CESNI)[40] alongside the further development and implementation of main standards in IWT: the European Standard laying down Technical Requirements for Inland Navigation vessels (hereinafter - ES-TRIN)[41], the European Standard for Qualifications in Inland Navigation (hereinafter - ES-QIN), the European Standard for River Information Services (hereinafter - ES-RIS).

The work of CESNI resulted in enhanced cooperation between MS and elimination of legislative fragmentation in terms of requirements and standards in IWT, by:

[38] "Boosting future-proof European inland waterway transport" - NAIADES III (europa.eu)
[39] Towards a Strategic Research Agenda: Inland Waterways Transport and Ports in Horizon Europe (inlandnavigation.eu)
[40] https://www.cesni.eu/en/
[41] https://www.cesni.eu/en/standards-and-explanatory-notices/

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- development of the initiatives for the energy transition of the sector together with support of "green" innovations (reflected in the subsequent EU-funded projects for the fleet, such as PROMINENT[42], LNG Breakthrough[43], Novimar[44], and Watertruck [45] for example)
- implementation of legal acts supporting the energy transition and measures facilitating deployment of alternative fuels across main transport corridors (e.g., EU-funded project "The LNG Masterplan for Rhine/Meuse-Main-Danube"[46]). Although LNG is still a fossil fuel, the procedures and lessons learned from implementation of LNG as fuel can be applied as well for future proof alternative renewable fuels such as (green) hydrogen and methanol
- development and implementation of innovative solutions in the field of digitalization (establishment of Digital Inland Waterway Area[47], development of RIS and RIS-based solutions on the corridor level)

As given above, a scope for further actions to meet the objectives of the EGD and the SSMS identified and described a need for a coherent program to establish new priorities for IWT sector development.

In this way, taking into account that during previous years modal shift has not been realized in the desired extend and required additional support measures, foremost at the regulatory and policy level the modal shift today has to be backed up with the support of energy transition solutions for IWT. Therefore, a clear need for active measures to be undertaken towards IWT has been recognized in NAIADES-III.

NAIADES-III reflects in its structure the main needs of the IWT sector, such as:

- Dedicated investments into ports and IWT infrastructure by the MS and by EU funding instruments
- Dedicated funding of the energy transition of the sector, namely through the deployment of innovations for the fleet and alternative energy sources
- Synchro modal solutions and digitalization to increase the share of IWT by a full integration in the multimodal chain

Through these principal points and the NAIADES-III Action Plan, the EC is aiming for a single approach to be implemented for the IWT market, eliminating uncoordinated and fragmented actions. NAIADES-III Action Plan has to serve as a single, unified program towards the IWT joint vision from the perspective of the whole sector. It is setting priorities, but there is no fixed schedule for dedicated measures to be delivered on time. Concrete actions are to deploy the flagships for achieving emissions reduction; to contribute to a coordinated sustainable water management, to induce climate change mitigation and to implement climate change adaptation solutions, and the development of subsidiarity principles in funding have to be foreseen in a future document.

A3-II:CCNR Strategy for IWT: Mannheim Declaration and CCNR Roadmap

The Central Commission for the Navigation of the Rhine (CCNR) published a Roadmap for reducing inland navigation emissions on the Rhine. This was done in the framework of a mandate to the CCNR given by the Ministerial Declaration of 17 October 2018 in Mannheim. The CCNR thus developed a roadmap aiming at largely eliminating GHG emissions and air pollutants of the inland navigation sector by 2050, a long term vision which is also shared by the EU.

[42] https://www.prominent-iwt.eu/
[43] https://lngbinnenvaart.eu/
[44] https://novimar.eu/
[45] https://watertruckplus.eu/
[46] http://www.lngmasterplan.eu/
[47] https://ec.europa.eu/transparency/expert-groups-register/screen/expert-groups/consult?lang=en&do=groupDetail.groupDetail&groupID=3505&NewSearch=1&NewSearch=1

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Building on the CCNR study on the energy transition towards a zero-emissions inland navigation sector this roadmap shall be understood as the primary CCNR instrument for mitigating climate change, fostering the energy transition and contributing to the European IWT policy. As this energy transition represents a crucial challenge to Rhine and European inland navigation, the aim of the roadmap is to contribute to a reduction in emissions from inland waterways navigation on the Rhine by:

- setting transition pathways for the fleet (new and existing vessels)
- suggesting, planning, and implementing measures directly adopted by the CCNR
- monitoring the intermediate and final objectives laid down by the Mannheim Declaration

The CCNR hopes that this roadmap will contribute to developing a common vision of the energy transition and the associated challenges within the inland navigation sector, as well as to generating support and acceptance for related political measures. To ensure a common understanding between all the actors involved in the energy transition of inland navigation, the CCNR decided to:

- lay focus on inland navigation meaning the transport of goods and the carriage of passengers by inland waterway vessels. Recreational crafts, service vessels and floating equipment were not included at this stage
- define emissions as atmospheric pollutants and GHG arising from the operation of an inland navigation vessel's propulsion and auxiliary systems
- adopt a "tank-to-wake" approach (TTW), as an interim solution, until a "well-to-wake" approach (WTW) is available for the relevant energy carriers. Application of this approach, however, implies making assumptions concerning the upstream chains (emissions produced and fuel availability) which are idealised

Two transition pathways for inland navigation leading up to 2050 were sketched. The first one is a more conservative transition pathway, based on technologies that are already mature, cost efficient in the short-term but with uncertainties on the availability on certain fuels. The second one, a more innovative one, relying on technologies still in their infancy stage but providing more promising (zero) emission reduction potential on the long run. The two transition pathways are both sufficiently ambitious to achieve the objectives of the Mannheim Declaration.

A key conclusion points to the absence of a "one size fits all" technology solution adapted to all types of vessels and navigation profiles. A technologically neutral approach appears, therefore, relevant to achieve the energy transition.

Initial estimates show that the financial challenge involved in achieving the aim of zero-emissions by 2050 is considerable. Depending on the transition pathway, the financial gap to be bridged for achieving the Mannheim Declaration emission reduction objectives varies significantly, but is several billions in any scenario. The energy transition-related costs will exceed the financial resources of the navigation profession, which will only be able to bear a part of the costs required to achieve this transition.

Significant grants are needed to close this gap, and to make the transition pathways economically viable for the inland navigation industry, energy suppliers, and shore-side infrastructure operators. Strong public support is therefore necessary. In order to support the energy transition of the IWT sector, the CCNR considers its opportune to pursue the idea of a European financial support instrument for the energy transition of the IWT sector, based on mixed sources (public and private), including a sector contribution.

In order to ensure a level playing field, such a European funding and financing instrument should be open to EU countries as well as Rhine and Danube riparian states which are not members of the EU (Switzerland, Serbia, Moldavia and Ukraine in particular). Easy access to such an instrument is paramount, as is administrative simplicity.

The CCNR Roadmap contains an implementation plan and defines next steps. It consists of regulatory measures, voluntary measures, and financial measures.

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The regulatory measures are:

- Appropriate regulatory framework for the use of alternative fuels and batteries (vessel construction, crew, vessel operation transport of dangerous goods, definition, fuel characteristics, blending and supply)
- Scrutiny and where appropriate amendment of safety and statutory requirements for bunkering of alternative fuels in IWT
- Possible out phasing of the most harmful technologies which appear inconsistent with the CCNR's and EU's long-term emission reduction ambition
- Infrastructure requirements for alternative fuel and electricity for propulsion
- Examination of the possibility of a sector contribution in the framework of a European funding and financing instrument

The voluntary measures are:

- Label for environmental and climate protection
- Carbon offsetting measures (carbon compensation)
- Pilot vessel trials (all vessel types)
- Innovative vessels (Database)
- Innovation award
- Situation reports: Regularly analyse emissions reduction status and the effectiveness of measures

The financial measures are:

- Examination of European funding and financing instrument to support the inland navigation energy transition
- EU Taxonomy – establishment of an EU classification system for sustainable activities
- Stimulate research and innovation projects

The CCNR will undertake to report by 2025 on the progress of the implementation as well as the need to for an update. If necessary, the CCNR will revise the roadmap and the corresponding action plan by 2030. The CCNR states that it is desirable to deepen the cooperation with other energy transition actors, especially the EU, with a view to implement the proposed action plan jointly as well as to ensure that measures are tailored to the inland navigation sector.

As regards to the specific targets, the chapter 3 of the CCNR Roadmap presents a more specific description. The Mannheim Declaration from 2018 states the following (quote from the original document):

"To further improve the ecological sustainability of inland navigation, we task the CCNR to develop a roadmap in order to

- *reduce GHG emissions by 35 % compared with 2015 by 2035,*
- *reduce pollutant emissions by at least 35 % compared with 2015 by 2035,*
- *largely eliminate GHG and other pollutants by 2050."*

"Largely eliminate" is explained in section 3.2 and is seen as: "A reduction of at least 90 % of GHG and air pollutants by 2050 compared to 2015. This interpretation does not, however, preclude a reduction exceeding 90 %. As with the approach adopted for estimating emissions, this reduction ambition may be adjusted in a future edition of the roadmap."

Moreover, it presents the baseline emission data for the year 2015 in terms of the absolute levels of GHG and air pollutant emissions (CO_2, CH_4, CO, NO_x, PM_{10}) in tons of emissions. This makes it thus possible to derive the target values in absolute terms for 2035 and 2050 years according to the Mannheim Declaration targets.

It shall, however, be noted that the Mannheim Declaration stems from 2018, which means before the EGD and Fit-for-55 were published. It is important to realise that the national emission reduction targets for EU Member States have been lowered in the framework of the revision of the Effort Sharing Regulation. This also affects the CCNR Member States (except for Switzerland) and therefore it can be argued that the CCNR

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targets for IWT for 2035 and 2050 are outdated. For example, The Netherlands announced in April 2024 to include IWT under scope of ETS2 which means that, according to the applied definition by CCNR, the fuel supply in The Netherlands to the IWT sector is already climate neutral from 2044 onwards. This is, therefore, stricter that achieving 90 % by 2050 on TTW, taking into account the IPCC method where all biofuels are seen as climate neutral in TTW scope.

However, when taking the viewpoint of Well-to-Wake emissions, the climate neutrality will not be achieved by ETS alone. It needs to be noted in this respect that other EU interventions such as Renewable Energy Directive, CountEmissionsEU and FuelEU Maritime apply the well-to-wake scope, based on values for the grams CO_2 per MJ of energy.

A3-III National IWT policies

A3-III-1 The Netherlands

The Dutch Ministry of Infrastructure and Water Management developed the Dutch Green Deal on Maritime and Inland Shipping and Ports (2019) with specific ambitions for zero-emission inland waterway transport by 2050. The goal is to equip at least 150 inland waterway vessels with zero-emission power trains by 2030. In the Green Deal attention is paid to the use of biofuels as well as to the development and implementation of an emission label for inland vessels. This label was implemented in 2021 and provides a rating for both the GHG emissions and also for the air pollutant emissions of a vessel. The Netherlands is supporting the development of an international emission label.

An important initiative from the Netherlands is Zero Emission Services (ZES) as this company aims to deploy inland vessels with swappable battery containers for fully emission-free operations along major shipping routes. With this concept the aim is to establish zero-emission transport corridors in the Netherlands. A budget of 50 million euro is provided by the Dutch government to support the implementation.

This budget is granted from the Dutch Growth fund ("nationaal groei fonds"), which has been established in 2020. The goal of this fund is to invest in project related to the transition towards a sustainable economy within the Netherlands. From the EU REPowerEU initiative, which is funded by the Recovery and Resilience facility (RRF), the Netherlands got granted 5.4 billion EUR for their Recovery and Resilience plan[48]. Part of this money will be used for financing the growth fund projects including the ZES project.

A second project that is being funded is for the development of modular and exchangeable storage and energy systems for hydrogen as fuel for IWT. This concerns a budget of 63.5 million euro. The Dutch project CONDOR, under the RH2INE initiative provided the main context for the required funding.

Moreover, additional funding is planned in the Dutch Climate Fund to give a boost to the energy transition in inland navigation. It concerns a budget of 163.5 million euro for the period 2025 – 2030 which is linked to the national decision to implement ETS-2. The revenues from ETS-2 are used to feed a budget dedicated to the greening of the inland fleet.

The Netherlands implements RED-III with specific targets for energy supply to inland vessels focussing on the Well-To-Wake scope for CO_2e emissions in grams per MJ. This concerns the following stepwise increase for the reduction of CO_2e emissions to be achieved[49]:

- 2026: 3.0 % specific target, 0.8 % can be acquired from other modes = 3.8 % in total
- 2027: 4.1 % specific target, 1.0 % can be acquired from other modes = 5.1 % in total
- 2028: 6.1 % specific target, 1.5 % can be acquired from other modes = 7.6 % in total

[48] Netherlands' recovery and resilience plan - European Commission

[49] Overheid.nl | Consultatie Wijziging Besluit energie vervoer REDIII (internetconsultatie.nl)

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- 2029: 8.2 % specific target, 2.0 % can be acquired from other modes = 10.2 % in total
- 2030: 11.6 % specific target, 2.9 % can be acquired from other modes = 14.5 % in total

Allowed feedstocks are denoted in Annex IXa and Annex IXb of the RED-III, but also RFNBO and other forms of energy (electricity) are allowed. Conventional feedstocks are thus not allowed to generate the required CO_2e reductions in IWT. The conventional feedstocks are, however, applicable in road transport, but the generated CO_2 reduction tickets cannot be sold to other modes.

A final subject that plays a prominent role in the Dutch climate policies is research and development on national level. In 2023 the PATH2ZERO Project was started. This project is led by TU Delft and focuses on creating sustainable business models and technical solutions for zero-emission inland shipping, including a "Digital Twin" to simulate emission reduction scenarios and strategies.

A3-III-2 Belgium/Flanders

In Belgium the implementation of the Green Deal is not regulated by law but can best be described as a kind of consortium that joins their forces to prepare and execute tasks, related to greening IWT, which is referred to as the Flemish Green Deal for Inland Navigation[50]. This Green Deal is a public-private partnership between various stakeholders involved in inland shipping with 15 strategic objectives (SO) formulated in 4 different domains to achieve zero-emission shipping by 2050. The stakeholders involved are: De Vlaamse Waterweg nv, Department of Mobility and Public Works, Port of Antwerp- Bruges, North-Sea Port and the inland navigation business community. The different domains and SOs included in the Flemish Green Deal are:

Domain 1: Technology for green inland shipping

- SO1: Making green technologies that contribute to greening accessible and feasible (retrofit and new construction)
- SO2: Using a uniform system for emission measurements and reporting in line with European frameworks
- SO3: Accelerated evolution towards a multi-fuel situation
- SO4: Continuously improving the energy efficiency of inland shipping

Domain 2: Financial solutions for green inland shipping

- SO5: Building a fund for greening with contributions from various stakeholders
- SO6: Developing solutions to make the costs of greening feasible
- SO7: Realizing greening through a substantial effort by every actor in inland shipping (shippers, financial institutions, ports, inland shipping entrepreneurs, etc.)
- SO8: Creating a business case for inland shipping actors who want to invest in greening
- SO9: Working on a policy that provides direction in both the short and long term (2030 and 2050)

Domain 3: Policy to support green inland shipping

- SO10: The Flemish Government and port companies are taking an exemplary role in the field of greening
- SO11: Achieving simpler regulations for greening
- SO12: Develop tax incentives that make green technologies economically feasible in a transition phase

[50] Green Deal Binnenvaart: Een Groene Toekomst in Watervervoer

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- SO13: Gain a thorough insight into how a European emission label can be used for effective greening

Domain 4: Implementation of green inland shipping

- SO14: Achieving a mind shift among all (current and future) actors in Flemish inland shipping, with a focus on inland shipping entrepreneurs and shippers
- SO15: Guiding inland shipping entrepreneurs in collecting information about greening and effective greening

Together with tightly involved stakeholders, Belgium wants to make it a movement that makes the efforts and achievements for green inland navigation visible. In this way, it can also become a guide for short- and medium-term policy and the envisioned trajectory can be used as a frame of reference for future initiatives.

The scope of the Flamisch Green Deal includes both the reduction of CO_2 emissions as well as air pollution emission reduction. In the concept nota of the Flemish Green Deal[51] no concrete reduction values have been developed. However, three timeframes, which are 2026, 2030 and 2050, have been establish with corresponding ambitions. In 2026 Belgium has committed to remove existing barriers and create the first visible changes in the energy transition. For 2030 the ambition is to optimise the greening of inland navigation by 2030, with an outlook towards climate neutrality in 2050.

Even though no concrete reduction values have been set out by the Flemish Green Deal, their national climate policy does include some quantifiable targets for the IWT. These targets will be the main driver for the Green Deal objectives. For CO_2 reduction the goal is the have a 23 % reduction in 2030, where for air pollution it only states that they need to be reduced.

Embarking on the reduction goals for both CO_2 and air pollution emissions the objective is to induce modal shift of 6.3 billion t·km from road traffic to rail and inland navigation transport as a solution. This comes down to an increase of 30 % of transport being facilitated by the rail and IWT sector. A second goal that is included into the climate policy of the Flamisch government is the increase of shore power charging stations at ports, which impacts both IWT and Coastal shipping. The aim was to have around 600 charging station in 2025. In 2024 already 764 charging stations were deployed for use, so the objective regarding the charging station has been accomplished.

A3-III-3 Germany

The German government is following the European Union's climate targets. However, there is a special funding programme for inland shipping with several funding calls per year to support the transformation to a more climate-friendly mode of transport. Small companies are a particular focus here, as they can achieve particularly high funding rates. The latest programme from 2023 is divided into:

- Infrastructure: maintenance and expansion
- Environmental friendliness and fleet structure: more efficient and lower-emission vessels and promotion of alternative drive systems in inland navigation
- Digitalisation: networking of ports, digitalisation of locks and ships, automation of transhipment points, 5G mobile communications standard
- Strengthening the multimodal transport chain: increase the share of inland waterway transport in the modal split to 12 percent
- More skilled personnel: recruiting young talent, promoting training for inland waterway and port professionals

[51] 221104_conceptnota_finaal.pdf

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In the first, there is the opportunity to support measures to reduce emissions. These are, for example, fuel-water emulsion systems or exhaust gas aftertreatment systems. For each of the subsidised measures, there is a minimum target for reducing emissions. In addition to these measures, there are also opportunities to support the following measures in a second part of the programme for the sustainable shift of traffic to waterways: Digitalisation and automation, hydrodynamics, greater operational capability at low water, structural adaptation of inland vessels for freight transport. The third part of the programme supports low-emission and zero-emission propulsion systems.

The funding is provided on the following legal basis: "The granting of state subsidies to economically active companies is considered aid within the meaning of Article 107(1) of the Treaty on the Functioning of the European Union (TFEU). The grant is given based on Commission Regulation (EU) No 651/2014 of 17 June 2014 declaring certain categories of aid compatible with the internal market in application of Articles 107 and 108 of the Treaty on the Functioning of the European Union (General Block Exemption Regulation, GBER) (OJ L 187, 26.6.2014, p. 1) in the version of Commission Regulation (EU) No 2023/1315 of 23 July 2023 (OJ L 167, 30.6.2023, p. 1). The Directive is notified to the European Commission in accordance with Article 11(1)(a) GBER. Investment aid for the upgrading and retrofitting of inland waterway vessels to qualify as clean or zero-emission vehicles pursuant to Article 36b GBER and investment aid for energy efficiency measures pursuant to Article 38 GBER are applicable."[52]

In addition to the funding programme, there is also the Inland Waterway Transport Masterplan of the Federal Ministry of Transport and Digital Infrastructure from 2019, which defines five key areas:

- Infrastructure: maintenance and expansion
- Environmental friendliness and fleet structure: more efficient and lower-emission vessels and promotion of alternative drive systems in inland navigation
- Digitalisation: networking of ports, digitalisation of locks and ships, automation of transhipment points, 5G mobile communications standard
- Strengthening the multimodal transport chain: increase the share of inland waterway transport in the modal split to 12 per cent
- More skilled personnel: recruiting young talent, promoting training for inland waterway and port professionals

[52] https://www.elwis.de/DE/Service/Foerderprogramme/Nachhaltige-Modernisierung-von-Binnenschiffen/Richtlinie-Antriebe.pdf?__blob=publicationFile&v=4

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| Annex 4: Detailed description of the policies relevant for Coastal shipping

A4-I International Maritime Organisation

In 2000 the International Maritime Organisation (IMO) published their first study on the estimated amount of global anthropogenic CO_2 emissions that was contributed by the maritime industry. In this study it was estimated to be 1.8 % of the global emissions in 1996. In their latest study (the third study), published in 2014, it was estimated that the contribution to the global anthropogenic CO_2 emissions by the maritime industry in 2012 had grown to 2.2 %, which is equivalent to 796 million tonnes of CO_2, and that by 2050 this will increase further to 50 % to 250 % more CO_2 emissions.

Due to these estimations the Marine Environment Protection Committee (MEPC) of the IMO approved a roadmap in 2016, called "Roadmap for developing a comprehensive IMO strategy on reduction of GHG emissions from ships" to reduce the GHG emissions of the maritime sector which contains strategies, goals and activities to achieve this goal.

One of the objectives in this roadmap was to publish an initial GHG emission reduction strategy in 2018[53], which was eventually published on 13 April 2018. In this strategy the main goal was to enhance the contribution of the maritime industry to achieve the 2015 Paris Agreement, while keeping the impact on the States minimalised. In this strategy the reduction targets were set to 50 % overall GHG emission reduction in 2050, a 30 % Carbon emission intensity, in CO_2/ton km, reduction of 40 % in 2030 and a 70 % reduction in 2050 compared to 2008.

On of the objectives written in the roadmap on the initial strategy is that it has be revised every 5 years, which was realised on 7 July 2023[54]. The revised strategy intensifies the rate at which the maritime industry needs to get more sustainable. Where in the initial strategy, published in 2018, the goal was to reduce the total GHG emissions by 50 % in 2050 the revised strategy aims to reach net-zero GHG emissions in 2050.

Another amendment in the revised strategy is that it sets goals for the total required percentage of zero or near zero-emission technologies and/or energy carriers used within the maritime industry. It is stated that in 2030 the amount of zero or near zero-emission technologies and/or energy carriers needs to be at least 5 %, but aiming for 10 %, of the total energy used in the maritime industry.

One of the strategies that is imposed is to focus on improving the energy efficiency of the vessels. Since the first of January 2013 the Energy Efficiency Design Index (EEDI) requirements set limits to the minimum energy efficiency for new build vessels weighing 400 GT or above, in which it has also been stated that the energy efficiency of these types of ships needs to be increased by 30 % for ships constructed in 2025 compared to 2014.

A requirement for all ships that weigh 400 GT or above is that they implement and maintain a Ship Energy Efficiency Management Plan (SEEMP). Besides the required EEDI and SEEMP regulations there also exists the Energy Efficiency Operational Indictor (EEOI) guidelines for monitoring operational energy efficiency, however, these are available on voluntary basis.

To ensure the safety of the human health, especially of those who live in port cities, limits on the amount of Sulphur Oxides (SO_x) and Particular Matter (PM) have been established. From 1st January 2020 the limit has been set to 0.5 % Sulphur content outside the outside of Emission Control Areas (ECAs). The Sulphur

[53] https://unfccc.int/sites/default/files/resource/250_IMO%20submission_Talanoa%20Dialogue_April%202018.pdf
[54] https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/annex/MEPC%2080/Annex%2015.pdf

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limits for inside an ECA vary and can be found in MARPOL ANNIX VI, which also defines the different ECAs. When entering an IWT ECA the Sulphur limit is set to 0.1 % Sulphur content.

Vessels entering or exiting ECAs are required to report the amount of ECA-approved fuel oil that is present on board together with the date, time, and position of entering/exiting the ECA. There are two ways in which ships can comply with the set SO_x and PM limits. Either by the of fuel oils that have low SO_x and PM exhaust emissions (primary prevention) or by the use of exhaust filtration techniques (secondary prevention), for example a scrubber.

For NO_x exhaust emissions there also exist regulations, but these highly depend on the location and engine speed rate. In MARPOL ANNEX VI, the different NO_x limits (called Tiers) per vessel type and location are defined. All vessels with a 130 kW marine diesel engine that is not solely used for emergencies on board are obligated to comply with the NO_x regulations.

To reach these goals set in the initial and revised strategy the IMO subdivides possible solutions into three main categories. These are short term, mid-term, and long-term measures. Short-term GHG emission reduction measures are finalized and agreed by the MEPC Committee in the period 2018-2023, which are included in the MARPOL Annex VI regulation and Appendix 1 of the in 2023 published revised strategy. Mid-term measures are defined as either a basket of GHG emission reduction measures finalized and agreed by the MEPC Committee in 2025, or other GHG emission reduction measures finalized and agreed by the MEPC Committee in the period 2023-2030, where for both cases the date of entry into force and when they can start effectively reduce GHG emission will be defined per regulation individually. An example of a mid-term measure is the revised EU-ETS regulation that will go into force from 2027 on. GHG emission reduction measures finalized and agreed by the MEPC Committee beyond 2030, which can be developed as part of the 2028 revision of IMO GHG reduction strategy, are defined as long-term measures.

A4-II EU Policy: FuelEU Maritime

FuelEU Maritime sets maximum limits for the yearly average GHG intensity of the energy used by seagoing ships above 5000 GT calling at European ports, regardless of their flag. Targets will ensure that the greenhouse gas intensity of fuels used in the sector will gradually decrease over time, starting with a 2% decrease by 2025 and reaching up to an 80 % reduction by 2050. Those targets will become more ambitious over time to stimulate and reflect the necessary developments in technology and the uptake in production of renewable and low-carbon fuels. The targets cover not only CO_2 but also CH_4 and N_2O emissions over the full Well-to-Wake (WtW) lifecycle of the fuels used onboard.

The Regulation also introduces additional zero-emission requirements for ships at berth, mandating the use of on-shore power supply (OPS) or alternative zero-emission technologies in ports, by passenger ships and containerships. This with a view to mitigating air pollution emissions in ports, which are often close to densely populated areas.

By taking a lifecycle, goal-based and technology-neutral approach, FuelEU Maritime allows for innovation and the development of new sustainable fuels and energy conversion technologies, offering operators the freedom to decide which fuels to use based on ship-specific or operation-specific profiles. The Regulation also provides for different flexibility mechanisms, supporting existing fleets to find suitable compliance strategies and rewarding first-movers for early investment in energy transition.

FuelEU Maritime will enter into force from 1 January 2025 except for Articles 8 and 9 on monitoring plans which shall apply from 31 August 2024.

A4-III National policies for coastal vessel operations

A4-III-1 The Netherlands

The in 2019 published Dutch green deal by the Dutch Ministry of Infrastructure and Water Management for Maritime (I&W), Inland Shipping and Ports has, besides the goals mentioned in section 3.2.3.1/A3-III-1, a

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separated chapter devoted to Maritime sustainability goals, which includes coastal shipping. The goals included in the Dutch Green Deal for coastal shipping are based on the goals set in the 2018 published IMO initial GHG reduction strategy, which are described in chapter 3.3.1/A3-I. In this strategy, the GHG reduction target is 50 % by 2050 compared to 2008. However, this was not ambitious enough according to the Dutch government, so the GHG emission reduction target in the Dutch Green Deal have been set to:

- At least 1 zero-emission seagoing ship, with appealing business case, by 2030
- The I&W's Government Shipping Company will use fuel containing at least 30 % biofuel (HVO)
- 70 % total reduction by 2050 compared to 2008
- After 2050 the maritime fleet needs to reach climate-neutrality as soon as possible, but at least before the end of the century

The scope of the Dutch Green Deal also includes air pollution reduction targets (SO_x, NO_x and PM reduction). The air pollution targets in the Dutch Green Deal are the same as the targets set in the initial IMO strategy, which are:

- The SO_x content in the North Sea ECA is set to be 0.1 %.
- The SO_x content outside the ECAs is 0.5 %
- From 1 January 2021 the NO_x reduction target for new ships have been stringent to more than 70 % compared to the targets set before 2021.

As part of achieving these targets the Dutch Green Deal has set the goal to develop at least 5 new business cases for shore power for maritime shipping, which have to comply with the Green Deal terms. The Dutch ministry of I&W will reserve 1 million EUR of funding per year, up until the set terms in the Dutch Green Deal, for the assessment and validation of the techniques described in article 23, paragraph 4 of the Dutch Green Deal.

With the revised RED-III some extra emission reduction targets compared to the Green Deal have been established by the Netherlands. The Netherlands implements RED-III, as mentioned in chapter 3.2.3.1, through specific targets for energy supply to transport focussing on the Well-To-Wake scope for CO_2e emissions in grams per MJ. For sea going vessels, this concerns the following stepwise increase for the reduction of CO_2e emissions to be achieved:

- 2026: 2.5 % specific target, 1.1 % can be acquired from other modes = 3.6 % in total
- 2027: 3.3 % specific target, 1.5 % can be acquired from other modes = 4.8 % in total
- 2028: 4.1 % specific target, 1.8 % can be acquired from other modes = 5.9 % in total
- 2029: 4.9 % specific target, 2.2 % can be acquired from other modes = 7.1 % in total
- 2030: 5.7 % specific target, 2.5 % can be acquired from other modes = 8.2 % in total

Allowed feedstocks are limited to the in Annex IXa denoted feedstock, RFNBO and other (electricity). In contrast to inland waterways, the required CO_2 reduction can therefore not be accomplished by means of fuels made from Annex IXb feedstock. This also applies for tickets acquired from other modes, these cannot be sold to fuel suppliers for their targets in seagoing operations.

Furthermore, the FuelEU Maritime and ETS regulation applies for seagoing vessels above 5000 GT. The Netherlands was in favour of including also vessels below 5000 GT in the scope of the EU legislation, but there was no majority in Europe to implement it in this way. The Netherlands, however, will lobby for such an extension when the legislation is evaluated within a couple of years.

In terms of research and development there are projects funded by the subsidy for R&D Mobility sectors (RDM)[55] supporting the maritime industry since 2021 focussing on:

[55] https://swzmaritime.nl/news/2021/12/08/these-three-maritime-rd-projects-have-won-funding-from-the-dutch-rdm-scheme/

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- Methanol via project MENENS, https://menens.nl/
- Hydrogen via project Sh2ipdrive, https://sh2ipdrive.com/
- LNG with carbon capture via project LNG-ZERO, https://www.lngzero.com/about-us/about-lng-zero

This is a subsidy from the Dutch Ministry of Economic Affairs and Climate Policy, providing € 52.9 million to three consortia of maritime companies and knowledge institutions. This is seen as an important first step towards realising the Dutch Maritime Master Plan, a plan to become a global leader in the construction and use of smart, clean, and safe ships. By 2030, the sector aims to have fifty emission-free ships in operation.

Moreover, there is the Maritime Masterplan programme https://maritiemmasterplan.nl/, which follows-up the work ongoing/done in the RDM projects and also distinguishes the solutions hydrogen, methanol and carbon capture for LNG propelled vessels.

The aim is to develop 30-40 demonstration vessels using these solutions to reduce the carbon footprint. In total a grant of 210 million EUR is rewarded by the National Growth Fund while private and public actors provide 926 million EUR to implement the plans. Attention is paid as well to digital cooperation in ship building and improving the human capital.

New grant schemes are upcoming from the national Climate Fund, with a plan to providing 111.3 million EUR of support aiming on roll-out of the developed innovations by ship owners. The focus of this grant is to support the capital expenditures (CAPEX) for purchasing and installing:

- 1. Propulsion systems using hydrogen or methanol as fuel, possibly combined with the purchase of energy saving technologies such as Wind Assisted Ship Propulsion (WASP) or others.
- 2. Battery packs including the required adaptations on board of the vessel. The goal is to use shore power (cold ironing) to recharge the batteries with the objective to be able to manoeuvre without any emissions in and out of the port.

A4-III-2 Germany

The granting of state subsidies to economically active companies is deemed to be aid within the context of Article 107(1) of the Treaty on the Functioning of the European Union (TFEU) (OJ C 326, 26.10.2012, p. 1). The grant under these guidelines is given based on Regulation (EU) No. 651/2014 of the European Commission (General Block Exemption Regulation - GBER). Environmental aid pursuant to Article 36 and Article 36b of the GBER and investment aid for energy efficiency measures pursuant to Article 38 of the GBER apply.

The following items and measures are eligible for funding:

Clean or emission-free propulsion systems:

- Propulsion systems consisting of hybrid or dual-fuel engines which, in normal operation at sea or in port, obtain at least 25 % of their energy from fuels that do not cause direct CO_2 tailpipe emissions or receive battery power, or propulsion systems for ships whose EEDI (Energy Efficiency Design Index) is 10 % below the EEDI requirements applicable on 1 April 2022 and which can be operated with fuels that do not cause direct CO_2 tailpipe emissions or are generated from renewable energy sources.
- In addition, new ships must be partially powered by electricity or hydrogen.
- For existing ships without IMO Tier III certification: After retrofitting, nitrogen oxide emissions must fulfil or fall below the minimum requirements of IMO Tier III in accordance with Regulation 13 (4) of Annex VI of the MARPOL Convention.
- For existing ships with IMO Tier III certification: The NO_X emissions after retrofitting must be 10 per cent below the minimum requirements of IMO Tier III in accordance with Regulation 13(4) of Annex VI of the MARPOL Convention.

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- For newbuilt ships: NO_X emissions must be 10 % lower than the minimum requirements of IMO Tier III. Hydrocarbon emissions must not exceed 0.19 g/kWh. In addition, high-speed engines must not exceed particulate emissions of 0.04 g/kWh.
- If ammonia is used as a fuel, the engine manufacturer must provide proof that no nitrous oxide (N_2O) is emitted during combustion in the engine by means of suitable measures.
- Systems that run on natural gas (LNG and CNG) or on-board auxiliary engines that are to be up-graded or converted and are used for environmentally friendly on-board power generation during port periods are not eligible for funding under this guideline.

Measures to minimise pollutants:

- This includes all technical innovations that lead to the emission reductions. It should be noted that the measures must not lead to increased consumption of fossil fuels. The requirements for funding are
- reduction of PM emissions by at least 90 %
- reduction of NO_X emissions by at least 80 %
- reduction of HC emissions by at least 90 %
- equivalent combined reduction of PM, NO_X and HC emissions from the engine is documented by a manufacturer's declaration or by measurement evidence from a certified test centre. Certified test centres are the classification societies and maritime research institutes
- The use of exhaust gas scrubbers to comply with the sulphur limits of EU Directive 2016/802 is not subsidised

Improving the energy efficiency of the propulsion system:

- Improvements to hydrodynamics or propulsion-improving measures, for example, are eligible for funding, provided that a saving of at least 10 % in propulsion energy consumption compared to the original vehicle is achieved for coastal vessels in service (existing vessel). This also includes engine-internal measures that demonstrably achieve 10 %efficiency. Proof must be provided or confirmed by a certified testing centre.
- The installation of a wind assistance system that saves 10 per cent of propulsion energy is eligible for funding for both conversion measures and new ships due to its proven increase in energy efficiency.

Merchant ships are eligible for funding if they - fly the German federal flag or the flags of the Member States of the European Union, Iceland, Liechtenstein, Norway and Switzerland or - fly the German federal flag on the basis of a flag licence pursuant to Section 11 (1) of the German Flag Act.

For the purposes of the directive, a merchant ship is a seagoing (coastal) vessel which:

- is used commercially for the transport of passengers and goods, for port operations or for auxiliary activities or which is hired out commercially for this purpose and
- is permitted to pass through the Kiel Canal (maximum dimensions 235 m in length, 32.5 m in width, 40 m in height and 9.5 m in draught).

Merchant ships include:

- Ships carrying passengers;
- Dry cargo ships (railway ferries, other ferries, ro-ro ships, general cargo ships, reefer ships, container ships, multipurpose dry cargo ships, specialised transport ships, bulk carriers, multipurpose bulk carriers);
- Tankers (mineral oil tankers, gas tankers, chemical tankers, others).
- Vessels for salvage and towing activities, traffic safety, pilotage, cable laying, dredging, crane or other services, construction or maintenance work and supply of fixed installations at sea (e.g. wind farms, drilling rigs), research or expertise activities, burials at sea.

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Fishing vessels are not eligible for funding, as such vessels are excluded from the scope of the GBER. Also, traditional vessels, recreational crafts, state vessels used for sovereign purposes (e.g. WSV vessels, coast guard vessels, training vessels, fishery protection vessels, state research vessels) are excluded from funding.

A4-III-3 Cyprus

As part of the emission reduction strategy pf Cyprus, they have implemented a modification of its Tonnage Tax System in April 2024. Within this new taxation system, it is possible to obtain a Annual Tonnage Tax reduction of up to 30% levied on owners of Cyprus ships (and foreign-flagged ships under certain conditions) if the ships use "mechanisms-equipment for the environmental preservation of the marine environment and the reduction of the effects of climate change".

Tables 26 to 28 provide details on how the reduction of Annual Tonnage Tax is calculated. The existing energy efficiency instruments Energy Efficiency Existing Ship Index (EEXI), Carbon Intensity Indicator (CII), as well as fuel consumption (normalized by the total distance travelled) are used as criteria.

26 | Reduction of Annual Tonnage Tax based on reduction of Attained EEXI

Reduction of Attained EEXI in comparison to Required EEXI	Reduction of Annual Tonnage Tax
> 10 %	5 %
> 15 %	10 %
> 20 %	20 %
> 30 %	25 %

27 | Reduction of Annual Tonnage Tax based on reduction of fuel consumption relative to the total distance travelled between two consecutive reporting periods

Reduction between two consecutive reporting periods	Reduction of Annual Tonnage Tax
> 4 %	10 %
> 6 %	15 %
> 8 %	20 %

28 | Reduction of Annual Tonnage Tax based on Carbon Intensity Rating

Carbon Intensity Rating	Reduction of Annual Tonnage Tax
Rating A	20 %
Rating B	10 %

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