PLATINA3
IWT policy platform

D2.7 Report on policy recommendations on regulatory pathway towards zero emission fleet

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Executive Summary

Regulations and standards belong to the group of obvious policy instruments to support the transition to zero emissions for the IWT fleet. In fact, the legal certainty associated with regulations and standards significantly influences the ability to invest in new technologies (energy carriers / converters). Appropriate regulations and standards allow to:

- reduce risks for ship owners willing to invest (and help companies plan their investments),
- reduce operating costs (initial investment, running costs and insurance costs),
- facilitate the acceptance of new technologies by mitigating safety and environmental risks, and
- stimulate market structuring and enable a wider adoption of technologies and clean forms of energy (it reinforces market potential for technology suppliers and may result in economies of scale).

More generally, regulations and standards influence the costs and duration of the transition process to zero emissions for the IWT fleet. In synergy with financial support, a consistent and effective regulatory framework is needed to level out the operational advantages of conventional fossil fuels and related technologies over renewable fuels and thereby improve the business case for cleaner solutions for the fleet.

The purpose of this report is to identify the regulations and standards related to vessels and technologies (energy carriers / converters) which are missing nowadays to effectively support the transition towards a zero-emission IWT fleet in Europe.

The scope of this report is limited to fleet-related regulations and standards: vessel design, including energy converters, energy used, and vessel operations including bunkering, charging and swapping. It covers regulations and standards enacted by the EU, but also those of the River Commissions (such as CCNR or DC) and UNECE which co-exist alongside EU law. In terms of technologies considered (energy carriers / converters), this report takes into account the study published by the CCNR on the energy transition towards a zero-emission inland navigation sector as well as the roadmap for reducing inland navigation emissions adopted in December 2021.

In terms of methodology, a desk study of existing regulations and standards was initially conducted to clarify the general impact on the IWT fleet, the specific gaps for new energy sources as well as gaps in terms of missing regulations for effective emission reduction policies. Then, interviews and discussions (with policy makers, classification societies, technology and energy suppliers, shipyards, IWT sector) allowed to improve the analysis further and prepare recommendations. In particular, the findings of this report were also examined during the third (10-11 February 2022) and sixth (23-24 March 2023) PLATINA3 stage events to ensure acceptance and support by the main impacted stakeholders. This report was elaborated with guidance from the PLATINA3 Advisory Board, as well as representatives of the European Commission's DG MOVE.

This report includes 42 recommendations to effectively support the transition towards zero emissions for the fleet. In this respect, the recommendations are summarised in table format on the following pages. They include:

- 21 recommendations for the vessel regulations,
- 11 recommendations for fuel regulations and
- 10 recommendations for the operational regulations.

no V=vessel, F=fuel, P=operation/police	Who	What	When	Priority
V1	EC, CCNR, DC, Moselle Commission, Sava Commission, National administrations	facilitate the financing and commissioning of pilot vessels using alternative technologies, subject to the sharing of the experience collected for the regulatory work	Continuous	I
V2	CESNI, EC, CCNR	investigate the opportunity to introduce efficiency and greenhouse gas emission limits, possibly both for existing vessels and newly built vessels, in line with emission reduction target	2023-2025	I
V3	CESNI and EUROMOT	update regularly their FAQ document on NRMM and ES-TRIN	Continuous	I
V4	EC	review opportunity to further reduce exhaust emission limits for inland navigation vessels, taking account of existing related Union and international standards and propose any necessary legal changes	2025	II
V5	EC, CCNR, CESNI	consider introducing a phasing out of existing engines in ES-TRIN to achieve minimum air pollutant emission standards	2030	II
V6,8	EC, engine manufacturers classification societies	facilitate the use of marinized engines (clarify the accepted inducement strategies and possible use on board vessels transporting dangerous goods)	Continuous	II
V7	EC	review the extent to which the engine emissions measured during type-approval tests using corresponding test cycles reflect engine emissions in real operating conditions and propose any necessary changes.	2025	II
V9	EC	evaluate the need to lower the factor A of emission limits for gas engine in NRMM to increase the climate performance of LNG propulsion systems	2025	II
V10	CESNI	evaluate the requirements for lithium-ion batteries after several years	2024-2025	II
V11	CESNI/CCNR	develop provisions to allow the swappable battery containers for the considering the risks involved	2023	I
V12	CESNI	monitor the development in the use of batteries for propulsion and anticipate the spreading of type of batteries other than LIB.	Continuous	II

V13	CESNI	collect experience regarding the approval of the hydrogen tanks and the relevant standards	2023	I
V14	CESNI	finalise the requirements for the compressed and liquefied storage of hydrogen	2023-2025	I
V15	EUROMOT/CESNI	develop guidelines for the implementation of Articles 34 and 35 of NRMM for engines using hydrogen as fuel (pending a revision of NRMM).	2023	I
V16	CESNI	start the development of safety requirements for hydrogen in internal combustion engine	2024	II
V17	ADN SC (UNECE-CCNR)	confirm that hydrogen is accepted for propulsion of vessels carrying dangerous goods	2024-2025	II
V18	CESNI	monitor the development in the hydrogen carriers	2025	II
V19	CESNI	finalise the requirements for the storage of methanol and its use in internal combustion engines (ES-TRIN 2025)	2023	I
V20	EUROMOT/CESNI	develop guidelines for the implementation of Articles 34 and 35 of NRMM for engines using methanol as fuel (pending a revision of NRMM).	2023	I
V21	ADN SC (UNECE-CCNR)	confirm that methanol is accepted for propulsion of vessels carrying dangerous goods	2024-2025	II

F1	Member States, CCNR, DC, Moselle Commission, Sava Commission, EC	coordinate on implementation of REDII revision and FQD as regards obligations for energy suppliers to inland vessels (preferably this coordination takes place at River Commissions level in relation with IWT fleet modernisation issues or even on EU level).	2023-2024	I
F2	EC	start policy research/development and impact assessment study for a proposal of "FuelEU IWT" based on the FuelEU Maritime proposal in Fit for 55, aligned with EU Taxonomy technical screening criteria and methodology	2024-2025	I
F3	EC	start policy research/development and impact assessment study for a proposal about IWT to be included in ETS (based the approach for road transport in ETS)	2024-2025	I
F4, F5	Member States / EC	limit the share of EN590 and fossil LNG in fuel supply, e.g. by means of limits on carbon intensity levels and/or ETS on EU level.	2030	I
F6, F9, F10, F11	Member States / EC	promote the share of fuels (HVO or biofuels/e-fuels, hydrogen and methanol) as well as electricity from renewal sources in fuel supply, e.g. by means of limits on carbon intensity levels and/or ETS on EU level	2030	I
F7	CEN	investigate need for more strict fuel quality standards for FAME and their blends as well as quality checks in the supply chains of these fuels and enforcement.	2025	II
F8	EBU / ESO / national shipowner associations / IVR	launch awareness campaigns on the usage of biodiesel to be aware of possible technical risks and mitigation measures to prevent problems (e.g. as regards filter blockage, water separation)	2024	I

P1	CCNR, DC, Moselle Commission, UNECE	examine the need of operational requirements to ensure safety in case of thermal runaway of batteries	2023	I
P2	National authorities	facilitate the exchange of good practices between the fire brigades involved in fires with LIB, especially on-board inland vessels	2023-2024	I
P3	CEN, CENELEC	develop standards for shore-side battery recharging and battery swapping, taking into account the experience gained in inland navigation and the difference with the maritime sector.	2026	I
P4	CCNR, DC, Moselle Commission, UNECE	examine the need of operational requirements to ensure safety of hydrogen	2023-2024	I
P5	CEN, CENELEC	develop standards for swapping of racks/containers of compressed hydrogen, taking into account the experience gained in inland navigation and the existing industrial standards	2026	I
P6	CEN, CENELEC	develop standards for bunkering of liquefied hydrogen	2028	II
P7, P10	National authorities	collect and share the experience gained with the first pilot vessels to feed in the regulatory work	Continuous	I
P8	CCNR, DC, Moselle Commission, UNECE	examine the need of operational requirements to ensure safety of methanol	2023	I
P9	CEN, CENELEC	develop standards for bunkering of methanol, taking into account the experience gained in inland navigation and the existing industrial standards	2024	I

List of abbreviations

AIS	Automatic Identification System
ADN	European Agreement Concerning the International Carriage of Dangerous Goods by Inland Waterways
ADNR	Regulation for the transportation of dangerous goods on the Rhine
CCNR	Central Commission for the Navigation of the Rhine
CEN	European Committee for Standardisation
CENELEC	European Committee for Electrotechnical Standardisation
CESNI	Comité Européen pour l'élaboration de Standards dans le domaine de la Navigation Intérieure
CEVNI	European Code for Inland Waterways
CO	Carbon monoxide
CRS	Croatian Register of Shipping
DC	Danube Commission
DFND	Fundamental provisions for the Navigation of the Danube
EC	European Commission
ECDIS	(Inland) Electronic Charts Display Information System
EGD	European Green Deal
ES-TRIN	European Standard laying down Technical Regulations in the field of Inland Navigation
ESO	European Standardisation Organisation
EUROMOT	European Association of Internal Combustion Engine Manufacturers
FAME	Fatty Acid Methyl Ester
FAQ	Frequently Asked Questions
FC	Fuel Cell
FQD	Fuel Quality Directive
GHG	Green House Gas
HC	Hydrocarbon
HVO	Hydrotreated Vegetable Oil
ICE	Internal Combustion Engine
IGF (code)	International Code of Safety for Ship Using Gases or Other Low-flashpoint Fuels
IMO	International Maritime Organisation
IWP	engines exclusively for use in inland waterway vessels, for their direct or indirect propulsion, in accordance with Non-Road Mobile Machinery regulation
IWA	auxiliary engines exclusively for use in inland waterway, in accordance with Non-Road Mobile Machinery regulation
IWT	Inland Waterway Transport

LIB	Lithium-Ion Batteries
LOHC	Liquid Organic Hydrogen Carrier
LNG	Liquefied Natural Gas
NOx	Mono-nitrogen oxides
NRE	Non-Recurring Engineering
NRMM	Non-Road Mobile Machinery
PM	Particulate matter (mass)
PN	Particulate matter (number)
PRS	Polish Register of Shipping
RPNM	Police Regulations for the Navigation of the Moselle
RPR	Police Regulations for the navigation of the Rhine
RVIR	Rhine Vessel Inspection Regulations
SSMS	Sustainable and Smart Mobility Strategy
TRL	Technological Readiness Level
UNECE	United Nations Economic Commission for Europe

1. Introduction

The Horizon 2020 PLATINA3 project provides a platform for the implementation of the European Commission's NAIADES III action programme dedicated to inland navigation. PLATINA3 is structured around four fields: Market (WP1), Fleet (WP2), Jobs & Skills (WP3) and Infrastructure (WP4). Work package 2 "Fleet" deals with various aspects of the fleet, such as:

- a zero-emission fleet;
- a climate resilient fleet;
- digital and automated vessels;
- technical regulations and standards for the fleet and fuels; and
- accurate fleet data.

This report addresses the topic "technical regulations and standards for the fleet and fuels", which is Task 2.7 of PLATINA3 according to the Grant Agreement. The title of Task 2.7 is "Regulatory aspects supporting the transition towards zero emissions for the fleet" and CCNR Secretariat leads the execution of this task.

2. Objectives and methodology

Regulations and standards belong to the group of obvious policy instruments to support the transition to zero emissions for the IWT fleet. In fact, the legal certainty associated with regulations and standards significantly influences the ability to invest in new technologies (energy carriers / converters). For example, Classification Societies involved in inland navigation recently observed that legal uncertainties and long administrative procedures are a more important obstacle to greening of the fleet than strictly technical issues[1].

Appropriate regulations and standards allow to:

- reduce risks for ship owners willing to invest (and help companies plan their investments),
- reduce operating costs (initial investment, running costs and insurance costs),
- facilitate the acceptance of new technologies by mitigating safety and environmental risks, and
- stimulate market structuring and enable a wider adoption of technologies and clean forms of energy (it reinforces market potential for technology suppliers and may result in economies of scale).

More generally, regulations and standards influence the costs and duration of the transition process to zero emissions for the IWT fleet. In synergy with financial support and incentives, a consistent and effective regulatory framework is needed to level out the operational advantages of conventional fossil fuels and related technologies over renewable fuels and thereby improve the business case for cleaner solutions for the fleet.

Regulations and standards need to address the international character of the inland waterway transport sector and to ensure the level playing field between the countries.

Therefore, the purpose of this report is to identify the regulations and standards related to vessels and technologies (energy carriers / converters) which are missing nowadays to effectively support the transition towards a zero-emission IWT fleet in Europe. To do so, a desk study of existing regulations and standards was initially conducted to clarify their general impact on the IWT fleet, the specific gaps for new energy sources as well as gaps in terms of missing regulations for effective emissions reduction in accordance with relevant European targets. Then, interviews and discussions (with policy makers,

[1] Interview with Group of recognised classification societies, 25th October 2022

classification societies, technology and energy suppliers, shipyards, IWT sector) allowed to improve the analysis further and prepare recommendations. In particular, the findings of this report were also examined during the third (10-11 February 2022) and sixth (23-24 March 2023) PLATINA3 stage events to ensure acceptance and support by the main impacted stakeholders. This report was elaborated with guidance from the PLATINA3 Advisory Board, as well as representatives of the European Commission's DG MOVE.

The entire process took into account the experience gained with liquefied natural gas (LNG) and biodiesels as well as the first steps to prepare legislation for hydrogen, methanol and large capacity batteries.

3. Policy context

The European Commission's (EC) European Green Deal (EGD)[2] sets a Green House Gas (GHG) reduction target of roughly to 55% by 2030 compared with 1990 (for all sectors) and highlights the need for a 90% reduction in transport emissions by 2050 compared to 1990 (road, rail, aviation and waterborne transport). The EC's Sustainable and Smart Mobility Strategy (SSMS)[3] reaffirms the reduction target in GHG emissions from transport and lays out priority policy areas and actions to be realised to achieve climate neutrality by 2050. To achieve this systemic change, EC expressed the need to "(1) make all transport modes more sustainable, (2) make sustainable alternatives widely available in a multimodal transport system and (3) put in place the right incentives to drive the transition". In line with the above, the EC's NAIADES III Action Plan[4] was released in June 2021, with the core objective of facilitating the transition to zero-emission vessels by 2050.

In the Declaration signed in Mannheim in 2018, the inland navigation ministers of the Member States of the Central Commission for the Navigation of the Rhine (CCNR) defined similar target of largely eliminating GHG by 2050, but also largely eliminating other pollutants by 2050. CCNR adopted in 2021 a dedicated roadmap[5] including two transition pathways for the fleet by 2050 as well as policy measures.

The Danube Commission (DC)'s Working platform for fleet modernization also adopted comparable targets for the Danube fleet, aiming at a reduction of GHG emissions and air pollutants to a significant extent (up to 90% by 2050 compared to 2015).

Furthermore, the European Commission recently published the recommendations by the Sustainable Finance Platform for the update of the technical screening criteria for the EU Taxonomy for climate mitigation for inland vessels[6]. The updated version presents a clear technology neutral pathway for individual vessels to reduce the carbon intensity in terms of grams of CO2e emissions per MJ of energy used. It is not yet 100% certain if the European Commission will take over the recommendations and when updated Delegated Acts will be released.

[2] European Commission, "A European Green Deal", December 2019, https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en.

[3] European Commission, "Sustainable and Smart Mobility Strategy", December 2020, https://transport.ec.europa.eu/transport-themes/mobility-strategy_en.

[4] European Commission, "NAIADES III Action Plan", June 2021, https://transport.ec.europa.eu/transport-modes/inland-waterways/promotion-inland-waterway-transport/naiades-iii-action-plan_en

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

[6] Platform on sustainable finance: technical working group supplementary: methodology and technical screening criteria, October 2022 https://finance.ec.europa.eu/system/files/2022-11/221128-sustainable-finance-platform-technical-working-group_en.pdf

4. Scope of the analysis

In terms of regulations and standards, this report considers those enacted by the EU, but also those of the River Commissions (such as CCNR or DC) and UNECE which co-exist alongside EU law, as well as the recommendations established by the UNECE. This shared governance structure should be taken into account for the analysis and the recommendations to ensure a smooth and coordinated transition of the applicable European regulatory frameworks.

The scope of this report is limited to fleet-related regulations and standards: vessel design, including energy converters, energy used, and vessel operations including bunkering, charging and swapping. They have effects on the total cost of ownership and the legal certainty.

To prevent duplications, regulations which are specifically addressed in other tasks of the PLATINA3 project are not considered in the scope of this report. For instance, the regulatory and policy frameworks to ensure a modal shift is described by task 1.5; the incentives such as grant schemes and state-aid rules are addressed under task 2.5; the EU taxonomy or emission label / energy index in vessel design, are addressed under task 2.6; crew requirements and qualifications are analysed under task 3.1; infrastructure needs for alternative fuels are addressed under task 4.2.

Special attention is also paid to the legislative proposals introduced by the Fit for 55 Package of the EC[7] and the developments in the negotiations within the European Council and Parliament[8]. It concerns especially measures targeting the emissions reduction in transport or energy sectors, for example the recently adopted FuelEU Maritime which does not affect inland navigation but could inspire other policy measures.

In terms of technologies considered (energy carriers / converters), this report takes into account the study recently published by the CCNR on energy transition towards a zero-emission inland navigation sector[9] as well as the roadmap adopted in December 2021. Therefore, the following technologies (and corresponding energy carriers and converters) are considered:

[7] European Commission, "Fit for 55 package", COM (2021) 550, July 2021, https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=COM:2021:550:FIN.

[8] Timeline, European Green Deal and Fit for 55 - https://www.consilium.europa.eu/en/policies/green-deal/timeline-european-green-deal-and-fit-for-55/

[9] CCNR, "CCNR study on energy transition towards a zero-emission inland navigation sector", 2021, https://www.ccr-zkr.org/12080000-en.html.

Technologies considered in the pathways	Description	TRL (1-9) vessel application	TRL (1-9) fuel / energy production and supply
Stage V, Diesel	Fossil diesel in an internal combustion engine which complies with the emission limits EU Stage V.	9	9
LNG	Liquefied Natural Gas in an internal combustion engine which complies with the emission limits EU Stage V.	9	9
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
LBM	Liquefied Bio Methane (or bio-LNG) in an internal combustion engine which complies with the emission limits EU Stage V.	9	8
Battery	Battery electric propulsion systems, with fixed or exchangeable battery systems.	8	7
H_2, FC	Hydrogen stored in liquid or gaseous form and used in fuel cells.	7	7
H_2, ICE	Hydrogen stored in liquid or gaseous form and used in internal combustion engines.	5	7
MeOH, FC	Methanol used in fuel cells.	7	6
MeOH, ICE	Methanol used in internal combustion engines.	5	6

Fig 1. Technology readiness levels (TRL) levels for application on an inland vessel and TRL for the fuel / energy production and supply (source: CCNR, 2021)

Technology readiness levels (TRL) are defined as follows: "TRL 1 – basic principles observed ; TRL 2 – technology concept formulated ; TRL 3 – experimental proof of concept ; TRL 4 – technology validated in lab ; TRL 5 – technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies) ; TRL 6 – technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies) ; TRL 7 – system prototype demonstration in operational environment ; TRL 8 – system complete and qualified ; TRL 9 – actual

system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)"[10].

The mentioned technologies reflect the current state of knowledge. It was decided to focus on a set of technologies with a technology readiness level (TRL) of 5 and above. For instance, other technological options like lithium-air batteries or LOHC (Liquid Organic Hydrogen Carrier) could be studied at later stage. Even if ammonia seems to be a serious candidate for seagoing vessels, it still presents major safety issues in inland navigation[11] and is therefore excluded from this analysis.

[10] European Commission, "TRL levels", Horizon 2020 Work Programme 2014-2015, https://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/annexes/h2020-wp1415-annex-g-trl_en.pdf.

[11] Rijkswaterstaat, "Safety aspects for new energy carriers in inland navigation", Adviesgroep AVIV BV, 2021, https://puc.overheid.nl/rijkswaterstaat/doc/PUC_710445_31/.

5. Vessel design and propulsion systems – Overview and gap analysis

Three regulatory environments are considered and described in this Chapter:

- vessel technical requirements, especially the European Standard laying down Technical Requirements for Inland Navigation vessels (ES-TRIN[12]) and associated regulations,
- regulations for the transport of dangerous goods, especially the European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways (ADN) and the Directive 2008/68/EC[13]), and
- regulations applicable to engines, especially the Regulation (EU) 2016/1628[14], or energy converters (such as fuel cells).

These regulations determine the legal feasibility of the use of alternative energies for propulsion, but also to transport new fuels cargo in inland navigation. Moreover, specific attention is paid to the rules adopted by classification societies which also influence the development of the technologies, especially for pilot vessels.

This Chapter includes a gap analysis for all state-of-the-art technologies considered regarding the three regulatory environments described as well as the lack of regulations for vessel design and propulsion systems. It highlights if one regulatory change might affect one or several technologies, as well as the body who can adopt this change.

5.1 Vessel technical requirements

A vessel operating on EU waterways or on the Rhine must carry either a Union inland navigation certificate or a Rhine vessel inspection certificate. Both certificates are issued by the competent national authorities (inspection bodies) and confirm the full compliance of the vessel with the European Standard laying down Technical Requirements for Inland Navigation vessels (ES-TRIN). This standard contains provisions on inland navigation vessel construction and equipment as well as special provisions for certain categories of vessels such as passenger or container vessels. The objective of these technical requirements is to guarantee a high level of safety in inland navigation, thereby also protecting the environment and the people on board. ES-TRIN is updated every two years by the European Committee for drawing up standards in the field of inland navigation (CESNI).

References to ES-TRIN are nowadays included in the legal frameworks of the EU and the CCNR, respectively directive (EU) 2016/1629[15] and Rhine vessel inspection regulations (RVIR)[16].

For inland navigation vessels on the Danube, the DC regularly updates the "Recommendations concerning technical requirements for inland navigation vessels"[17] which were initially based on the Resolution No 61 of the UNECE. Taking into account that currently 7 EU Member states of the DC and Serbia had already implemented ES-TRIN, while Ukraine and Moldova (as non-EU Member states) are planning to fully implement ES-TRIN into national legislation. DC suggests certain proposals to the ES-TRIN with regards to technical requirements that can be made based on the former DC's Recommendations, taking into account the specificity of the Danube fleet and navigational conditions.

[12] CESNI, "Standards and explanatory notices", 2022, https://www.cesni.eu/en/standards-and-explanatory-notices/.
[13] European Union, "Directive on the Transport of Dangerous Goods", 2008//68/EC, http://data.europa.eu/eli/dir/2008/68/oj.
[14] European Union, "Regulation on requirements relating to gaseous and particulate pollutant emission limits and type-approval for internal combustion engines for non-road mobile machinery", (EU)2016/1628, http://data.europa.eu/eli/reg/2016/1628/oj
[15] European Union, "Directive laying down technical requirements for inland waterway vessels", (EU) 2016/1629, http://data.europa.eu/eli/dir/2016/1629/oj.
[16] CCNR, "CCNR Regulations", 2022, https://www.ccr-zkr.org/13020500-en.html.
[17] Danube Commission, "Home Page", 2022, https://www.danubecommission.org/dc/en/.

As reflected in its work plan 2021[18], the International Sava River Basin Commission intends to create a reference to ES-TRIN in its legal framework.

The Recommendations on Harmonized Europe-Wide Technical Requirements for Inland Navigation Vessels (Resolution no 61)[19] adopted by the United Nations Economic Commission for Europe (UNECE) is regularly updated to follow the developments of ES-TRIN, but the major difference remains with the absence of transitional provisions for existing vessels[20]. It means in practice that EU Member States cannot fully apply the recommendations included in Resolution no 61 because they are less stringent than EU law.

ES-TRIN is generally designed for vessels using conventional diesel as fuel. For instance, its article 8.01(3) foresees that "Only internal-combustion engines burning fuels having a flashpoint of more than 55 °C may be installed." Article 8.05 includes safety requirements which are targeted for diesel tanks and piping. However, since its 2017 edition, ES-TRIN includes general provisions for low flash point fuels (Chapter 30) and one dedicated Annex 8 on liquefied natural gas (LNG). For the time being, other low flash point fuels (such as methanol or hydrogen) are not allowed in ES-TRIN. The edition 2021 of ES-TRIN includes Article 10.11 which regulates lithium-ion batteries (especially the design of rooms where such batteries are stored). The 2023 edition of ES-TRIN includes provisions for fuel cells.

ES-TRIN includes safety requirements for different types of propulsion systems, such as internal combustion engines, electric motors and hybrid systems. For example, internal combustion engines must comply with certain emission regulations to minimize air pollution (see Article 9.01(2)) and electric motors must have appropriate safety controls. However, ES-TRIN does not include provisions regarding energy efficiency of propulsion systems, nor about the overall efficiency of the vessel, in contrast to "Energy Efficiency Design Index (EEDI)" which is applied in the maritime sector. Details of such an EEDI methodology for inland vessels have been reviewed already and further information can be found in the PLATINA3 Deliverable D2.6[21].

Derogations from ES-TRIN remain possible in accordance with the Rhine vessel inspection Regulations (RVIR) or Directive (EU) 2016/1629. For example, on 17 June 2021, the CCNR adopted a derogation (so called "recommendation to the inspection body") for the motor vessel MAAS which aims to operate with hydrogen in a fuel cell.[22] On 16 January 2023, the CCNR adopted a derogation for the tank vessel STOLT IJSSEL which aims to operate with methanol in an internal combustion engine.

The acceptance of derogations relies mainly on the demonstration of their equivalent safety by a risk assessment but also complementary safety requirements. A guide describing in more detail the derogation procedure was published by CESNI in March 2019[23] with the objective to facilitate administrative procedures and actively support the greening of the fleet. More generally, a limited number of pilot vessels with alternative fuels are operating and several projects are ongoing to put innovative vessels into service.

Since July 2020, CESNI has mandated a temporary working group responsible for preparing the ES-TRIN amendments to allow the use of fuel cells but also the storage of methanol and hydrogen on board of inland vessels (CESNI/PT/FC). The chosen approach is for instance a combination of prescriptive rules and risk analysis (like the LNG rules currently in ES-TRIN) aiming a more prescriptive regulation after having gained more experience with the first vessels. Annex 8 of ES-TRIN was also reorganised to distinguish the question of the energy converter (engine or fuel cell) from that of

[18] ISRBC, work plan 2021, part navigation, item 1.1.6.
[19] UNECE, "Resolutions", 2022, https://unece.org/resolutions-1.
[20] ES-TRIN, Chapters 32 and 33, includes deadlines for regular upgrades of the existing vessels towards the latest safety standards.
[21] PLATINA3 Deliverable 2.6, February 2022: https://platina3.eu/wp-content/uploads/2022/11/220228_Deliverable-final-D2.6-Label-index-inland-vessels_public-2.pdf
[22] Future proof shipping, July 2021, https://futureproofshipping.com/news/2021/fps-secures-landmark-recommendation-from-the-ccnr-to-sail-on-hydrogen/
[23] CESNI, "Leaflet On Deliberation On Derogations And Equivalences Of Technical Requirements Of The Es-Trin For Specific Craft", March 2019, https://www.cesni.eu/wp-content/uploads/2019/04/Guide_Sp_craft_en.pdf.

storage. The revised Chapter 30 as well as the fuel cell requirements are included in ES-TRIN 2023 which could enter into force in January 2024. The regulatory work follows the timeline below:

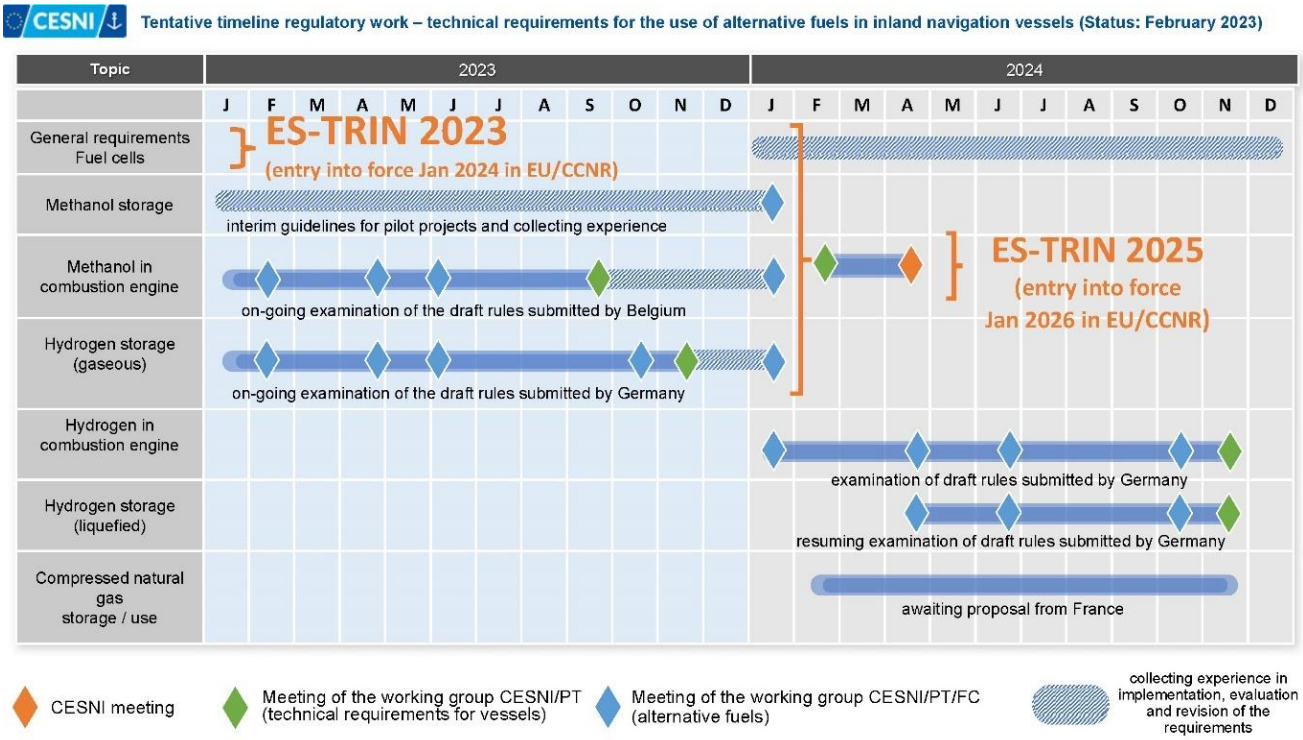

Fig 2. Timeline regulatory work – vessel technical requirements for the use of alternative fuels (source: CESNI, February 2023)

At the same time, the aforementioned recommendations of the DC, as well as resolution No 61 of the UNECE[24], do not contain provisions for vessels using alternative fuels, except LNG. But considering that all the Danube riparian states are in the process of implementing ES-TRIN, it can be assumed that there is no need to work on the elaboration of separate Chapters with regards to new fuel types in the structure of the "Recommendations concerning technical requirements for inland navigation vessels" of the DC.

5.2 Regulations on the transport of dangerous goods

Since the 19th century, specific rules for the transport of dangerous goods agreed upon at the CCNR are applicable on the Rhine (for example on explosives, poisonous or corrosive substances.). The ADNR regulation adopted in 1971 by the CCNR regulated the carriage of dangerous goods by inland vessels on the Rhine for decades and inspired corresponding regulations for other waterways in Europe.

On 26 May 2000, on the occasion of a diplomatic conference held under the joint auspices of the UNECE and the CCNR, the European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways (ADN)[25] was signed. In force since 29 February 2008, the ADN has replaced progressively the ADNR on the Rhine. References to the ADN are nowadays included in the legal

[24] UNECE, Resolution 61, 2019 https://unece.org/transport/standards/transport/recommendations-harmonized-europe-wide-technical-requirements-inland
[25] UNECE, "ADN 2021", January 2021, https://unece.org/transport/dangerous-goods/adn-2021.

frameworks of the EU and the CCNR (respectively directive 2008/68/EC[26] and CCNR resolution 2009-II-20[27]). In 2008, the ADN has also replaced previous regulations for dangerous goods transportation on the Danube River (ADN-D), which were adopted by the DC Member states to define conditions under which transportation of dangerous goods on the Danube can be performed.

The ADN contains provisions concerning classification of dangerous substances, their carriage in packages, containers and in bulk on board dry-cargo or tanker vessels, as well as provisions concerning the construction and operation of such vessels. The ADN aims at ensuring a high level of safety of international carriage of dangerous goods by inland waterways; contributing effectively to the protection of the environment by preventing any pollution resulting from accidents or incidents during such carriage; and facilitating transport operations and promoting international trade in dangerous goods. The ADN agreement has 19 contracting parties[28] and is updated every two years by the UNECE.

To transport dangerous goods by inland waterways (bulk, tank or container), a vessel must carry a certificate of approval issued by the competent national authorities (inspection bodies) in compliance with the provisions of the ADN. These vessels must be built under the supervision of a recognised classification society for its highest class. Only tanker vessels must maintain the highest class. The certificate of approval is supplemented by "a list of all the dangerous goods accepted for carriage in the tank vessel, drawn up by the classification society which has classified the vessel" (1.16.1.2.5).

The ADN is generally designed for vessels using conventional diesel as fuel. As in ES-TRIN, "only internal combustion engines running on fuel having a flashpoint above 55°C are allowed" for vessels falling in the scope of the ADN. However, it does not apply to internal combustion engines which are part of propulsion systems which comply with Chapter 30 and Annex 8 of ES-TRIN. This general exemption was introduced for LNG a few years ago but will remain applicable for other low flash point fuels. For the ADN 2021 this approach regarding propulsion systems was confirmed by the UNECE (ADN 7.1.3.31, 7.2.3.31, 9.3.1.31, 9.3.2.31.1, 9.3.3.31.1).

The ADN Safety Committee currently assesses the need for additional requirements for the ADN regarding innovative propulsion systems using alternative fuels[29].

Derogations to the requirements of the ADN can be accepted by international decision of the Administrative Committee of the UNECE. The list of derogations for innovative vessels is published on the UNECE website[30].

In the context of this report, the **focus of the analysis of the ADN is the propulsion system requirements.** The regulatory state-of-play for transport of alternative energy sources, as a cargo on board of inland vessels, are addressed in Annex 1. As addressed in the Deliverable 1.5 (Policy and regulatory actions encouraging and facilitating the use of IWT), to allow the transport of alternative energies (not yet covered by the ADN), it is necessary to amend the ADN rules regarding the design of storage tanks, pumping systems and signalisation systems for the detection of leaks or pressure decreases, etc…

5.3 Regulations applicable to engines or energy converters

Beyond the safety requirements for engine rooms of inland vessels, since 2003, the engines of inland vessels have been subjected to specific requirements in terms of emissions of air pollutants. The first limits of air pollutants were introduced in the RVIR in 2003 (so called CCNR stage I). These limits only

[26] European Union, "Directive on the inland transport of dangerous goods", 2008/68/EC, http://data.europa.eu/eli/dir/2008/68/oj.
[27] CCNR, "CCNR resolution 2009-II-20", 2009, https://www.ccr-zkr.org/files/documents/resolutions/ccr2009_IId.pdf.
[28] United Nations, "ADN Treaty – Contracting parties", https://treaties.un.org/Pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XI-D-6&chapter=11&clang=_en.

[29] See item 5 of minutes of the 41st meeting of the ADN Safety Committee, ECE/TRANS/WP.15/AC.2/84, https://unece.org/sites/default/files/2023-02/ECE-TRANS_WP.15-AC.2-84-clean%281%29.docx.
[30] UNECE, "ADN – Equivalences and derogations", 2022, https://unece.org/equivalences-and-derogations.

applied to newly installed engines onboard inland vessels. A few years later, the CCNR and the EU introduced jointly stringent emission limits in the RVIR and the Directive 2004/26/EC (so called CCNR II and EU IIIa). Taking effect as of 1 January 2019, new emission limits were introduced by the "NRMM Regulation" (EU) 2016/1628[31] (so called EU Stage V limits). The CCNR decided to align its regulatory framework and referred to this regulation. A summary of the successive limits of air pollutants emissions is given below for engines above 300 kW.

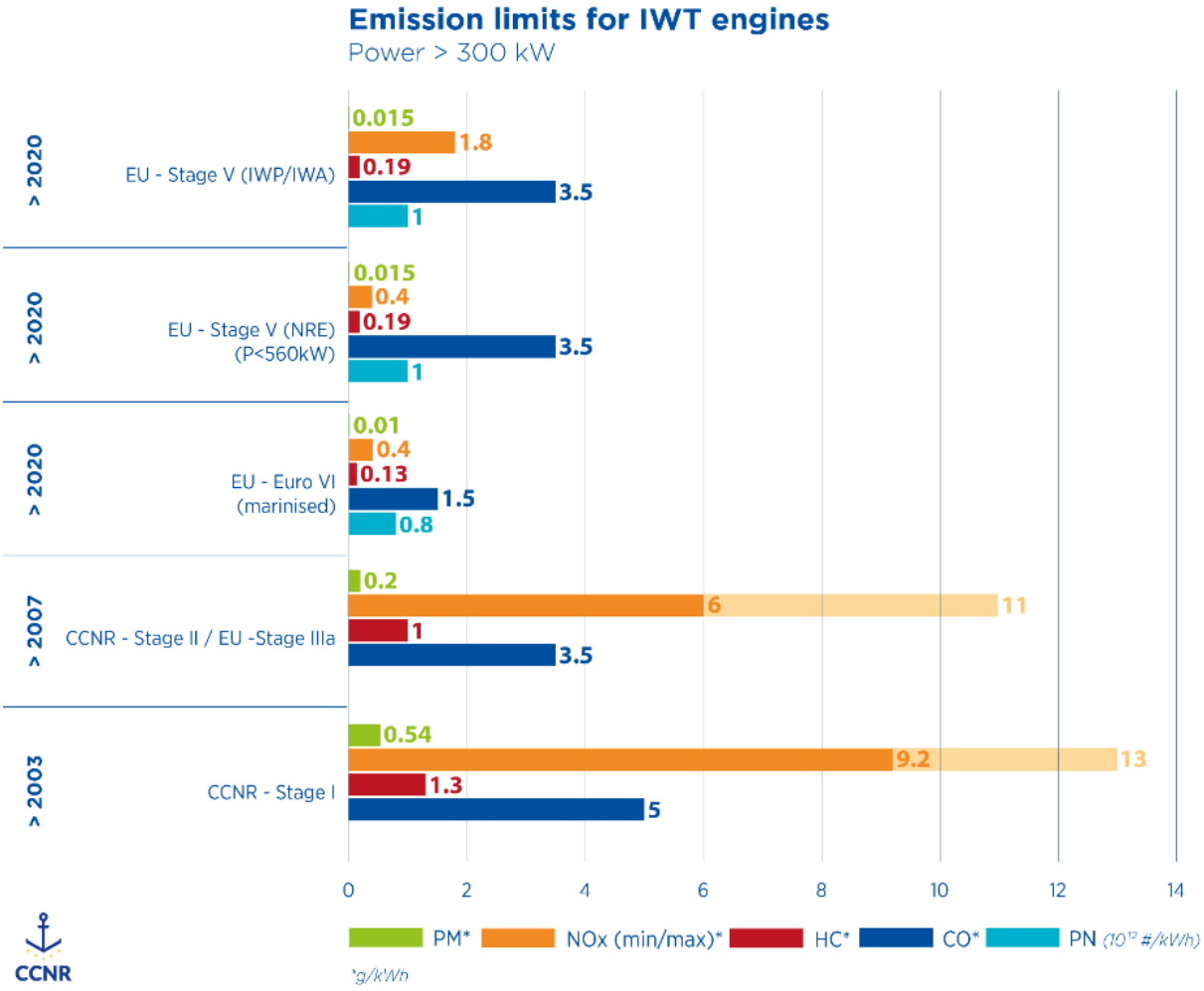

Fig 3. Summary of mandatory limits of air pollutants emissions (source: CCNR)

As pointed out in the EU funded RTD project Prominent (2015)[32], and still today as seen in recent study executed for the Municipality of Rotterdam[33], a large share of the European inland navigation fleet is equipped with engines installed before 2003. In Rotterdam for the month January 2022, recorded data showed that 64% of the unique visiting vessels are equipped with engine(s) pre-CCNR2 (built before 2007) while around 33% of the unique visiting vessels have one or more unregulated engine(s), built before 2003 thus having an age of at least 20 years. It needs to be noted that engines which were put on the market before year 2003 (pre-CCNR1, older than 20 years) are not subject to any emission limits because the emission requirements only apply to newly installed engines. It can be concluded that engines used for inland navigation have a relatively long technical lifetime and therefore the pace of

[31] European Union, "Regulation on requirements relating to gaseous and particulate pollutant emission limits and type-approval for internal combustion engines for non-road mobile machinery", (EU)2016/1628, http://data.europa.eu/eli/reg/2016/1628/oj.

[32] Prominent, D 1.2 List of best available greening technologies and concepts.

[33] See tables 10 and 32 in the following report made by CE Delft and published in February 2023: https://ce.nl/wp-content/uploads/2023/01/CE_Delft_220164_Maatregelen_verschoning_binnenvaart_Rotterdam_Def.pdf

emission reduction is relatively slow for example compared to emission reduction of heavy-duty vehicles.

Although NRMM Stage V does bring quite significant reductions on air pollutant emissions, the NRMM Regulation does not address the CO_2 emissions of internal combustion engines. It does also not have any requirement on the efficiency rate of engines.

Only in light of the development of LNG as a fuel for inland vessels, the NRMM Regulation includes specific provisions on total hydrocarbon (HC) limits for fully and partially gaseous-fuelled engines. The objective was notably to limit the emission of unburned methane (which is a GHG) from the combustion engine. Indeed, the experience gained with pilot vessels using LNG in first generation dual-fuel engines showed significant reductions of air pollutants but a slight increase of GHG in comparison with conventional CCNR II diesel engines. However, the monofuel gas engines currently installed in new vessels comply with the Stage V limits and do result in GHG savings of around 10% for fossil LNG compared to fossil diesel engines[34].

NRMM Regulation includes the possibility of field testing for non-type-approved engines (Article 34) and the legal basis for type-approval of engines with new technologies or concepts (Article 35). The implementation of these articles is intended for exemptions/pilots (pending a possible revision of NRMM regulation) and particularly relevant for the pilot vessels using methanol or hydrogen as fuel.

For the time being, there are no specific regulations for other energy converters, such as a gas turbines or fuel cells.

5.4 Classification rules

Classification is an important process of assessment of a vessel's condition and verification of its compliance with a wide set of technical requirements. The classification of inland navigation vessels is performed by classification societies in accordance with the rules they have published. There should be no confusion between the classification process and the statutory control in accordance with ES-TRIN. Contrary to the maritime sector, except for tanker vessels falling in the scope of the ADN or for high-speed vessels in accordance with ES-TRIN[35], the classification of inland vessels is not mandatory. Sometimes, ES-TRIN requires a specific attestation from a classification society (like for vessel longer than 110 meters in Article 28.03), without requiring that the vessel is classed.

In other words, only part of the fleet is built and surveyed in accordance with classification rules. The vessel certificate is issued by competent authorities, taking into account the attestations issued by the classification societies.

For innovative vessels, although this is not required by the regulation, classification societies are involved in almost all pilot projects. Indeed, they have special rules and expertise to handle the new technologies, provide assistance to perform the risk assessment required by ES-TRIN and ensure proper implementation of the risk mitigation measures in the design and building phases.

Nowadays, six classification societies are recognised by the EU in inland navigation in accordance with Directive (EU) 2016/1629: DNV, Bureau Veritas Marine & Offshore (BV), Lloyd's Register (LR), RINA, Polish Register of Shipping (PRS) and Croatian Register of Shipping (CRS). The list of classification societies recommended for recognition by the ADN Administrative Committee can be found on the UNECE website[36].

The classification rules and guidelines are a very valuable source for the development of pilot projects, while maintaining high levels of safety. As examples, the following recent publications (inland and

[34] CCNR Studies 2021, RQC2, table 1 https://www.ccr-zkr.org/files/documents/EtudesTransEner/Deliverable_RQ_C_Edition2.pdf
[35] ES-TRIN 2023, Article 29.01(3), https://www.cesni.eu/wp-content/uploads/2022/11/ES-TRIN23_signed_en.pdf
[36] UNECE, "List of classification societies recommended for recognition by the ADN Administrative Committee", 2022, https://unece.org/classification-societies.

maritime navigation) should be mentioned: LR's guidance notes for fuel system risk assessments, hazard identification – Hydrogen and Ammonia; DNV's Handbook for Hydrogen-Fuelled Vessels[37]; BV's Rules for methanol ships[38] and fuel cells[39] and RINA's Rules for hydrogen fuelled ships.

5.5 Gap analysis

The gap analysis summarised in the table below results from:

- a desk study of existing regulations and standards, in close cooperation with experts from the CCNR and the DC involved in the regulatory work;
- interviews and discussions (25th October 2022 with classification societies, EICB Innovation Lab partners in December 2022 / January 2023);
- the feedback collected during the third PLATINA3 stage event (10-11 February 2022)

When conducting this gap analysis for vessel design and propulsion systems, special consideration was also given to the documents produced by IMO in recent years, such as, for instance, the International Code of Safety for Ship Using Gases or Other Low-flashpoint Fuels (IGF Code)[40] or the interim guidelines for the safety of ships using methyl/ethyl alcohol as fuel[41].

The structure of the table follows the list of technologies identified in Chapter 4. For each energy carrier, a description of the identified gaps in ES-TRIN, NRMM, ADN and classification rules is provided, as well as possible actions to remedy these gaps. Moreover, it also includes at the top the missing regulations or standards which are common for all fuels. To avoid duplication of content, some cross-references are given between fuels (e.g. "same as diesel").

[37] DNV, "Handbook for Hydrogen-fuelled Vessels", 2022, https://www.dnv.com/maritime/publications/handbook-for-hydrogen-fuelled-vessels-download.html.
[38] Bureau Veritas, NR670 – Methanol & ethanol fuelled ships (edition August 2022) https://erules.veristar.com/dy/data/bv/pdf/670-NR_2022-08.pdf
[39] Bureau Veritas, NR547 – Ships using Fuel Cells (edition Jan 2022), https://erules.veristar.com/dy/data/bv/pdf/547-NR_2022-01.pdf
[40] IMO resolutions MSC.391(95) and MSC.422(98).
[41] IMO MSC.1/Circ.1621.

Fig 4. Gap analysis regarding the regulations and standards for vessel design and propulsion system

Technologies	Status of the technology in inland navigation	Main requirements (and foreseen amendments)	Identified gaps	Required actions
All			Need to facilitate the financing[42] and commissioning of pilot vessels No limits on CO2e emissions contrary to air pollutants emissions (besides methane slip for methane fuelled combustion engines). No limits on energy efficiency	1) EC, CCNR, national administrations should continue to facilitate the financing and commissioning of pilot vessels using alternative technologies, provided that the experience collected is shared to feed in the regulatory work. 2) CESNI, EC, CCNR should investigate the opportunity to introduce efficiency and greenhouse gas emission limits, possibly both for existing vessels and newly built vessels, in line with emission reduction targets[43]
Diesel	Regular fuel	ES-TRIN: Chapters 8 and 9, as well as Chapter 11 for diesel electric propulsion systems. Clarification for the replacement or repair of existing engines are included in the new Article 9.10 in ES-TRIN 2023.	-	3) CESNI and EUROMOT should continue to regularly update their FAQ document to help those involved with the inland waterways transport sector to understand and interpret the applicable requirements to engines in the light of the new requirements for non-road mobile machinery (NRMM) as well as ES-TRIN.

[42] One member of the advisory board pointed out that the current Guidelines on State aid for climate, environmental protection and energy (CEEAG based on taxonomy criteria) may hinder financing of vessels using alternative propulsion systems. Reference is made to the following criteria: "an inland vessel for freight transport that has direct (tailpipe) emissions of CO2 per tonne kilometre (gCO2/tkm), calculated (or estimated in case of new vessels) using the International Maritime Organization Energy Efficiency Operational Indicator (EEOI), that are 50 % lower than the average reference value for emissions of CO2 determined for heavy-duty vehicles (vehicle subgroup 5-LH) in accordance with Article 11 of Regulation (EU) 2019/1242". The unadjusted approach of the IMO contains the risk that no funding projects could be implemented. Due to the scale effects, large inland vessels achieve a more favourable g CO2/tkm ratio than that of small inland vessels. The variety of EEOI values will be much wider than is the case for any other defined vehicle class (such as truck). It is therefore important to develop uniform assumption and comparable boundary conditions. In general, the criteria in the CEEAG are based on the taxonomy which needs to have practically applicable and future proof criteria.

[43] See CCNR, DC and EC targets in Chapter 3

		NRMM: emission limits and testing requirements for putting on the market engines of categories IWP (propulsion) and IWA (auxiliary), as well as equivalent (especially[14] marinized NRE and Euro VI engines).	NRMM Regulation includes a review clause requiring the EC produce a report by 31 Dec. 2025. The outcome of this review cannot be pre-empted. It might address the limits applied to inland waterways (including the 'A' factor), the results from the Stage V in-service monitoring (ISM) programme and the extent to which the existing type-approval tests (inclusive of the existing test cycles) correspond to real engine operating conditions. No limits for existing engines (fleet). Unclarity regarding the requirements in terms of inducement strategy (reduction of engine power in case NOx reduction system failure of malfunctioning) for marinized engines, especially NRE. In June 2022, CESNI considered that deactivation of engine inducement of this marinized engines is not required for safety reasons and sent proposals to the EC.	4) EC should review opportunity to further reduce exhaust emission limits for inland waterways vessels, taking account of existing related Union and international standards and propose any necessary legal changes. 5) EC, CCNR, CESNI should consider introducing a phasing out of existing engines in ES-TRIN to achieve minimum air pollutant emission standards[44] 6) EC, in close cooperation with CESNI and EUROMOT, should clarify the accepted inducement strategies for marinized engines 7) EC should review the extent to which the engine emissions measured during type-approval tests using corresponding test cycles reflect engine emissions in real operating conditions and propose any necessary changes.
		ADN: combustion engines running on fuel having a flashpoint above 55°C are allowed (7.1.3.31, 7.2.3.31, 9.3.1.31, 9.3.2.31.1, 9.3.3.31.1)	-	-
		Classification rules: specific classification type approval of all engine components, including crankshaft	IWP/IWA engines are often identical for maritime and IWT markets. In addition to their emission type-approval in accordance with NRMM, these engines have received a class type-approval certificate for installation in sea-going vessels. This class	8) Engine manufacturers in cooperation with classification societies should certify the marinized engines to allow their use on board vessels transporting dangerous goods

[44] For example, include an obligation to reaching certain emission standards at certain time period (e.g. Stage V emission limit performance to be reached by the year in 2035 for all of the fleet)

			certificate is needed for engines of vessels transporting dangerous goods (which are mandatory classed or built in accordance with class rules). For [15] marinized engines (NRE or Euro VI), this class certificate could be obtained (ex. NPS Diesel with LR) but requires action from the engine manufacturer.	
LNG / LBM	Regular fuel	ES-TRIN: Chapter 30 and Annex 8, as well as Chapter 11 for gas electric propulsion systems. NRMM: emission limits and testing requirements for putting on the market engines of categories IWP (propulsion) and IWA (auxiliary), as well as equivalent. Specific provisions on total hydrocarbon (HC) limits for fully and partially gaseous-fuelled engines (factor A of emission limits). ADN: Reference to ES-TRIN for propulsion systems with combustion engines (7.1.3.31, 7.2.3.31, 9.3.1.31, 9.3.2.31.1, 9.3.3.31.1) Classification rules: specific classification type approval of all engine components, including crankshaft.	Same as diesel	9) EC should evaluate the need to lower the factor A of emission limits for gas engine in NRMM in order to increase the climate performance of LNG propulsion systems
HVO/advanced biofuels/e-fuels	Regular fuel	ES-TRIN: Same as diesel NRMM: Same as diesel. There are different reference fuels for type approval (see point 1.2.2 of Annex I of Regulation 2017/654). It can be EN 590 (which is a road standard) or “non-road diesel” as described in point 1.1 of Annex IX	Same as diesel	-

		of Regulation 2017/654. For these fuels, the engine manufacturer shall not indicate the fuel in the type-approval certificate. The characteristics of HVO fuels (EN15940 standard) are in line with the characteristics of the reference fuel "non-road diesel" of NRMM. Thus the use of HVO in a stage V engine is allowed without it having to be mentioned in the type-approval certificate as it is a reference fuel. However, fuels with FAME blend > 7% do not comply with the characteristics of the "non-road diesel". EN 590 also includes an 8% blending limit. So additional tests must be conducted to certify the engine with a higher share of FAME. For instance, the use of B20, B30, B100 fuels must be mentioned on the type-approval certificate (point 1.2.3 of Annex I of Regulation 2017/654). ADN: Same as diesel Classification rules: Same as diesel		
Battery	Lithium-ion batteries (LIB) are almost regular energy carrier in inland navigation, but the collection of experience could lead to improvement of the regulatory framework. It does not anticipate the development of	ES-TRIN: Article 10.11 for batteries, including safety requirements for lithium-ion batteries (LIB) and associated rooms. A fire protection concept is required, having regard to the other equipment located in the same room, the LIB manufacturer's instructions and the thermal runaway issues. Chapter 11 for electric propulsion systems. CESNI committed to follow the implementation of the requirements for the use of LIB (task PT-19 of its 2022-2024 work	ES-TRIN Article 10.11(2) forbids the installation of batteries for the propulsion in the cargo holds. On-going discussion within CESNI/CCNR to clarify the possible location of swappable battery containers, especially considering the risks of external damages. For the time being, the regulations and standards only addressed the LIB. It does not anticipate the development of other types of batteries (for which the	10) CESNI should evaluate the requirements for LIB after several years, especially the safety issue of combination of LIB with other energy sources. 11) In the light of experience gained with pilot vessels, CCNR/CESNI should develop provisions to allow the swappable battery containers for the propulsion at several locations on board, especially considering the risks involved. 12) CESNI should monitor the development in the use of batteries for propulsion and anticipate the spreading of type of batteries other than LIB.

	other types of batteries.	programme). It might lead to revision of Article 10.11(17).	corresponding safety risks are not yet known)	
		NRMM: not relevant	-	-
		ADN: 1.1.3.7 exempts the carriage of electric energy storage and production systems (e.g. Lithium-ion batteries, electric capacitors, asymmetric capacitors, metal hydride storage systems and fuel cells) for the vessel's propulsion system Vessel only powered by LIB shall be assigned as UN 3171 battery-powered vehicle. LIB installed in cargo transport unit shall be assigned as UN 3536.	-	-
		Classification rules: dedicated safety rules for LIB systems (for example LR: Pt 6, Ch 2, 12 Batteries of the Rules and Regulations for the Classification of Ships, July 2022). Type-approval required for LIB system with capacity of 20 kWh and more.	-	-
H2 in fuel cells / H2 in internal combustion engines (ICE)	Hydrogen not allowed as fuel	ES-TRIN: Chapter 30 and Annex 8. Edition CESNI reviewed the general requirements for the use of low flash point fuels and developed specific requirements for hydrogen fuel cells in ES-TRIN 2023. The requirements for the storage of compressed and liquified hydrogen are expected to be included in ES-TRIN 2025.	Storage requirements for liquefied and compressed hydrogen are missing. CESNI has started the examination of draft requirements for both types of storage in 2022, taking into the experience with pilot projects. One major change is the approval of the tanks which are often from other transport or industrial sectors and do not comply with the safety requirements for the operation of vessels (ie absence of safety valves). The experience collected with pilot projects is particularly useful in this context.	13) With the help of classification societies, CESNI could collect experience regarding the approval of the hydrogen tanks and the relevant standards for other industrial sectors 14) CESNI should finalise the requirements for the compressed and liquefied storage of hydrogen , involving field experts via sector associations

			Safety requirements for the use of hydrogen in ICE and associated engine rooms are missing. They could be developed by analogy with those for natural gas in engine rooms. For the time being the majority of projects of inland vessels are currently based on swappable cylinders or specific containers concepts, with pressurised hydrogen. According to the Kick-start study of the RH2INE project, the use of hydrogen carriers is considered to be a long-term scenario (10-20 years)[45]. At the same time, the industry expressed interests for other carriers such as Liquid organic hydrogen carrier (LOHC)[46].	
		NRMM: CESNI questioned the EC regarding the scope of application of the NRMM for combustion engines using alternative fuels. The EC clarified this as follows: "engines installed before 2003 are permitted to use any fuel because they have no type approval nor emissions limits. For new engines on the other hand, the requirements have not yet been defined. Following EC's proposal, a task force with experts from Member States and EUROMOT is in charge to develop guidelines for the implementation of Articles 34 and 35 of NRMM. At mid-term, a revision of the NRMM is needed for engines using hydrogen as fuel.	NRMM Articles 34 and 35 are for pilots or exceptional cases. If the EC considers the use of alternative fuels in internal combustion engines as important, an extension the NRMM must be initiated. Timing is also crucial in order not to hinder developments. NRMM Article 35 provides limited legal certainty for manufacturers to make the necessary investments.	15) In cooperation with EC, EUROMOT and CESNI should develop guidelines for the implementation of Articles 34 and 35 of NRMM for engines using hydrogen as fuel (pending a revision of NRMM). 16) In cooperation with EUROMOT, CESNI should start the development of safety requirements for hydrogen in combustion engine

[45] RH2INE, Kickstart Study, Regulatory and Safety Analysis, https://www.rh2ine.eu/wp-content/uploads/2021/10/RH2INE-Kickstart-Study-Regulatory-and-Safety-Analysis-Regulatory-and-Standards-Gap-Assessment.pdf

[46] For example, Hydrogenius along the Danube - https://www.hydrogenious.net/index.php/en/.

		ADN: Reference to ES-TRIN for propulsion systems with combustion engines (7.1.3.31, 7.2.3.31, 9.3.1.31, 9.3.2.31.1, 9.3.3.31.1).	Reference limited to LNG systems. Fuel cells not allowed.	17) When ES-TRIN is updated, ADN Safety committee (UNECE) could confirm that hydrogen is accepted for propulsion system of vessels carrying dangerous goods (the reference from ADN to ES-TRIN seems sufficient). 18) CESNI should monitor the development in the hydrogen carriers
		Classification rules: Classification societies have developed rules for hydrogen fuelled vessels, including the use of fuel cells (for example BV's NR547).	-	
Methanol in fuel cells / Methanol in internal combustion engines (ICE)	Methanol not allowed as fuel	ES-TRIN: Chapter 30 and Annex 8. CESNI reviewed the general requirements for low flash point fuels and developed specific requirements for the use of methanol in fuel cells in ES-TRIN 2023. In June 2022, CESNI approved the draft requirements for methanol storage, as "interim guidelines". Their aim is to facilitate the examination of derogations for pilot projects, pending revision and inclusion in the draft ES-TRIN 2025.	CESNI finalised draft requirements and decided to collect experience before revision and inclusion in the draft ES-TRIN 2025. Specific attention was paid to the design of the tanks (inerted / non-interted) as well as the leakages in normal operation or after collision. The experience gained with pilot projects (such as the tugboat in the Port of Antwerp-Bruges) was also taken into account. Safety requirements for the use of methanol in ICE and associated engine rooms are missing. CESNI is currently preparing draft requirements.	19) CESNI should finalise the requirements for the storage of methanol and its use in combustion engines (ES-TRIN 2025), involving field experts via sector associations
		NRMM: Methanol is not one of the standard fuel foreseen in the NRMM and probably require change of components of engines designed to run with diesel. Following EC's proposal, a task force with experts from Member States and EUROMOT is in charge to develop guidelines for the implementation of Articles 34 and 35 of NRMM. At mid-term, a revision of the	NRMM Articles 34 and 35 are for pilots or exceptional cases. If the EC considers the use of alternative fuels in internal combustion engines as important, an extension the NRMM must be initiated. Timing is also crucial in order not to hinder developments.	20) In cooperation with EC, EUROMOT and CESNI should develop guidelines for the implementation of Articles 34 and 35 of NRMM for engines using methanol as fuel (pending a revision of NRMM).

		NRMM is needed for engines using methanol as fuel.	NRMM Article 35 provides limited legal certainty for manufacturers to make the necessary investments.	21) When ES-TRIN is updated, ADN Safety committee (UNECE) could confirm that methanol is accepted for propulsion system of vessels carrying dangerous goods (the reference from ADN to ES-TRIN seems sufficient).
		ADN: Reference to ES-TRIN for propulsion systems with combustion engines (7.1.3.31, 7.2.3.31, 9.3.1.31, 9.3.2.31.1, 9.3.3.31.1).	Reference limited to LNG systems. Fuel cells not allowed.	
		Classification rules: Classification societies have developed rules for methanol (for example BV's NR670 for Methanol & ethanol fuelled ships or RINA Class Rules for Methyl/ethyl alcohol fuelled ships)	-	

Remarks

1) The possible combination of technologies on board should not be overlooked by the regulations and standards, as it leads to combine different risks and requires the appropriate mitigation measures. For instance, vessels equipped with fuel cells often rely on batteries for the peak shaving of the energy demand, as fuel cells work better at constant power.

2) The new requirements introduced in ES-TRIN 2023/1 combine goal oriented and prescriptive requirements. The safety objectives are described as well as several "state-of-the-art" solutions fulfilling the safety objectives. Such approach supports the innovation by allowing new technical solutions and recognising technical solutions which are already available.

3) **Annex 2** provides the same gap analysis but using the regulations/standards as content breakdown.

6 Fuel sources and characteristics (incl. blending) – Overview and gap analysis

Two regulatory environments are considered under this Chapter:
- the Fuel Quality Directive (Directive 98/70/EC[47]);
- the Renewable Energy Directive or REDII (Directive (EU) 2018/2001[48]), taking into account the proposals of revision in the Fit for 55 package;

They have influence on the availability of certain types of fuels, notably biofuels.

Furthermore, the Fit-for-55 package was analysed as regards the emission reduction policies for the other modes in view of greenhouse gas reductions.

6.1 Fuel Quality Directive

The EU Fuel Quality Directive 98/70/EC of 13 October 1998 was first launched with the objectives of ensuring the quality of petrol and diesel fuels. The strict quality requirements are imposed within the EU for petrol and diesel fuels used in road transport and also non-road mobile machinery (including inland waterway vessels) to protect human health and the environment. One of the key underlying reasons for the adoption of the 1998 FQD was to rule out the marketing of leaded petrol for all Member States and for diesel fuels complying with key environmental specifications such as cetane number, density, distillation, polycyclic aromatic hydrocarbons (PAHs), and sulphur content.

The FQD sets, in respect of road vehicles and non-road mobile machinery (**including inland waterway vessels when not at sea**):
- technical specifications for fuels to be used in combustion engines (both positive-ignition and compression-ignition engines), taking account of the technical requirements of those engines; and
- a target for the reduction of life cycle greenhouse gas emissions.

The FQD applies to:
- petrol, diesel and biofuels used in road transport
- **gasoil (diesel) used in non-road-mobile machinery (including inland waterway vessels)**[49]

Since 2009, the FQD gives the possibility to Member States to permit the placing on the market of diesel with a fatty acid methyl ester (FAME) content greater than 7 % (Article 4(1)). In this context, the Member States shall ensure the provision of appropriate information to consumers concerning the biofuel, in particular FAME, content of diesel fuel. It is relevant to note here, however, that the EN590 standard specifies a maximum FAME content of 7%. Furthermore, EN590 diesel is used as reference fuel for CCR1 and 2 type approved engines.

From January 2011, FQD introduces a maximum permissible sulphur content of gas oils intended for use by non-road mobile machinery (including inland waterway vessels) of 10 mg/kg. However, in order to accommodate minor contamination in the supply chain, Member States may permit gas oil to contain up to 20 mg/kg of sulphur at the point of final distribution to end users. This regulation on very low sulphur gas oils is a major difference between inland navigation and maritime navigation (for which the requirements are less stringent still).

[47] European Union, "Directive 98/70/EC on the quality of petrol and diesel fuels, 98/70/EC, https://eur-lex.europa.eu/eli/dir/1998/70/oj.
[48] European Union, "Directive on the promotion of the use of energy from renewable sources", 2018/2001, http://data.europa.eu/eli/dir/2018/2001/oj.
[49] Article 2(3): "gas oils intended for use by non-road mobile machinery (**including inland waterway vessels**), agricultural and forestry tractors, and recreational craft" means any petroleum-derived liquid, falling within CN codes 2710 19 41 and 2710 19 45, intended for use in compression ignition engines referred to in Directives 94/25/EC, 97/68/EC and 2000/25/EC".

Article 7a of the FQD requires a reduction of the greenhouse gas intensity of transport fuels by a **minimum of 6% by 2020**[50]. Member States are obliged to ensure that suppliers respect the target of 6% after the year 2020. The monitoring and reporting obligations relating to greenhouse gas emissions intensity also remain applicable after 2020.

In the FQD, the greenhouse gas intensity of fuels is calculated on a life-cycle basis, covering emissions from extraction, processing and distribution. Emissions reductions are calculated against a 2010 baseline of 94.1 gCO2eq/MJ[51]. The 6% reduction target (88.45 gCO2eq/MJ) is likely to be achieved primarily through:

- **the use of biofuels, electricity, less carbon intense fossil fuels, and renewable fuels of non-biological origin (such as e-fuels);**
- a reduction of upstream emissions (such as flaring and venting) at the extraction stage of fossil feedstocks.

It is up to the individual EU Member States to devise their own laws on how to reach the specified 6% GHG intensity reduction target for the transport of fuels sold in their country. Considering the REDII, the road and rail transport sector are already addressed with targets for the share of renewable energy[52]. Therefore, a Member State can decide to achieve higher targets for the share of renewable energy in other modes, and not to impose GHG intensity reduction requirements to fuel suppliers active in IWT. Moreover, Article 7a(5) opens the possibility for a group of suppliers to choose to meet jointly the reduction obligation (in such case they shall be considered as a single supplier) which gives leeway to redistribute the targets as well.

As example, The Netherlands initially intended to implement FQD with specific targets to fuel suppliers active in inland waterway transport (IWT) by 1 January 2023. The idea was to implement an obligation for those suppliers to purchase 'renewable energy tickets' from other suppliers having a ticket excess or to supply IWT with renewable fuels (for example FAME, HVO). However, the Dutch Ministry of Infrastructure and Water Management[53] decided to postpone this requirement of the blending of biofuels beyond 1 January 2023 after discussions with Belgium, Germany and the EC to ensure a level playing field. These discussions showed that Belgium and Germany are not unwilling to introduce the reduction obligation and support the sustainability challenge for inland navigation. In Germany in particular, however, the decision has yet to be made at the political level, and if it is positive, the German legislation will have to be amended. This has not been settled in Germany by 1 January 2023. For this reason, the Netherlands decided not to introduce the expansion of the scope of the mandatory system of imposing renewable energy tickets to fuel supplied to IWT on 1 January 2023 either, in order to ensure a level playing field. However, IWT fuel supply will be in scope of the calculation of the fuel volume for which The Netherlands, as a Member State, must achieve the 6% greenhouse gas intensity reduction target. This means that other modes shall compensate for the exclusion of IWT by means of reaching higher reduction levels. Consequently, the other areas of transport will bear the costs for achieving this goal on national level.

[50] Article 7a(2): "2. Member States shall require suppliers to reduce as gradually as possible life cycle greenhouse gas emissions per unit of energy from fuel and energy supplied by up to 10 % by 31 December 2020, compared with the fuel baseline standard et out in Annex II to Council Directive (EU) 2015/652. That reduction shall consist of: (a) **6 % by 31 December 2020**. Member States may require suppliers, for this reduction, to comply with the following intermediate targets: 2 % by 31 December 2014 and 4 % by 31 December 2017; […]"

[51] Council Directive (EU) 2015/652 of 20 April 2015 laying down calculation methods and reporting requirements pursuant to Directive 98/70/EC of the European Parliament and of the Council relating to the quality of petrol and diesel fuels

[52] Renewable Energy – Recast to 2030 (RED II), JRC, January 2023, https://joint-research-centre.ec.europa.eu/welcome-jec-website/reference-regulatory-framework/renewable-energy-recast-2030-red-ii_en

[53] Letter to Parliament on the state of play of the introduction of biofuels in inland navigation, July 2022, https://www.rijksoverheid.nl/documenten/kamerstukken/2022/07/01/uitstel-invoering-reductieverplichting-in-de-binnenvaart-en-stand-van-zaken-vervolgonderzoek-gebruik-van-biobrandstoffen-in-de-binnenvaart.

In Germany, the Fuel Quality Directive (FQD) has been implemented in the 10th Federal Emission Control Regulation[54]. Only standardised fuels are permitted for being distributed on the market. The objectives of the FQD are also implemented in the Federal Emission Control Act through the greenhouse gas reduction quota (implementation of RED II). There are no mandatory blending rates in Germany. Fuel suppliers have to fulfil a greenhouse gas reduction quota of 25% in their fuels supplied to road and rail transport by 2030. Maritime shipping and inland navigation are not covered by the greenhouse gas reduction quota.

France implemented a system called TIRUERT as "incentive tax on the use of renewable energy in transport" in the Customs Code[55]. It sets a target[56] for the use of renewable energy in transport beyond which the amount due under this tax is equal to zero for the taxpayer. This is an incentive mechanism whose main objective is not the payment of the tax but to induce a change in the behaviour of taxpayers (mainly fuel suppliers) and to improve the use of renewable energy in transport. Inland navigation is not covered by the TIRUERT system.

The TIRUERT system applies to total volumes, so it does not prejudge the availability of biofuels throughout the country. Only biofuels or fuels of renewable origin that meet strict sustainability criteria can be taken into account for the calculation of the tax rate reduction of TIRUERT (biofuels from palm plants are banned from 2020 onwards, while those from soy are banned from 2022 onwards). The supply of electricity to road transport via public charging stations has made it possible to generate credits for reducing the TIRUERT. Given the availability of resale credits for biofuels that go beyond the target (8.6% incorporation), this helps to lower the price of sustainable biofuels on the market.

In addition, the proposed revision of the Renewable Energy Directive, Directive (EU) 2018/2001 (REDII) brings additional uncertainties and higher risks of distortion of the level playing field between the fuel suppliers at the EU level. The EC's proposal is to raise the GHG intensity reduction target for transport fuels from 6% (FQD) to 13% from 2025 onwards. However, similar to FQD, the EC leaves freedom at the level of individual Member States to decide how to reach their national target. Without coordination between Member States, there can be significant discrepancies between how EU Member States want to implement the revised REDII. This may again lead to an exclusion to put specific obligations in place to fuel suppliers active in IWT.

To be noted that, if a Member State decides not to impose GHG intensity reduction requirements to fuel suppliers active in IWT, it needs to achieve higher targets for the share of renewable energy in other modes to compensate.

More information about the REDII revision is being presented in the next section.

(The FQD has always had strong interactions with the RED. In fact, a new EU Directive 2015/1513 amended and harmonized both the FQD (98/70/EC) and RED (2009/28/EC) in terms of sustainability criteria and ILUC (indirect land use change) emissions requirements. The harmonisation of the RED and FQD made sense as they focused on the renewable energy replacement and GHG emissions savings, respectively. The two key aims need to be harmonised to prevent having dual narratives which are conflicting.)

[54] Zehnte Verordnung zur Durchführung des Bundes-Immissionsschutzgesetzes*)**) (Verordnung über die Beschaffenheit und die Auszeichnung der Qualitäten von Kraft- und Brennstoffen - 10. BImSchV), 08.12.2010 https://www.gesetze-im-internet.de/bimschv_10_2010/BJNR184900010.html

[55] Code des douanes, Article 266 quindecies, 30.12.2022, https://www.legifrance.gouv.fr/codes/article_lc/LEGIARTI000037993315/2023-01-30/

[56] An increase in the TIRUERT incorporation targets for diesel from 8.4% to 8.6% entered into force on 1 January 2023.

6.2 Renewable Energy Directive II and the proposed revision

Renewable Energy Directive II

The RED II is a recast of the Directive 2009/28/EC (RED I) and established a common framework for the promotion of energy from renewable sources in the EU. It set a binding target of 32 % for the overall share of energy from renewable sources in the EU's gross final consumption of energy in 2030. It also established sustainability and GHG emissions saving criteria for biofuels, bioliquids and biomass fuels, and lays down rules on financial support to enhance the use of renewable energy usage.

One element in the "Fit for 55" package is the revision of the RED II to help the EU deliver the new 55 % GHG reduction target by 2030[57]. The proposal for a revision of RED II strengthens the EU target with a minimum 40 % share of renewable energy sources in final energy consumption by 2030, together with new sectoral targets.

Regarding REDII, the following two Articles (25 and 27) capture the essence in relation to renewable energy in the transport sector:

"Article 25 "Mainstreaming renewable energy in the transport sector

1. In order to mainstream the use of renewable energy in the transport sector, each Member State shall set an obligation on fuel suppliers to ensure that the share of renewable energy within the final consumption of energy in the transport sector is at least 14 % by 2030 (minimum share) in accordance with an indicative trajectory set by the Member State and calculated in accordance with the methodology set out in this Article and in Articles 26 and 27"

…

"Member States may exempt, or distinguish between, different fuel suppliers and different energy carriers when setting the obligation on the fuel suppliers, ensuring that the varying degrees of maturity and the cost of different technologies are taken into account."

…

"The greenhouse gas emissions savings from the use of renewable liquid and gaseous transport fuels of non biological origin shall be at least 70 % from 1 January 2021."

[57] https://www.europarl.europa.eu/thinktank/en/document/EPRS_BRI(2021)698781

"Article 27

Calculation rules with regard to the minimum shares of renewable energy in the transport sector

1. For the calculation of the minimum shares referred to in the first and fourth subparagraphs of Article 25(1), the following provisions shall apply:

*(a) for the calculation of the denominator, that is the energy content of **road- and rail- transport fuels** supplied for consumption or use on the market, petrol, diesel, natural gas, biofuels, biogas, renewable liquid and gaseous transport fuels of non-biological origin, recycled carbon fuels and electricity supplied to the **road and rail transport** sectors, shall be taken into account;*

(b) for the calculation of the numerator, that is the amount of energy from renewable sources consumed in the transport sector for the purposes of the first subparagraph of Article 25(1), the energy content of all types of energy from renewable sources supplied to all transport sectors, including renewable electricity supplied to the road and rail transport sectors, shall be taken into account. Member States may also take into account recycled carbon fuels.

2. For the purposes of demonstrating compliance with the minimum shares referred to in Article 25(1):

(a) the share of biofuels and biogas for transport produced from the feedstock listed in Annex IX may be considered to be twice its energy content;

(b) the share of renewable electricity shall be considered to be four times its energy content when supplied to road vehicles and may be considered to be 1,5 times its energy content when supplied to rail transport;

(c) with the exception of fuels produced from food and feed crops, the share of fuels supplied in the aviation and maritime sectors shall be considered to be 1,2 times their energy content. "

Article 27 shows that all transport sectors are considered for the calculation of the numerator and hence the overall equation, this also includes Inland Waterway Transport.

RED 2 Revision FF55

The following text boxes present the relevant articles in the EC proposal for revision for RED II (part of Fit for 55 package) of the in view of impact on Inland Waterway Transport.

Article 1(14) amends Article 25(1) REDII by increasing the ambition level of renewables in transport by setting a 13% greenhouse gas intensity reduction target, increasing the subtarget for advanced biofuels from at least 0.2 % in 2022 to 0.5% in 2025 and 2.2 % in 2030, and introducing a 2.6% sub-target for RFNBOs.

Article 1(15) amends Article 26 REDII to reflect the greenhouse gas intensity target set in transport.

Article 1(16) amends Article 27(1) REDII by setting out rules to calculate both the reduction of the greenhouse gas intensity of fuels achieved by the use of renewables in transport and the targets for advanced biofuels and biogas and renewable fuels of non-biological origin. Article 1(16) deletes Article 27(2) REDII to remove the multipliers associated to certain renewable fuels and to renewable electricity used in transport. Article 1(16) amends Article 27(3) REDII to delete the additionality framework for electricity in transport and to make the provisions on the calculation of renewable fuels of non-biological origin produced from electricity apply regardless of the sector in which such fuels are consumed.

'1a. For the calculation of the targets referred to in Article 25(1), first subparagraph, point (b), the following rules shall apply:

(a) for the calculation of the denominator, that is the amount of energy consumed in the transport sector, all fuels and electricity supplied to the transport sector shall be taken into account;

(b) for the calculation of the numerator, the energy content of advanced biofuels and biogas produced from the feedstock listed in Part A of Annex IX and renewable fuels of non-biological origin supplied to all transport modes in the territory of the Union shall be taken into account;

(c) the shares of advanced biofuels and biogas produced from the feedstock listed in Part A of Annex IX and of renewable fuels of non-biological origin supplied in the aviation and maritime modes shall be considered to be 1,2 times their energy content.';

In summary, EC's proposal in the FF55 package aims at

- Changing from setting a minimum share of renewable energy to achieving a carbon intensity reduction objective taking into account the Well-to-Wake carbon intensity values for energy types
- Introducing an objective to reduce $CO_{2\,eq}$ per MJ for energy supply to transport with 13% in 2030 compared to the 2010 reference value as known from the Fuel Quality Directive.
- Ensuring that all modes of transport are addressed equally, thus also fuel delivered to IWT must be taken into account in the national quotation. However, this does not mean that also for IWT there are measures to be imposed to suppliers of energy/fuels to IWT. Member States can decide themselves how to reach the overall reduction target and whether or not to include specific measures for IWT. The experience with FQD however shows that specific measures for IWT were not implemented so far by countries like Belgium, Germany and The Netherlands.

In order to prevent issues with distortion of level playing field and thus ineffective policy, a reinforced coordination between Member States is recommended by PLATINA3. This concerns in particular coordination between neighbouring Member states (or within a corridor) with significant inland transport intensities and fuel supply to inland vessels. Preferably the coordination takes place on the level of River Commissions (Rhine, Danube, Moselle, Sava).

Comparison Fit-for-55 as regards regulatory developments for fuel supply

Given the clear absence and the uncertainty with respect to the RED 2 revision and impact on IWT, there may be a need to propose specific additional regulatory measures for IWT specifically. In this respect it is interesting to see what is being proposed, discussed and implemented for other modes of transport.

Here, inspiration can be found in the FuelEU Maritime proposal in Fit-for-55[58], which proposed to introduce strict carbon intensity levels of fuels provided to seagoing vessels. PLATINA3 recommends investigating if a similar regulatory framework can be developed for inland vessels, e.g. a "FuelEU IWT" because the IWT and maritime markets might have overlap in some regions and ports.

In addition, also the inclusion of Inland Waterway Transport in the Emission trading scheme (ETS) can be considered as potential solution, similar to what is proposed in Fit-for- 55 for road transport[59]. Arranging this via the fuel suppliers has the advantage that it reduces administrative costs for inland vessel owners/operators and ETS impact will be reflected in the energy prices and thus creates an incentive to use renewable fuels with low/zero carbon intensity.

6.4Fuel types and fuel quality specifications

FQD allows non-road-mobile machinery, including inland waterway vessels, to use the following fuels: CN code 2710 11 41 (EN590) or CN code 2710 19 41 (gas oils intended for use by non-road mobile machinery agricultural and forestry tractors, and recreational craft. It is only sulphur restricted, no direct FAME restriction). This means there is no EU standard for non-road fuel. Some countries have national standards.

In the context of the energy transition and the need to reduce GHG emissions, the promotion and stimulation of usage of renewable fuels and for the short-term biofuels instead of fossil fuel can be seen as quick-win solution which helps to reach short term emission reduction targets for 2030 and 2035. Currently biodiesel (FAME) and renewable diesel (HVO) is already on the market of fuels for IWT, although there is no obligation in fuel regulations to use these fuels in inland waterway transport.

In the discussion of a possible introduction of reduction targets in IWT fuel, the Dutch vessel owners' representatives (KBN and ASV) underline the technical risks of using biodiesel (FAME) as fuel in IWT. They made a plea to establish as soon as possible a common quality for biofuel, in particular biodiesel, that is usable by inland navigation and to guarantee that it is actually delivered and safe to use. These concerns are not specific to inland navigation and raised by users of road and non-road machineries.

In general, there is more information and awareness required at the level of the vessel owner/operator about the different types of renewable and biofuels and how to handle them on board of the vessel and what to demand from their fuel suppliers concerning the fuel characteristics and specifications.

There are different fuel quality specifications and reference fuels for type approval. Manufacturers may however limit the blending of some fuels for warranty purposes. The following fuels can be mentioned:

- EN590 (up to 8% FAME[60]) and EN15940 (paraffinic diesel, e.g. HVO);
- B100 (=100%FAME) according to EN 14214:2012+A1:2014;
- B20 or B30 FAME blends according to EN16709:2015;
- Natural gas according to EN 16726:2015, Wobbe Index (WI).

[58] Legalisative proposal FuelEU Maritimne : https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021PC0562
[59] See for more information: https://commission.europa.eu/system/files/2021-07/revision-eu-ets_with-annex_en_0.pdf
[60] Regulation (EU) 2016/1628 does effectively put a limited specifications on market fuel for an engine only tested on the reference (diesel) fuel.

As example, the Finnish company NESTE also produced a handbook, mainly focussing on parties interested in HVO which describes the standards[61].

The previous paragraphs show there are multiple types of fuel quality specifications and reference fuels for type-approval of the combustion engines used on board of the vessel. However, not all engines are type approved for multiple reference fuels. Figure 5 presents the summary of the shares of biodiesels including HVO linked to the type approval process for combustion engines.

Pre CCNR <2003)	CCNR I & II / EU Stage IIIA	EU NRMM Stage V
Not regulated	• Max 7% FAME • Max 30% HVO • Total max 37% biofuel within EN590 • LNG by means of a derogation approved by CCNR (based on RVIR 2015, chapter 8a)	• Max 8% FAME • High blends up to 100% with HVO[62] and FAME (if used as reference fuel for type approval) • 100% LBM • Synthetic blends

Fig 5. Type-approval reference fuels for combustion engines used in IWT sector

In conventional fossil diesel, a volume share of up to 7% or 8% FAME is allowed as well as up to 30% HVO in order to remain within the EN590 specification of diesel fuel for which combustion engines are certified. Other blends can optionally also be applied by engine manufacturers in NRMM Regulation for the engine certification.

However, a higher level of blends does need specific test runs for the engine type-approval process. These test runs are expensive to do since at least 2,500 running hours need to be done for an engine in a laboratory in order to provide sufficient data on the emission performance and thus to get certification for an engine family if the emission limits are met. In order to make this step as engine manufacturer, a business case perspective is required. This means that there shall be a clear indication that there will be a significant market demand for using higher blends of bio-/renewable fuel in their engines. At this moment, taking into account the implementation of the FQD and RED II regulations for the IWT sector, there is no perspective on the short term. This therefore results in reluctance of manufacturers of IWP/IWA engines to certify their products also for high blends. This situation is however different for NRE engines as well as marinized Euro VI engines which serve a much larger market and thus have more market demand.

It can be seen that older engines (before 2003) have no legal limitation to use other fuels as they are not type approved for emission performance (meeting the EN590 specifications required from FQD). However, also guarantee requirements from engine manufacturers may play a role in the share of biofuel or renewable fuel which can be applied in practice without jeopardising the guarantee on the engine. Therefore, it is recommended to vessel owner/operators to check beforehand with the engine supplier what type of fuel can be used. In general most engine suppliers/manufacturers indicate that B20/B30 and HVO>30 blends are possible if good-house keeping measures are applied.

As regards the standards of fuel there are in particular concerns with regard the usage of FAME. This is mainly related to the storage on board and the fuel system including the fuel filters. The quality of

[61] The NESTE hanbook is available at: https://www.neste.com/sites/default/files/attachments/neste_renewable_diesel_handbook.pdf

[62] Since there is no density restriction on market non-road fuel (as EN590 has) HVO can be used up to 100% on a standard engine test. Manufacturer may limit for warranty.

the FAME plays a role as the quality determines the sensitivity of the FAME to exposure to lower temperatures and humidity. Especially at low temperatures problems may occur with the blocking of fuel filters and problems with fuel injectors.

After a study executed by TNO[63] and EICB in 2020, NEN (Nederlands Normalisatie Instituut)[64] executed further research in 2021 as regards the risks of usage of biofuels in inland navigation. This has resulted to several recommendations for the composition of the fuel, the risks for ship engines, the logistics chain of inland navigation, control and enforcement and the legal and normative framework

Fuel quality and composition

A first step in reducing the risks associated with biodiesel quality is to increase awareness of what is fuelled and consumed. It must then become clear whether and which additional housekeeping is necessary for fuel suppliers and ships operators depending on the blend composition of the fuel.

Risks of biofuels on ships and in IWT engines

Temperature, water and product quality control on ships reduces risks from the use of biofuels but is not the sole solution. Good housekeeping forms an interplay in which the (adaptation of the) installations on the ship may play a role. Engine manufacturer/shipbuilder should indicate what additional measures apply for certain biodiesels. In general, the industry could develop agreements and draw up instructions for filter use and replacement, energy content and shelf life of the fuel, engine management and application of certain materials that can cause problems on the ship.

Apart from using synthetic diesel, improvements to the composition of FAME based fuels is also possible to lower risks for biodiesel use. For example, via a (temporarily) more stringent standard quality. Plus, the control thereof, and execution of additional chemical analysis on components which may lead to filter blocking on ships. Besides, this development of a method for FAME solvability of diesel may be an option.

Impact of the logistic chain

The inland navigation vessels are less flexible than trucks when it comes to major fuel (quality) adaptations. It is often a world in which people know each other well, which often makes it easier to work together. Skippers often have fixed bunkering places. The fuel suppliers only have few options to vary in which types of fuel is offered. It is important that all market parties agree on certain basic qualities (properties) of the fuel and develops documents on good housekeeping for bunkering and for ships.

Control and enforcement

Control of product quality in the market (both what is supplied and what may cause problems) is fragmented and often only addresses a few aspects of product quality. In The Netherlands for example, there is a limited enforcement function for fuels for inland shipping. The sector prefers that the government guarantees that the fuel meets the requirements set. It is better, also from the point of view of independence, to consider this as a joint effort. Through additional sampling and quality controls of the (bio)diesel, better information and security to the market will be given leading to

[63] Source: TNO 2020 R11455 Impact assessment biobrandstoffen voor de binnenvaart (2020), https://repository.tno.nl/islandora/object/uuid%3Ac8ff78e0-34ef-4458-80dd-3c13ac7b6349

[64] Source: https://www.rijksoverheid.nl/documenten/rapporten/2021/12/17/rapportage-nen-vervolgonderzoek

improved (acknowledgement about) product quality. This may be financed through a fund, installed, and controlled by the sector itself, whereby data is shared centrally.

Legal and normative framework

The existing FAME and biodiesel regulations and standards should in principle be sufficient for the current situation in inland navigation. However, there are a few things where the sector and governments can jointly take steps to ensure greater confidence in the market regarding fuel quality. Examples are setting up guidelines for good house keeping and sharing information on incidents and doing more research.

However, the latest information from The Netherlands is that further research would be needed on the standards for FAME and biodiesel in view of setting stricter limits for SG (sterol glucosides) and SMG (Saturated Mono Glycerides) values (e.g. max 40 mg/litre of fuel) and passage criteria for Filter Blocking tests at difference temperatures (e.g. -1 degree Celsius and 3 degree Celsius) as well as maximum amounts of water in the fuel. This is to increase the shelf time of the fuel and to reduce the sensitivity to cold and humid weather conditions. Possibly, this leads to a stricter standard for the fuel quality for biodiesel.

Moreover, research was suggested by diesel fuel suppliers on the possible usage of WAT and WDT (temperatures when wax starts to develop in the fuel) to be more pragmatically compared to the Cloud Point. The WAT is the temperature at which wax crystals start to come out of the solution – the equivalent of cloud point of a distillate fuel. The WDT is the temperature at which all precipitated wax has been dissolved on heating a fuel – this is the temperature that one would have to hit if you will board to redissolve any precipitated wax. Cloud Point is the temperature at which the distillate fuel becomes slightly opaque in appearance – wax crystals begin to come out of solution.

Anyway, as a conclusion, it can be stated that awareness among fuel suppliers and fuel users is of key importance to reduce risks as result of (bio)diesel quality. Already for existing diesel, there is a differentiation between winter quality and summer quality which can make a difference and needs to be taken into account. The fuel supplier shall make clear what are the characteristics and points of attention of the fuel delivered to inland vessels. At the same time, the fuel user shall be aware on how to work with the fuel and how to arrange the housekeeping on board such as regular inspection of filters and taking out water from the fuel storage and supply system on board. Moreover, the quality and characteristics of the fuel shall be clear and guaranteed and checked in the production and supply chain of the respective fuel.

A point for further research is the sensitivity of fuels to high temperatures and high pressures, which in particular may be the case when using Common Rail Direct injection engines.

A key conclusion and recommendation from investigations and discussions done and ongoing in The Netherlands is the need for a common European specification of the biodiesel (FAME and their blends) as fuel for inland vessels. Therefore a recommendation is to ask the European Committee for Standardisation (CEN) to study this.

6.4 Outstanding questions and recommendations

Fig 7. Summary of the outstanding questions and recommendations for fuel sources and characteristics

Technologies	List of outstanding questions	Required actions
For all	The fuel related regulations (FQD, REDII) do not include any specific requirements for IWT in terms of greenhouse gas emissions and the carbon intensity of energy (from Well-to-Wake perspective) How to fill this gap in fuel supply regulation to inland vessels?	1) Member States should coordinate on the implementation of REDII revision and FQD as regards obligations for energy suppliers to inland vessels (preferably this coordination takes place at River Commissions level in relation with IWT fleet modernisation issues or even on EU level). 2) EC should start policy research/development and impact assessment study for a proposal of "FuelEU IWT" based on the FuelEU Maritime proposal in Fit for 55, aligned with EU Taxonomy technical screening criteria and methodology for inland vessels 3) EC should start policy research/development and impact assessment study for a proposal about IWT to be included in ETS (based on the Fit for 55 proposal for inclusion of road transport in ETS, arranged via introducing ETS to the involved fuel suppliers to inland waterway transport).
Diesel	How to increase share of renewable fuel while EN590 limits the share of FAME (7%) and HVO (30%)?	4) Member states / EC should limit the share of EN590 in fuel supply, e.g. by means of limits on carbon intensity levels and/or ETS on EU level.
LNG / LBM	How to increase share of renewable fuel?	5) Member states / EC should limit the share of fossil LNG in fuel supply, e.g. by means of limits on carbon intensity levels and/or ETS on EU level.
HVO/advanced biofuels/e-fuels	How to increase share of renewable fuel? How to ensure quality fuels being delivered as regards and housekeeping rules?	6) Member states / EC should promote the share of HVO or other biofuels/e-fuels from renewal sources in fuel supply, e.g. by means of limits on carbon intensity levels and/or ETS on EU level (which duly take into account the Well-to-Tank emissions due to the type and sustainability of the feedstock used to produce these fuels). 7) CEN should investigate need for more strict fuel quality standards for FAME and their blends as well as quality checks in the supply chains of these fuels and enforcement. 8) EBU / ESO / national shipowner associations / IVR (Association for the representation of the mutual interests of the inland shipping and the insurance) should launch awareness campaigns on the usage of biodiesel to be aware of possible technical risks and mitigation measures to prevent problems (e.g. as regards filter blockage, water separation)
Battery	How to increase share of electricity from renewable sources?	9) Member States /EC should promote the share of electricity from renewal sources in the energy supply, e.g.

		by means of limits on carbon intensity levels and/or ETS on EU level (which duly take into account the Well-to-Tank emissions due to the type and sustainability of the source of the electricity used to charge the batteries).
H2 in fuel cells / H2 in internal combustion engines (ICE)	How to increase share of hydrogen in IWT and in particular hydrogen made from renewable sources?	10) Member States / EC should promote the share of hydrogen from renewable sources in energy supply, e.g. by means of limits on carbon intensity levels and/or ETS on EU level (which duly takes into account the Well-to-Tank emissions due to the type and the production process to make hydrogen and to distribute it to IWT users).
Methanol in fuel cells / Methanol in internal combustion engines (ICE)	How to increase share of methanol in IWT and in particular methanol from renewable sources?	11) Member States / EC should promote the share of methanol from renewable sources in energy supply, e.g. by means of limits on carbon intensity levels and/or ETS on EU level (which duly takes into account the Well-to-Tank emissions due to the type and the production process and/or feedstock to make methanol and to distribute it to IWT users).

7 Vessel operation – Overview and gap analysis

Three regulatory environments are considered under this chapter:

- the Police regulations for the navigation of the Rhine (RPR)[65], established by the CCNR;
- the Fundamental provisions for the navigation of the Danube (DFND)[66], established by DC;
- the Police regulations for the navigation of the Moselle (RPNM)[67], established by the Moselle Commission.

These regulations determine the legal feasibility of the use of alternative energies as fuel in inland navigation. Specific attention is paid to the non-binding recommendations adopted by the UNECE, meaning the European Code for Inland Waterways (CEVNI)[68] which participates in the harmonisation of the national legislations. As reminder, there is no EU legal instrument in the field of police requirements.

This chapter takes also into account the mandate[69] given by the EC to CEN as regard the bunkering of alternative energies.

This chapter includes a gap analysis for all the technologies considered regarding the regulatory environments described.

7.1 Police regulations for the navigation of the Rhine (RPR)

The safety of persons and goods is a longstanding concern for the Rhine navigation. In accordance with the Mannheim Act, first police regulations for the navigation of the Rhine (RPR) were established in 1850[70].

The RPR contains the core rules applicable to the traffic on the Rhine such as visual and sound signals, the lights to display by vessels and convoys, the rules for meeting, crossing, overtaking and berthing of vessels. Moreover, Article 1.10 and Annex 13 of RPR prescribe the set of certificates and documents that the boatmaster must carry on board, such as the vessel certificate mentioned in part 5.1 of this report.

RPR also defines the waterway signs and markings as well as the allowed dimensions of vessels and convoys. It also regulates for example the electronic reporting requirements (data interchange between vessels and sector traffic centres) or mandatory use of the Automatic identification system (AIS) equipment.

These RPR constitute the legal basis for the international navigation of the Rhine and inspired national regulations of the five CCNR Member States (The Netherlands, Belgium, Germany, France, Switzerland) significantly.

After having temporarily authorised 15 vessels using LNG as fuel for testing purposes, the CCNR updated its legal framework in 2015, especially the RPR, to allow the use of LNG as conventional fuel for the navigation of the Rhine[71]. In close cooperation with the inland navigation profession and

[65] CCNR, "Police Regulations for the Navigation of the Rhine (RPR), 2022, https://www.ccr-zkr.org/13020500-en.html#01.
[66] Danube Commission, "Grundsätzliche Bestimmungen für die Schifffahrt auf der Donau / Dispositions fondamentales relatives à la navigation sur le Danube", 2022, https://www.danubecommission.org/uploads/doc/2018/DFND_2018_de.pdf.
[67] Mosel Commission, Réglement de police pour la navigation de la Moselle, Janvier 2022, http://moselkommission.org/index.php?id=748&L=2
[68] UNECE, "CEVNI - European Code for Inland Waterways (Rev.6)", November 2021, https://unece.org/transport/publications/cevni-european-code-inland-waterways-rev6.
[69] Commission implementing decision of 24.3.2022 on a standardisation request to the European standardisation organisations as regards communication exchange, electricity and hydrogen supply for road, maritime transport and inland navigation in support of Directive 2014/94/EU and its planned revision under the 'Fit for 55' package; https://ec.europa.eu/growth/tools-databases/mandates/index.cfm?fuseaction=search.detail&id=606.
[70] CCNR, "Documents on the history of the RPNR", 2022, https://www.ccr-zkr.org/12020100-en.html#03.
[71] CCNR, "CCNR plenary session – Spring 2015", June 2015, https://www.ccr-zkr.org/files/documents/cpresse/cp20150603en.pdf.

technical experts who already have experience with the use of LNG, the CCNR incorporates in the RPR requirements concerning markings, passing through locks, electronic reporting obligations, safekeeping and surveillance as well as LNG bunkering. For the latter, a dedicated checklist[72] was drawn up in light of the experience of the maritime ports. More generally, the LNG requirements contained in the RPR were an important source of inspiration for national or international instruments. For instance, they were included in the CEVNI rev. 6 adopted in November 2021.

In light of the objectives of the Mannheim Declaration, the CCNR included in its work programme 2022-2023 the update of the RPR to facilitate the use of other alternative fuels, such as hydrogen and methanol.[73]

7.2 Fundamental provisions for the navigation of the Danube (DFND)

In accordance with the article 8 paragraph (f) of the Belgrade Convention 1948 Danube Commission establishes a uniform system of standards on the whole navigable portion of the Danube and lays down the basic provisions governing navigation on the Danube, including those governing the pilot service, with due consideration for the specific conditions on particular sections.

DFND (Grundsätzliche Bestimmungen für die Schifffahrt auf der Donau) were adopted by the decision of 48th session of the Danube Commission on the 25th of April 1990, according to which it was recommended to the Danube riparian states and special river administrations to use these rules as well as the Special Recommendations for the Application by the Competent Authorities of the Danube Countries of the DFND. They contain general provisions, types of vessels, convoys, identification signs and markings, ship measurements, sound alarms, radiotelephone communications, navigational equipment, navigation rules for different types of vessels, waste handling, special provisions. Current revision of the DFND is from 2018.

In 2021, the DC started the process of revision of the DFND, which aims to update and harmonize it with CEVNI rev. 6 issued by UNECE in November 2021. Taking into account that certain Danube states have their national local navigation rules for particular national sections of the Danube River (Germany, Romania, Austria, Slovakia, Hungary, Croatia) as well as Lower Danube local rules, which are incorporated in special provisions on the navigation on the Danube River, they must be updated accordingly after the adoption of the new DFND in 2023. This revision process is intended to improve the safety of navigation on the Danube.

At the same time, considering the emergence of innovative vessels foreseen with the European Green Deal, it has to be mentioned that DFND does not contain information on operation of the vessels using alternative fuels, except for LNG or electric propulsion systems. This can be explained by no practice existing for operation of such vessels in the scope of the Danube region. However, these questions must already be raised in order to develop future requirements for the operation of vessels using alternative fuels. These requirements should apply to all types of the Danube fleet: self-propelled cargo and passenger vessels, pushers, convoys etc., as well as taking into account the peculiarities of their navigation and operation.

7.3 Police regulations for the navigation of the Moselle (RPNM)

The Police regulations for the navigation of the Moselle (RPNM) contains the core rules applicable to the traffic on the Moselle such as visual and sound signals, radiotelephony, waterway signs and markings, as well as navigational, crossing and berthing rules. They also regulate for example the

[72] See Art. 15.07 of the RPR, which refers to the different checklist/standard adopted by the CCNR: https://www.ccr-zkr.org/13020500-en.html.
[73] CCNR, "Resolution 2021-II-8, RP", 2021, https://www.ccr-zkr.org/files/programtravail/Resolution2021-II-8_RP_fr.pdf.

mandatory use of the Inland AIS and ECDIS equipment. High degree of harmonisation of the provisions of the RPN and RPNM is ensured by close cooperation between the CCNR and the Moselle Commission.

These RPNM constitute the legal basis for the navigation of the international Moselle in the three Member States (Germany, France, Luxembourg).

The subject of alternative fuels is also an important topic on the Moselle, to make inland navigation even greener. So, the committees in charge of the regulation on the Moselle are very attentive which new forms of fuels will be launched on the market and intend to adopt regulations to guarantee a safe use of these energies for all the users of the Moselle. A very close cooperation with the CCNR for example is essential and helpful to set harmonised rules for the use of alternative fuels.

7.4 European Code for Inland Waterways (CEVNI)

The European Code for Inland Waterways (CEVNI) contains the core provisions applicable to the traffic on inland waterways in the UNECE region such as marks and draught scales on vessels, visual and sound signals on vessels, waterway signs and markings, as well as navigational, crossing and berthing rules.

CEVNI is not legally binding but constitutes a technical basis to facilitate the harmonisation of the police requirements in Europe. Indeed, CEVNI is regularly updated to follow the evolution of the navigation regulations of River Commissions or national rules.

This sixth revised edition of CEVNI, adopted by resolution UNECE No. 102, in November 2021, took into account best practices from the existing up-to-date traffic regulations. In particular, this edition contains the updated provisions for the list of documents to be present onboard an inland waterway vessel, the stability of vessels carrying containers, safety of vessels using LNG, navigation by radar, radiotelephony, information and navigation devices, reporting requirements, and prevention of pollution of water.

7.5 Standardisation requests to CEN/CENELEC

In 2022, the EC adopted a standardisation request towards the European Committee for Standardisation (‘CEN’) and the European Committee for Electrotechnical Standardisation (‘CENELEC’) for several standards regarding communication exchange, electricity and hydrogen supply for road, maritime transport and inland navigation in support of Directive 2014/94/EU and its planned revision under the ‘Fit for 55’ package. The most relevant items for inland navigation are listed below:

Fig 8: Extract of annex I of Commission implementing decision of 24.3.2022

Table 3: List of new European standards supporting an interoperable infrastructure for electricity supply for maritime transport and inland navigation.

Reference information		Deadline for adoption by the ESOs
1	European standard containing technical specifications with a unified solution for **shore-side battery recharging points** for **each technical category of vessels**, featuring interconnectivity and system interoperability.	31.12.2024
2	European standard containing technical specifications with a unified solution for each technical category of vessel-to- **port grid communication interface** in automated onshore power supply (OPS) and battery recharging systems.	31.12.2025
3	European standard containing technical specifications with a unified solution for **battery swapping and recharging at onshore stations for inland waterways vessels.**	31.12.2026

Table 4: List of new European standards supporting an interoperable infrastructure for refuelling vessels and hydrogen, methanol and ammonia bunkering.

Reference information		Deadline for adoption by the ESOs
1	European standard containing technical specifications with a unified solution for **compressed (gaseous) hydrogen** refuelling points and bunkering for maritime and **inland waterway hydrogen-fuelled vessels.**	31.12.2026
2	European standard containing technical specifications with a unified solution for **liquefied hydrogen** refuelling points and bunkering for maritime and **inland waterway hydrogen- fuelled vessels.**	31.12.2028
3	European standard containing technical specifications with a unified solution for **methanol** refuelling points and bunkering for methanol-fuelled maritime and **inland waterway vessels.**	31.12.2024
4	European standard containing technical specifications with a unified solution for **ammonia** refuelling points and bunkering for ammonia-fuelled maritime and **inland waterway vessels.**	31.12.2027

7.6 Gap analysis

The gap analysis summarised in the table below results from:

- a desk study of existing regulations and standards, in close cooperation with experts of CCNR and DC involved in the regulatory work;
- interviews and discussions with representatives of Member States;
- the feedback collected during the third PLATINA3 stage event (10-11 February 2022).

When conducting this gap analysis for vessel operation, special considerations were also given to the documents produced in the maritime sector, as for instance, the specifications for bunkering of methanol fuelled vessels (CWA 17540:2020)[74] or the bunkering checklists developed by International Association of Ports and Harbors[75].

[74] NBN, "Navires et technologie maritime – Spécifications pour le soutage des navires alimentés au methanol", Norme CWA 17540:2020, https://www.nbn.be/shop/fr/norme/cwa-17540-2020_34447/.
[75] IAPH, https://sustainableworldports.org/clean-marine-fuels/lng-bunkering/bunker-checklists/#use-and-edit

Fig 9. Gap analysis regarding the regulations and standards for vessel operation

Technologies	Status of the technology In inland navigation	Main requirements (and foreseen amendments)	Identified gaps	Required actions
Diesel	Regular fuel and cargo in inland navigation.	Obligation of vigilance during bunkering operations is required (RPR Art. 15.06, DFND Art. 10.07, RPNM Art. 11.06, CEVNI Art. 10.07)	-	-
LNG / LBM	Regular fuel and cargo in inland navigation.	Special marking of vessel using LNG as fuel (RPR Art. 2.06, DFND Art. 2.06, RPNM Art. 2.06, CEVNI Art. 2.06). Vessel cannot enter in a lock when there are probable methane emissions from the LNG system (safety valve for the boil-off notably) (RPR Art. 6.28(10), DFND Art. 6.28(10), RPNM Art. 6.28(10), CEVNI Art. 6.28(10) Safety requirements for bunkering (RPR Art. 8.11, DFND Art. 8.11, RPNM Art. 8.11, CEVNI Art. 8.11 Obligation of vigilance during bunkering operations is required (RPR Art. 15.06, DFND Art. 10.07, RPNM Art. 11.06, CEVNI Art. 10.07) Bunkering checklists (based on those adopted by the international association of ports and harbours) are published by CCNR[76]	-	-
HVO/advanced biofuels/e-fuels	Regular fuel and cargo in inland navigation.	Same as diesel	-	-

[76] CCNR, "Police regulations for the navigation of the Rhine (RPR)", 2022, https://www.ccr-zkr.org/13020500-en.html#01.

Battery	Lithium-ion batteries (LIB) are almost regular energy carrier in inland navigation, but the collection of experience could lead to improvement of the regulatory framework. It does not anticipate the development of other types of batteries.	No specific requirements in police rules.	Thermal runaway is a chain reaction within a battery cell that occurs when the temperature inside a battery reaches the point that causes a chemical reaction inside the battery. The latter produces even more heat, which drives the temperature higher, causing further chemical reactions that create more heat. In case of thermal runaway, the energy stored is released very suddenly and produces a fire extremely difficult to stop. Special precautions are needed to prevent and manage the thermal runaway, especially to avoid injuries to the crew and damage to vessel structure. For swappable battery containers, it might be required to put the container on shore for fire-fighting purposes, while the thermal runaway is still in progress.	1) CCNR, DC, Moselle Commission, UNECE should examine the need of operational requirements to ensure safety in case of thermal runaway of batteries. 2) National authorities should facilitate the exchange of good practices between the fire brigades involved in fires with LIB, especially on-board inland vessels. 3) CEN/CENELEC should develop standards for shore-side battery recharging and battery swapping, taking into account the experience gained in inland navigation[77] and the difference with the maritime sector.
H2 in fuel cells / H2 in internal combustion engines (ICE)	Hydrogen is only used in pilot vessels	No specific requirements in police rules.	With its high flammability range and low ignition energy, hydrogen could lead to potential fire or explosion (especially for enclosed spaces or insufficiently ventilated areas). It is also hard to identify hydrogen leaks without dedicated detectors (colorless/odorless). A hydrogen flame is almost invisible in daylight. Safety provisions are desirable, especially to guarantee proper ventilation of hydrogen leaks and vigilance of the crew. In terms of bunkering, all pilot projects rely currently on handling of rack or container of bottles of compressed hydrogen. Safety measures are needed for the swapping of such racks / containers. At later stage, the bunkering of liquefied hydrogen (cryogenic fuel at -253°C) should also be examined.	4) CCNR, DC, Moselle Commission, UNECE should examine the need of operational requirements to ensure safety of operation of vessels using hydrogen for the propulsion. 5) CEN/CENELEC should develop standards for swapping of racks/containers of compressed hydrogen, taking into account the experience gained in inland navigation[78] and the existing industrial standards. 6) CEN/CENELEC should develop standards for bunkering of liquefied hydrogen, taking into account the international bunkering checklists. 7) National authorities should collect and share the experience gained with the first pilot vessels to feed in the regulatory work.

[77] ZESpack with the vessel Alphenaar and project CurrentDirect.
[78] Msc Maas (NL), Elektra (DE), Zulu (FR).

Methanol in fuel cells / Methanol in internal combustion engines (ICE)	Methanol is only used in pilot vessels	No specific requirements in police rules.	Methanol is liquid like diesel and stored at room temperature. Safety approach used for diesel (ie obligation of vigilance during bunkering) might be relevant. In case of leaks during bunkering or in case of collision, the methanol will dilute in water unlike diesel.[79] However, the main risks of methanol are its toxicity for the crew or passengers as well as its higher flammable potential (flash point at 11°C whereas diesel is at 52-96°C). Safety provisions are desirable, especially to handle toxic leaks in a closed environment. In terms of bunkering, standards are needed for safety and interoperability purposes.	8) CCNR, DC, Moselle Commission, UNECE should examine the need of operational requirements to ensure safety of methanol. 9) CEN/CENELEC should develop standards for bunkering, taking into account the experience gained in inland navigation[80], the existing industrial or maritime standards and international bunkering checklists. 10) National authorities should collect and share the experience gained with the first pilot vessels to feed in the regulatory work.

[79] FASTWATER, "Report on methanol supply, bunkering guidelines, and Infrastructure", November 2021, https://www.fastwater.eu/images/fastwater/news/FASTWATER_D71.pdf.
[80] Project Fastwasser, notably the tugboat in Port of Antwerp-Bruges.

8 Recommendations on the regulatory and standardisation actions to be implemented in priority

At this stage, the current European regulatory framework for inland navigation remains incomplete to provide the necessary legal certainty to ensure investment, encourage players and create sufficient incentives for alternative technologies.

Several technologies are still at an experimental stage and thus not yet sufficiently developed to enable large-scale use. Pilot applications in inland vessels are critical to address the technical barriers to the deployment of technologies and feed in the regulatory work at an early stage. Indeed, the experience gained with the deployment of LNG in 2010-2015 shows very well how the first vessels were used by national administrations and classification societies to build the relevant rules within the competent international bodies, such as CESNI.

The gap analysis carried out enables to identify possible improvements of the regulatory frameworks. The respective measures are summarised below.

Fig 10: Summary of recommendations

no V=vessel, F=fuel, P=operation/police	Who	What	When	Priority
V1	EC, CCNR, DC, Moselle Commission, Sava Commission, National administrations	facilitate the financing and commissioning of pilot vessels using alternative technologies, subject to the sharing of the experience collected for the regulatory work	Continuous	I
V2	CESNI, EC, CCNR	investigate the opportunity to introduce efficiency and greenhouse gas emission limits, possibly both for existing vessels and newly built vessels, in line with emission reduction target	2023-2025	I
V3	CESNI and EUROMOT	update regularly their FAQ document on NRMM and ES-TRIN	Continuous	I
V4	EC	review opportunity to further reduce exhaust emission limits for inland navigation vessels, taking account of existing related Union and international standards and propose any necessary legal changes	2025	II
V5	EC, CCNR, CESNI	consider introducing a phasing out of existing engines in ES-TRIN to achieve minimum air pollutant emission standards	2030	II
V6, V8	EC, engine manufacturers classification societies	facilitate the use of marinized engines (clarify the accepted inducement strategies and possible use on board vessels transporting dangerous goods)	Continuous	II
V7	EC	review the extent to which the engine emissions measured during type-approval tests using corresponding test cycles reflect engine emissions in real operating conditions and propose any necessary changes.	2025	II

V9	EC	evaluate the need to lower the factor A of emission limits for gas engine in NRMM to increase the climate performance of LNG propulsion systems	2025	II
V10	CESNI	evaluate the requirements for lithium-ion batteries after several years	2024-2025	II
V11	CESNI/CCNR	develop provisions to allow the swappable battery containers for the considering the risks involved	2023	I
V12	CESNI	monitor the development in the use of batteries for propulsion and anticipate the spreading of type of batteries other than LIB.	Continuous	II
V13	CESNI	collect experience regarding the approval of the hydrogen tanks and the relevant standards	2023	I
V14	CESNI	finalise the requirements for the compressed and liquefied storage of hydrogen	2023-2025	I
V15	EUROMOT/CESNI	develop guidelines for the implementation of Articles 34 and 35 of NRMM for engines using hydrogen as fuel (pending a revision of NRMM).	2023	I
V16	CESNI	start the development of safety requirements for hydrogen in internal combustion engine	2024	II
V17	ADN SC (UNECE-CCNR)	confirm that hydrogen is accepted for propulsion of vessels carrying dangerous goods	2024-2025	II
V18	CESNI	monitor the development in the hydrogen carriers	2025	II
V19	CESNI	Finalise the requirements for the storage of methanol and its use in internal combustion engines (ES-TRIN 2025)	2023	I
V20	EUROMOT/CESNI	develop guidelines for the implementation of Articles 34 and 35 of NRMM for engines using methanol as fuel (pending a revision of NRMM).	2023	I
V21	ADN SC (UNECE-CCNR)	confirm that methanol is accepted for propulsion of vessels carrying dangerous goods	2024-2025	II
F1	Member States, CCNR, DC, Moselle Commission, Sava Commission, EC	coordinate on implementation of REDII revision and FQD as regards obligations for energy suppliers to inland vessels (preferably this coordination takes place at River Commissions level in relation with IWT fleet modernisation issues or even on EU level).	2023-2024	I
F2	EC	start policy research/development and impact assessment study for a proposal of “FuelEU IWT” based on the FuelEU Maritime proposal in Fit for 55, aligned with EU Taxonomy technical screening criteria and methodology	2024-2025	I
F3	EC	start policy research/development and impact assessment study for a proposal about IWT to be included in ETS (based the approach for road transport in ETS)	2024-2025	I

F4, F5	Member States / EC	limit the share of EN590 and fossil LNG in fuel supply, e.g. by means of limits on carbon intensity levels and/or ETS on EU level.	2030	I
F6, F9, F10, F11	Member States / EC	promote the share of fuels (HVO or biofuels/e-fuels, hydrogen and methanol) as well as electricity from renewal sources in fuel supply, e.g. by means of limits on carbon intensity levels and/or ETS on EU level	2030	I
F7	CEN	investigate need for more strict fuel quality standards for FAME and their blends as well as quality checks in the supply chains of these fuels and enforcement.	2025	II
F8	EBU / ESO / national shipowner associations / IVR	launch awareness campaigns on the usage of biodiesel to be aware of possible technical risks and mitigation measures to prevent problems (e.g. as regards filter blockage, water separation)	2024	I
P1	CCNR, DC, Moselle Commission, UNECE	examine the need of operational requirements to ensure safety in case of thermal runaway of batteries	2023	I
P2	National authorities	facilitate the exchange of good practices between the fire brigades involved in fires with LIB, especially on-board inland vessels	2023-2024	I
P3	CEN, CENELEC	develop standards for shore-side battery recharging and battery swapping, taking into account the experience gained in inland navigation and the difference with the maritime sector.	2026	I
P4	CCNR, DC, Moselle Commission, UNECE	examine the need of operational requirements to ensure safety of hydrogen	2023-2024	I
P5	CEN, CENELEC	develop standards for swapping of racks/containers of compressed hydrogen, taking into account the experience gained in inland navigation and the existing industrial standards	2026	I
P6	CEN, CENELEC	develop standards for bunkering of liquefied hydrogen	2028	II
P7, P10	National authorities	collect and share the experience gained with the first pilot vessels to feed in the regulatory work	Continuous	I
P8	CCNR, DC, Moselle Commission, UNECE	examine the need of operational requirements to ensure safety of methanol	2023	I
P9	CEN, CENELEC	develop standards for bunkering of methanol, taking into account the experience gained in inland navigation and the existing industrial standards	2024	I

Annex 1 Regulatory gaps state-of-play for transport of alternative energy sources, as a cargo on board of inland vessels

Energy carrier	Status of the cargo	Main requirements (ADN)
Diesel	Regular cargo in inland navigation.	Table A, UN1202
LNG / LBM		Table A, UN1972. Possible use of membrane tanks with ADN edition 2021.
HVO/advanced biofuels/e-fuels		Table A, UN1202
Battery		LIB installed in cargo transport unit shall be assigned as UN 3536.
Hydrogen		Table A, because column (8) is empty, the transport of the material is only authorized in packages (on board ships, this term includes containers, tank containers ,…). Hydrogen can be transported by dry cargo vessel (2F for flammable gas) but not by tanker vessel.
Methanol		Table A, UN1230. Transport in tankers is allowed.

Annex 2 Gap analysis (breakdown by regulation / standards)

Regulation / Standards	Technologies	Main requirements (and foreseen amendments)	Identified gaps	Required actions
Missing regulations or standards	All		Need of support of pilot vessels No limits on CO2e emissions (besides methane slip for methane fuelled combustion engines) No limits on energy efficiency	1) EC, CCNR, national administrations should continue to facilitate the financing and commissioning of pilot vessels using alternative technologies, provided that the experience collected is shared to feed in the regulatory work. 2) CESNI, EC, CCNR should investigate the opportunity to introduce efficiency and greenhouse gas emission limits, possibly both for existing vessels and newly built vessels

ES-TRIN	Diesel	Chapters 8 and 9, as well as Chapter 11 for diesel electric propulsion systems. Clarification for the replacement or repair of existing engines are included in the new Article 9.10 in ES-TRIN 2023.	-	3) CESNI and EUROMOT should continue to regularly update their FAQ document to help those involved with the inland waterways transport sector to understand and interpret the applicable requirements to engines in the light of the new requirements for non-road mobile machinery (NRMM) as well as ES-TRIN.
	LNG / LBM	Chapter 30 and Annex 8, as well as Chapter 11 for gas electric propulsion systems.	-	
	HVO/advanced biofuels/e-fuels	Same as diesel	-	
	Battery	Article 10.11 for batteries, including safety requirements for lithium-ion batteries (LIB) and associated rooms. A fire protection concept is required, having regard to the other equipment located in the same room, the LIB manufacturer's instructions and the thermal runaway issues. Chapter 11 for electric propulsion systems. CESNI committed to follow the implementation of the requirements for the use of LIB (task PT-19 of its 2022-2024 work programme). It might lead to revision of Article 10.11(17).	ES-TRIN Article 10.11(2) forbids the installation of batteries for the propulsion in the cargo holds. On-going discussion within CESNI/CCNR to clarify the possible location of swappable battery containers, especially considering the risks of external damages. For the time being, the regulations and standards only addressed the LIB. It does not anticipate the development of other types of batteries (for which the corresponding safety risks are not yet known)	10) CESNI should evaluate the requirements for LIB after several years, especially the safety issue of combination of LIB with other energy sources. 11) In the light of experience gained with pilot vessels, CCNR/CESNI should develop provisions to allow the swappable battery containers for the propulsion at several locations on board, especially considering the risks involved. 12) CESNI should monitor the development in the use of batteries for propulsion and anticipate the spreading of type of batteries other than LIB.
	Hydrogen	Chapter 30 and Annex 8. Edition CESNI reviewed the general requirements for the use of low flash point fuels and developed specific requirements for hydrogen fuel cells in ES-TRIN 2023. The requirements for the storage of compressed and liquified hydrogen are expected to be included in ES-TRIN 2025.	Storage requirements for liquefied and compressed hydrogen are missing. CESNI has started the examination of draft requirements for both types of storage in 2022, taking into the experience with pilot projects. One major change is the approval of the tanks which are often from other transport or industrial	13) With the help of classification societies, CESNI could collect experience regarding the approval of the hydrogen tanks and the relevant standards for other industrial sectors

			sectors and do not comply with the safety requirements for the operation of vessels (ie absence of safety valves). The experience collected with pilot projects is particularly useful in this context. Safety requirements for the use of hydrogen in ICE and associated engine rooms are missing. They could be developed by analogy with those for natural gas in engine rooms. For the time being the majority of projects of inland vessels are currently based on swappable cylinders or specific containers concepts, with pressurised hydrogen. According to the Kick-start study of the RH2INE project, the use of hydrogen carriers is considered to be a long-term scenario (10-20 years)[81]. At the same time, the industry expressed interests for other carriers such as Liquid organic hydrogen carrier (LOHC)[82].	14) CESNI should finalise the requirements for the compressed and liquefied storage of hydrogen (most likely for ES-TRIN 2025) 16) In cooperation with EUROMOT, CESNI should start the development of safety requirements for hydrogen in combustion engine 18) CESNI should monitor the development in the hydrogen carriers
	Methanol	Chapter 30 and Annex 8. CESNI reviewed the general requirements for low flash point fuels and developed specific requirements for the use of methanol in fuel cells in ES-TRIN 2023. In June 2022, CESNI approved the draft requirements for methanol storage, as "interim guidelines". Their aim is to facilitate the examination of derogations for pilot projects, pending revision and inclusion in the draft ES-TRIN 2025.	CESNI finalised draft requirements and decided to collect experience before revision and inclusion in the draft ES-TRIN 2025. Specific attention was paid to the design of the tanks (inerted / non-interted) as well as the leakages in normal operation or after collision. The experience gained with pilot projects (such as the tugboat in the Port of Antwerp-Bruges) was also taken into account. Safety requirements for the use of methanol in ICE and associated engine rooms are missing. CESNI is currently preparing draft requirements.	19) CESNI should finalise the requirements the storage of methanol and its use in combustion engines (ES-TRIN 2025)
NRMM	Diesel	emission limits and testing requirements for putting on the market engines of categories IWP (propulsion)	Not strict enough limits on air pollution performance in view of reaching (near) zero-	4) EC should update air quality limits in NRMM and make them stricter, bring it

[81] RH2INE, Kickstart Study, Regulatory and Safety Analysis, https://www.rh2ine.eu/wp-content/uploads/2021/10/RH2INE-Kickstart-Study-Regulatory-and-Safety-Analysis-Regulatory-and-Standards-Gap-Assessment.pdf
[82] For example, Hydrogenius along the Danube - https://www.hydrogenious.net/index.php/en/.

		and IWA (auxiliary), as well as equivalent (especially marinised NRE and Euro VI engines).	emission performance. No limits for existing engines (fleet). Unclarity regarding the requirements in terms of inducement strategy (reduction of engine power in case NOx reduction system failure of malfunctioning) for marinized engines, especially NRE. In June 2022, CESNI considered that deactivation of engine inducement of this marinized engines is not required for safety reasons and sent proposals to the EC. Test cycle (E3) used in the type approval regulation does not reflect the real sailing conditions in IWT.	closer to (near) zero-emission performance, e.g. based on Euro VI and VII emission performance standards. 5) EC, CCNR, CESNI should consider introducing a phasing out of existing engines in ES-TRIN to achieve minimum air pollutant emission standards[83] 6) EC, in close cooperation with CESNI and EUROMOT, should clarify the accepted inducement strategies for marinized engines 7) ISO, in close cooperation with EUROMOT, should develop and adopt a test cycle which does reflect better the operation of a propulsion engine in IWT
	LNG / LBM	Emission limits and testing requirements for putting on the market engines of categories IWP (propulsion) and IWA (auxiliary), as well as equivalent. Specific provisions on total hydrocarbon (HC) limits for fully and partially gaseous-fuelled engines (factor A of emission limits).	Same as diesel	9) EC should evaluate the need to lower the factor A of emission limits for gas engine in NRMM in order to increase the climate performance of LNG propulsion systems
	HVO/advanced biofuels/e-fuels	Same as diesel. The information about the correct fuel or fuel blend approved for the engine (that may be HVO or advanced biofuels) is reported in the type approval certificate of the engine.	Same as diesel	-
	Battery	not relevant		
	Hydrogen	CESNI questioned the EC regarding the scope of application of the NRMM for combustion engines		15) In cooperation with EC, EUROMOT and CESNI should develop guidelines for the

[83] For example, include an obligation to reaching certain emission standards at certain time period (e.g. Stage V emission limit performance to be reached by the year in 2035 for all of the fleet)

		using alternative fuels. The EC clarified this as follows: "engines installed before 2003 are permitted to use any fuel because they have no type approval nor emissions limits. For new engines on the other hand, the requirements have not yet been defined. Following EC's proposal, a task force with experts from Member States and EUROMOT is in charge to develop guidelines for the implementation of Articles 34 and 35 of NRMM. At mid-term, a revision of the NRMM is needed for engines using hydrogen as fuel.		implementation of Articles 34 and 35 of NRMM for engines using hydrogen as fuel.
	Methanol	Methanol is not one of the standard fuel foreseen in the NRMM and probably require change of components of engines designed to run with diesel. Following EC's proposal, a task force with experts from Member States and EUROMOT is in charge to develop guidelines for the implementation of Articles 34 and 35 of NRMM. At mid-term, a revision of the NRMM is needed for engines using methanol as fuel.		20) In cooperation with EC, EUROMOT and CESNI should develop guidelines for the implementation of Articles 34 and 35 of NRMM for engines using methanol as fuel.
ADN	Diesel	combustion engines running on fuel having a flashpoint above 55°C are allowed (7.1.3.31, 7.2.3.31, 9.3.1.31, 9.3.2.31.1, 9.3.3.31.1)	-	
	LNG / LBM	Reference to ES-TRIN for propulsion systems with combustion engines (7.1.3.31, 7.2.3.31, 9.3.1.31, 9.3.2.31.1, 9.3.3.31.1)	-	
	HVO/advanced biofuels/e-fuels	Same as diesel	-	
	Battery	1.1.3.7 exempts the carriage of electric energy storage and production systems (e.g. Lithium-ion batteries, electric capacitors, asymmetric capacitors, metal hydride storage systems and fuel cells) for the vessel's propulsion system	-	

		Vessel only powered by LIB shall be assigned as UN 3171 battery-powered vehicle. LIB installed in cargo transport unit shall be assigned as UN 3536.		
	Hydrogen	Reference to ES-TRIN for propulsion systems with combustion engines (7.1.3.31, 7.2.3.31, 9.3.1.31, 9.3.2.31.1, 9.3.3.31.1).	Reference limited to LNG systems. Fuel cells not allowed.	17) When ES-TRIN is updated, ADN Safety committee (UNECE) could confirm that hydrogen is accepted for propulsion system of vessels carrying dangerous goods (the reference from ADN to ES-TRIN seems sufficient).
	Methanol	Reference to ES-TRIN for propulsion systems with combustion engines (7.1.3.31, 7.2.3.31, 9.3.1.31, 9.3.2.31.1, 9.3.3.31.1).	Reference limited to LNG systems. Fuel cells not allowed.	21) When ES-TRIN is updated, ADN Safety committee (UNECE) could confirm that methanol is accepted for propulsion system of vessels carrying dangerous goods (the reference from ADN to ES-TRIN seems sufficient).
Classification rules	Diesel	Specific classification type approval of all engine components, including crankshaft	IWP/IWA engines are often identical for maritime and IWT markets. In addition to their emission type-approval in accordance with NRMM, these engines have received a class type-approval certificate for installation in sea-going vessels. This class certificate is needed for engines of vessels transporting dangerous goods (which are mandatory classed or built in accordance with class rules). For marinised engines (NRE or Euro VI), this class certificate could be obtained (ex. NPS Diesel with LR) but requires action from the engine manufacturer.	8) Engine manufacturers in cooperation with classification societies should certify the marinized engines to allow their use on board vessels transporting dangerous goods

	LNG / LBM	Same as diesel		
	HVO/advanced biofuels/e-fuels	Same as diesel		
	Battery	dedicated safety rules for LIB systems (for example LR: Pt 6, Ch 2, 12 Batteries of the Rules and Regulations for the Classification of Ships, July 2022). Type-approval required for LIB system with capacity of 20 kWh and more.		
	Hydrogen	Classification societies have developed rules for hydrogen fuelled vessels, including the use of fuel cells (for example BV's NR547).		
	Methanol	Classification societies have developed rules for methanol (for example BV's NR670 for Methanol & ethanol fuelled ships or RINA Class Rules for Methyl/ethyl alcohol fuelled ships)		

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