



Deliverable title:

D3.2 Proposed labelling concept and Implementation roadmap

Grant Agreement No.	101137650
Start date of Project	01-01-2024
Duration of the Project	36 months
Deliverable Leader	DST
Dissemination level	Public
Deliverable number	D7 / D3.2
Status	Final
Submission Date	28-09-2026
Main authors	Benjamin Friedhoff, DST, friedhoff@dst-org.de Justin Jasa, DST, jasa@dst-org.de Martin Quispel, SPB, m.quispel@eicb.nl Khalid Tachi, SPB, k.tachi@eicb.nl
Co-authors	Katja Hoyer, DST Daan Siebenheller, SPB



This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101137650. The opinions expressed in this document reflect only the author's view and in no way reflect the European Commission's opinions. The European Commission is not responsible for any use that may be made of the information it contains.

Version

Version #	Date	Author	Organisation
V0.1	03-07-2025	J. Jasa, K. Hoyer	DST
V0.2	05-12-2025-	K. Tachi, D. Siebenheller, M. Quispel	SPB
V0.3	15-12-2025	B. Friedhoff, K. Hoyer	DST
V0.4	24-02-2026	K. Tachi	SPB
V0.4	23-03-2026	K. Tachi, D. Siebenheller, M. Quispel	SPB
V0.5	08-07-2026	K. Hoyer, B. Friedhoff,	DST
Reviews	09-07-2026	M. Quispel, K. Tachi	SPB
Draft final	27-09-2026	B. Friedhoff	DST
Final	28-09-2026	M. Quispel, K. Tachi	SPB

Release Approval

Name	Role	Date
B. Friedhoff	WP3 leader	27-09-2026
M. Quispel	Project coordinator	28-09-2026

Table of Contents

Table of Contents.....	3
List of abbreviations	5
List of tables	7
List of figures	7
Executive summary	8
1. Introduction.....	10
1.1 <i>Objective of the Work Package.....</i>	10
1.2 <i>Tasks in WP3.....</i>	11
1.2.1 Task 3.1: Updating state-of-play	11
1.2.2 Task 3.2: Setting objectives and boundaries for the label	11
1.2.3 Task 3.3: Developing options and evaluation.....	12
1.2.4 Task 3.4: Developing implementation roadmap	12
1.2.5 Task 3.5: Developing baseline data and examples for specific segments	12
1.3 <i>Summary of PLATINA4Action report D3.1</i>	13
1.4 <i>Approach and content of this report</i>	15
2. Development and evaluation of labelling options	16
2.1 <i>CCNR emission passport</i>	19
2.1.1 Implementation roadmap CESNI standard.....	19
2.1.2 Conclusions	21
3. Methodology C3: Grams CO₂e per t·km ex post (CountEmissionsEU/ISO 14083:2023) 22	
3.1 <i>Rationale and context.....</i>	22
3.2 <i>The administrative burden challenge</i>	22
3.3 <i>Objectives and scope</i>	23
3.4 <i>Methodological approach.....</i>	23
3.5 <i>Detailed specification of the methodology C3</i>	24
3.6 <i>Analysis of existing data sources and infrastructure</i>	25
3.7 <i>Synergies and integration opportunities</i>	27
3.8 <i>Data quality: validation and verification</i>	28
3.9 <i>Legal and regulatory considerations</i>	28
3.10 <i>How (not) to use the C3 metric</i>	30

3.11	<i>Implementation roadmap</i>	31
3.12	<i>Example case study</i>	34
4.	Methodology E1: Wh per t·km ex ante	37
4.1	<i>Inception of the EEDI_{INLAND} concept</i>	37
4.1.1	<i>Latest developments</i>	37
4.2	<i>EEDI_{INLAND} methodology</i>	39
4.3	<i>Implementation roadmap</i>	40
4.4	<i>Baseline data and examples of E1 methodology application</i>	41
5.	Conclusions	43
	Annex A: Manual for methodology C3 emissions reporting	A0
	Annex B: Methodology E1 (EU EEDI_{INLAND})	B0

List of abbreviations

AIS	Automatic Identification System
API	Application Programming Interface
BICS	Barge Information and Communication System
BMV	German Federal Ministry of Transport
BSFC	Brake-specific fuel consumption
CCNR	Central Commission for the Navigation of the Rhine
CDNI	Convention on the Collection, Deposit and Reception of Waste generated during navigation on the Rhine and other inland waterways
CEERIS	Central and Eastern European Reporting Information System
CEMT	Conférence européenne des ministres des Transports
CESNI	Comité Européen pour l'Élaboration de Standards dans le Domaine de la Navigation Intérieure
CII	Carbon Intensity Indicator
CMNI	Convention de Budapest relative au contrat de transport de marchandises en navigation intérieure
CO	Carbon monoxide
CSRD	Corporate Sustainability Reporting Directive
DG MOVE	Directorate-General for Mobility & Transport
DWT	Deadweight
eBDN	electronic bunker delivery note
EEDI	Energy Efficiency Design Index
EEOI	Energy Efficiency Operating Indicator
eFTI	electronic Freight Transport Information
ERI	Electronic Reporting International
ERINOT	Electronic Reporting International Notices for Transport Operations
ES-RIS	European Standard for River Information Services
ESRS	European Sustainability Reporting Standards
ES-TRIN	European Standard laying down Technical Requirements for Inland Navigation vessels
EU	European Union
EuRIS	European River Information Services
FAME	Fatty Acid Methyl Ester
GDPR	General Data Protection Regulation

GHG	Greenhouse gases
GPS	Global Positioning System
HC	Hydrocarbons
HVO	Hydrotreated vegetable oil
IMO	International Maritime Organization
ISO	International Organization for Standardization
ITTC	International Towing Tank Conference
IWT	Inland Waterway Transport
KPI	Key Performance Indicator
LNG	Liquefied natural gas
MARPOL	International Convention for the Prevention of Pollution from Ships (IMO)
MRV	Measuring, Reporting and Verification
NO _x	Nitrogen oxides
NRMM	Non-Road Mobile Machinery
OPS	Onshore power supply
PM	Particulate matter
RED	Renewable Energy Directive
RIS	River Information Services
RVIR	Rhine vessel inspection regulation
RWS	Dutch national waterway authority
SEEMP	Ship Energy Efficiency Management Plan
SME	Small and Medium-sized Enterprises
TCE	Transport Chain Element
TFEU	Treaty on the Functioning of the European Union
TOC	Transport Operation Categories
TTW	Tank-to-Wake
WTT	Well-to-Tank
WTW	Well-to-Wake

List of tables

Table 1 Main methodologies and the key characteristics.....	18
Table 2 Implementation roadmap for methodology C3	33
Table 3 Timeline for implementation of CountEmissionsEU	34
Table 4 Definition and units for the simplified EEDI calculation	38
Table 5 Exemplary calculation of the EEDI _{INLAND} for different vessel categories.....	41

List of tables Annex A

Table A - 1 Well-to-Wake emission factors for different fuel types.....	A8
---	----

List of tables Annex B

Table B - 1 Definitions and units of measurement of parameters used in calculating the Attained EEDI _{INLAND}	B12
Table B - 2 Regression coefficients for power computation [reference 1].	B13
Table B - 3 Regression coefficients for trial speed computation [reference 1].	B13
Table B - 4 Parameters for Fujiwara regression formula.	B20

List of figures

Figure 1 Tentative timeline for the implementation of methodology A and C1 (Source: CESNI Secretariat).	20
Figure 2 Distribution of the C3 indicator values per voyage over the considered year for the inland push-tow vessel.	36
Figure 3 Graphical overview of EEDI _{INLAND} values depending on the DWT or Δ	42

List of figures Annex B

Figure B - 1 Conceptualisation of the conversion of the power curve.....	B17
Figure B - 2 Definition of parameters of the windage area for wind loads estimation.	B20
Figure B - 3 Flowchart of speed-power analysis to compute the EEDI _{INLAND}	B26
Figure B - 4 Flowchart to determine the speed-power curve.	B27

Executive summary

PLATINA4Action is a Coordination and Support Action responding to the Horizon Europe call “Towards the implementation of the inland navigation action programme with a focus on Green and Connected Inland Waterway Transport”. One of the expected outcomes is a “Proposal of a European labelling system for EU waterways” in line with the NAIADES III action 11 “...elaboration of an EU energy index methodology for assessing carbon intensity levels...”. This report of the corresponding project work package “WP3 – Label for vessels on EU waterways” addresses the question how the operational greenhouse gas emissions (methodology C3) and the design-based energy efficiency (methodology E1) of inland waterway vessels can be determined, reported and verified in a way that is technically feasible, comparable between vessels and suitable as a basis for a future labelling scheme.

Based on research and analysis of numerous approaches to assessing emissions and energy efficiency in maritime and inland waterway transport, a new categorisation of the methodologies examined was created by PLATINA4Action. These differ from one another in terms of system boundaries, boundary conditions and units of measurement used in the assessment:

A: Average air pollutant emissions of engines installed on board of vessels [e.g.: gNO_x/kWh; gPM/kWh]

C1: Greenhouse gas intensity of energy used on board [gCO₂e¹/MJ]

C2: Greenhouse gas intensity of fuel and energy conversion [gCO₂e/kWh]

C3: Operational greenhouse gas emissions [gCO₂e/t·km, gCO₂e/p·km]²

E1: Energy efficiency by design [Wh/t·km]

After a short introduction on the methodologies A and C1, which are in the focus of the Central Commission for the Navigation of the Rhine (CCNR) and the European Committee for drawing up Standards in the field of Inland Navigation (CESNI) work, this report evaluates and elaborates the methodology C3 and methodology E1. The C2 methodology is expected to be the result of combining A and C1 once operational, providing further added value because of the insight on efficiency of the energy conversion (e.g. favourable for battery-electric propulsion systems). This is, however, not foreseen in the CESNI work programme for the time being.

Methodology C3 deals with managing and documenting the operational greenhouse gas (GHG) emissions performance in inland waterway transportation, measured in **gCO₂e/t·km**. A specific manual was developed in PLATINA4Action which can serve as guideline (Annex A Manual for methodology C3 emissions reporting). The report explores the technical feasibility of implementing this method by leveraging existing data collection systems to reduce administrative burden while ensuring accuracy and verifiability. A roadmap is presented with clear links and added value in relation to the implementation of the recently adopted **CountEmissionsEU regulation** for inland waterway transport. Many inland vessel operators already gather relevant data through mandatory and/or available digital frameworks, such as bunkering records in the electronic payment system of the Convention on the Collection, Deposit and Reception of Waste (CDNI), voyage reports via River Information Services and platforms (EURIS/CEERIS). With to effective and efficient compliance to CountEmissionsEU, the opportunities are discussed for integrating and automating data using specialised software platforms aligned with the **ISO 14083:2023 standard**. This standard applies a common approach to all modes of transport and is key reference in the CountEmissionsEU regulation.

¹ Carbon dioxide equivalent (CO₂e)

² The unit p denotes the number of passengers, which is also designated as ‘pax’ in some standards and publications.

However, challenges include data governance, privacy regulations, interoperability, and financial constraints for small and medium-sized enterprises. It concludes with recommendations for both vessel operators and policymakers to ensure the smooth adoption of standardised emissions reporting across the inland waterway fleet. In a second step, these data can be collected, analysed and used as a basis for the Transport Operation Categories (TOC), which are required for the reporting according to the ISO 14083:2023. In contrast to the emission reporting with TOC, the approach described herein is the transport service of a specific ship and motivates ship operators to optimise the energy efficiency of the vessel, the navigation and logistics.

While C3 characterises the transport service (the transport chain element) actually delivered, methodology E1 characterises the efficiency performance of the vessel itself. Both methodologies therefore give owners and operators an incentive to optimise, but at different levels.

Methodology E1 was developed on the basis of the Energy Efficiency Design Index (EEDI) in the maritime sector, two studies on the adoption for inland waterway vessels and further refined as part of PLATINA4Action. The E1 method determines an ex-ante index in **Wh/t·km** that assesses a vessel's energy efficiency and focuses on the **energy consumption for propulsion** in relation to the transport performance. In contrast to the maritime sector, inland waterway transport is characterised by a wide variety of conditions and circumstances vessel types and sizes (from small motor vessels to large push-tow convoys), different fairway conditions (water depth, current, restricted channel dimensions, locks) and loading conditions (draught, load factor, empty voyages). These varying conditions and circumstances make the application and comparability of a design index challenging.

As part of the PLATINA4Action project, the test conditions for determining the attained EEDI were defined and possible correction procedures for deviations from the ideal test conditions were developed. This was consolidated into a draft calculation procedure, presented in Annex B ("Procedure for calculation of the Estimated and Attained Energy Efficiency Design Index of inland waterway vessels"), which can serve as a direct basis for future CESNI standardisation. This lays the foundation for this methodology, and a number of test examples demonstrate its applicability in principle. The next step is to validate the method using real-world data. With this, the report aims to pave the way for incorporating an EEDI-type index for inland vessels into a CESNI standard, as requested by the Member States in the European Commission expert group.

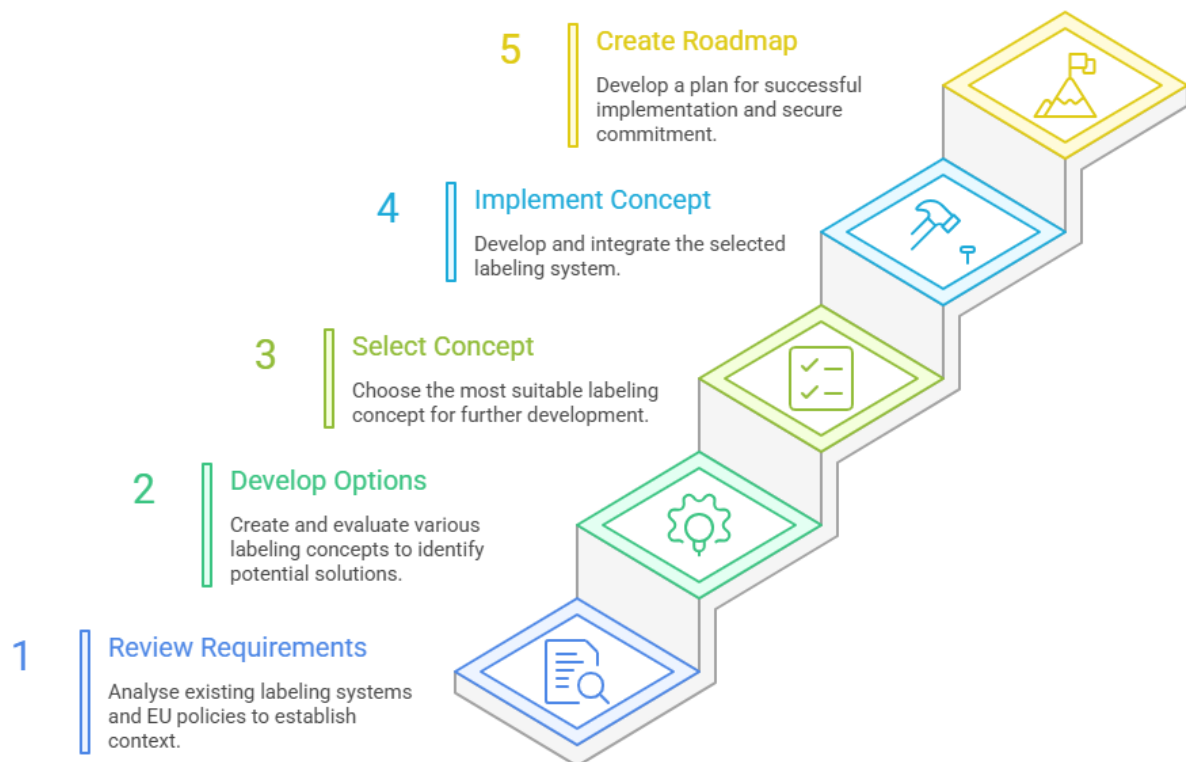
1. Introduction

1.1 Objective of the Work Package

The Horizon Europe project PLATINA4Action responded to the call for proposals HORIZON-CL5-2023-D5-01-17 “Towards the implementation of the inland navigation action programme with a focus on Green and Connected Inland Waterway Transport”. One of the expected outcomes of this call is a “Proposal of a European labelling system for EU waterways” in line with the NAIADES III action 11 “...elaboration of an EU energy index methodology for assessing carbon intensity levels...”. This is addressed by the project’s work package WP3 – Label for vessels on EU waterways.

Work Package 3 aims at:

- Providing an updated review of requirements for maritime and inland labelling systems, including EU policy and legislation to set the scene, the boundary conditions, and the objectives.
- Development and assessment of options and evaluation of labelling concepts.
- Selecting one concept and further development including its implementation.
- Making implementation roadmap and raising commitment for implementation.



The project PLATINA4Action started in January 2024 and is running until December 2026. WP3 was scheduled to be completed by December 2025 and was extended to follow and include the latest developments e.g. in the context of CountEmissionsEU. It is a follow-up activity of the work done in the PLATINA3 project which delivered a specific report (D2.6) [1] to present the basic modules which can be distinguished for a label/indexing instrument for energy and emission performance of inland vessels. More information can be found in section 1.3 of PLATINA4Action deliverable D3.1 [2] or in PLATINA3 report D2.6.

The outcomes of WP3 are reported in two deliverables, namely the PLATINA4Action report D3.1 “*State of play and requirements for the label for inland vessels*” [2] presenting an updated overview of the current state-of-play, considering the latest policy and research developments relevant to labelling vessels operating on EU waterways. In addition, the report outlines the objectives, requirements and boundaries of the proposed labelling scheme. Drawing on consultations and interactions with stakeholders, it defines the overarching purpose and key objectives, and provides conclusions on priority policy goals and associated key performance indicators (KPIs). This report was finalised in December 2024 and is available on the official PLATINA4Action webpage:

<https://platina4action.iwtprojects.eu/reports/>

This PLATINA4Action report D3.2 “*Proposed labelling concept and implementation roadmap*” builds on the findings of PLATINA4Action report D3.1. It identifies and evaluates various labelling options, then develops an implementation roadmap for the selected approach, including recommendations for regulatory integration. Finally, the report presents example results illustrating how both the current fleet and innovative, green, or clean vessels perform under the proposed labelling scheme. This report was scheduled to be completed by December 2025 but updated and submitted in September 2026 to include the latest developments outside of PLATINA4Action.

1.2 Tasks in WP3

The PLATINA4Action report D3.1 builds on the findings of Tasks 3.1 and 3.2, while PLATINA4Action report D3.2 builds on the findings of Tasks 3.3, 3.4 and 3.5. The following Tasks are described in the Grant Agreement of PLATINA4Action:

1.2.1 Task 3.1: Updating state-of-play

The PLATINA3 project reported on the emission label/index systems and the link to carbon footprint calculation in February 2022. Later developments need to be considered. This concerns NAI4DES III actions, EU Taxonomy technical screening criteria, Corporate Sustainability Reporting requirements, CountEmissionsEU, the Dutch label scheme, the CCNR (Central Commission for the Navigation of the Rhine) correspondence group on labelling as well as the German study on energy efficiency indicators for inland waterway transport (IWT) and the experience in maritime such as: Energy Efficiency Design Index (EEDI), Energy Efficiency Operating Indicator (EEOI), Ship Energy Efficiency Management Plan (SEEMP) and Carbon Intensity Indicator (CII).

1.2.2 Task 3.2: Setting objectives and boundaries for the label

Based on the stocktaking and updating in Task 3.1 as well as consultations with stakeholders, the objectives and boundaries will be defined. For example, this will concern the discussion on costs, complexity, confidentiality, legal consequences and level playing field. In this task also the overarching purpose and key objectives shall be made clear. Priorities will be defined in terms of policy objectives and related KPIs.

1.2.3 Task 3.3: Developing options and evaluation

Building on the insights from Task 3.1 (updated state-of-play) and the requirements defined in Task 3.2 (objectives and boundaries), this task focuses on identifying and evaluating various labelling options. The evaluation will consider feasibility, effectiveness, efficiency, and proportionality. This will involve examining whether the label should be voluntary or mandatory, its scope, and potential governance models. The evaluation will be informed by desk research, expert opinions, and stakeholder workshops. Engagement with key stakeholders, such as the NAIADES Implementation Expert Group and the European Commission DG MOVE (Directorate-General for Mobility and Transport), will be critical for ensuring alignment with the broader implementation process.

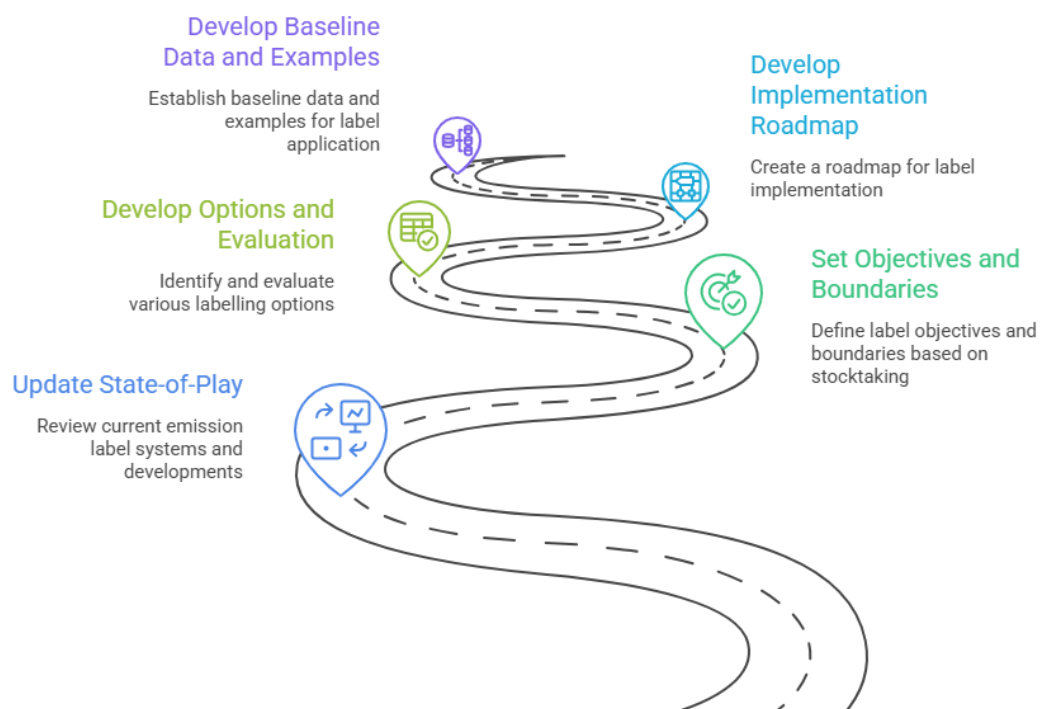
1.2.4 Task 3.4: Developing implementation roadmap

This task involves creating a roadmap for implementing the label, building on the outcomes of Task 3.3. It will outline next steps and propose follow-up activities for post-project implementation. Stakeholder interviews and broader consultations will be conducted to secure commitment for these steps. The roadmap will also provide recommendations for integrating the label into regulations and incentivising its adoption by users. This task ensures a clear path for transitioning from development to practical application and wider acceptance of the label scheme.

1.2.5 Task 3.5: Developing baseline data and examples for specific segments

This task aims to establish a database of baseline data on energy demand and emission factors for various vessel technologies. Drawing on literature and results from previous projects (PROMINENT, NEEDS, SYNERGETICS), sailing profiles for different vessel types and operations will be developed. The task also includes creating examples of how the label applies to current fleet performance and assessing how innovative, green or clean vessels might perform under the proposed scheme. This will provide tangible insights into the label's functionality and value for stakeholders.

Work Package 3 Tasks Sequence



1.3 Summary of PLATINA4Action report D3.1

The report D3.1 “*State of play and requirements for the label for inland vessels*” [2] provides the results produced in the first two tasks (Tasks 3.1 and 3.2) of PLATINA4Action’s WP3. These tasks addressed an update of the state-of-play, objectives, and boundary conditions regarding the setting up of a data and label system for inland vessels on EU waterways. It builds on the PLATINA3 work from January 2021 to February 2022 ([Deliverable 2.6](#)) [1] while taking into account the new developments which influence the objectives, choice of indicators, and the way forward towards the envisaged implementation of a proper methodology. This methodology concerns collecting and monitoring emission performance data of inland vessels and possibly implementing a label based on the collected data.

These relevant new developments are the following:

- Activities within the CCNR and in the framework of the CESNI (Comité Européen pour l’Élaboration de Standards dans le Domaine de la Navigation Intérieure) to define an international standard relating to a methodology for measuring and calculating emissions (air pollutant and GHG) from inland navigation vessels as well as emission classes.
- Implementation of Corporate Sustainability Reporting Directive (CSRD) and European Sustainability Reporting Standards (ESRS), providing sustainability reporting requirements for companies
- Publication of ISO 14083:2023 and the adoption of CountEmissionsEU Regulation (EU) 2026/1030 of the European Parliament and of the Council on the greenhouse gas emissions accounting of transport services, in force since June 2026 and applicable from 2030, which makes this ISO-standardised methodology the reference for reporting the GHG emissions of transport services.
- Revision of the EU taxonomy technical screening criteria for inland vessels for post 2025
- Additional study work in Germany on the concept of the EEDI methodology for inland vessels
- Additional study work in the Netherlands to further develop the Dutch label methodology

In general, there is a trend towards the need for data and information on the emission and energy efficiency performance. Preferably the actual data from vessels and the operation is to be used for the alignment with EU Taxonomy, ISO 14083:2023. Therefore, it is wise to prepare the sector for this increasing demand for reliable primary data and to support the data exchange. Especially this question is also studied in view of further development of the Dutch label methodology. Another conclusion is that some indicators have become more prominent. This concerns the expression of the carbon intensity of the fuel, via an emission factor in grams CO_{2e} per MJ, which is now also applied in the revised EU taxonomy technical screening criteria for inland vessels by means of the reference to the FuelEU Maritime methodology and, in future, the planned CESNI methodology. Finally, the German study on the EEDI_{INLAND} concluded on the methodology to determine EEDI values which could be relevant to apply for new vessels during their trial voyage.

In terms of the main objectives and priorities the following is distinguished regarding setting the scope and purpose of the data and labelling system for inland vessels:

- Greenhouse gas emission reduction
- Air pollutant emission reduction
- Increasing energy efficiency

An emission data and label system can serve two main purposes:

1. Providing a reference to decide on subsidies and to offer incentives to vessel owners/operators
2. Supporting disclosure of information on energy consumption and emissions to stakeholders

For the 1st purpose, having transparency on emission performance and possibly a label, may help to provide a level playing field for green vessels compared to 'grey' vessels. There is currently a market failure as green vessels are not rewarded sufficiently to offset the additional capital costs and operational costs. This is partly due to lack of visibility and because of incentives from stakeholders which are lacking to promote and support green vessels. By means of providing a reliable data and label system as reference, effective incentives can be implemented to solve this problem. State aid schemes can make use of the same methodology to decide on subsidies for investments in cleaner ships.

For the 2nd purpose, the required disclosure of energy and emission data, the CSRD/ESRS, the CountEmissionsEU/ISO 14083:2023, the EU taxonomy criteria and the related State Aid regulations are the starting points and references. The type of data and the criteria are leading for the design of the data and label. For example, a label may possibly indicate if the vessel is compliant with EU taxonomy criteria or not. The legal instruments referred to here reflect the state of play in 2026. The indicators themselves are defined independently of any single instrument: where legislation still relies on tank-to-wake accounting, the same data allow well-to-wake reporting. A periodic review of the labelling framework is therefore recommended, so that it can follow the state of the art rather than freeze it.

By means of comparing the type of indicators and the required data to be collected, it is concluded already that synergies can be reached as often the same basic data is needed (for example amount of energy consumption, type of fuel and transport performance). The different methodologies are complementary to each other. They differ, however, in the quality, granularity and verifiability of the required input data: A and E1 rely on measured or type-approval data obtained under controlled conditions, whereas C3 relies on operational data reported by the operator. This difference in data quality has to be reflected in the way the indicators are combined and communicated. The total set of indicators can provide a valuable dashboard of information providing a full picture on the emission and energy efficiency indicators. This concept of bring different indicators together is also called the 'emission passport'.

Regarding the boundary conditions it is concluded that the system shall be reliable, replicable, sufficiently exact, and easy to implement as a practicable label or index instrument. A balance needs to be found here. It needs to be sound and possible for authorities to grant equal treatment. Confidential and business sensitive data needs to be addressed properly with clear agreements. Of course, the involved costs and required efforts are relevant as well.

There are relevant lessons learned as well from the automotive sector which already introduced labels for passenger cars. Also, valuable lessons have been learned from the maritime seagoing sector as they have already experience with EEDI, EEOI, CII and MRV (Measuring, Reporting and Verification). Each of them has a different purpose and they are complementary. However, the inland navigation sector is quite a different sector compared to the seagoing vessels. The main differences lie in the dynamic operating conditions (water levels, currents), the variety in terms of the size of ships and convoys, and the infrastructural aspects; furthermore, the low replacement rate and the limited series production of ships (apart from the passenger and tanker segments) play a decisive role.

It is concluded that there may be opportunities to develop a tool that efficiently supports inland navigation companies in the disclosure of information to their clients and other stakeholders, such as banks, ports and grant providers.

1.4 Approach and content of this report

The report presents the development and evaluation of different labelling options. The first part distinguishes and compares five different methodologies, which are complementary to each other. These five different methodologies are based on the work done in PLATINA3.

However, although it was originally foreseen that PLATINA4Action would elaborate the complete picture, in the meantime, CCNR decided and CESNI was assigned to further elaborate two of these methodologies:

- Methodology “A” for air pollutant emissions (grams per kWh)
- Methodology “C1” for the carbon intensity of energy used (grams CO₂e per MJ)

Moreover, the methodology “C2” can be derived from the methodologies A and C1 as the calculation of the CO₂e emissions per kWh, as this indicator can simply be based on data resulting from methodologies “A” and “C1”.

In light of this task for CCNR and CESNI, a discussion took place with European Commission (DG MOVE)³ and it was agreed and decided that PLATINA4Action focussed the efforts on providing further elaborations for the remaining methodologies:

- Methodology “C3” the greenhouse gas emission intensity (grams CO₂e per t·km)
- Methodology “E1” for the energy efficiency of a vessel (Wh per t·km).

The second part of this report therefore focuses on those pursued in this project, providing detailed descriptions, implementation roadmaps, and examples of application.

The report is completed by two Annexes; both designed as a stand-alone document for further use beyond this project:

- Annex A is a “*Manual for level C3 emission reporting*”;
- Annex B presents the “*Procedure for calculation of the Estimated and Attained Energy Efficiency Design Index of inland waterway vessels*”.

³ “Members wanted to attain a certain prioritisation and coordination of the works, which DG MOVE acknowledges. Methodology A is already at CESNI level and apparently to be finalised soon. Methodology C1, which has considerable backing from the group, is soon to be finalised by the CCNR, too, and could be further developed by CESNI. DG MOVE also concluded that Methodology C4 (Ed. note: now E1) sees some supports and PLATINA4Action could focus on this methodology. Methodology C3 is considered to be pertinent, but the concrete implementation may cause a too high administrative burden if it is to be tamper proof, even though it could steer the sector towards efficient operation/use of resources.”

Source: <https://ec.europa.eu/transparency/expert-groups-register/screen/meetings/consult?lang=en&meetingId=63847&fromExpertGroups=3496>

2. Development and evaluation of labelling options

The development and evaluation of labelling options is the main purpose of Task 3.3. This task builds upon the findings of Deliverable D3.1 [2] as well as insights gathered from workshops and meetings with key stakeholders and expert groups. As a result of these collaborative efforts, five possible methodologies have been identified in the beginning and were selected for further consideration.

It was collectively agreed that the selected methodologies should fulfil essential criteria: they must be tamper-proof and cost-effective, impose a low administrative burden and be compatible with existing systems. Further they should allow for comparability among different vessels and, ideally, cover as much of the inland fleet as possible.

The criteria are detailed below:

- **Tamper-proof:** the methodology must be robust, credible, and reliable. Input data must be trustworthy and not easily manipulated. The approach should allow cross-checking against independent sources and demonstrate that the data are logical, consistent and technically sound;
- **Costs:** the costs of the methodology need to be limited and offset with incentives provided to vessel owners/operators, especially when a methodology is to be applied on a voluntary basis;
- **Administrative burden and compatibility:** the methodology shall not create significant additional administrative work for vessel owners/operators to collect and process data. Preferably, it should be compatible with existing data systems and rely on automated data collection;
- **Level playing field and comparability of vessels:** the methodology should account for different vessel characteristics, operational profiles, and market segments. It must produce emission performance indicators that allow fair comparisons between vessels. Because the actual emission intensity of a voyage is strongly influenced by factors that are only partly within the operator's control (fluctuating water levels, currents, varying cargo loads and empty voyages), the methodology shall either normalise for these factors or, where it does not, document them transparently, so that reported values cannot be misused – accidentally or deliberately – for comparisons they were not designed for.
- **Coverage of inland fleet:** in order to reduce emissions from all inland vessels, the methodology should cover as much of the fleet as possible. However, considering the huge fleet diversity, the scope could initially be limited to vessels transporting freight and passengers, covering both new-build vessels and, where the methodology allows, existing vessels, with the option to later expand to floating equipment, such as crane vessels, dredgers and similar.

Each of the proposed methodologies below pursues different objectives and, as such, is expected to generate varying incentive effects within the sector. Some methodologies may, for example, focus on the uptake of alternative fuels, while others could emphasise operational efficiency or new technologies. Depending on the specific goals and requirements, these methodologies can be implemented individually, in combination, or in parallel to maximise their overall impact. Combined methodologies can be displayed in an “emission passport”.

It is important to note that each methodology is at a different stage of development and implementation. Some are already partially established and could be adopted in the short term, while others require further refinement, piloting, or regulatory adjustments before they can be rolled out on a larger scale.

The five methodologies selected from the broader set of options identified in PLATINA3 D2.6 and D3.1 are the following:

- **Methodology A (Air Pollutant emissions in g/kWh)**
 - Based on onboard measurements, applicable also to existing vessels equipped with engines prior to Stage V emission standards;
 - Based on the Dutch label methodology, EU project PROMINENT and preparatory work within CCNR with expertise centres in France (CERTAM), the Netherlands (TNO) and Germany (BAW);
 - Draft standard developed within CESNI for use by CCNR and EU Member States, [3], [4];
- **Methodology C1 (GHG intensity of energy in gCO₂e/MJ)**
 - Focusing on fuel (quantity and type) and shore power supply used combined with associated GHG emission factors in a WtW approach;
 - Based on research work in The Netherlands (RVO)
 - Grams **CO₂e per MJ ex post** based on FUEL EU Maritime regulation
 - Draft standard developed within CESNI for use of CCNR and EU Member States;
- **Methodology C2 (combined GHG and air pollutants emission in g/kWh)**
 - An extension of the first two (A and C1), encompassing both air pollutants and GHG emissions, considering efficiency of onboard energy conversion;
 - Grams **CO₂e per kWh ex post** as based on Dutch label methodology;
- **Methodology C3 (operational emissions in gCO₂e/t-km)**
 - Based on operational data, including transported cargo and/or passengers, distance travelled and energy used, based on ISO 14083:2023;
 - Grams **CO₂e per t-km ex post** (MRV/CountEmissionsEU/ISO 14083:2023)⁴;
- **Methodology E1 (Energy Efficiency Design Index – EEDI)**
 - A design-focused approach looking at the representative emission;
 - **Wh per t-km ex ante** (EEDI_{INLAND} as developed by DST).

The “A” stands for the focus on Air Pollutants, the “C” stands for the focus on Climate change emissions and the “E” stands for the focus on the Energy Efficiency performance. Table 1 provides an overview of the selected methodologies.

As mentioned in section 1.4, after careful evaluation with the expert working groups and European Commission DG MOVE, it became clear that the PLATINA4Action project should focus on developing methods C3 and E1. Methodologies A and C1 are being developed within CESNI. These two methodologies (A and C1) will be implemented independently of this project, but they are briefly described here for context. Methodology C2, which uses data from A and C1 and was therefore not pursued further and is also mentioned briefly.

Thus, the primary focus of this project is on Methodologies C3 and E1, which are presented in detail in the following sections. The results of these methodologies may also be integrated into the CCNR emission passport, introduced in Section 2.1, as additional parameters.

⁴ Within CountEmissionsEU and ISO 14083:2023, the gCO₂e/t-km metric serves as an intermediate input for calculating total emissions from a transport operation or transport chain. It should therefore be presented alongside total emissions to improve transparency, rather than used as a standalone final comparator.

Table 1 Main methodologies and the key characteristics

	Unit of measurement	Ex ante/ Ex post	Scope/ Vessels ⁵	Application	Data and measurement	Readiness
A: Air pollutants	$\left[\frac{\text{g or \#}}{\text{kWh}} \right]$	Ex post	All	EU Taxonomy Local (port) policies CSRD/ESRS Dutch label	Characteristics of energy converters: power rating, energy consumption, running hours, net power output, emission profile (g/kWh), efficiency.	Medium
C1: FuelEU	$\left[\frac{\text{g CO}_2\text{e}}{\text{MJ}} \right]$	Ex post	All	EU Taxonomy/State aid CSRD/ESRS	Energy mix and GHG intensity factors (WTW based on RED Annex V, the CLEVER project, and other sources)	Medium
C2: CO ₂ e/kWh	$\left[\frac{\text{gCO}_2\text{e}}{\text{kWh}} \right]$	Ex post	All	Dutch label	Emission profile (g fuel/kWh), energy consumption, and mix (GHG intensity per MJ, WTW based on RED Annex V)	High
C3: EEOI/MRV/ ISO 14083:2023	$\left[\frac{\text{g CO}_2\text{e}}{\text{t}\cdot\text{km}} \right]$	Ex post	Transport services with freight and passenger	CountEmissionsEU CSRD/ESRS	- Gross used energy and type of energy (GHG intensity) per trip (including empty sailing), per client - Net of transported cargo (excluding the weight of containers) or passengers per trip, per client - Loaded transport distance per trip - Aggregated data for reporting	Medium
E1: EEDI	$\left[\frac{\text{Wh}}{\text{t}\cdot\text{km}} \right]$	Ex ante	New builds and retrofits - Freight and passenger	State aid To be defined, new application	- Representative conditions (displacement, waterway) - Predefined speed or power - Measurement of power (shaft power, electrical motor power, or fuel flow) and speeds. Ignores aux. engines and hotel load.	Medium

It shall be noted that the options are not competing but they are complementary to each other, providing the overall picture.

⁵ scope of application: “All” = all vessels covered by the instrument concerned, including floating equipment and workboats; “Freight and passenger” = cargo and passenger vessels only. Ex-ante methodologies apply to new builds and major conversions, ex-post methodologies to vessels in service.

2.1 CCNR emission passport

Based on the PLATINA3 report, the Dutch label methodology, EU project PROMINENT and expertise within its Member States, CCNR developed methodologies for air pollutant emissions (A) and GHG intensity (C1), with the aim of combining both into a single standard and contributing to the setting up of an emission passport, a first version of a dashboard of key indicators. The CESNI standard will need to be supplemented by a legal framework at CCNR and/or EU level in order to make its application mandatory or to link it to incentives.

Methodology A is based on the standardised periodic on-board measurement of air pollutants combined with engine running hours to calculate a weighted average air pollution performance of the vessel. For Stage V engines however, as way of derogation to the standard (to be reviewed every two years), onboard measurements are not required, and type-approval data can be used. This saves costs and makes it easier while the reliability is not much compromised. The air pollutants distinguished, as defined in the NRMM (Non-Road Mobile Machinery) Regulation, are nitrogen oxides (NO_x), particulate matter (PM), carbon monoxide (CO), and hydrocarbons (HC) expressed in g/kWh. Due to on-board measurement protocol for engines, the methodology is applicable to existing vessels equipped with engines, including those prior to Stage V emission standards.

Methodology C1 defines GHG intensity expressed in gCO₂e /MJ, depending on the type of fuel or, in general, energy carrier combined with associated GHG emission factors in a WtW approach. It is based on the calculation methodology used in the FuelEU Maritime regulation and is currently under development within CESNI. This methodology is foreseen to be referenced in the updated technical screening criteria for the EU Taxonomy for inland freight and passenger vessels.

PLATINA4Action partners DST and SPB/EICB took part in the working group meetings organised by CCNR to discuss the development and testing of the methodologies A and C1.

2.1.1 Implementation roadmap CESNI standard

The draft standard for Methodologies A and C1 is developed within CESNI and was supported by CCNR, the Dutch agency RVO and PLATINA4Action. Discussions relating to emission factors are ongoing. Work with the Dutch state agency RVO relating to implementation aspects is ongoing, especially fuel certification and collection of data from Member States related to fuels supplied to IWT. The IWT-specific work concerns the input data, the certification of fuels supplied to inland navigation and the collection of these data from Member States. It is not intended as a sector-specific emission factor methodology: the calculation itself follows the cross-modal frameworks (ISO 14083:2023 / CountEmissionsEU and RED Annex V), so that emission factors remain comparable across modes.

The draft standard is expected to be updated after ongoing practical tests of the air pollutant protocol in France, Germany and the Netherlands, allowing CESNI to adopt a single standard covering both air pollutants and GHG intensity in 2027. The standard will most likely be adopted as a separate standard and therefore will not be included in ES-TRIN.

It is planned to implement a single emission passport recognised by all CCNR national authorities in application of the principle of mutual recognition. In practice this means that vessel owners would therefore only need to obtain a single passport, that emissions passports delivered by one CCNR

Member States would be recognised by other CCNR Member States and that Member States could renew a passport issued by another State, following current practice under the Rhine Vessel Inspection Regulation (RVIR). The emission passport is planned to remain voluntary: Member States are not obliged to issue passports, but if they do, the CESNI standard must be applied. In order to ensure the effectiveness of the mutual recognition principle, it is essential to establish common and binding rules governing the procedure for issuing the certificate. These rules are currently being developed by the CCNR. No mandatory emission reduction targets (as in FuelEU Maritime) or emission limits will be introduced by CCNR; these may instead be addressed at the EU level. A study by PLATINA4Action is ongoing to consider such specific binding EU policy interventions to promote the energy transition and emission reduction in IWT.

	2025			2026								2027
	September		December		March		June		September		December	
Air pollutants	Review of draft standard									Adoption of CESNI standard (combining air pollutants and GHG in one standard)		
	Implementation trials with the draft standard (NL, DE and FR)			Incorporate lessons learned from the trials								
GHG			Submission draft GHG standard (CCNR)	Review of draft standard to incorporate the remarks and finalization of emission classes (CESNI/PT)								
Implementation												regional, national or international initiatives

Figure 1 Tentative timeline for the implementation of methodology A and C1 (Source: CESNI Secretariat).

2.1.2 Conclusions

The proposed scenario enables Member States or regional authorities to apply the CESNI standard on a voluntary basis. Such standard could incorporate at a later stage or connect with Methodologies C3 and E1. Overall, this provides a robust system for measuring and reporting vessel emissions and energy performance, which could support future EU initiatives by building on an already operational framework. Methodology C2: Grams CO₂e per kWh as based on Dutch label methodology.

If Methodology A is combined with Methodology C1, it is rather straightforward to also determine the CO₂e performance per unit of output power of the energy conversion on board of vessels. The indicator to be used is grams CO₂e per kWh. Both methodologies, A and C2, are already implemented in the Netherlands in a combined labelling scheme covering both air pollutant emissions and GHG emissions. In case methodology A is already implemented, the methodology C2 does require only an additional calculation, without the need for additional measurements on board. Therefore, it can be concluded that there is a strong synergy between A, C1 and C2 and they complement each other. This is especially true for emission data needs on aggregated level for certain periods of time, for example on quarterly or annual level.

The merit of the grams per kWh indicator is that it provides high-level information on the efficiency of the energy conversion. For example, this information would be useful to promote the use of more efficient engines or power trains, such as hybrid drives including batteries charged with electricity from shore. Vessels using batteries charged with green electricity from shore used to propel an electric motor do usually require only half of the energy amount compared to a traditional power train using a combustion engine. Furthermore, making the CO₂e grams per kWh visible also gives insight for benchmarking and supports better power management on board, e.g. avoiding idling engines or usage of engines at low load rates. It however excludes the hydrodynamic performance of the vessel and energy efficient navigation. For this reason, the E1 methodology has been developed in PLATINA4Action to complete the picture on the energy efficiency of a vessel.

3. Methodology C3: Grams CO₂e per t·km ex post (CountEmissionsEU/ISO 14083:2023)

3.1 Rationale and context

The inland waterway transport sector faces increasing pressure to quantify and report greenhouse gas (GHG) emissions in a standardised and verifiable manner. Key regulatory drivers include the Corporate Sustainability Reporting Directive (CSRD) with its European Sustainability Reporting Standards (ESRS), the CountEmissionsEU Regulation, and ISO 14083:2023.

The C3 methodology focuses on freight transport, measured in tonne-kilometres (t·km), while passenger transport (p·km) is also covered by CountEmissionsEU. Workboats, service craft and floating equipment (e.g. crane vessels, dredgers) are excluded, as they do not produce a transport activity that can be expressed in t·km or p·km. For these vessel types, methodologies C1 and C2 are more appropriate to provide information on the greenhouse gas emission performance.

The C3 methodology expresses greenhouse gas emissions in grams of carbon dioxide equivalent per tonne-kilometre (gCO₂e/t·km) on an ex-post basis. It reflects the combined impact of factors within and outside the control of vessel owners and operators: the carbon intensity of energy carriers, efficiency of energy conversion systems, hydrodynamic characteristics and operational practices including sailing speed. The calculation is based on total energy consumption registered during a defined period, including energy consumption during empty sailing and waiting in ports, attributed to the CO₂e emissions of the transport activity⁶.

3.2 The administrative burden challenge

The administrative burden of comprehensive data collection systems is a significant barrier, particularly for **Small and Medium-sized Enterprises** (SMEs). Furthermore, the IWT sector is characterised by the high share of very small, usually family-owned, businesses, owning and operating 1 or 2 vessels. These are self-employed operators with limited administrative capacity and financial resources. This requires implementation methods that minimise extra reporting efforts while maintaining data quality and regulatory compliance. The findings on the existing IWT data systems are directly relevant to the SME-oriented calculation tool foreseen under CountEmissionsEU; continued coordination with the development of that tool is recommended, so that it can build on the data sources described here.

⁶ The C3 indicator was conceived as a mechanism by which data could be compiled and presented in a way to facilitate data sharing between transport operators and their clients as an intermediate step in the calculation of the total GHG emissions of a transport service or longer transport chain, while maintaining an element of commercial confidentiality for the transport operator over the primary data that goes into the calculation.

3.3 Objectives and scope

The C3 methodology minimises administrative burden by means of directly using the available digital data already available at shipowner/operator level on the energy consumption and the journeys and transport performance. The specific objectives are:

1. Specify the data requirements for implementing C3 methodology, with attention to accuracy and validation mechanisms.
2. Identify synergies with existing data systems, specifically fuel/energy consumption data derived from bunkering data in the electronic payment system of the Convention on the Collection, Deposit and Reception of Waste (CDNI), voyage information from RIS platforms (ERINOT/EURIS/CEERIS⁷), and financial records maintained for accounting and tax purposes.
3. Assess the feasibility and proportionality of different implementation approaches, considering trade-offs between data accuracy, administrative burden, and costs.
4. Address legal and technical barriers, including data ownership and privacy considerations related to RIS data, technical interfaces, and verification requirements.
5. Develop recommendations for implementation, including pilot testing, stakeholder engagement, and timelines aligned with regulatory requirements.

3.4 Methodological approach

The executed work combined desk research, technical analysis, and stakeholder consultation, building on PLATINA4Action WP3 reviews. Technical input was obtained through interviews with software providers, RIS system managers (EURIS), CDNI administrators (SAB and ITB), vessel operators, representative organisations (IWT-P), national waterway authorities (RWS and viadonau) and administration service suppliers (e.g. Autena Marine).

⁷ ERINOT - Electronic Reporting International Notices for Transport Operations; EURIS - European Information Service; CEERIS - Central and Eastern European Reporting Information System

3.5 Detailed specification of the methodology C3

Conceptual framework and formula

The methodology C3 quantifies freight transport efficiency by relating climate impact to transport activity:

emission intensity (gCO₂e/t·km) = greenhouse gas emissions (gCO₂e) / transport activity (t·km)

$$I_{CO_2e} = E_{GHG} \div TP$$

Symbol	Description	Unit
I_{CO_2e}	Emission intensity (emission per unit of transport work)	gCO ₂ e/t·km
E_{GHG}	Total greenhouse gas emissions over the reporting period	gCO ₂ e
TP	Transport performance (sum of net tonne-kilometres for all loaded t·km trips in the period)	

This is an ex-post methodology based on actual historical performance over a predefined period (journey, quarter, or year). Unlike ex-ante methods predicting performance under idealised conditions, the methodology C3 reflects real operational efficiency including payload utilisation, cargo density, water levels, empty trips, the vessel's design and operating characteristics and sailing speed.

The resolution depends on the frequency of energy consumption information. Ideally, vessels use real-time measurement systems enabling detailed ISO 14083:2023 application per individual transport service. However, few vessels are equipped with such devices. The preferred alternative would be to use CDNI bunker data as input, supplemented with electricity from onshore power supply (OPS). This is not possible under the current CDNI framework, as the boundary conditions for such secondary use, including the conditions for the vessel operator's consent, would first have to be set by the CDNI Conference of Contracting Parties. Electricity taken from onshore power supply (OPS) is not registered in the SPE-CDNI and has to be obtained separately, from the OPS operator's metering or invoices.

The energy consumption for a given period is then being calculated using emission factors per energy type (gCO₂e per kg or kWh), which shall be based on the data used as well for the C1 methodology factors. The total CO₂e emission is then divided by the net transport activity (summed tonne-kilometres for loaded trips). Context information on dominant waterway types and goods transported is added. The latter will enable deriving possible benchmarking values and 'default' values to be used as secondary data for IWT companies not able or willing to collect the primary data themselves.

System boundaries and scope. Emissions are expressed in CO₂e. According to ISO 14083:2023, the calculation must be based on a Well-to-Wake (WTW) basis, including emissions from fuel production, distribution, and combustion on board. These WTW emission factors should be aligned in the future with the C1 methodology based on the central database to be set up by the European Energy Agency (EEA) in the context of CountEmissionsEU.

The methodology encompasses all energy consumption during the reporting period. As the fleet diversifies, the system must accommodate emerging technologies including hydrogen, battery-electric propulsion, swappable batteries and shore-side electricity.

The C3 approach. The C3 methodology is deliberately designed to minimise the threshold for emissions reporting across the entire inland waterway fleet, anticipating the limited administrative capabilities and financial resources of small IWT entrepreneurs whose vessels cannot record energy consumption per individual journey. By focusing on data already provided in the existing administrative framework (CDNI bunker registration, RIS voyage data via EURIS/CEERIS), the additional administrative burden is minimized and even the smallest operators can participate, provided that they report their journeys electronically by means of EURIS / CEERIS platforms.

Over time, the collected data will support development of reliable default values differentiating between vessel type/size, waterway type and goods transported, so enabling benchmarking between vessels while considering sector diversity and enabling development of operationally-based ex-ante default data for specific transport operation categories. Data resolution may be enhanced further, for example by installing fuel consumption measurement devices for trip-specific recording.

3.6 Analysis of existing data sources and infrastructure

Fuel consumption data/The electronic payment system of the Convention on the collection, deposit, and reception of waste generated during navigation on the Rhine and other inland waterways (CDNI)

The CDNI requires operators to document fuel purchases through official attestations of receipt. In force since 2009, the disposal-charge system has generated, as a by-product of the charge payment and the international financial clearance, a verified record of bunkered gas oil volumes. Vessel-specific data are, however, only available to the ECO-account holder in the SPE-CDNI from 2021/2022 onwards; for earlier years the data exist only in aggregated form. Neither the CDNI Secretariat nor the national institutions are entitled to release these data to third parties on Convention waterways (Rhine, Moselle, and other connected waterways across Western Europe), estimated to cover around 70 % of IWT fuel consumption in Europe.

Operators pay through the digital SPE-CDNI 3.0 system, with disposal fees levied at each bunkering event. The online ECO account provides a transaction history directly linked to bunkered gas oil volumes, which could be used by the ECO-account holder (generally the vessel operator) as an aggregated overview of fuel purchases fitting C3 data requirements. However, using SPE-CDNI data for emissions reporting is currently only possible for ECO-Account holders with the data of their own vessels, as the system is designed for the payment of the disposal charge and for the international financial clearance, not fuel consumption monitoring. Furthermore, the system is currently linked to gas oil as defined in Article 1(m) CDNI, which includes blends with biofuels and synthetic fuels. Other energy carriers outside that definition are limiting applicability for vessels transitioning to other alternative fuels. The resolution of 2 July 2026 will add the fuel type and blend composition to the SPE-CDNI from 1 January 2027, which removes part of this limitation. Access nevertheless remains restricted to the ECO-account holder and requires the operator's explicit consent, and energy carriers outside the disposal charge - notably shore-power electricity, LNG, methanol and hydrogen⁸ - remain out of scope. The questions of data ownership and of the data protection obligations attached to these data have not been settled; this description reflects current practice and not a legal position.

⁸ See for the final legal text: see <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32026R1030>

Electronic bunker delivery notes

The transition to digital bunker delivery notes provides substantial benefits: streamlined documentation, enhanced data accuracy through minimised manual errors, and reinforced integrity of recorded information.

Shore power and alternative energy carriers

Shore power consumption must be included in C3 calculations. Operators collect the metering data or utility invoices for electricity at berth and aggregate the kWh over the reporting period. As the fleet diversifies, it will be essential to account for hydrogen, methanol, swappable batteries and shore charging. Current data sources are geared to gas oil, which is a limitation for the front-runners of the energy transition. This is not a shortcoming of the CDNI: the CDNI only needs the data required for the disposal charge and the international financial clearance. For energy carriers outside that scope, the operator has to supply the additional input directly. HVO and other paraffinic or blended diesel fuels do fall within the gas oil definition of Article 1(m) CDNI; from 1 January 2027 the fuel type and blend composition are registered in the SPE-CDNI, which is what allows the correct emission factor to be applied to them.

Voyage reporting data: River Information Services (RIS) and Electronic Reporting

River Information Services requirements mandate Electronic Reporting International Notices for Transport Operations (ERINOT) messages for specified vessel categories. These messages contain detailed information on vessel identification, cargo type and quantity, loading and unloading locations, and estimated arrival and departure times.

ERINOT is currently mandatory on the Rhine for container vessels, dangerous goods vessels, vessels longer than 110 metres, cabin vessels, seagoing vessels, LNG-fuelled vessels and special transport services (Article 12.01 of the Police Regulations for the Navigation of the Rhine). The CCNR has adopted regulations extending ERINOT requirements to all vessels above 86 metres from end of 2026, ensuring a critical mass of the fleet routinely generates digital journey data. Electronic reporting systems such as BICS, eRIBa and VELI facilitate preparation and submission of these messages. The EuRIS⁹ and CEERIS platforms make the resulting data available to and between authorities.

Transport distance

Both straight-line distance (great circle distance between loading and unloading ports, derived from EURIS data) and estimated travelled distance are recorded. This allows preparing CO₂e emissions per t·km for two applications: using straight-line distances for inter-modal comparison, and using real sailed distance for inter-vessel comparison.

Tools such as BlueRoad, RiverGuide and VisuRIS offer practical means to calculate logical waterway distances.

The Automatic Identification System (AIS) is a radio navigation system through which vessels continuously transmit their position, course, and speed. These signals are received by shore stations and satellites, resulting in the track of the vessel's movements.

When more detailed analysis is required, AIS data can be used, if the vessel owner/operator gives approval for providing and analysing AIS data to a third party taking care of the analyses. The system

⁹ See <https://www.eurisportal.eu/pages/ElectronicReporting>

provides two advantages for enhanced C3 calculations. It enables precise distance calculation through map-matching algorithms. The raw AIS data, consisting of time-stamped coordinates, can be processed to reconstruct the exact route travelled between ports.

Financial and fiscal records

Vessel operators maintain detailed financial records for business management and fiscal compliance. These records include fuel purchase documentation, invoices and bunker delivery notes, which are retained for accounting and tax purposes. Financial bookkeeping tracks operational expenses including energy costs. These records serve as independent verification sources for fuel consumption data and enable cross-checking against audited financial statements, in case such checks are needed or required.

3.7 Synergies and integration opportunities

The principle of data repurposing/reuse. A significant part of inland waterway operators routinely collect data that can directly serve the C3 methodology. These existing data flows are mandated by current regulatory frameworks for a large part of the IWT fleet. The C3 implementation approach therefore focuses on data repurposing: leveraging information already generated for other contexts rather than introducing new collection obligations. This reduces effort and cost, improves data quality (recorded at source rather than reconstructed retrospectively), ensures consistency through standardised formats, and creates economies of scale for technology providers.

Technical integration. Effective data repurposing requires standardised connections between current systems and emissions calculations. This includes:

- data extraction from bunker delivery note platforms and voyage reporting systems (with explicit operator approval);
- format conversion into standardised calculation inputs;
- application of emission factors and allocation rules per ISO 14083:2023;
- validation through cross-checks between sources and;
- reporting in formats suitable for stakeholders, customers and internal monitoring.

The role of C3-compliant software platforms. Specialised software platforms based on ISO 14083:2023 principles represent a significant enabler for C3 implementation. Core functionalities include data ingestion from multiple sources (fleet management, fuel cards, voyage reporting, AIS) through Application Programming Interfaces (APIs), calculation engines applying current emission factors per ISO 14083:2023 and standardised reporting modules. These platforms drastically reduce administrative burden and guarantee auditable calculation methods, which is crucial for CSRD compliance.

Data processing and enrichment. For operators implementing C3 manually, the workflow consists of the following steps at the end of each reporting period:

1. Aggregate all fuel and electricity consumption data (electronic bunker delivery notes, CDNI account summaries, shore power invoices, other renewable fuel/energy usage data).
2. Compile voyage data by exporting the complete voyage and cargo journal from reporting software.
3. Optional: Obtain and process AIS data from a commercial provider.

4. Integrate data sources: extract transport distance from tools like BlueRoad, link to EURIS voyage reporting to determine real-sailed and straight-line distances, calculate and aggregate tonne-kilometres for laden voyages.
5. Calculate CO₂e emissions by applying Well-to-Wake emission factors to aggregated energy consumption, aligned with the data used for the C1 methodology.
6. Calculate the C3 metric by dividing total CO₂e by transport performance, using both straight-line and real sailed distances.
7. Add context information (typical routes/waterways, cargo types transported).

Document and report, archiving all source files for verification and auditing.

3.8 Data quality: validation and verification

Cross validation. To ensure data quality and prevent manipulation, cross-validation checks should compare total fuel consumption from C3 with separate fuel purchase records. Additional validation may involve consistency checks with AIS data, eFTI/CMNI transport documents and financial bookkeeping records (e.g. trip-based invoices).

Audit trail requirements. Robust audit trails are essential for external assurance in sustainability reporting. An effective audit trail must include:

- retention of all source documentation (bunker delivery notes, fuel invoices, CDNI records);
- detailed data transformation records documenting each processing step;
- clear documentation of emission factors and their application;
- validation results from cross-checks and;
- version control preserving all corrections or adjustments to reported values.

3.9 Legal and regulatory considerations

Data protection and privacy. The use of RIS data for environmental reporting constitutes the most significant non-technical implementation risk. A formal opinion by the European Data Protection Supervisor states that certain RIS data (vessel position, identification numbers) qualifies as personal data under the General Data Protection Regulation (GDPR), particularly when vessels are operated by self-employed entrepreneurs. Many inland vessels are both workplace and residence, making continuously transmitted positions sensitive location data. See also the CCNR statement on the AIS privacy concerns raised by the Netherlands delegation (CCNR document RP14_10) and the CESNI guidelines on RIS and the GDPR (2025).

Data from the SPE-CDNI are collected for the payment of the disposal charge and for the international financial clearance. Any use for emission reporting beyond the ECO-account holder's own vessels would require the conditions of use to be adjusted by the CDNI Conference of Contracting Parties, including the arrangements for the operator's explicit consent and for aggregated or anonymised use.

Without explicit consent or legal basis, waterway managers cannot share data with third parties that offer the services to provide emissions calculations. The revised RIS Directive (Directive (EU) 2025/2482), which will apply in each Member State once it has been transposed into national law and at the latest by 2 January 2029, includes requirements for information exchange, a single point of

access platform, called European RIS Environment and updated privacy and reuse rules. Proper regulation would remove an important obstacle to data-driven emissions reporting.

(Directive (EU) 2025/2482), which will apply in each Member State once it has been transposed into national law and at the latest by 2 January 2029. Article 3(m) of the Directive defines the “European RIS Environment” as an electronic single-point-of-access platform based on national RIS information that provides technical and operational services for RIS users and contains links to electronic reporting according to the “once-only” principle.

C3 protects privacy through data aggregation. Rather than disclosing detailed individual voyage data, operational information is aggregated at quarterly or annual level prior to external disclosure, provided the ship owner/operator agrees and gives explicit consent. This ensures necessary data availability for reporting while maintaining privacy and commercial confidentiality.

Liability and accuracy. The use of emissions data for regulatory compliance, commercial contracting, and sustainability reporting raises questions about liability for data accuracy, whether due to system errors, data quality issues or intentional manipulation.

3.10 How (not) to use the C3 metric

A key question is how to appropriately use and apply the C3 methodology. While C3 provides valuable insights into operational GHG performance and supports regulatory compliance, the emission intensity (CO₂e/tonne-kilometre) indicator has inherent limitations for qualified inter-vessel comparisons. Understanding these limitations is essential for appropriate interpretation and the use cases. This is reflected in:

1. its primary role as an intermediate data point in the calculation of total GHG emission from a transport service;
2. the acknowledgement in ISO 14083 that emission intensity should always be associated with a clearly defined TOC that defines the characteristics of the transport in question.

1. Regional and operational variability. Two vessels of similar specifications carrying identical cargo may show substantially different C3 values due to external factors beyond operator control: waterway characteristics (curves increasing sailed kilometres), customer decisions, water levels and currents influencing payload and fuel consumption. A vessel navigating the Upper Rhine (strong currents, seasonal water level variations) will inevitably show higher fuel consumption per tonne-kilometre than an identical vessel on the relatively stable Main-Danube Canal. Such geographical differences create bias not reflecting vessel efficiency or environmental commitment.

2. Vessel size considerations. Smaller vessels inherently exhibit higher emission intensities per tonne-kilometre than larger vessels for equivalent cargo types and distances. Yet small vessels fulfil essential economic functions: flexibility, specialised niches, access to shallow or narrow waterways (closer to the actual origin/destination of transport), and vital regional transport links. The C3 metric must therefore be accompanied by guidance that absolute values cannot be meaningfully compared across vessel size categories.

3. Diversity of operational profiles. The tonne-kilometre metric is only meaningful for measuring long-distance freight transport. It cannot be applied to vessels having other functions. Examples where the meaningfulness is reduced is for example for bunkering vessels (short-distance fuel supply), dredging support vessels, floating cranes, offshore wind service vessels, or ship-to-ship transfer operations. For these, the C1 and C2 methodologies are more appropriate.

4. Commodity-specific characteristics. Commodity weight and gravimetric density greatly affect the C3 metric. Ships carrying heavy cargo (iron ore, coal) score well due to high cargo weight per energy used, while vessels transporting lighter goods (consumer products, empty containers, abnormally sized goods) are disadvantaged even when fully loaded in terms of the maximum metric volume (m³). The C3 metric thus reflects physical characteristics of transported goods, not only operational efficiency. Reports should therefore describe cargo types and their shares. It also disregards the value and the societal function of those goods: a tonne-kilometre of bulk cargo and a tonne-kilometre of high-value or critical goods count equally. Reports should therefore describe the cargo types carried and their shares.

5. Geographic efficiency paradox. The tonne-kilometre metric rewards longer transport distances through increased t·km in the denominator, while there is also energy consumption for loading/unloading and being at berth between journeys. This creates a counterintuitive dynamic where industries far from raw materials or markets achieve more favourable emission intensities than

those strategically positioned to minimise transport distances. The effect is inherent to any distance-based intensity metric and is not specific to inland navigation, and its practical significance is probably limited: longer transports are typically carried out with larger vessels and, for economic reasons, at good load factors, which in themselves yield favourable emission intensities. The magnitude of the effect has not been quantified for inland navigation; indications from the maritime sector suggest it is limited, and quantification is recommended as follow-up work once C3 data across distance classes are available.

This limitation does not undermine C3 for tracking individual performance, but clarifies it reflects only one aspect of environmental performance. These limitations collectively underscore the necessity for careful, contextualised interpretation. The following key principles shall be kept in mind:

1. C3 values should not be used for simplistic rankings comparing vessels across different size categories, regions, or market segments without appropriate classification and contextual explanation.
2. Regulatory frameworks incorporating C3 must prevent systematic disadvantaging of vessels serving essential but challenging routes.
3. Customer awareness is essential to prevent market dynamics discouraging environmentally beneficial waterway transport.
4. Complementary indicators (C1, C2 and also E1 and A) should accompany C3 reporting to ensure a fair and usable applicable data on the environmental performance of a vessel.

ISO 14083 provides an initial recommendation as to how such a categorisation could be structured for IWT in Tables C.1 and C.2. If additional parameters need to be added for additional contextualization on a one-off or regular basis this is accepted within the implementation of ISO 14083¹⁰.

3.11 Implementation roadmap

The EU regulation CountEmissionsEU established a harmonised methodological framework for quantifying and reporting greenhouse gas emissions from transport services, based on EN ISO 14083:2023. For the inland waterway transport sector, which operates in an international context (Rhine and Danube navigation) and was previously confronted with fragmented national and sectoral methods, this standardisation is of strategic importance. The regulation was agreed upon on 5 November 2025 and officially entered into force¹¹ on 1 June 2026.

Well-to-Wheel approach and hub operations. The regulation mandates a Well-to-Wheel (WTW) approach, encompassing both upstream emissions from fuel production and distribution (Well-to-Tank) and operational emissions during vessel operation (Tank-to-Wheel). This is vital for the inland shipping sector as it undergoes its energy transition: a WTW approach ensures a fair comparison with other transport modes and prevents the externalisation of upstream emissions. Additionally, the regulation explicitly recognises hub operations (transshipment, loading, unloading) as part of the transport service, meaning emissions during cargo handling in inland ports and terminals are integral to the supply chain's emissions accounting.

¹⁰ If an additional parameter is regularly required it could be added to the list of recommended parameters at the time of next amendment to ISO 14083.

¹¹ See for the final legal text: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32026R1030>

Data hierarchy and SME provisions. The regulation prioritises primary data (direct measurement) over secondary data (default values). However, the impact assessment acknowledges that nearly 100% of entities in the inland waterway freight sector are SMEs. To address this, several provisions apply: secondary data may be used when primary data is unavailable or prohibitively costly; Member States may introduce incentives for primary data use but cannot make it compulsory for SMEs and neither in cross-border transport. The fact that both cross border transport and also SMEs have exemptions, result in the situation that IWT can largely be exempted from using primary data. This is an important learning from the final version of the regulation which entered into force in June 2026. This gives particular need for a reliable process to arrive at solid secondary data (default values) to be used in IWT. Furthermore, the European Commission will establish centralised EU databases for emission intensity values and emission factors, assisted by the European Environment Agency. The database for emission factors must be ready within 24 months (2 June 2028) and the database for emission intensities must be ready within 42 months (2 December 2029). A point of attention here is that it should be aligned with the emission factors used for other indications in the IWT emissions and efficiency dashboard (emission passport), such as the methodologies C1 and C2 which also require WTW CO₂e gram per MJ input values.

The binding opt-in mechanism. The regulation adopts a binding opt-in approach: operators are not obliged to calculate emissions. However, if an operator chooses to disclose emissions data (for marketing, shipper requests, or national law requirements), the prescribed methodology must be followed. In practice, the integration of IWT into supply chains of large multinational shippers with mandatory CSRD reporting requirements will likely create a de facto market standard requiring IWT operators to provide standardised data.

EU Calculation Tool and verification exemption. To bridge the gap between complex ISO standards and SME operational reality, the regulation mandates a free, publicly accessible EU Calculation Tool. Operators input basic operational data (fuel consumption, distance, cargo weight) and the tool automatically applies ISO 14083:2023 algorithms and draws from centralised databases. If an operator uses this tool correctly, the calculation process is presumed to be compliant. Furthermore, SMEs are explicitly exempt from mandatory external verification. Voluntary verification is possible for operators seeking commercial advantage but is not legally required. The free EU calculation tool for SMEs must be publicly accessible within 48 months (2 June 2030). Other tools will be allowed, if certified to be compliant with ISO 14083:2023. This is also an important learning for the IWT application, given the large share of SMEs active as inland vessel owner/operator.

Handling of empty runs. The ISO 14083:2023 methodology requires that emissions from empty runs (repositioning) be allocated to the transport service. Operators use a service average approach: total fuel consumed (loaded + empty) over a reporting period is divided by total transport performance (t·km). This mechanism penalises inefficiency, as vessels with high empty-run percentages report higher CO₂e/t·km intensity. Operators may calculate an average emission intensity based on the previous year's performance and use this value ex-ante for quotes and contracts.

Strategic implications for IWT. CountEmissionsEU offers the inland waterway sector two principal advantages. First, the harmonised methodology enables IWT to quantitatively demonstrate its environmental efficiency compared to road transport using certified, comparable data, supporting EU modal shift objectives. Second, the SME provisions (verification exemption, free calculation tool, protection against mandatory primary data requirements for cross-border transport) shield the sector from excessive administrative burden and costs. The C3 methodology implementation aligns directly

with CountEmissionsEU requirements, and the regulation's databases and tools provide the infrastructure needed for standardised emissions reporting across the diverse IWT fleet.

Recommendations for operators. Vessel operators should adopt a proactive stance toward emissions reporting to develop competitive advantage through environmental transparency compared to road transport. Specific actions include initiating pilot C3 implementation on a single vessel over one quarter to gain insights into data needs and processes; and prioritising digitalisation of administrative systems, ensuring voyage and cargo journals are consistently maintained as a foundation for emissions calculation.

Recommendations for policymakers. Policymakers must create an enabling environment for emissions reporting, particularly considering CountEmissionsEU implementation. Priority actions include supporting integration with EURIS, CEERIS, and CDNI data; funding pilots and third-party application development using EURIS/CEERIS and CDNI APIs; funding R&D for benchmarking services and representative default values for simplified SME calculators; facilitating communities of practice; and supporting advice on further energy consumption and GHG emission reduction.

Implementation roadmap. The successful implementation requires coordinated action across multiple stakeholder groups within different timeframes. The roadmap adopts a voluntary, incentive-based strategy that matches the industry's pace of digitalisation and gradually expands from pilot initiatives to wider use.

Table 2 Implementation roadmap for methodology C3

Specific Action	Leading Actor	Involved Actors
Launch pilot projects for manual C3 implementation on selected vessels	Vessel operators	Software providers, Sector associations (IWT-P), National waterway authorities
Establish funding mechanisms and subsidies for pilot participants	National governments / EU Commission	Ministry of Transport, Financial institutions, regional authorities
Create communities of practice for knowledge sharing amongst early adopters	Sector associations (IWT-P)	Vessel operators, Software providers, Research institutions
Harmonise C3 methodology guidelines at EU level (e.g. CESNI)	EU Commission (DG MOVE)	National governments, Sector associations, technical experts
Implement API connections between RIS (EURIS/ERINOT) and reporting software	RIS system managers, Member States in EURIS	Software providers, National waterway authorities, Data protection authorities
Establish data governance framework and privacy protocols for RIS and CDNI data usage	National waterway managers and Member States authorities	Data protection authorities, EU Commission, Vessel operators, CDNI
Develop quality benchmarking and verification standards for C3 reporting	Technical standardisation bodies	Sector associations, Auditing firms, Policymakers

Development of the central CountEmissionsEU calculation tool and integration with IWT structures	EU Commission	Research institutes, sector associations
Roll out digitalisation support programmes for SME operators	National governments	Administration institutions (e.g. Autena Marine), Sector associations, Software providers
Implement incentive schemes (e.g., reduced port dues) for vessels reporting emissions	Port authorities	Vessel operators, National governments, financial institutions
Establish certification and audit procedures for C3 compliance	Independent auditing bodies ¹²	Sector associations, Vessel operators, Policymakers

Table 3 Timeline for implementation of CountEmissionsEU

Specific Action	Due Date
Entry into force	1 June 2026
Database for emission factors	2 June 2028
Database for emission intensity	2 December 2029
Free EU calculation tool	2 June 2030

3.12 Example case study

A company may calculate and declare in accordance with ISO 14083:2023 itself. The standard does not require third-party verification. Under CountEmissionsEU, SMEs are exempt from mandatory external verification, and correct use of the EU Calculation Tool gives a presumption of compliance. Verification becomes relevant where the figures feed CSRD reporting, where a customer requires it contractually, or where the value is used for a public claim or a label.

In view of execution of Task 3.5 of PLATINA4Action, a specific action was to analyse the greenhouse gas emissions of an inland vessel operating in European waterways, specifically along the Rhine-Alpine and Rhine-Danube corridors and to derive the greenhouse gas emission value for the transport performance (grams CO₂e per t km). The vessel, an inland pushtow with one cargo barge (dry bulk/dry cargo), operates in two configurations: 1×2 and 2×1. This example is not to be considered as a direct application of the methodology C3, but shows the bandwidth for one vessel and provides insights into the work required for the database of secondary GHG intensities of transport operations.

Operational framework:

The vessel is engaged in a tramp service, a transport model where routes and schedules are not fixed but dictated by market demand. Tramp service vessels move between ports of departure and

¹² in practice these may be classification societies and recognised organisations already active under Directive (EU) 2016/1629, verifiers accredited for EU MRV/ETS work, or the auditors engaged for CSRD assurance; no accreditation scheme specific to C3 exists at present

destinations with a mix of empty trips and loaded voyages. According to ISO 14083:2023, empty trips are considered part of the transport process, as the vessel departs from the destination port of the previous transport to reach the port, where it will load cargo and continue to the next destination. In the vast majority of transport operations used for this case study, the vessel was engaged in single-destination transport, meaning it was not loaded for operations involving multiple destination ports.

Data collection:

The analysis is based on a dataset spanning 2023–2024, capturing real-world vessel operations. The primary data collected for emissions calculation includes:

- Fuel consumption for each transport operation (TO), covering both empty and loaded voyages, derived from the ship's onboard reporting system;
- Cargo mass and transport distance for each transport operation (TO), based on the ship's cargo and voyage journal. The distance is obtained from the EURIS portal and corresponds to the real sailed distance along the waterway between the ports.

Onshore electricity used during port stays and additional GHG emissions sources (such as lubricating oil burned in the combustion chamber) are not included in this example.

Calculation:

The calculation of the C3 indicator (GHG emission intensity) for each transport operation, or for a defined period, requires two components: total GHG emissions and transport activity. The GHG emissions are calculated by multiplying the fuel consumption for the considered transport operation, or for a defined period, by the Well-to-Wake (WTW) GHG emission factor. The WTW factor is the sum of the Tank-to-Wake (TTW) and the Well-to-Tank (WTT) components. For fossil diesel fuel, the GHG emission factors provided in ISO 14083:2023 (Table K.1) are 3.17 gCO₂e/gfuel for Tank-to-Wake (referred to in the standard as vehicle operation) and 0.57 gCO₂e/gfuel for Well-to-Tank (referred to as vehicle energy provision). These emission factors have been used as example for the calculation.

The transport activity for the considered transport operation, or for a defined period, is calculated as the product of the cargo transported and the distance travelled. Although they do not contribute denominator (t·km) to this calculation, empty voyages are taken into account in order to include the GHG emissions generated during these trips. The C3 indicator (GHG emission intensity) for the considered transport operation, or for a defined period, is calculated as the ratio between the total GHG emissions and the transport activity.

Results:

The following results represent the findings based on one year of collected data between 2023 and 2024. The annual average C3 indicator (GHG emission intensity) considering both vehicle operation and vehicle energy provision, is about 25 gCO₂e/t·km. For upstream transport operations, the annual average C3 indicator (GHG emission intensity) is about 40 gCO₂e/t·km, whereas for downstream operations, it is about 15 gCO₂e/t·km. These numbers include the consumption and emissions of the empty trip to the port of origin, which may have a different direction (upstream/downstream). Figure 2 shows the values of the C3 indicator and their occurrence over the considered year.

Future improvements and research:

- Incorporation of additional GHG emission sources, such as lubricating oil burned in the combustion chamber and other relevant emitters, in order to further refine the calculation.

- Categorisation of transport operations according to the Transport Operation Category (TOC) defined in ISO 14083.

The categorisation into TOCs is important because, as stated in ISO 14083, it enables a simplified calculation of GHG emissions. However, the definition of TOCs must be sufficiently detailed to avoid generating misleading results. Inland vessels operate under highly variable conditions, including water depth, fairway width, traffic density, loading condition, and other operational factors. TOC definitions should therefore account for these parameters to prevent incorrect estimation of GHG emissions. The use of nominal or overly generalised TOCs would reduce the sensitivity of the methodology and could ultimately slow down progress in GHG emission reductions.

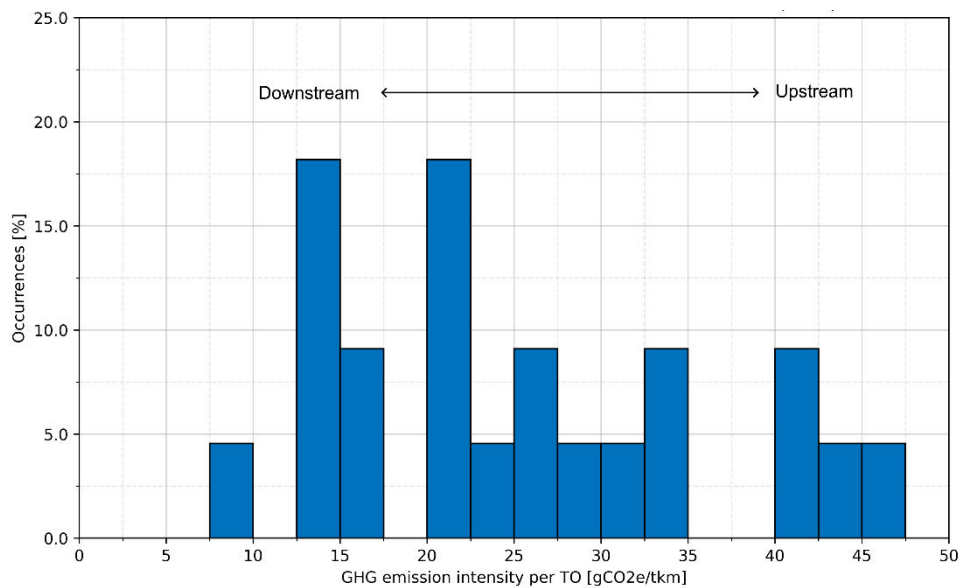


Figure 2 Distribution of the C3 indicator values per voyage over the considered year for the inland push-tow vessel.

4. Methodology E1: Wh per t·km ex ante

Methodology E1, i.e., the Energy Efficiency Design Index for inland waterway vessels (EEDI_{INLAND}), is based on the version commissioned by the German Federal Ministry of Transport (BMV) and initially developed by DST. Unlike methodologies A and C1, C2 and C3, the E1 methodology provides a predictive (ex-ante) measure of a vessel's energy efficiency, expressed in terms of energy consumption per transport activity (Wh/t·km) under idealised boundary conditions. This methodology focusses on propulsion energy and does not account for consumption from auxiliary engines or hotel loads.

Although primarily targeting energy efficiency, the methodology also contributes to lower GHG and air-pollutant emissions, since reduced energy demand in idealised conditions corresponds to reduced energy carrier consumption in real operation, as has been shown in maritime shipping by the correlation of EEDI and CII values.

4.1 Inception of the EEDI_{INLAND} concept

The development of the maritime EEDI for seagoing vessels began in 1997 with the introduction of MARPOL Annex VI, Regulations for the Prevention of Air Pollution from Ships, by the IMO. One year later, the IMO launched its first GHG study to estimate emissions from global shipping, followed by nine years of data collection to validate the methodology and establish reference lines. It was not until 2013 that the EEDI and SEEMP became mandatory for new and existing seagoing ships. In total, 16 years passed from the inception of the EEDI to its mandatory implementation for seagoing ships.

This extended development phase on the maritime side laid the conceptual and methodological foundation for similar initiatives in inland navigation. As the maritime EEDI matured and proved effective in structuring energy-efficiency improvements, policymakers and researchers began examining how its principles could be adapted to the distinct operational characteristics of inland vessels. In 2019, the German Federal Ministry for Transport (BMV) commissioned DST to evaluate the energy demand of inland vessels using energy-efficiency indices. This was followed in 2025 by a second initiative, Energy Efficiency and Greenhouse Gas Intensity of Inland Waterway Vessels, which broadened the scope to include both energy performance and GHG intensity across the inland fleet. Reports can be found here:

- <https://www.bmv.de/SharedDocs/DE/Anlage/G/energieeffizienz-treibhausgasintensitaeten-binnenschiffe-schlussbericht.html> [10]
- <https://www.bmv.de/SharedDocs/DE/Anlage/G/energieeffizienz-treibhausgasintensitaeten-binnenschiffe-anlagen.pdf> [11]

4.1.1 Latest developments

The methodology E1 draws upon the existing EEDI_{INLAND} methodology set out in the German framework, which is in turn based on the maritime concept of EEDI. The original approach involves an ex-ante assessment of the energy efficiency of vessels based on pre-defined settings under representative conditions, expressed in grams CO₂e per t km. However, the results of the proposed calculation can be influenced by the CO₂e emission factors of the energy carrier used by the vessel. For instance, changing the sole Well-to-Wake or Tank-to-Wake (TTW) emission factor can affect the results without altering the vessel's power system or hydrodynamics. Moreover, there could be confusion with the methodology C3 if also the GHG emissions per t km would be used for the design performance.

To overcome this inconvenience and better reflect the objective of creating a pure index to evaluate the energy efficiency of vessel design from an architectural perspective, the PLATINA4Action methodology E1 focuses on analysing a vessel's power demand under representative conditions. It does not calculate the GHG emissions. Note here that the efficiency of the energy converter, which acts as a bridge between the vessel's energy demand and its GHG emissions, is covered in the other complementary methodologies, notably in C2 while the GHG emission intensity of the energy used is covered in C1. Therefore, a pure focus on the energy consumption in Wh/t·km provides a targeted indicator without any confusion and less overlap with other methodologies. The following simplified formulas illustrate the changes to the formulation:

$$\frac{CF \cdot SFC \cdot P_S}{V_{OG} \cdot (DWT \text{ or } \Delta)} \text{ in } \left[\frac{\text{gCO}_2}{\text{t} \cdot \text{km}} \right] \rightarrow 1000 \frac{P_P}{V_{TW} \cdot (DWT \text{ or } \Delta)} \text{ in } \left[\frac{\text{Wh}}{\text{t} \cdot \text{km}} \right]$$

Table 4 Definition and units for the simplified EEDI calculation

Symbol	Description	Unit
CF	Conversion factor between fuel consumption and CO ₂ emission	gCO ₂ /gFuel
SFC	Specific fuel consumption	gFuel/kWh
P _S	Target propulsive power	kW
V _{OG}	Speed of vessel over ground	km/h
DWT	Deadweight	t
Δ	Displacement mass	t
V _{TW}	Speed through water	km/h
P _P	Propulsive power	kW

For the E1 methodology, the unit of measurement, **Wh/t·km**, is more useful for ship owners because it is directly related to energy consumption and related operating costs.

The EEDI studies for inland navigation in the German framework distinguished three test zones: deep water, waterways with limited depth, and canals. Each area requires either setting a target power and measuring the resulting speed, or, conversely, setting a target speed and measuring the power needed to reach it. However, analysis of experimental data proved that the intrinsic interrelationship between power, speed, and the EEDI_{INLAND} formula strongly affects the resulting index. In simple terms, if a target power is set, the index improves in direct proportion to the design improvement. If a target speed is set, the index improvement scales with the square of that design improvement (assuming numerical improvements greater than 1). As a result, the index becomes more sensitive when a target speed is used, better capturing reductions in energy demand.

To avoid this issue and reduce the burden, methodology E1 distinguishes only two navigation areas, waterway requirements with water depths greater than 5 m (=A1) and canals (=A2), and it requires setting a target speed and measuring the power needed to reach it in each area. The target speed is derived from an investigation to determine the average representative speed of vessels according to their length, based on data reported in the Driving Dynamics of Inland Vessels.

In any case, the limitations of inland waterways are acknowledged, and it is not always possible to set the exact target speed because of external environmental factors. To address this, a portion of the vessel's speed-power curve must be identified in line with the maritime approach and ITTC (International Towing Tank Conference) recommendations. This portion of the curve enables

corrections for external influences (current, wind and water depth) and allows interpolation to the target point without affecting the full-scale trial.

Furthermore, in contrast to the German framework which originally used reference curves, the methodology E1 does not require pre-set reference curves. Instead, it incorporates correction methods for water depth and wind conditions, ensuring that deviations from ideal test conditions can be accounted for more accurately. These correction methods make the new approach more adaptable and realistic for real-world conditions, providing more meaningful results.

4.2 EEDI_{INLAND} methodology

The EEDI_{INLAND} represents a measure of vessels' energy efficiency, expressed in terms of energy consumption per transport activity (Wh/t-km). Two terms are distinguished depending on the method of determination:

- Estimated EEDI_{INLAND}: a value obtained from predictive approaches such as computational fluid dynamics (CFD) or model tests. This value is typically determined prior to full-scale trials, at the design stage, and serves to verify whether the design of the new vessel or the retrofit meets the intended efficiency objectives;
- Attained EEDI_{INLAND}: a value calculated based on measurements collected during speed-power trials conducted on the full-scale vessel under defined test conditions. This value is used to verify compliance in full scale.

Annex B provides the full methodology for determining the Estimated and Attained EEDI_{INLAND}. This section offers a concise overview.

In the full-scale trials, the calculation process involves the following key steps:

- Preparation: this includes collecting comprehensive vessel information (e.g., type, deadweight/displacement) and powertrain details, verifying on-board measuring systems, and ensuring the vessel is loaded to at least 70 % of its maximum deadweight or displacement;
- Execution: trials are performed in the designated Test Zones (A1 or A2) under controlled operational and environmental conditions, with at least three double runs required. During each run, the vessel follows the trial route while continuously recording key parameters such as propulsive power, speed over ground, and wind conditions;
- Analysis and correction: the objective is to determine the ideal speed-power curve that expresses the relationship between propulsive power and the speed through water, while minimising disturbances from current and wind. An iterative regression procedure is used to establish the curve and estimate the water current velocity;
- Final calculation: the final curve is interpolated to the required target speed to obtain the corresponding propulsive power. These values are then used in the EEDI_{INLAND} formula. The resulting value is the Attained EEDI_{INLAND}.

At the design stage, the estimation methodology mirrors the requirements for the Attained EEDI_{INLAND} in terms of loading condition and operational zone. Tank tests or CFD simulations must be carried out under controlled, calm-water conditions, without wind, current, or waves, at water depths defined by the guidelines. An ideal full-scale speed-power curve is then established, interpolated at the required target speed to obtain the corresponding propulsive power, and used in the EEDI_{INLAND} formula. The resulting value is the Estimated EEDI_{INLAND}.

4.3 Implementation roadmap

The gradual introduction of the EEDI_{INLAND}, the methodology E1 for energy efficiency by design of the inland vessel, requires a structured implementation roadmap to ensure effectiveness, consistency, and uptake across the fleet. The draft methodology has been developed and published within this deliverable, providing the technical foundation for its application. The implementation can follow a stepwise flow:

Pilot → Refinement → Data Collection → Scaling → Regulation & Governance → Standardisation → Training

1. Pilot phase
 - a. Voluntary application on selected vessels;
 - b. Test measurement procedures; sensitivity analysis for environmental boundary conditions and vessel load case, and identification of practical challenges;
2. Methodology refinement
 - a. Conduct additional tank tests and CFD simulations to better estimate EEDI_{INLAND} values and compare design-stage predictions with actual vessel performance;
 - b. Cover a wider range of water depths and develop correction methods for depths below 5 m to improve accuracy and include shallower testing zones;
 - c. Calibrate and adapt the methodology based on collected data;
 - d. Refine representative operating conditions and initiate reference curves;
 - e. Define energy-saving solutions tailored to individual vessel characteristics, providing guidance to ship owners considering EEDI_{INLAND} upgrades;
3. Comprehensive data collection & analysis
 - a. Gather data across vessel types and sizes to define the reference curves;
4. Gradual scaling
 - a. Expand application to additional vessels and environments;
5. Regulatory integration, governance & supervision
 - a. Decide whether the framework should remain voluntary or become mandatory;
 - b. Link incentives to high performance to encourage uptake;
 - c. Define responsibilities for managing the EEDI_{INLAND} scheme, including data collection, verification, methodology updates, and transparent reporting;
6. Standardised data collection & reporting
 - a. Define and publish standard procedures for trials, including calibration, sampling, and accounting for environmental conditions;
 - b. Define standard digital templates for reporting;
 - c. Reports should be clear and usable by authorities, inspection bodies, and researchers for verification and benchmarking;
 - d. Create centralised storage with controlled access and automated quality checks to ensure reliability and support long-term trend analysis;
7. Training
 - a. Train inspection bodies and technical personnel in power measurement techniques, data recording, and reporting procedures.

The methodology still faces several open questions that can only be resolved as more data and experience become available, e.g. via further RD&I works, discussion in the NAIADES EG and the European Commission sending the methodology to the CESNI for assessment and integration in the standard:

1. Are the proposed requirements for test areas adequate?
2. Are the proposed requirements applicable in different Member State territories?
3. Who can perform power measurements in each Member State?
4. Should the EEDI apply only to new vessels, or also to existing ones (e.g., at certificate renewal)?
5. Should its use be mandatory or voluntary?
6. Which incentives could be linked to EEDI performance, and what benefits would vessel owners or operators gain?
7. Who should manage the EEDI scheme, and how should governance and execution be organised?

4.4 Baseline data and examples of E1 methodology application

In view of Task 3.5 and to evaluate fleet performance and the effectiveness of energy-saving solutions under the EEDI_{INLAND} scheme, two groups of vessels were analysed. The first group, based on full-scale trials, serves to assess current fleet performance. The second group, consisting of three vessels with data from tank tests, is used to evaluate energy-saving measures and water depth corrections.

In the second group, the first vessel, from a demonstration activity in the EU funded [SYNERGETICS project](#), is a 105 m cargo ship with one propeller and two rudders (CEMT Va class, Rhine). The stern of the ship model was optimised to reduce energy consumption. The second vessel, from the RESHIP project, is a 110 m cargo ship with two propellers and four rudders. A flow separation plate was mounted at the stern to investigate energy-saving performance. The third vessel is a 100 m cargo ship with one propeller and two rudders, also CEMT Va class. All sail in deep water, and one was tested at water depths of 7.5 m and 5 m to demonstrate corrections to the reference water depth.

Table 5 and Figure 3 present the results. When based on full-scale measurements, the index is referred to as “Attained”, when based on tank tests, it is defined as “Estimated”. The vessel category is defined according to ES-TRIN 2025.

Table 5 Exemplary calculation of the EEDI_{INLAND} for different vessel categories

-	Vessel category	DWT or Δ [t]	h [m]	Type EEDI	EEDI [Wh/t·km]
Group 1					
Vessel 1.1	Passenger vessel	90.4	7.5	Attained	30.83
Vessel 1.2	Motor tanker	1800.6	7.5	Attained	16.42
Vessel 1.3	Motor tanker	2403.7	7.5	Attained	16.38
Vessel 1.4	Motor cargo vessel	2665.4	7.5	Attained	17.63
Vessel 1.5	Pushed convoy	4403.2	7.5	Attained	15.49
Vessel 1.6	Pushed convoy	3203.4	7.5	Attained	15.98
Vessel 1.7	Pushed convoy	10278.3	7.5	Attained	10.14

Vessel 1.8	Pushed convoy	7101.6	7.5	Attained	15.81
Vessel 1.9	Pushed convoy	3476.3	7.5	Attained	17.27
Group 2					
Vessel 2.1	Motor cargo vessel	1894.225 (83%)	7.5	Estimated	15.64
Vessel 2.1 - stern optimised	Motor cargo vessel	1894.225 (83%)	7.5	Estimated	13.09
Vessel 2.1	Motor cargo vessel	1894.225 (83%)	5.0	Estimated	19.18
Vessel 2.1	Motor cargo vessel	1894.225 (83%)	7.5 (corrected for 5.0)	Estimated	15.55
Vessel 2.2	Motor cargo vessel	2449.2 (84%)	7.5	Estimated	15.08
Vessel 2.2 with flow separation plate	Motor cargo vessel	2449.2 (84%)	7.5	Estimated	11.75
Vessel 2.3	Motor cargo vessel	1645.308 (70%)	10.0	Estimated	13.96

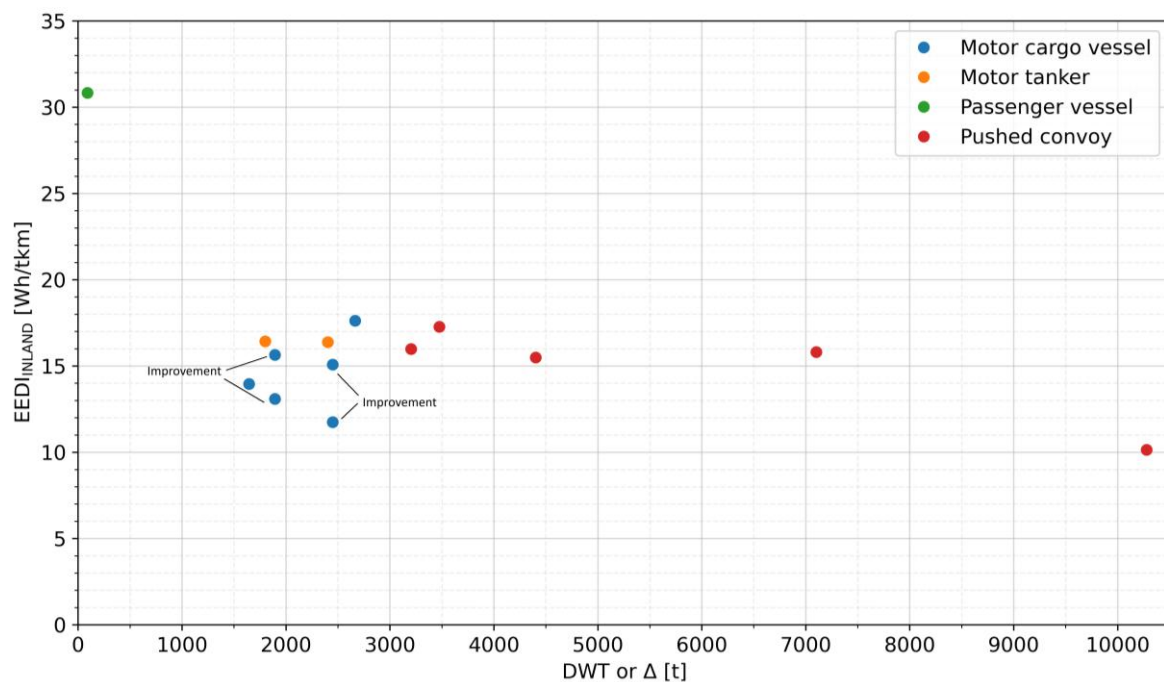


Figure 3 Graphical overview of EEDI_{INLAND} values depending on the DWT or Δ for different vessel categories.

From Table 5 and Figure 3 it can be seen that the EEDI_{INLAND} methodology (“E1”) clearly values hydrodynamic improvements. For Vessel 2.1, the stern optimisation results in an EEDI_{INLAND} reduction of approximately 16.3 % at the reference water depth of 7.5 m. For Vessel 2.2, installing the flow separation plate yields an EEDI_{INLAND} reduction of about 22.1 % at the reference water depth of 7.5 m. For tests carried out at water depths between 5 and 7.5 m, the results show that the EEDI_{INLAND} computed at 5 m aligns well with the reference depth of 7.5 m once the water depth corrections are applied.

5. Conclusions

This report presents the development and evaluation of labelling options for inland waterway vessels as part of PLATINA4Action Work Package 3. Building upon the state-of-play analysis from Deliverable D3.1, it focuses on the practical implementation of methodologies for assessing emissions and energy efficiency. The document refers to the five different performance indicators to label vessels regarding their emissions and energy efficiency performance. The methodologies are categorised by their measurement units and system boundaries. PLATINA4Action focussed deliberately on providing a more extensive assessment for the methodologies C3 and E1. This is because the methodologies A and C1 were being developed in parallel with a leading role for the Central Commission for the Navigation of the Rhine (CCNR) and the European Committee for drawing up Standards in the field of Inland Navigation (CESNI). PLATINA4Action supported and supports this work led by CCNR, by means of active participation by PLATINA4Action in the working groups, correspondence and common expert group meetings which were and are being organised by CCNR and European Commission.

Given the agreement on the work division, the methodologies A and C1 are briefly described in this report for context. Methodology C2 is seen as valuable to add to as it combines aspects of A and C1 and can relatively easily be added as additional indicator based on the data already used for methodologies A and C1. This is seen as a 'quick-win' and 'no-regret' action.

The report includes implementation roadmaps and application examples for the methodologies C3 and E1 which were further elaborated by PLATINA4Action. Two annexes provide standalone practical guidance: Annex A offers a comprehensive manual for methodology C3 emissions reporting. Annex B details the procedure for methodology E1, calculating the Estimated and Attained Energy Efficiency Design Index for inland waterway vessels.

Conclusions on Methodology C3 establish a framework for quantifying operational greenhouse gas emissions of transport services in grams of CO₂ equivalent emissions per tonne-kilometre, directly aligning with the ISO 14083:2023 standard and the newly implemented CountEmissionsEU regulation which entered into force in June 2026. The C3 methodology developed by PLATINA4Action leverages existing data infrastructure to minimize administrative burden, a critical consideration for the small and medium-sized operators that constitute the majority of the inland waterway transport sector. By utilizing data already collected through mandatory systems such as the Convention on the Collection, Deposit and Reception of Waste for fuel consumption derived from bunkering data (CDNI) and River Information Services platforms for voyage information (EURIS/CEERIS), methodology C3 enables comprehensive emissions reporting without imposing significant additional requirements. The use of such data however requires the lifting of several technical and legal barriers. The implementation roadmap for methodology C3 is closely tied to the CountEmissionsEU timeline and the further work which needs to be done, with the regulation having entered into force on 1 June 2026. Key milestones include the establishment of a database for emission factors by 2 June 2028, a database for emission intensities by 2 December 2029, and the availability of a free EU calculation tool for SMEs by 2 June 2030. The further implementation of the C3 methodology developed by PLATINA4Action fits perfectly to this new context set by CountEmissionsEU and is expected to fill the gap which is currently there with respect to guidance, tools and the development of reliable secondary data.

The phased approach recommends voluntary pilot projects to gain practical experience, followed by broader adoption as digital infrastructure matures and as the benefits of standardized emissions data become apparent to both operators and their customers. The methodology's particular strength lies

in its ability to provide standardized, verifiable emissions data that supports both regulatory compliance and commercial transparency. This enables inland waterway operators to quantitatively demonstrate their environmental performance to shippers, ports, and other stakeholders, supporting the European Union's modal shift objectives. However, it is crucial to recognize the limitations inherent in the tonne-kilometre metric, which can be significantly influenced by factors beyond the operator's control. Those factors nonetheless produce real emissions and are therefore rightly included in the calculation; the consequence is not that they should be excluded, but that the emission intensity must be understood for what it is under ISO 14083:2023 - an intermediate input for calculating the total emissions of a transport service or chain, usable as a comparator only in specific, controlled and clearly documented circumstances. Waterway characteristics such as locks, water levels, and currents can substantially affect fuel consumption and thus the resulting C3 value, even for identical vessels carrying the same cargo. Similarly, the physical characteristics of transported goods, with heavier cargoes yielding more favourable emission intensities, create biases that do not necessarily reflect operational efficiency. These limitations necessitate careful interpretation and contextual reporting to ensure fair comparisons between vessels., while providing also the results on other indicators (A, C1, C2, E1) next to the values from following the C3 methodology.

The implementation roadmap emphasizes the importance of developing data governance frameworks and privacy protocols for River Information Services data usage and for potential usage of SPE-CDNI bunkering data usage, as well as the establishment of benchmarking standards to support quality assurance and meaningful comparisons. For policymakers, the priority is to create an enabling environment through funding for pilot projects, support for digitalization programs, and the establishment of incentive schemes that reward vessels for reporting their emissions. The successful implementation of methodology C3 will depend on coordinated action across vessel operators, software providers, sector associations, and national and international authorities, with the ultimate goal of achieving standardized emissions reporting that supports the European Union's sustainability targets while remaining practical for the diverse inland waterway fleet.

Conclusions on Methodology E1, the Energy Efficiency Design Index for inland waterway vessels, offer a complementary ex-ante approach to assessing vessel energy efficiency. Unlike the operational focus of C3, E1 evaluates the inherent energy efficiency of a vessel's design expressed in watt-hours per tonne-kilometre. This methodology builds upon the established maritime EEDI concept but adapts it to the unique operational characteristics of inland waterways and avoids any confusion between EEOI and EEDI as designed in the seagoing vessel segment. The development within PLATINA4Action has refined the original German EEDI_{INLAND} concept by allowing less demanding test conditions, eliminating the calculation to GHG emissions, developing correction methods for deviations from ideal conditions, and establishing comprehensive procedures for both estimated values at the design stage and attained values through full-scale trials.

The implementation roadmap for the PLATINA4Action methodology E1 follows a structured progression that begins with a pilot phase involving voluntary application on selected vessels to test measurement procedures, analyse the sensitivity of test conditions and identify practical challenges. This will be followed by comprehensive data collection across diverse vessel types and sizes to define the reference curves. Subsequent phases include methodology refinement, gradual scaling to additional vessels and environments, and eventual regulatory integration with appropriate governance structures.

The methodology has already demonstrated clear value in identifying and quantifying hydrodynamic improvements, as evidenced by the significant EEDI_{INLAND} reductions achieved through design

modifications such as stern optimization and aft-ship replacement studies. The correction methods for water depth have also proven effective, with results at shallower depths aligning well with reference conditions after applying the corrections. However, the comparability of data after using these correction methods requires further validation with real-world data, as the maritime sector's experience with establishing reference lines took nearly a decade. The gradual introduction of methodology E1 will provide vessel owners with a practical tool to assess and improve their vessels' energy efficiency and thereby also to improve the sector's operational performance. As with C3, the successful implementation of E1 will depend on clear guidelines, standardized procedures, and comprehensive training for inspection bodies and technical personnel.

The work performed in Work Package 3 has clearly demonstrated that developing a single, comprehensive label for inland vessels presents significant challenges due to the sector's inherent complexity and variability and the different purposes and use cases of emission and energy efficiency performance data. The diverse operating conditions, vessel types, and market segments in inland navigation cannot be adequately captured by a single metric. Instead, a suite of complementary methodologies provides a more effective approach, with each methodology addressing different but equally important aspects of environmental performance. Methodologies A and C1, focusing on air pollutant emissions and greenhouse gas intensity of energy respectively, are already well advanced through the CCNR and CESNI processes and will soon be available for implementation through the emission passport concept. The harmonisation and updating of emission factors remain a cross-methodological tasks. Methodology C2, which combines elements of A and C1, offers additional valuable insights into the efficiency of energy conversion systems and is recommended by PLATINA4Action to add to the emission passport as soon as A and C1 are implemented. Methodologies C3 and E1, which form the primary focus of this report D3.2, address operational GHG emissions of the transport services and the performance of the energy efficiency by design of the vessel. Taken together, the set of indicators provided through the methodologies A, C1, C2, C3 and E1 provide comprehensive picture when used together and a valuable dashboard for a broad and effective and fair use by stakeholders.

The next steps involve pilot testing to gain practical experience, systematic data collection to establish robust default values and benchmarks, publication and continuous refinement of methodology standard based on real-world application, and the development of supporting infrastructure such as calculation tools and verification procedures. For the inland waterway transport sector, the adoption of these methodologies represents not just a regulatory requirement but a strategic opportunity to demonstrate environmental credentials, access green financing mechanisms (EU Taxonomy), and contribute meaningfully to the European Union's sustainability goals.

The voluntary nature of the proposed implementation allows for gradual adoption, while the development of secondary data (default values) and simplified calculators will ensure accessibility for smaller operators with limited administrative resources. Ultimately, the success of these labelling methodologies will depend on the commitment of all stakeholders—vessel operators, policymakers, software providers, and verification bodies—to work together in creating a robust, practical, and widely accepted system for assessing and continuously improving the environmental performance of inland waterway transport.

The complementary methodologies developed within this project provide the necessary tools to support this transformation while respecting the unique characteristics and constraints of the inland navigation sector.

Bibliography and References

- [1] Martin Quispel, 'Report on implementation of European IWT emission label / energy index / GLEC for vessels', D2.6, Feb. 2022. Accessed: Dec. 16, 2025. [Online]. Available: Report on implementation of European IWT emission label / energy index / GLEC for vessels D2.6
- [2] Benjamin Friedhoff, Justin Jasa, Martin Quispel, Khalid Tachi, 'State of play and requirements for the label for inland vessels', D3.1, Dec. 2024. Accessed: Dec. 16, 2025. [Online]. Available: https://platina4action.iwtprojects.eu/wp-content/uploads/2025/01/250123_PLATINA4Action_D3.1-State-of-play-and-requirements-for-the-label-for-inland-vessels.pdf
- [3] Pim van Mensch, Dick Abma, Ruud Verbeek, and Willem Hekman, 'Technical evaluation of procedures for Certification, Monitoring & Enforcement', D5.7, Apr. 2018. Accessed: Dec. 16, 2025. [Online]. Available: https://www.prominent-iwt.eu/wp-content/uploads/2018/07/2018_04_30_PROMINENT_D5.7_-_Technical_Evaluation_of_Procedures_for_Certification-Monitoring-and-Enforcement_v2.0.pdf
- [4] Gerrit Kadijk, 'Prominent - WP3 Certification, Monitoring and Enforcement', Prominent. Accessed: Dec. 16, 2025. [Online]. Available: <https://www.prominent-iwt.eu/wp3-certification-monitoring-and-enforcement/>
- [5] 'Central Commission for the Navigation of the Rhine'. Accessed: Dec. 16, 2025. [Online]. Available: <https://www.ccr-zkr.org/12040801-en.html>
- [6] 'BICS website'. Accessed: Dec. 16, 2025. [Online]. Available: <https://www.bics.nl/en/node/20>
- [7] 'Inland waterways — river information services (RIS)'. Accessed: Dec. 16, 2025. [Online]. Available: <https://eur-lex.europa.eu/EN/legal-content/summary/inland-waterways-river-information-services-ris.html>
- [8] European Data Protection Supervisor, 'Opinion 14/2024 on the Proposal for a Directive on harmonised river information services (RIS) on inland waterways in the Community', Mar. 2024. Accessed: Dec. 16, 2025. [Online]. Available: https://www.edps.europa.eu/system/files/2024-03/24-03-20_opinion_harmonised_ris_inland_waterways_en.pdf
- [9] Deborah Cater, 'EU council and parliament agree to update River Information Services', vol. Water News Europe, Jul. 04, 2025. Accessed: Dec. 16, 2025. [Online]. Available: <https://www.waternewseurope.com/eu-council-and-parliament-agree-to-update-river-information-services/>
- [10] DST, 'Entwicklung von Indizes für die Energie-Effizienz und die Treibhausgasintensität von Binnenschiffen', FE-Projekt-Nr. VB300355, Nov. 2024. Accessed: Dec. 17, 2025. [Online]. Available: https://www.bmv.de/SharedDocs/DE/Anlage/G/energieeffizienz-treibhausgasintensitaet-binnenschiffe-schlussbericht.pdf?__blob=publicationFile
- [11] 'Anlagen "Entwicklung von Indizes für die Energie-Effizienz und die Treibhausgasintensität von Binnenschiffen', FE-Projekt-Nr. VB300355, Nov. 2024. Accessed: Dec. 17, 2025. [Online]. Available: https://www.bmv.de/SharedDocs/DE/Anlage/G/energieeffizienz-treibhausgasintensitaeten-binnenschiffe-anlagen.pdf?__blob=publicationFile

Annex A: Manual for methodology C3 emissions reporting

This Annex contains a manual for the methodology C3 emission reporting. It is designed as a stand-alone document for further application beyond the project.

Manual for methodology C3 emissions reporting

1. Introduction.....	2
2. References.....	2
3. Definitions, symbols, and abbreviations	2
4. Scope of application.....	3
4.1 <i>Intended Users</i>	3
4.2 <i>Scope</i>	3
5. Understanding the C3 methodology	3
5.1 <i>The C3 formula</i>	3
5.2 <i>Key Components</i>	4
5.2.1 <i>Total Greenhouse Gas Emission</i>	4
5.2.2 <i>Transport Performance</i>	4
5.3 <i>Allocation of Empty Sailing</i>	4
6. Data Requirements	4
6.1 <i>Energy Consumption Data</i>	4
6.1.1 <i>Required Information</i>	4
6.1.2 <i>Primary Data Source: CDNI Records</i>	4
6.2 <i>Cargo Data</i>	5
6.2.1 <i>Required Information</i>	5
6.2.2 <i>Primary Data Source: Commercial Records</i>	5
6.3 <i>Voyage Data</i>	5
6.3.1 <i>Required Information</i>	5
6.3.2 <i>Primary Data Source: River Information Services (RIS)</i>	5
6.3.3 <i>Distance Calculation</i>	5
7. Step-by-Step calculation procedure.....	6
8. Emission factors.....	7
8.1 <i>Well-to-Wake vs Tank-to-Wake</i>	7
8.2 <i>Reference emission factors (Well-to-Wake)</i>	7
8.3 <i>Fuel Blends</i>	8

1. Introduction

This manual offers step-by-step guidance for inland waterway vessel operators to use the C3 methodology for measuring and reporting greenhouse gas emissions. Following the methodology C3 results in the calculation of the greenhouse gas emission intensity as grams of CO₂ equivalent per tonne-kilometre (gCO₂e/t-km), based on actual operational data combined with emission factors for the energy used.

The guide aims to simplify reporting by using existing data sources such as CDNI fuel records, RIS voyage data, and bookkeeping documents.

2. References

The following document was used to develop this guideline: **ISO 14083:2023**.

3. Definitions, symbols, and abbreviations

For the purposes of this document, the following definitions shall apply:

- *C3 Methodology*: A method for calculating emission intensity at an aggregated level, expressing greenhouse gas emissions in grams of CO₂ equivalent per tonne-kilometre on an ex-post (after-the-fact) basis;
- *Emission Factor*: A coefficient that converts activity data (e.g., fuel consumption) into greenhouse gas emissions. Typically expressed as grams of CO₂e per unit of fuel;
- *Emission Intensity*: The ratio of greenhouse gas emissions to transport performance, expressed in gCO₂e/t-km. Lower values indicate better environmental efficiency;
- *Empty Sailing*: Ballast voyages where the vessel travels without cargo, typically to reposition for the next loaded transport operation;
- *Empty Sailing Factor*: The ratio of total distance travelled to loaded distance. A factor of 1.0 means no empty sailing; higher values indicate greater proportion of empty voyages;
- *Ex-post*: After the fact. Ex-post reporting uses actual measured data from completed operations rather than estimates or forecasts;
- *ISO 14083:2023*: International standard for quantification and reporting of greenhouse gas emissions from transport chain operations;
- *Tank-to-Wake*: Emissions accounting approach that includes only combustion emissions from fuel use on the vessel, excluding upstream production and distribution emissions;
- *(Freight) Transport Activity*: The total amount of freight transport work performed, measured in tonne-kilometres. Calculated by summing the product of cargo mass and distance for all loaded voyages;
- *Well-to-Wake*: Comprehensive emissions accounting approach that includes both upstream emissions (fuel production, processing, distribution) and combustion emissions;
- *Well-to-Tank*: Upstream emissions from fuel production, processing, and distribution to the point of delivery to the vessel;

For the purposes of this document, the following abbreviations shall apply:

- **CDNI**: Convention on the Collection, Deposit and Reception of Waste produced during the navigation on the Rhine and inland waterways. Mandatory legal framework for documenting fuel deliveries and waste disposal via a digital payment system;

- CO₂e: Carbon dioxide equivalent. A standardized unit that expresses the impact of different greenhouse gases in terms of the amount of CO₂ that would have the same global warming potential;
- ENI Number: European Number of Identification. Unique eight-digit identifier assigned to each inland waterway vessel;
- EURIS / CEERIS: European River Information Services platforms that facilitate electronic reporting of vessel movements, cargo information, and operational data;
- gCO₂e/t-km: Grams of carbon dioxide equivalent per tonne-kilometre. The standard unit for expressing emission intensity in freight transport;
- RIS: River Information Services. Digital platforms and systems for exchange of information about inland waterway transport operations;
- TTW: Tank-to-Wake;
- t-km: tonne-kilometres. A measure of transport performance calculated by multiplying cargo mass in tonnes by distance travelled in kilometres;
- WTW: Well-to-Wake;
- WTT: Well-to-Tank;

4. Scope of application

4.1 Intended Users

- Vessel owners/operators transporting freight on inland waterways
- Fleet managers in charge of environmental reports
- Administrative staff managing fuel and voyage records
- Software providers creating emission calculation tools
- Auditors and verification bodies reviewing emissions data

4.2 Scope

Covers: Freight transport on inland waterways, measured in tonne-kilometres.

Excludes:

- Passenger transport
- Workboats/service craft (use C1 methodology)
- Non-freight maritime operations

5. Understanding the C3 methodology

5.1 The C3 formula

The core formula for calculating emission intensity under the C3 methodology is:

$$\text{Emission Intensity (gCO}_2\text{e/t-km)} = \text{GHG Emissions (gCO}_2\text{e)} / \text{Transport Performance (t-km)}$$

This metric expresses the climate impact per unit of transport work performed, enabling meaningful comparisons across vessels, routes, and operational practices.

5.2 Key Components

5.2.1 Total Greenhouse Gas Emission

Total emissions are calculated by multiplying energy consumption by the appropriate emission factors. The calculation accounts for:

- **Energy consumption:** Total fuel or energy used during the reporting period, measured in litres, kilograms, or kilowatt-hours
- **Emission factors:** Carbon intensity values that convert fuel consumption to CO₂ equivalent emissions (Well-to-Wake basis), aligned and based on data used for methodology C1
- **Energy carriers:** Different fuels (diesel, biofuels, electricity) have different emission factors

5.2.2 Transport Performance

Transport performance is expressed as tonne-kilometres (t·km), calculated as:

$$\text{Transport Performance} = \text{Cargo Mass (tonnes)} \times \text{Distance Travelled (kilometres)}$$

Important considerations:

- Only loaded voyages contribute to transport performance
- Empty sailing distances must be tracked separately
- Energy consumed during empty sailing is allocated (proportionally) to loaded transport performance

5.3 Allocation of Empty Sailing

Empty sailing is an inherent part of inland waterway operations. The C3 methodology in line with the ISO 14083:2023 standard requires that emissions from empty sailing be allocated to the transport performance of loaded voyages. This is calculated using the empty sailing factor:

$$\text{Empty Sailing Factor} = \text{Total Distance} / \text{Loaded Distance}$$

The total emissions (including those from empty sailing) are then divided by the transport performance from loaded voyages only to give the emission intensity.

6. Data Requirements

Implementing the C3 methodology requires systematic collection of three primary data categories. This section details each requirement and identifies available data sources.

6.1 Energy Consumption Data

6.1.1 Required Information

For each refuelling event, record:

1. Date of bunkering
2. Type of fuel or energy carrier (e.g., diesel, B30, HVO100, shore power, H₂, Battery swap)
3. Quantity supplied (litres, kilograms, or kilowatt-hours)
4. Vessel identification (name, ENI number)

6.1.2 Primary Data Source: CDNI Records

The Convention on the Collection, Deposit and Reception of Waste is the primary source for fuel consumption data. Bunker delivery notes should contain required information for emissions calculations.

Advantages of CDNI data:

- Mandatory for a significant part of the vessels operating in CDNI signatory states
- Already collected and stored by operators
- Verified by fuel suppliers
- Provides complete audit trail

6.2 Cargo Data**6.2.1 Required Information**

For each transport contract or cargo movement:

1. Cargo mass (tonnes)
2. Loading port and date
3. Unloading port and date
4. Cargo type

6.2.2 Primary Data Source: Commercial Records

Cargo data is typically available from existing commercial documentation:

- Transport contracts and freight agreements
- Bills of lading and waybills
- Loading and discharge confirmations
- Financial invoicing systems

6.3 Voyage Data**6.3.1 Required Information**

For each voyage segment:

1. Departure location and timestamp
2. Arrival location and timestamp
3. Distance travelled (kilometres)
4. Loading status (loaded or empty)

6.3.2 Primary Data Source: River Information Services (RIS)

River Information Services, particularly through EURIS/ CEERIS platforms, provide comprehensive voyage tracking data:

- Automated reporting of departures and arrivals
- Route information for distance calculation
- Loading status
- Type and quantity of load

6.3.3 Distance Calculation

Distance may be determined through:

- **Official waterway distances:** Published kilometre markers on navigable waterways
- **RIS data extraction:** Automated calculation from departure/arrival locations
- **Standard route tables:** Pre-calculated distances for common port pairs
- **GPS/AIS tracking:** Direct measurement from positioning systems

7. Step-by-Step calculation procedure

This section provides sequential process for calculating C3 emission intensity. Follow these steps for accurate and compliant reporting.

Step 1: Define the reporting period

Establish clear boundaries for your reporting period:

- Typical reporting periods: Monthly, quarterly, or annual
- Start date and end date
- Vessel included in the report

Step 2: Collect energy consumption data

Gather all fuel consumption records for the reporting period:

1. Retrieve bunker delivery notes for all refuelling events (including via CDNI if this option is available in the future)
2. Extract quantity and fuel type for each bunkering
3. Sum total fuel consumption by fuel type
4. Convert all quantities to consistent units (e.g., litres for liquid fuels, kg for gas, kWh for electricity)

Step 3: Calculate total greenhouse gas emissions

Apply emission factors to fuel consumption:

1. Use the appropriate emission factors for each fuel type (see Section 5 for reference values)
2. Multiply fuel quantity by emission factor: $\text{Emissions} = \text{Fuel Quantity} \times \text{Emission Factor}$
3. Calculate emissions for each fuel type separately
4. Sum all emissions to get Total GHG Emissions in grams CO₂e
5. Document the emission factors used and their source

Step 4: Collect Voyage and Cargo Data

Compile information for all voyages in the reporting period:

For loaded voyages EURIS/CEERIS:

- Extract cargo mass
- Determine loading and unloading ports
Calculate distance for each transport segment: both the real-sailed distance and straight-line distance

For empty voyages:

- Identify departure and arrival ports from RIS or logbook
- Calculate distance for each empty sailing segment

Step 5: Calculate Transport Activity

Determine the total transport work performed:

- For each loaded voyage: Calculate $t \cdot km = \text{Cargo Mass (tonnes)} \times \text{Distance (km)}$
- Sum all loaded voyage $t \cdot km$ values
- Record this value as Total Transport Activity

Step 6: Calculate empty sailing factor

If the vessel performed any empty sailing during the period:

- Calculate total distance: Sum of all loaded and empty voyage distances
- Calculate loaded distance: Sum of loaded voyage distances only
- Empty Sailing Factor = Total Distance / Loaded Distance

Note: If there was no empty sailing (all voyages were loaded), the empty sailing factor equals 1.0 and can be omitted from calculations.

Step 7: Calculate emission intensity

Apply the C3 formula to determine final emission intensity:

$$\text{Emission Intensity} = \text{GHG Emissions (gCO}_2\text{e)} / \text{Transport Activity (t}\cdot\text{km)}$$

The empty sailing factor is inherently included because emissions from empty sailing are part of Total GHG Emissions but only loaded transport performance is counted in the denominator.

Result: Your emission intensity value in gCO₂e/t·km.

Step 8: Document and verify

Maintain comprehensive documentation:

- Archive all source documents (CDNI notes, bills, EURIS/CEERIS extracts)
- Record calculation methodology and emission factors used
- Perform quality checks
- Prepare audit for verification

8. Emission factors

Emission factors convert fuel consumption into greenhouse gas emissions. This section provides reference values and guidance on selecting appropriate factors.

8.1 Well-to-Wake vs Tank-to-Wake

Well-to-Wake (WTW) emission factors are recommended for C3 reporting. WTW includes both:

- **Well-to-Tank (WTT):** Emissions from fuel production, processing, and distribution
- **Tank-to-Wake (TTW):** Emissions from fuel combustion on the vessel.

8.2 Reference emission factors (Well-to-Wake)

Table A-1 provides example Well-to-Wake emission factors for common fuel types used in inland navigation. These values should be updated according to the latest ISO 14083:2023 guidance or the central database specified under the CEEU regulation to be managed by the European Environment Agency.

Table A - 1 Well-to-Wake emission factors for different fuel types.

Fuel Type	Unit	WTW Emission Factor (gCO ₂ e/MJ)
Diesel (Gas Oil)	l	91.6
Liquefied Natural Gas (LNG)	kg	76.4
Biodiesel (FAME B100)	l	13.6
HVO (Hydrotreated Vegetable Oil)	l	13.6
Electricity (shore power)	kWh	Varies by grid*

*Grid emission factors vary by country and time period. Use national grid factors from official sources.

8.3 Fuel Blends

For fuel blends (e.g., B20 biodiesel blend containing 20 % biodiesel and 80 % diesel):

1. Determine the blend ratio from supplier documentation
2. Calculate weighted emission factor based on component proportions
3. Example: B20 = (0.20 × Biodiesel EF) + (0.80 × Diesel EF)

Important: Always document blend ratios and calculations for verification purposes.

Annex B: Methodology E1 (EU EEDI_{INLAND})

The following section describes the Procedure for calculation of the Estimated and Attained Energy Efficiency Design Index of inland waterway vessels, the methodology E1.

It is designed as a stand-alone document for further application beyond the project.

Version: 2026-01-20

Procedure for calculation of the Estimated and Attained Energy Efficiency Design Index of inland waterway vessels

1. Introduction.....	2
2. References.....	2
3. Definitions, symbols, and abbreviations	2
4. Scope of application.....	4
5. Guidelines on the method of calculation of the Attained EEDI for inland waterway vessels.....	5
5.1 <i>Working steps for the speed-power trials.....</i>	5
5.1.1 Vessel information and condition	5
5.1.2 Environment conditions	6
5.1.3 Trial preparations	7
5.1.4 Trial execution	9
5.1.5 Analysis procedure	11
5.2 <i>Determination of the Attained EEDI</i>	12
5.3 <i>Trial power and trial speed settings</i>	12
5.4 <i>Speed-power curve determination</i>	14
5.5 <i>Water depth correction</i>	16
5.5.1 Jiang-Friedhoff water depth correction method	16
5.5.2 Sinkage-speed-water-depth relationship.....	18
5.6 <i>Wind force</i>	19
5.6.1 Semi-empirical approach for the estimation of wind resistance coefficient	20
6. Guidelines on the method of calculation of the Estimated EEDI at the design stage ..	21
6.1 <i>Working steps for the speed-power prediction and EEDI estimation</i>	21
6.1.1 Vessel information and condition	21
6.1.2 Environmental conditions	22
6.1.3 Test preparation and execution	22
6.1.4 Analysis procedure	22
Annex A Derivation of the statistical coefficients “a” and “b” in the speed-power curve	24
Annex B Flowchart of speed-power trial analysis	26
Annex C Flowchart of speed-power curve determination	27
Annex D Conversion methodologies.....	28

1. Introduction

The EU defined $EEDI_{INLAND}$ from the PLATINA4Action project, also known as “Methodology E1” represents a measure of vessels’ energy efficiency, expressed in terms of energy consumption per transport activity (Wh/t-km). Two terms are distinguished depending on the method of determination:

- **Estimated $EEDI_{INLAND}$:** a value obtained from predictive approaches such as computational fluid dynamics (CFD) or model tests. This value is typically determined prior to full-scale trials and serves to verify whether the design of the new vessel or the retrofit meet the intended efficiency objectives;
- **Attained $EEDI_{INLAND}$:** a value calculated based on measurements collected during speed-power trials conducted on the full-scale vessel under defined test conditions. This value is used to verify compliance in full scale.

The purpose of this document is to provide a comprehensive methodology for computing the Estimated and Attained $EEDI_{INLAND}$.

2. References

The following documents were used for the development of this guideline:

1. Energie-Effizienz und die Treibhausgasintensität von Binnenschiffen, DST Report Number 2376, November 2024;
2. European Standard laying down Technical Requirements for Inland Navigation vessels (ES-TRIN), Edition 2025/1;
3. Directive (EU) 2016/1629;
4. Preparation, Conduct and Analysis of Speed/Power Trials, ITTC, Revision 08, 2024;
5. Jiang, T., A new Method for Resistance and Propulsion Prediction of the Ship Performance in Shallow Water, in Proceedings of the 8th International Symposium PRACS’01, Shanghai, China, 2001;
6. Hooft, J. P., The influence of nautical requirements on the dimensions and layout of entrance channels and harbours, in Proceedings of the International Course Modern Dredging, The Hague, Netherlands, 1977;
7. Fujiwara, T. and Ueno, M. and Ikeda, Y., A New Estimation Method of Wind Forces and Moments acting on Ships based on Physical Component Models, in JASNAOE, Vol. 2, 2005;

These documents are referred to in the text as [reference x], where x denotes the number of the respective document.

3. Definitions, symbols, and abbreviations

For the purposes of this document, the following definitions shall apply:

- **Attained $EEDI_{INLAND}$:** it is the $EEDI_{INLAND}$ value calculated based on measurements collected during speed-power trials conducted on the full-scale vessel under defined test conditions. This value is used to verify compliance in full scale.
- **Cabin vessel:** a vessel constructed and equipped to carry more than 12 passengers with overnight passenger cabins;

- *Convoy*: a rigid or towed convoy of vessels;
- *Day trip vessel*: a vessel constructed and equipped to carry more than 12 passengers without overnight passenger cabins;
- *Deadweight*: it is the difference between the displacement of a ship and the lightweight of the ship. In practical terms, the maximum deadweight is the maximum possible cargo load for the ship (including cargo, fuel, fresh water, ballast water, provisions, passengers, and crew);
- *Motor cargo vessel*: a vessel, other than a motor tanker, intended for the carriage of goods and built to navigate independently under its own motive power;
- *EEDI_{INLAND}*: parameter that reflects the design energy efficiency of vessels;
- *Estimated EEDI_{INLAND}*: it is the EEDI_{INLAND} value obtained from predictive approaches such as computational fluid dynamics (CFD), empirical models, or model tests. This value is typically determined prior to full-scale trials and serves to verify whether the design of the new vessel or the retrofit meet the intended efficiency objectives
- *Inland waterway vessel*: a vessel intended solely or mainly for navigation on inland waterways;
- *Motor tanker*: a vessel intended for the carriage of goods in fixed tanks and built to navigate independently under its own motive power;
- *Naval vessel*: a vessel built, operated, or owned by a state and used for military purposes, including defence, patrol, and combat operations.
- *Passenger vessel*: a day trip or cabin vessel constructed and equipped to carry more than 12 passengers;
- *Propulsive power*: the power delivered to the propulsion system (e.g., propeller) to move the vessel through the water at a given speed;
- *Pushed convoy*: a rigid assembly of vessels of which at least one is positioned in front of the vessel providing the power for propelling the convoy, known as the pusher(s); a convoy composed of a pusher and a pushed vessel coupled to permit guided articulation is also considered as rigid;
- *Pusher*: a vessel specially built to propel a pushed convoy;
- *Reference trial propulsive power*: reference engine power selected for conducting the speed-power test in Test Zone A1;
- *Reference trial speed*: reference vessel speed over ground selected for conducting the speed-power test in Test Zone A2;
- *Seagoing ship*: a vessel approved and intended primarily for seagoing or coastal navigation;
- *Speed-power trial*: test to establish the speed-power relation of the vessel;
- *Target speed through water*: the specified vessel speed at which the EEDI_{INLAND} must be evaluated. It represents the reference speed through water used to extract the corresponding propulsive power from the ideal speed-power curve.

- *Target propulsive power*: the propulsive power obtained by interpolating the ideal speed-power curve at the target speed through water. This is the power value used to evaluate the $EEDI_{INLAND}$.
- *Transport activity*: parameter that quantifies freight transport. It shall be the quantity of freight multiplied by the transport activity distance, i.e., the distance over which the freight is transported;
- *Vessel*: an inland waterway vessel or seagoing ship;

For the purposes of this document, the following abbreviations shall apply:

- $EEDI_{INLAND}$: Energy Efficiency Design Index of inland waterway vessels;
- EU: European Union;
- GNSS: Global Navigation Satellite System;

For the purposes of this document, the following symbols shall apply:

- A1: symbol used in this document to refer to testing zones for vessels permitted to navigate on large inland waterways Zones 1, 2, and 3 as defined in Directive (EU) 2016/1629;
- A2: symbol used in this document to refer to testing zones for vessels NOT permitted to navigate on large inland waterways Zones 1, 2, and 3 as defined in Directive (EU) 2016/1629;
- DWT: deadweight;
- F_W : wind force (not still air);
- L: ship's length between perpendicular;
- P_P : propulsive power;
- $P_{P,T}$: target propulsive power;
- $P_{P,R}$: reference trial propulsive power;
- V_C : water current intensity;
- V_G : the speed of the vessel over the ground;
- $V_{G,R}$: reference trial speed over ground;
- V_{TW} : the speed of the vessel through water, i.e. with reference to the current flow;
- $V_{TW,T}$: target speed through water;
- Δ : displacement mass.

4. Scope of application

Based on ES-TRIN 2025 [reference 2] definitions, this document shall apply to inland waterway vessels of the following categories:

- Motor cargo vessel;
- Motor tanker;
- Pushed convoy;
- Passenger vessel;

This document does not apply to naval vessels and seagoing ships.

5. Guidelines on the method of calculation of the Attained EEDI for inland waterway vessels

5.1 Working steps for the speed-power trials

5.1.1 Vessel information and condition

Description	Summary
The process begins with the collection of all relevant information about the vessel necessary for the EEDI_{INLAND} assessment from official certificates and technical documentation of the vessel. This includes the vessel type, details of the convoy configuration to test (if applicable) and the maximum deadweight (or displacement for passenger vessels), as well as hydrostatic data. In addition, comprehensive information on the powertrain must be collected, such as the number of propellers, the type of propulsion system (e.g., conventional propeller or rudder propeller/azimuthing thrusters) and the specifications of the main engines, including the type of fuel(s) used. Check which on-board measurement systems required for the EEDI_{INLAND} trial are available. Useful systems may include: • Torque measurement system; • Electrical motor power; • Fuel consumption measuring system; • Propeller(s) revolution rate measuring systems; • GNSS; • Gyrocompass(es); • Anemometer (for wind speed and direction); • Speed log; • Vessel's draught measurement system (if available) or draught marks; • Echo sounder (for real-time water depth measurements). If the required systems are not available or are unsuitable, temporary measuring equipment must be installed specifically for the EEDI_{INLAND} test. Finally, the physical condition of the hull and propeller(s) must be assessed. Both must be clean and free of significant fouling or marine growth, as these factors can increase resistance. A visual inspection should be performed before the trial, and cleaning carried out as necessary in line with the coating manufacturer's recommendations. The dates of	1. Collection of relevant information about the vessel: vessel type, convoy configuration (if applicable), maximum deadweight (or displacement for passenger vessels) and hydrostatic data; 2. Collection of relevant information about the powertrain: number of propellers, the type of propulsion system, specifications of the main engines and fuel(s) used; 3. Determination of available on-board measuring systems required for EEDI_{INLAND} test: torque measurement system, fuel consumption measuring system, propeller(s) revolution rate measuring system, GNSS, gyrocompass(es), anemometer, speed log, vessel's draught measurement system or draught marks, and echo sounder; 4. Installation of not available or unsuitable on-board measuring systems required for the EEDI_{INLAND} test; 5. Assessment of the physical condition of the hull and propeller(s) and determination

the last dry-docking and the last hull and propeller cleaning must be recorded in the speed-power trial report.	of the date of the last hull and propeller(s) cleaning. 6. Record all data gathered at this point in the speed-power trial report.
---	---

5.1.2 Environment conditions

Description	Summary
To accurately determine the Attained EEDI_{INLAND}, speed-power trials must be performed under controlled and consistent environmental conditions. These conditions should minimise the impact of external influences, allowing the true performance of the vessel to be measured. In any case, the limitations of inland waterways are acknowledged, and the guidelines have been designed to reflect realistic but standardised test environments to enable the correction of measurements. Test zone Two types of test zones are here defined: • Zone A1: For vessels allowed to sail on large inland waterways (Zone 1, 2, and 3 as defined in Directive EU 2016/1629). Trials can be conducted where the water depth is greater than 7.5 m and water current is below 3 km/h. If the requirements on the water depth cannot be fully met, testing may still be allowed in areas with water depth greater than 5 m, provided that appropriate correction methods are applied. The width of the water flow should be at least 200 m. • Zone A2: For vessels operating exclusively in Zone 4 as defined in Directive (EU) 2016/1629, typically corresponding to canals or lakes. Trials can be conducted in canals with water depths ranging from 3.9 to 4.1 m with low water current conditions. Canal sections must comply with one of the following geometries: rectangular (R), trapezoidal (T), or rectangular–trapezoidal (RT). Trial route requirements The trial should be conducted in a sheltered area, with minimal wind, waves, and current, and free from interference by small boats or commercial traffic. The selected trial route should: • Have a minimum length of 2 km to have a reasonable amount of time (at least 5 minutes) to ensure a steady state condition of the vessel;	1. Choice of the test zone (A1 or A2) according to the vessel certificate; 2. Choice of the sheltered area where to conduct the tests that complies with the trial route requirements; 3. Determination of the maximum permitted cruising speed on the waterway selected; 4. Record all data gathered at this point in the speed-power trial report.

• A constant water depth, in accordance with the limits described above, maintained throughout the trial; • Wide enough that bank effects do not influence the vessel's motion or measurement accuracy, in accordance with the limits described above, maintained throughout the trial; • If applicable, be subject to a constant and uniform current velocity, free from cross-flow currents, and comply with the limits described above; • Experience limited and relatively constant wind conditions, avoiding crosswinds. Wind speeds shall not be higher than Beaufort 5. In case Beaufort 2 is exceeded a correction method shall be applied. Once the test area is selected, its location and dimensions must be documented in the speed-power trial report. Additionally, the maximum permitted cruising speed on the waterway must be identified and, of course, observed.	
---	--

5.1.3 Trial preparations

(immediately before the trial, or on day of the trial)

Description	Summary
Installation and calibration Based on the information collected from the previous steps, all the measuring systems required for the trial that are not already on board must be assembled and installed in their final configuration. Useful systems may include: • Torque measurement system (e.g., strain gauges); • Electrical motor power • Fuel consumption measuring system; • Propeller(s) revolution rate measuring systems; • GNSS; • Gyrocompass(es); • Anemometer (for wind speed and direction); • Speed log; • Vessel's draught measurement system (if available); • Echo sounder (for real-time water depth measurements). Once installed, all equipment that will be used must be tested to detect and resolve any malfunctions or system	1. Installation of all measuring systems required for the trial not already available on the vessel; 2. All measuring systems, previously installed and already on-board, must be tested to detect and resolve any malfunctions or system issues; 3. All sensors and signals that will be recorded must be fully calibrated; 4. Vessel's characteristics must be verified to ensure compliance with the loading and configuration requirements for the Attained EEDI_{INLAND} test (draught,

issues. Before the speed-power trials begin, all sensors and signals that will be recorded must be fully calibrated. This is done after installation by cycling each sensor across its full operating range to verify proper response and signal quality. Check vessel configuration Before starting the trial, the vessel's characteristics must be verified, to ensure compliance with the loading and configuration requirements for the Attained EEDI_{INLAND} test, and documented: • Draught: measure the vessel's draught at the zero speed through water by reading the draught marks. If available, the vessel's internal draught measurement system may also be used. • Deadweight/Displacement check: using the vessel technical documentation collected at the beginning, verify that the vessel is loaded to at least 70% of its maximum deadweight (or displacement for passenger vessels). • Convoy configuration (if the trial is performed with a convoy). Check of the waterway The conditions of the selected waterway must be verified and documented to ensure the trial can proceed safely and without interference: • Environmental conditions: document the expected wind conditions, water depth, and current velocity along the chosen trial route. These values should fall within the acceptable limits reported in the Section 5.1.2. • Traffic and restrictions: document the expected traffic situation in the area and ensure the trial can be conducted without interference from passing vessels. Check for any local or temporary restrictions that may affect trial execution. • Water properties: document the expected water temperature and water density at the time of the trial, as they may influence propulsion efficiency. Furthermore, they enable the calculation of the vessel's displacement from hydrostatics. Speed-power trial agenda The trial execution shall be coordinated by drawing up an agenda in advance with the boat master. This agenda should include the navigation plan and operational considerations.	deadweight/displacement and, if applicable, convoy configuration); 5. Document the expected environmental conditions at the selected waterway in which the trial is performed, including wind, water depth, water current, traffic, restrictions, and water properties such as density and temperature; 6. Definition of the trial agenda that includes the number of double runs planned, trial propulsive powers or, conversely, the trial speeds over ground, the indicative trajectory within the prescribed area, and the communication procedures with the crew during the trial; 7. Record all data gathered at this point in the speed-power trial report.
--	---

The selected trial trajectory must allow for a double-run procedure, meaning that each trial run shall be followed by a return run over the same route with the same engine settings, or speed. The trial agenda should specify: • Number of double runs planned (at least three); • Propulsive powers to set during each double run of vessels operating in Zone A1, as outlined in Section 5.3 (obtained from torque measurements, electric power, or fuel flow measurements). The propulsive powers should be appropriately distributed around the so called “reference trial propulsive power”, as specified in Section 5.3, to allow proper interpolations. • Speed over ground to achieve during each double run of vessels operating in Zone A2, as outlined in Section 5.3. The speeds should be appropriately distributed around the so called “reference trial speed over ground”, as specified in Section 5.3, to allow proper interpolations. • The indicative trajectory within the prescribed area. It shall be rectilinear and of sufficient length to accommodate a speed-power measurement with the required accuracy and to ensure that the vessel reaches and maintains a steady-state condition. It shall also be located sufficiently far from the riverbanks to avoid bank effects; • Clear communication procedures with the crew during the trial. If space permits, the ideal trajectory for performing a double run would be Williamson turns or similar manoeuvres. This ensures a quick and effective change of course to bring the vessel back onto the reciprocal heading.	
---	--

5.1.4 Trial execution

Description	Summary
Parameters that shall be recorded The parameters to be measured during each run are given below: • Ship track (through GNSS); • Speed over ground (through GNSS);	1. Conduct speed-power runs during daylight to ensure clear observation of environmental conditions (wind, waves, traffic);

• Torque on the shaft from strain gauges (if applicable); • Fuel consumption (if applicable); • Electric motor power (if applicable); • Ship heading (through gyrocompass, or compass-GNSS); • Trim and sinkage (if applicable); • Rudder angle (if applicable). High usage of the rudders to keep the course has a negative effect on the trial results; • Actual water depth during the run (change of water depth may affect the trial results); • Relative wind speed and direction (through ship anemometer); • Ship traffic. No overtaking and encountering during the trial; • Any potential disturbances in the trial are that may affect the results (cross currents, obstacles, shoals, etc). • Date and time; Conduct of trials The speed-power runs should be conducted during daylight hours to allow clear visual observation of environmental conditions such as wind, waves, and traffic. These should not deviate excessively from the expected conditions. All trials shall follow the previously agreed agenda, and the parameters mentioned above must be continuously recorded throughout the procedure. An experienced helmsman or adaptive autopilot will be required to maintain heading during each speed run. Minimum rudder angles are to be used while maintaining a steady heading. The test sequence is straightforward: 1. Navigate along the trial route at constant power or speed; 2. Once the vessel has reached a steady condition, prepare all measurement systems for data acquisition; 3. Initiate the speed run: – Control levers must remain unchanged; – Maintain straight heading using minimal rudder input;	2. Follow the agreed trial agenda and record all specified parameters throughout each run; 3. Execute the trial according to the defined test sequence; 4. Ensure the data acquisition system captures and presents complete time histories for quality assessment and analysis.
--	--

– Continue the run for a minimum of 5 minutes; – Record the speed over ground and power (or the parameters for calculating it); 4. Continuously observe and document environmental conditions (wind, wave, current, traffic) throughout the speed run; 5. At the end of the run, initiate a turning manoeuvre using small rudder angles to align the vessel for the counter run; 6. Perform the return (counter) run along the same geographical track; 7. Repeat steps 2 through 6 for the counter run at the same power (the same power facilitates mirroring during counter run). Data acquisition At the end of each run, the data acquisition system shall be able to present all recorded time histories to evaluate the quality and consistency of the acquired trial data and to be stored for subsequent analysis.	
--	--

5.1.5 Analysis procedure

Description	Summary
The scope of the analysis is to determine the ideal speed-power curve that can be used to calculate the Attained $EEDI_{INLAND}$. The procedure includes: 1. Evaluation of the acquired data for quality and consistency; 2. Derive the average of each measured parameter in steady condition for each speed run; 3. Determine the ideal speed-power curve, as described in Section 5.4. This means linking speeds through the water to the power that drives the ship forward. The effects of currents, shallow water and wind are already considered in determining this curve; 4. Interpolate the ideal speed-power curve to the so called “target speed” specified in Table B - 1 to obtain the corresponding “target propulsive power”; 5. Compute the Attained $EEDI_{INLAND}$, as described in Section 5.2.	1. Evaluate data quality and consistency; 2. Derive the average of each measured parameter for each speed run; 3. Determine the ideal speed-power curve; 4. Interpolate the ideal speed-power to the “target speed” to obtain the corresponding “target propulsive power”; 5. Compute the Attained $EEDI_{INLAND}$.

5.2 Determination of the Attained EEDI

The Attained EEDI_{INLAND} is calculated using the following formula:

$$\text{Attained EEDI}_{\text{INLAND}} = 1000 \frac{P_{P,T}}{V_{TW,T} \cdot (\text{DWT or } \Delta)} \quad \text{in} \quad \left[\frac{\text{Wh}}{\text{t} \cdot \text{km}} \right] \quad (1)$$

Table B - 1 provides the definitions of all terms used in the EEDI_{INLAND} calculation formula. Before applying the formula, the goal is to establish an ideal speed-power curve that captures the relationship between the power acting on the vessel to move it and speed through the water, while minimising the influence of current, wind, and shallow-water effects (see Section 5.4). This curve is then interpolated at the required target speed, reported in Table B - 1, to obtain the corresponding target propulsive power used in the index.

Table B - 1 Definitions and units of measurement of parameters used in calculating the Attained EEDI_{INLAND}.

Parameter	Unit of measurement	Definition
$P_{P,T}$	[kW]	Target propulsive power. It is obtained by interpolating the ideal speed-power curve at the required target speed of the vessel through water $V_{TW,T}$: $P_{P,T} = a(V_{TW,T})^b$ Where a and b are the coefficients defining the shape of the idea speed-power curve, as described in Section 5.4.
$V_{TW,T}$	[km/h]	Target speed of the vessel through water. It defined as follows: $\begin{cases} Fr = -0.0004 \cdot L + 0.1806 \\ V_{TW,T} = 3.6 \cdot Fr \cdot \sqrt{9.81 \cdot L} \end{cases}$ Where L is the ship's length between perpendicular, in meter.
$\text{DWT or } \Delta$	[t]	Deadweight (for dry motor cargo vessels, container vessels, motor tankers, and pushed convoys) and displacement mass (for passenger vessels). Determined through the vessel's draught marks (or draught measurement system, if applicable) and hydrostatics.
1000	[-]	Conversion factor from $\left[\frac{\text{kWh}}{\text{t} \cdot \text{km}} \right]$ to $\left[\frac{\text{Wh}}{\text{t} \cdot \text{km}} \right]$

Annex B of the current guideline reports the flowchart that summaries the steps to determine the Attained EEDI.

5.3 Trial power and trial speed settings

For vessels allowed to operate in Zone A1, as defined in this document, the EEDI_{INLAND} test requires specifying the following “reference trial propulsive power”:

$$P_{P,R} = (a_1 + a_2 \cdot e^{B/a_3}) \cdot (\text{DWT or } \Delta) \quad \text{in} \quad [\text{kW}] \quad (2)$$

Where B represents the vessel's breath in meters, DWT represents the deadweight in tonnes, Δ represents the displacement in tonnes, and the regression coefficients are reported in the Table B - 2. Only in the case of passenger vessels, displacement Δ shall be used instead of deadweight. Propulsive power can be determined using one of the following measurements:

- Fuel consumption meter (to be converted into propulsive power. See Annex D of the current guideline);
- Torque and propeller speed measurements (to be converted into propulsive power. See Annex D of the current guideline);
- Electrical power measurement (to be converted into propulsive power. See Annex D of the current guideline).

Annex D of the current guideline describes how propulsive power can be linked to different onboard measurements, including fuel flow, torque and propeller speed, or electrical power.

Table B - 2 Regression coefficients for power computation [reference 1].

Vessel type	a_1	a_2	a_3
Dry motor cargo and container vessel	0.268	0	1
Motor tanker	0.280	0	1
Pushed convoy	0.146	0.25	-11
Passenger vessel	0.200	0.42	-7.5

The propulsive powers used in each double run should be distributed around this reference trial value to allow reliable interpolation. Recommended settings for developing a representative curve can be 100%, 80%, and 60% with the corresponding speed over ground measured for each run. If more than three runs are performed or other settings are preferred, the propulsive power must remain between 60% and 100% of the reference trial value. Settings below 60% and above 100% are not recommended, as engines may operate in off-design regimes.

For vessels NOT allowed to navigate on large inland waterways (Zones 1, 2, and 3, as defined in Directive (EU) 2016/1629), the EEDI_{INLAND} test specifying the following “reference trial speed over ground”:

$$V_{G,R} = a_1 + (a_2 + a_3 \cdot B) \cdot T + (a_4 + a_5 \cdot B) \cdot T \quad \text{in [km/h]} \quad (3)$$

Where B represents the vessel’s breath in meters, T represents the draught in meters, and the regression coefficients are reported in the Table B - 3. In this case the regression coefficients depend on the shape of the canal.

Table B - 3 Regression coefficients for trial speed computation [reference 1].

Profile of the canal	Trapezoidal	Rectangular	Rectangular-trapezoidal
a_1	13.75	13.95	13.90
a_2	-0.26	-0.17	0.26
a_3	-0.12	-0.12	-0.18
a_4	0.036	0.004	-0.1
a_5	-0.008	-0.002	0.009

The speeds used in each double run should be distributed around the reference trial speed to allow reliable interpolation. Recommended settings are 100%, 80%, and 60% of the reference trial speed, with the corresponding propulsive power measured for each run. If more than three runs are

performed or other settings are preferred, the tested speeds must remain between 60 % and 100 % of the reference trial speed.

Particular attention must be paid to the maximum cruising speed in the selected test area.

5.4 Speed-power curve determination

The objective of this section is to determine the characteristics of the speed-power curve of the vessel under consideration from a set of runs. The speed-power curve expresses the relationship between the power acting on the vessel to move it and its speed through water. However, only the speed over ground V_G is measured during the tests, and therefore the water current velocity V_C must be estimated to derive the speed through water.

A minimum of three double runs is required. The power settings for Zone A1, or the speeds for Zone A2, should be appropriately distributed around the reference trial power or speed, as specified in Section 5.3, to enable an interpolation to the required target values after corrections have been made. For tests conducted in Zone A1 and water depths between 5 m and 7.5 m, the speed through the water must be corrected to align with the speed-power relationship at the reference depth of 7.5 m.

For each run, the data collected and averaged useful in this section include the propulsive power P_P (derived from torque measurement system, electrical motor power or fuel consumption measuring system), the wind parameters (direction and intensity), and the speed over ground V_G . The relationship between these quantities is expressed through the following empirical equations:

$$\begin{cases} V_{TW} = V_G - V_C > 0 \\ P_P + F_W(V_G - V_C) = a(V_G - V_C)^b \end{cases} \quad (4)$$

where:

- P_P : measured propulsive power (to propel the ship, derived from torque measurement system, electrical motor power or fuel consumption measuring system) [kW];
- F_W : added wind force, calculated according to Section 5.6 (negative with head wind, positive with stern wind) [kN];
- V_G : speed over ground (positive when the ship is moving forward relative to the ground, measured using GNSS) [m/s],
- V_C : current velocity (positive when the vessel sails downstream) [m/s];
- V_{TW} : speed of the vessel through water (by definition, it is, and must be for the trial, always positive) [m/s];
- a, b : coefficients defining the shape of the speed-power curve. For consistency, they should be greater than 1.

The coefficients a and b are obtained through regression, while V_C is determined iteratively by minimizing the total fitting error between measured and modelled power, as described below. To improve clarity in the mathematical formulation, all speeds have been expressed in meters per second (m/s).

To determine the coefficients a and b and the current velocity V_C , at least three double runs at different power settings are required, resulting in a total of at least six runs. Each double run consists of one upstream and one downstream measurement. In this analysis, the water current is assumed to be constant throughout the entire campaign, while wind parameters may vary between runs but are considered constant during each single run.

The regression is performed separately for runs conducted under the same sailing condition (either upstream or downstream), ensuring that variations in speed are attributable only to changes in power and not to variations in the relative current velocity.

The regression procedure is as follows:

1. For each run “ i ”, the average values of the measured quantities are taken: propulsive power $P_{P,i}$, speed over ground $V_{G,i}$, and wind force $F_{W,i}$, for $i = 1, 2, \dots, n$, where n corresponds to the number of runs under the same sailing condition;
2. A trial value of the current velocity V_c is assumed (example 0.1 m/s when it should be positive or -0.1 m/s when it should be negative). For each run, the speed through water and the total power including wind force are computed as:

$$x_i = V_{G,i} - V_c, \quad y_i = P_{P,i} + F_{W,i}x_i, \quad i = 1, 2, \dots, n \quad (5)$$

3. Only positive values of x_i and y_i are considered to allow a logarithmic transformation as follows:

$$X_i = \ln(x_i), \quad Y_i = \ln(y_i) \quad (6)$$

4. The transformed speed-power relationship becomes linear:

$$Y_i = \ln(a) + b X_i \quad (7)$$

5. The slope b and a are computed using least squares¹³:

$$b = \frac{\sum_{i=1}^n (X_i - \bar{X})(Y_i - \bar{Y})}{\sum_{i=1}^n (X_i - \bar{X})^2}, \quad \bar{X} = \frac{1}{n} \sum_{i=1}^n X_i, \quad \bar{Y} = \frac{1}{n} \sum_{i=1}^n Y_i, \quad a = e^{(\bar{Y} - b \bar{X})} \quad (8)$$

6. The sum of squared residuals is calculated as:

$$S(V_c) = \sum_{i=1}^n (a x_i^b - y_i)^2 \quad (9)$$

7. The trial value of V_c is adjusted (small variation from the previous trial value, example 0.1 m/s) and steps 2-7 are repeated until the residual $S(V_c)$ is minimized¹⁴. The optimal current velocity is the one that minimises the squared residuals:

$$V_c^* = \arg \min_{V_c} S(V_c) \quad (10)$$

8. The coefficients a and b are recomputed using the optimal V_c^* to obtain the final best-fit parameters (a, b, V_c^*) ;

¹³ The proof is given in 0 of the current guideline.

¹⁴ This is equivalent to minimizing the variance of the residuals between the observed data and the model.

9. The same procedure is applied independently for runs in the opposite direction (upstream or downstream) to verify the estimated parameters. In this case, the current will have the opposite sign.
10. Finally, the average values of the parameters a , b and V_c^* , each determined separately for upstream and downstream navigation, are calculated:

$$\begin{aligned}
 a_{avg} &= \frac{a_{upstream} + a_{downstream}}{2} \\
 b_{avg} &= \frac{b_{upstream} + b_{downstream}}{2} \\
 V_{c,avg}^* &= \frac{|V_{c,upstream}^*| + |V_{c,downstream}^*|}{2}
 \end{aligned} \tag{11}$$

For tests conducted in water depths between 5 m and 7.5 m, the speed through the water must be corrected, as described in Section 5.5, to align with the speed-power relationship at the reference depth of 7.5 m. Since the water current velocity $V_{c,avg}^*$ has already been estimated, the input speeds through the water to be corrected are defined as:

$$V_{TW,i} = V_{G,i} - V_{c,avg}^* \quad i = 1, 2, \dots, n \tag{12}$$

(the sign of $V_{c,avg}^*$ should be carefully considered for upstream and downstream navigation)

where n represents the number of runs performed under the same sailing condition, either upstream or downstream. For example, in the case of three double runs, there will be three speeds through the water measured downstream and three upstream.

After correcting the speeds through the water to the reference depth of 7.5 m, steps 2-5 are repeated using these corrected speeds ($x_i = V_{TW,i,corrected}$) to determine the new coefficients a and b for both sailing directions. Finally, the average values of parameters a and b at the reference water depth of 7.5 m are calculated.

$$\begin{aligned}
 a_{avg,h_{ref}=7.5} &= \frac{a_{upstream,h_{ref}=7.5} + a_{downstream,h_{ref}=7.5}}{2} \\
 b_{avg,h_{ref}=7.5} &= \frac{b_{upstream,h_{ref}=7.5} + b_{downstream,h_{ref}=7.5}}{2}
 \end{aligned} \tag{13}$$

Annex C of the current guideline reports the flowchart that summaries the steps to determine the speed-power curve.

5.5 Water depth correction

5.5.1 Jiang-Friedhoff water depth correction method

The method draws upon the findings reported in Jiang (2001) [reference 5]. It transforms the speed-power curve obtained at a specific water depth into a form that is independent of water depth. In principle, this transformed relationship can then be inverted to reconstruct the speed-power curve at any desired water depth. The transformation relies on defining an effective speed, that is a notional speed at which the vessel would experience an equivalent power regardless of water depth. Figure B - 1 illustrates this concept.

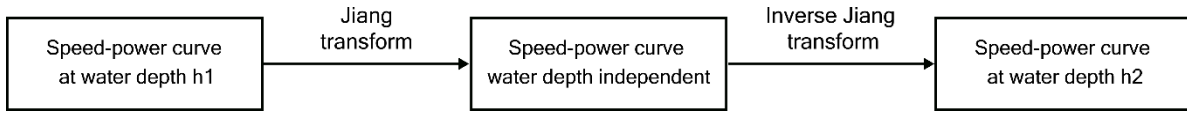


Figure B - 1 Conceptualisation of the conversion of the power curve between two different water depths.

It is noted that the correction method defined here adjusts the speed-power relationship obtained in water depths between 5 m and 7.5 m, aligning it with the speed-power relationship at a reference water depth of 7.5 m.

The inputs required for the computation and the outputs are the following:

1. h_1 : water depth during the test [m];
2. $V_{TW,1}$: average speed through water during the run at the water depth h_1 [m/s];
3. z_1 : the measured average sinkage during the run, if available, or otherwise the computed or empirically estimated value at the speed $V_{TW,1}$ and the test water depth h_1 [m];
4. m_1 : blockage parameter during the test, defined as the ratio between the vessel's underwater cross-sectional area and the cross-sectional area of the navigation area at the test water depth h_1 [-];
5. h_2 : reference water depth (7.5 m);
6. $V_{TW,2}$: estimated speed through water reached by the vessel at the reference water depth h_2 [m/s];
7. z_2 : computed or empirically estimated mean sinkage value at the speed $V_{TW,2}$ and water depth h_2 [m];
8. m_2 : blockage parameter at the reference water h_2 , defined as the ratio between the vessel's underwater cross-sectional area and the cross-sectional area of the navigation area at the reference water h_2 [-].

The procedure can follow two approaches: one keeps the propulsive power set fixed; the other keeps the speed through water set fixed.

First approach:

1. Once the speed through water $V_{TW,1}$ is known for a water depth h_1 between 5 m and 7.5 m, the corresponding effective speed is calculated using the following formula:

$$V_E = V_{TW,1} \sqrt{\frac{\left(1 + \frac{2gz_1}{V_{TW,1}^2}\right)}{\left(1 - \frac{z_1}{h_1} - m_1\right)}} \quad (14)$$

For each effective speed V_E , the vessel would experience the same power as it does at the actual speed $V_{TW,1}$ used to determine V_E ;

2. In the second step, the speed through water at the reference water depth h_2 , denoted as $V_{TW,2}$, is determined by solving the following equation using the previously calculated effective speed V_E :

$$V_E - V_{TW,2} \sqrt{\frac{\left(1 + \frac{2gz_2}{V_{TW,2}^2}\right)}{\left(1 - \frac{z_2}{h_2} - m_2\right)}} = 0 \quad (15)$$

This is a nonlinear equation where both $V_{TW,2}$ and z_2 are initially unknown. To solve it, the sinkage z_2 must be related to $V_{TW,2}$ and h_2 . This relationship can be obtained through model test data, CFD simulations, or empirical formula, such as that discussed in Section 5.5.2 and adopted by ITTC. Once z_2 is known for given $V_{TW,2}$ the equation can be solved numerically by finding the root of the function, yielding the corrected speed $V_{TW,2}$ at the reference depth. The resulting $V_{TW,2}$ represents the speed through water at which the vessel would operate at the same power in a water depth of 7.5 m.

Second approach:

1. Once the speed through water $V_{TW,1}$ at a water depth h_1 (between 5 m and 7.5 m) is known, the corresponding effective speed V_E is computed. Each effective speed V_E represents the speed at which the vessel would experience the same power as at the actual speed $V_{TW,1}$ used to derive it, but regardless of water depth;
2. The speeds through water at the reference depth h_2 , denoted $V_{TW,2}$, are taken to be the same set as $V_{TW,1}$. At h_2 , the vessel experiences new, typically smaller, sinkages. These sinkages at speeds $V_{TW,2}$ and depth h_2 can be obtained from model tests, CFD, or empirical formulas, yielding a new set of effective speeds V_E ;
3. Using the established effective speed-power relationship from step 1, the power corresponding to each new V_E , and thus to each $V_{TW,2}$ at the reference depth h_2 , is obtained by interpolation.

Both approaches lead to the same outcome: a new speed-power relationship at the reference water depth h_2 . In the first approach the speeds are shifted, while in the second the powers are shifted.

5.5.2 Sinkage-speed-water-depth relationship

The method draws upon the findings reported in Hooft (1977) [reference 6] and adopted by ITTC. It links the sinkage of a ship to its speed through water and the water depth. Readers are encouraged to consult the study for further details.

The inputs required for the computation and the outputs are the following:

1. L : length on the waterline of the ship [m];
2. ∇ : displacement volume of the ship [m³];
3. V_{TW} : average speed through water during the run at the water depth h [m/s];
4. h : water depth [m].

The procedure is explained as follows:

1. Determine the depth Froude number:

$$Fr_h = \frac{V_{TW}}{\sqrt{gh}} \quad (16)$$

where, g is the gravity field strength expressed in m/s^2 .

2. Determine the sinkage as follows:

$$z = 1.46 \frac{\nabla}{L^2} \frac{Fr_h^2}{\sqrt{1 - Fr_h^2}} \quad (17)$$

This process yields pairs (z, V_{TW}) at the water depth h , which serve as inputs for solving the equations presented in Section 5.5.1.

5.6 Wind force

In principle, the wind force can be positive or negative, depending on the relative wind direction. For instance, a headwind hinders forward motion (negative force), while a stern wind assists the ship's motion (positive force). The wind force is calculated as follows:

$$F_W = \frac{1}{1000} \left[\frac{1}{2} \rho_A V_{WR}^2 C_X(\psi_{WR}) A_F - \frac{1}{2} \rho_A V_G^2 C_X(0) A_F \right] \text{ in [kN]} \quad (18)$$

With this formulation, the force induced by still air is not taken into account.

The inputs required for the computation are the following:

1. ρ_A : air density [kg/m³];
2. V_{WR} : wind velocity relative to the ship, measured by an onboard anemometer (positioned at 10 m from the waterline) [m/s];
3. V_G : speed over ground of the ship [m/s];
4. C_X : wind resistance coefficient (defined below) [-];
5. ψ_{WR} : wind direction relative to the ship, as measured by an onboard anemometer. 0° corresponds to wind coming from the bow, 90° corresponds to wind coming from port side, 180° corresponds to wind coming from the stern, and 270° corresponds to wind coming from starboard side [° or rad];
6. A_F : total frontal projected area (see Figure B - 2) [m²].

Since wind speed and direction fluctuate over time, they are represented in the equation by their average values over a chosen time interval. In speed-power trials, it is generally assumed that wind conditions remain steady (or do not change significantly) during each run. The mean wind speed and direction for the run are then calculated based on the measurement period.

In line with ITTC Recommended Procedures and Guidelines [reference 4], three methods can be used to estimate the wind resistance coefficient C_X :

1. Wind tunnel experiments: if wind resistance tests have been conducted for the vessel or a similar one in a qualified wind tunnel, the resulting wind resistance coefficients shall be used to determine the vessel's wind resistance under trial conditions. These coefficients shall be based on the projected frontal area A_F .
2. Wind resistance coefficients from CFD: CFD-based wind resistance coefficients may be used, provided that the CFD code has been verified and validated against qualified wind tunnel measurements for comparable vessels, in accordance with ITTC Recommended Procedures 7.5-03-01-01. The simulation representing the trial condition shall employ the same grid

structure, grid density, geometric resolution, and modelling approach (including turbulence models and boundary conditions) as those used during the validation.

3. Semi-empirical approach: the method draws upon the findings reported in Fujiwara et al. (2005) [reference 7]. The underlying theory is summarized in the section 5.6.1.

5.6.1 Semi-empirical approach for the estimation of wind resistance coefficient

The regression formula for the wind resistance coefficient reported Fujiwara et al. (2005) [reference 7] was developed from wind tunnel model tests conducted on various ship types. With reference to Figure B - 2, the inputs required for the computation are the following:

1. L_{OA} : length overall of the ship [m];
2. A_L : total lateral projected area above the waterline [m²];
3. A_F : total frontal projected area above the waterline [m²];
4. B : breadth of the ship [m];
5. A_{OD} : lateral projected area of the superstructures on the deck [m²];
6. C : horizontal distance from amidships to the centre of the total lateral projected area A_L [m];
7. H_C : height from the waterline to centre of the total lateral projected area A_L [m];
8. H_{BR} : height of the top of superstructure from the waterline [m].

Furthermore, the non-dimensional parameters β_{ij} , δ_{ij} , ϵ_{ij} used in the regression formulae are reported in Table B - 4.

Table B - 4 Parameters for Fujiwara regression formula.

	i	j				
		0	1	2	3	4
$\beta_{(i,j)}$	1	-0.922	0.507	1.162	-	-
	2	0.018	-5.091	10.367	-3.011	-0.341
$\delta_{(i,j)}$	1	0.458	3.245	-2.313	-	-
	2	-1.901	12.727	24.407	-40.310	-5.481
$\epsilon_{(i,j)}$	1	-0.585	-0.906	3.239	-	-
	2	-0.314	-1.117	-	-	-

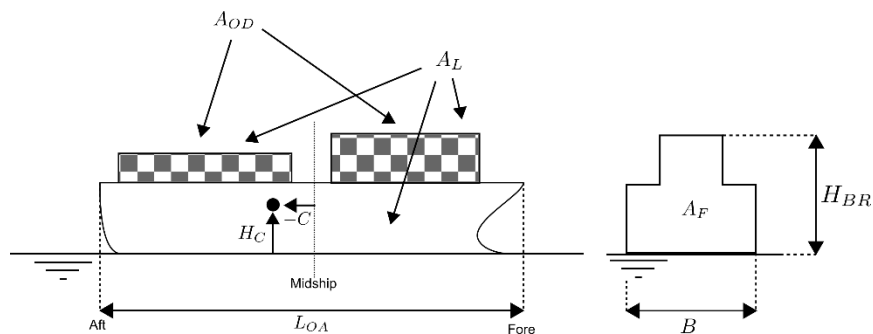


Figure B - 2 Definition of parameters of the windage area for wind loads estimation.

The aerodynamic coefficient is computed using a set of coefficients and the wind direction relative to the ship, as follows:

$$C_X = C_{LF} \cos(\psi_{WR}) + C_{XLI} [\sin(\psi_{WR}) - 0.5 \sin(\psi_{WR}) \cos^2(\psi_{WR})] \sin(\psi_{WR}) \cos(\psi_{WR}) + C_{ALF} \sin(\psi_{WR}) \cos^3(\psi_{WR}) \quad (19)$$

The longitudinal-flow drag coefficient C_{LF} is the following:

$$\begin{cases} C_{LF}^{0^\circ \leq \psi_{WR} < 90^\circ} = \beta_{(1,0)} + \beta_{(1,1)} \frac{A_L}{L_{OA} B} + \beta_{(1,2)} \frac{C}{L_{OA}} \\ C_{LF}^{90^\circ < \psi_{WR} \leq 180^\circ} = \beta_{(2,0)} + \beta_{(2,1)} \frac{B}{L_{OA}} + \beta_{(2,2)} \frac{H_C}{L_{OA}} + \beta_{(2,3)} \frac{A_{OD}}{L_{OA}^2} + \beta_{(2,4)} \frac{A_F}{B^2} \end{cases} \quad (20)$$

The lift and induced drag coefficient C_{XLI} is the following:

$$\begin{cases} C_{XLI}^{0^\circ \leq \psi_{WR} < 90^\circ} = \delta_{(1,0)} + \delta_{(1,1)} \frac{A_L}{L_{OA} H_{BR}} + \delta_{(1,2)} \frac{A_F}{H_{BR} B} \\ C_{XLI}^{90^\circ < \psi_{WR} \leq 180^\circ} = \delta_{(2,0)} + \delta_{(2,1)} \frac{A_L}{L_{OA} H_{BR}} + \delta_{(2,2)} \frac{A_F}{A_L} + \delta_{(2,3)} \frac{B}{L_{OA}} + \delta_{(2,4)} \frac{A_F}{H_{BR} B} \end{cases} \quad (21)$$

The additional longitudinal drag coefficient C_{ALF} is the following:

$$\begin{cases} C_{ALF}^{0^\circ \leq \psi_{WR} < 90^\circ} = \varepsilon_{(1,0)} + \varepsilon_{(1,1)} \frac{A_{OD}}{A_L} + \varepsilon_{(1,2)} \frac{B}{L_{OA}} \\ C_{ALF}^{90^\circ < \psi_{WR} \leq 180^\circ} = \varepsilon_{(2,0)} + \varepsilon_{(2,1)} \frac{A_{OD}}{A_L} \end{cases} \quad (22)$$

In principle, the coefficients at $\psi_{WR} = 90^\circ$ can be approximated by averaging the values obtained for $\psi_{WR} < 90^\circ$ and $\psi_{WR} > 90^\circ$. However, this is not a significant issue, as these coefficients are multiplied by cosine terms that vanish at 90° . Moreover, side winds should be avoided during speed-power trials.

6. Guidelines on the method of calculation of the Estimated EEDI at the design stage

Prior to the full-scale trial, the $EEDI_{INLAND}$ can be estimated or predicted to verify whether the design of the new vessel or retrofit meets the intended efficiency objectives. The value can be obtained through predictive approaches such as computational fluid dynamics (CFD) or tank tests.

Tank tests include model self-propulsion tests conducted in accordance with the latest ITTC Recommended Procedures and Guidelines by an accredited test organization. Numerical calculations may be accepted as equivalent, provided that the CFD setup has demonstrated verification and validation against qualified tank tests for similar ships using ITTC Recommended Procedure 7.5-03-01-01. The simulation corresponding to the actual trial case must employ the same grid structure, grid density, geometrical resolution, and modelling approach (e.g. turbulence models and boundary conditions) as used in the validation demonstration.

6.1 Working steps for the speed-power prediction and EEDI estimation

6.1.1 Vessel information and condition

The estimation of the $EEDI_{INLAND}$ can be performed either through tank tests or numerical simulations (CFD). In both cases, the vessel geometry, appendages, and propulsion system must be fully consistent with the design intended for the full-scale vessel or retrofit configuration.

For numerical simulations, calculations shall be carried out at full scale, while for tank tests, measurements shall be performed on a geometrically scaled model, applying appropriate scale corrections in accordance with the latest ITTC Recommended Procedures and Guidelines.

The model or numerical setup shall reproduce the same loading condition as the full-scale trial, corresponding to at least 70 % of the vessel's maximum deadweight (or displacement for passenger vessels).

If the vessel operates as part of a convoy, the convoy configuration shall match that of the intended full-scale trial.

6.1.2 Environmental conditions

Model tests and numerical simulations shall be performed under controlled environmental conditions, representative of calm water. No external effects such as wind, current, or waves shall be present. Tests shall be conducted in deep water to minimise shallow-water effects:

- For vessels operating in large inland waterways (Zones 1-3 as per Directive EU 2016/1629), the equivalent full-scale water depth should be greater than 7.5 m;
- For vessels operating exclusively in Zone 4, the corresponding full-scale water depth should range from 3.9 m to 4.1 m. Canal sections, if modelled, shall have one of the following geometries: rectangular (R), trapezoidal (T), or rectangular–trapezoidal (RT).

Both CFD domains and towing tanks must be configured to represent unbounded flow conditions, avoiding side-wall interference and ensuring that the selected depth is consistent with the zone of operation.

The water properties (density and viscosity) shall correspond to those expected at the location of the full-scale vessel trials.

6.1.3 Test preparation and execution

The objective of both model and numerical tests is to determine the speed-power relationship of the vessel in steady conditions. The series of test points shall cover the operating range necessary for interpolation at the target speed, as specified in Section 5.3.

For tank tests, the procedure shall include:

- Model self-propulsion tests following ITTC Recommended Procedures;
- Application of standard corrections for scale effects and appendage resistance, following ITTC Recommended Procedures;

For CFD simulations:

- The same grid structure, grid density, geometric resolution, and modelling approach (turbulence models, boundary conditions) as those verified and validated against comparable tank tests shall be used, in accordance with ITTC Recommended Procedure 7.5-03-01-01;
- Simulations shall be run until steady-state convergence is achieved.

6.1.4 Analysis procedure

After completing the tests or simulations, the following analysis shall be performed:

- Evaluate the quality and consistency of the acquired data or computed results;
- Construct the ideal full-scale speed-power curve linking propulsive power to vessel speed through the water;

- Interpolate the ideal speed-power curve to the target speed specified in Section 5.3 to obtain the corresponding target propulsive power;
- Compute the Estimated $EEDI_{INLAND}$ using the same formula applied for the Attained $EEDI_{INLAND}$, reported in Section 5.2, substituting the predicted power and speed values derived from the model or simulation results.

Annex A Derivation of the statistical coefficients “a” and “b” in the speed-power curve

The empirical relation adopted to describe the speed-power curve is expressed as:

$$y = a \cdot x^b$$

Taking the natural logarithm of both sides yields a linear relationship:

$$\ln(y_i) = \ln(a) + b \cdot \ln(x_i)$$

Defining $Y_i = \ln(y_i)$ and $X_i = \ln(x_i)$ the regression model becomes:

$$Y_i = \ln(a) + b \cdot X_i$$

The coefficients a and b are determined by minimizing the sum of squared residuals:

$$S = \sum (Y_i - \ln(a) - bX_i)^2$$

The least-squares solution is obtained by imposing that the partial derivatives of S with respect to $\ln(a)$ and b are equal to zero:

$$\begin{aligned} \frac{\partial S}{\partial \ln(a)} &= -2 \sum (Y_i - \ln(a) - bX_i) = 0 \\ \frac{\partial S}{\partial b} &= -2 \sum X_i (Y_i - \ln(a) - bX_i) = 0 \end{aligned}$$

From the first equation:

$$\ln(a) = \bar{Y} - b\bar{X}$$

where the overbars denote mean values over all n data points:

$$\bar{X} = (1/n) \sum X_i \quad \bar{Y} = (1/n) \sum Y_i$$

Substituting the expression for $\ln(a)$ into the second condition leads to:

$$b = \frac{n \sum X_i Y_i - (\sum X_i)(\sum Y_i)}{n \sum X_i^2 - (\sum X_i)^2}$$

Considering that:

$$\begin{aligned} n \sum X_i Y_i - (\sum X_i)(\sum Y_i) &= n \sum (X_i - \bar{X})(Y_i - \bar{Y}) \\ n \sum X_i^2 - (\sum X_i)^2 &= n \sum (X_i - \bar{X})^2 \end{aligned}$$

It gives:

$$b = \frac{\sum (X_i - \bar{X})(Y_i - \bar{Y})}{\sum (X_i - \bar{X})^2}$$

Once b is known, the coefficient a is computed from the mean values as:

$$a = \exp(\bar{Y} - b\bar{X})$$

Annex B Flowchart of speed-power trial analysis

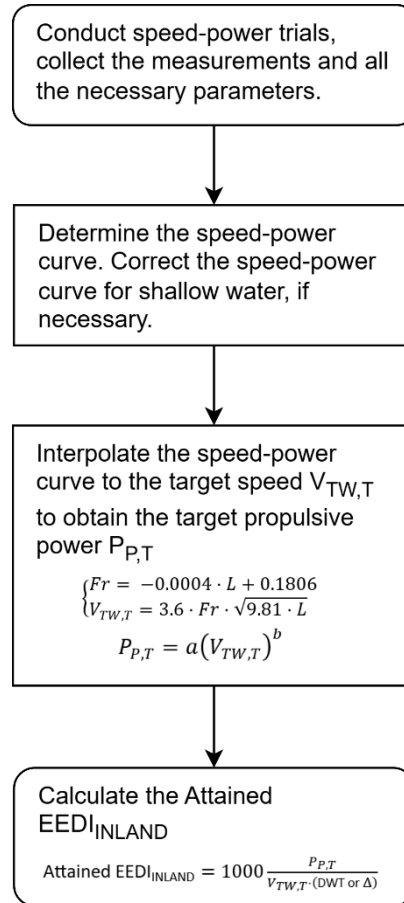


Figure B - 3 Flowchart of speed-power analysis to compute the $EEDI_{INLAND}$.

Annex C Flowchart of speed-power curve determination

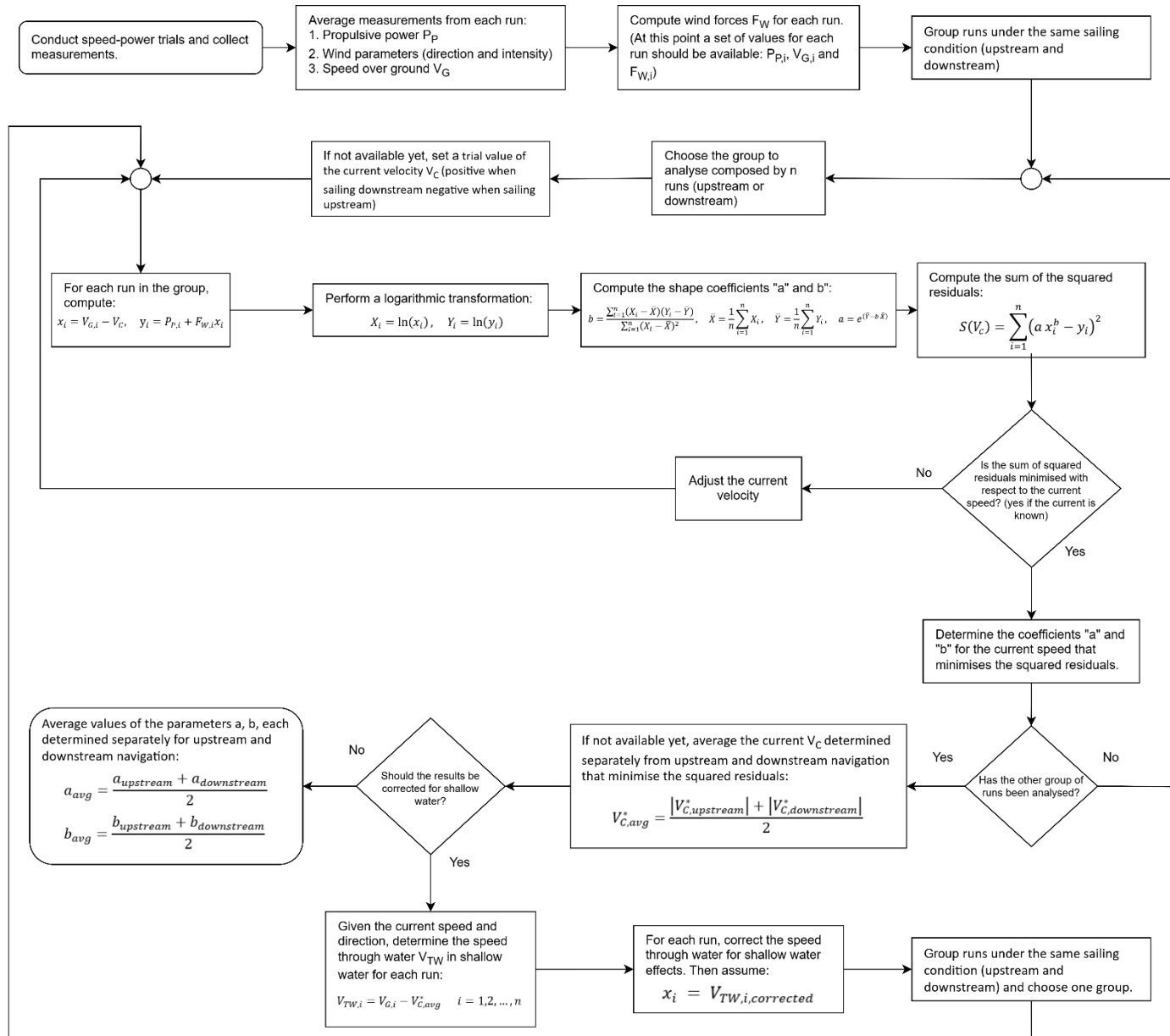


Figure B - 4 Flowchart to determine the speed-power curve.

Annex D Conversion methodologies

This section describes how propulsive power can be linked to different onboard measurements, including fuel flow, torque and propeller speed, or electrical power. The intent is to provide consistent methods for converting raw sensor data into comparable power estimates.

Fuel flow measurements → Propulsive power

$$P_P = 1000 \frac{\dot{V} \cdot \rho}{SFC} \eta_{trans} = P_{brake} \eta_{trans} \quad \text{in [kW]}$$

Where $\dot{V}$ is the volume flow rate measured by the flowmeter [m^3/h], ρ is the density of the fuel [kg/m^3], SFC is the specific fuel consumption of the engine [g/kWh] and μ_{trans} represents the transmission efficiency of the power transmission line from the meter to the propulsion system.

μ_{trans} depends on the transmission line (e.g. gear box and shaft bearings). If unknown, it can be assumed to be about 0.95 for conventional diesel-mechanical installations. If SFC curves are unavailable, a representative value of 200–220 g/kWh can be assumed for conventional medium/high-speed marine diesel engines at moderate load.

Torque and propeller speed measurements → Propulsive power

$$P_P = \frac{1}{1000} \frac{Q \cdot 2 \pi n}{60} \quad \text{in [kW]}$$

where Q is the torque [$\text{N}\cdot\text{m}$] and n is the rotational speed [rpm].

Electrical power → Propulsive power

$$P_P = P_{el} \eta_{motor} \eta_{inverter} \quad \text{in [kW]}$$

where P_{el} is measured electrical power [kW] and η are the efficiencies. Typically, motor efficiency is $\eta_{motor} \approx 0.93\text{--}0.97$ and inverter efficiency is $\eta_{inverter} \approx 0.95\text{--}0.98$. So total electric transmission: $\eta_{tot} \approx 0.88\text{--}0.95$, depending on load and technology.

These formulations provide general methods to estimate propulsive power from fuel flow, torque and propeller speed, or electrical power. They are valid in most cases, but the actual values depend on the specific engine, transmission, or electrical configuration of the vessel.

These formulae link the measured power on board (whether from fuel flow, torque and propeller speed, or electrical power) to the vessel's trial propulsive power.



Project coordination	Stichting Projecten Binnenvaart
Contact	platina4action@iwtprojects.eu

© 2026



This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101137650. The opinions expressed in this document reflect only the author's view and in no way reflect the European Commission's opinions. The European Commission is not responsible for any use that may be made of the information it contains.