Work Package 2: Innovation & Fleet

Report on the stakeholder exchange on external cost in inland navigation

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Table of Content

List of Abbreviations

CCNR	Central Commission for Navigation on the Rhine
CDNI	Convention relative à la collecte, au dépôt et à la réception des déchets survenant en navigation rhénane et intérieure (Convention on the Collection, Deposit and Reception of Waste Generated During Navigation on the Rhine and Other Inland Waterways)
CESNI	Comité Européen pour l'Élaboration de Standards dans le Domaine de Navigation Intérieure (European Committee for the realization of technical standards in Inland Navigation)
EC	European Commission
EHDB	European Hull Database
ES-TRIN	European Standard laying down Technical Requirements for Inland Navigation vessels
g	gram
GHG	greenhouse gas
IVR	IVR Ships Information System
IWT	Inland Waterway Transport
IWW	Inland Waterway(s)
LNG	Liquefied Natural Gas
m	metre
NIS	National Inventory Submissions
NSI	National Statistical Institutes
MS	Member State(s)
t	tonnes
TEU	Twenty-foot equivalent unit
tkm	Tonne-kilometre
vkm	Vehicle (or vessel) kilometre
WG	Working Group
Country abbreviations:	Austria (AT); Belgium (BE); France (FR); Germany (DE); Luxembourg (LU); the Netherlands (NL); Switzerland (CH); Cyprus (CY); Malta (MT)

EXECUTIVE SUMMARY

The reduction of external costs of transport is high on the political agenda. It is of key importance for the debate about modal shift and support for sustainable transport modes. Discussions on internalisation of external costs to be able to calculate infrastructure charges, to select transport infrastructure projects and to compare the impacts of externalities between transport modes have led to several initiatives aimed at improving the estimation of external costs. Specifically for inland waterway transport (IWT), this issue has been announced in the NAIADES II Communication. Moreover, the White Paper on Transport refers to the Communication on the Strategy for the internalisation of external costs (SEC(2008)2207, accompanying COM(2008)435) in which the Commission has laid down a common methodology to charge all external costs across the whole transport sector, including inland waterway transport.[1]

In respect of other transport modes, in particular road transport, inland navigation has a significant competitive advantage because of much lower external costs. However, the calculation of the external costs of inland navigation is being hampered by the lack of EU-wide quality data. Moreover, gaps that exist for the calculation of external costs in other transport modes are being actively addressed. Therefore, before sensible discussions can take place and analyses can be made, the knowledge gaps in the information basis need to be closed and a common understanding is needed.

Specifically for IWT, PLATINA2 carried out a review of the currently available European datasets for external costs calculations on emissions to air[2]. **Several knowledge gaps have been identified and recommendations and key actions have been proposed to close these gaps.**

This report proposes a road map with six concrete actions to increase the reliability and credibility of external costs calculations on an aggregated EU-level for the IWT sector over the next two years.

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[1] http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52008DC0435&from=EN

[2] Review of European data sets and gap identification for external costs calculations on emissions to air by inland navigation (PLATINA2, Deliverable 2.3).

Results from the exchange and feedback from stakeholders

In order to validate the actions proposed, to obtain information on other possible solutions and to encourage stakeholder commitment, PLATINA2 took an active approach in **three main stakeholder exchange activities**:

1. **Organisation and execution of an Expert Workshop** in Brussels on 5 October 2015
2. **Participation during a Working Group meeting on Inland Waterways Transport Statistics** in Luxembourg on 6 November 2015, including the preparation of a draft paper on the matter for the Working Group and bilateral contacts with experts after the meeting
3. **Development of a paper as input for a CESNI meeting** planned for 9 February 2016 concerning the way forward for better information on engines installed on board of inland vessels.

The following points summarize the **results of the stakeholder exchange** with policy makers, representatives from EUROSTAT and NSI's as well as experts on the matter:

- **The quality of the current datasets is not reliable for several key parameters so that the use of a model for the calculation of external costs leads to very large bandwidths.** Therefore, there is no basis yet to start discussions about internalising external costs. For that, the knowledge base needs to be improved first.

- For the short term, the European Commission DG MOVE made clear that their primary objective is to **improve the robustness of the external cost calculations on an aggregated EU-level**. This is needed to enable them to compare IWT external costs with other transport modes. This means that a **top-down approach** is needed first. At a later stage, more detailed datasets could be improved to allow calculations of the external costs per vessel type/size and waterway section.

- **CDNI fuel bunkering information** can be used as a first order estimate on fuel consumption on macro level. Research on this data and publication of results is already planned by CCNR in the framework of the Market Observation IWT EU. Also the **National Inventory Reports (NIR)** could be used as a first estimate for data on fuel consumption per country. These reports present information on CO_2 emissions. Since this emission type has a linear relationship with fuel consumption, a first order estimate on fuel consumption per country can be derived. However, the approach followed in the NIRs is coping with the same model limitations as already identified in the PLATINA2 review report (D2.3), such as unknown real fuel consumption data and sailing speeds. Nevertheless, the NIRs could be used to further allocate the overall sum of fuel bunkered according to the **CDNI** data and to get a first order estimate for non-CDNI countries. It can be concluded that also the reliability of data presented in the NIRs could benefit from actions to increase the reliability of external cost estimations for emissions produced by inland navigation.

- **There is no short term option to revise the European legal framework regarding data collection on IWT emissions**. Consequently the focus should be on **voluntary actions** to close data gaps. The following voluntary actions will be discussed by EUROSTAT and NSI's in 2016:

  - study the possible usage of energy statistics for fuel consumption and CO_2;
  - study the possibility and try to bring together data to reduce the lack of information about the empty trips;
  - expand the number of vessel size classes, in order to include further differentiation for the larger vessel classes.

- The possibility of using **AIS data** at aggregated and anonymised level will result in significant improvements of the knowledge base. EUROSTAT and the NSI's have indicated that they will not be active in collecting AIS data, as they don't have the know-how and required resources to collect and process the continued flows of live AIS data. An alternative could be the establishment of a **neutral 'Clearing Centre**' at a national/regional/European level. This concept could be achieved by building further upon the **CoRISMA project**. This involves the national RIS authorities and could possibly be supported by the European Commission (e.g. through a CEF project).

- Two possible ways to **improve the reliability of the data about engines in inland vessels** are:

  - Extend the use of the **European Hull DataBase (EHDB)** with type approval data of the engine. This involves amending the existing legal basis and involvement of CESNI and would require additional administrative efforts from the national certification authorities. It is possible to add the number and introduction date of the type approval in the EHDB. An additional database is then needed on a European level to provide further background data linked to the type approval number as regards engine information for at least: maximum rpm, maximum engine power, emission characteristics and year of construction.
  - Another option is to improve the current **IVR database** with more accurate and validated data on the installed engines provided by ship owners. This voluntary option could be achieved on the short term, since there is no need for any adaptations of the legal framework and private actors can take action immediately. However, since this is a voluntary measure, it cannot be guaranteed that all ship owners will participate. The reliability of the database may therefore still remain questionable.

- The **PROMINENT project** is also expected to contribute to the improvement of data on fuel consumption and emissions by executing real world measurements in 2016 and 2017.

- For the monetisation of external costs it is of crucial importance to have detailed data on the geographic location of emissions of air pollutant emissions, notably for the emission of particulate matter. Geographic Information Systems shall be used to bring data-layers together about the traffic intensities on waterway sections in relation to the data layer with data on the population density (metropolitan, urban, rural). The planned action[3] to collect data on inland waterway infrastructure for TENtec provides a clear opportunity to provide the required building blocks for this functionality.

[3] Call for tenders, MOVE/B1/2014-527, Data collection on the Trans-European Transport Network (TEN-T) using the TENtec system, Lot 2: Inland waterways infrastructure.

Roadmap

The outcome of the stakeholder exchange provided important input for the development of the final recommendations on how to improve the knowledge base for external cost calculations on emissions to air by inland navigation. These recommendations have been presented through a **roadmap comprising the following actions:**

- **Action 1: Collect and disseminate information on fuel consumption and sailing speeds** of vessels on waterway sections
- **Action 2: Collect and disseminate information on average loading factors and empty sailings** of vessels
- **Action 3:** Take into account the **geographic location of air pollutants** to determine the impact of NOx and PM emissions to air by IWT, through the use of a combination of sources
- **Action 4: Collect better information about the engines installed** in inland waterway vessels
- **Action 5: Make further differentiation in larger vessel size classes**
- **Action 6:** Collect data on real world emissions and derived emission factors (in g/kWh) through **on-board measurements** under actual sailing conditions.

The **first three actions are considered to have the highest priority**. The reason is that research by PLATINA2 (see Deliverable 2.3) has shown that there are currently no datasets available on a European level for the parameters mentioned in these actions. Furthermore, the bandwidth of the possible results (if different sources and assumptions are used) shows significant variations.

Through the stakeholder exchange, **commitment as regards the follow-up actions has already been expressed for 5 of the 6 actions. The remaining element is the** attention and commitment of actors regarding the use of **AIS data to support actions 1, 2 and 3**, while taking care of legal limitations and privacy issues.

It can be concluded that by means of the execution of these 6 actions, a significant step can be made over the next two years to increase the robustness of the datasets. As a result, the reliability and credibility of external costs calculations on an **aggregated EU-level** will be significantly improved.

1. INTRODUCTION

1.1 Background and main objectives of the stakeholder exchange

The reduction of external costs of transport is high on the political agenda. The White Paper "Roadmap to a Single European Transport Area - Towards a competitive and resource efficient transport system" (2011) highlights the EU policy priority for sustainable transport and presents for 2050 modal shift targets towards environmental friendlier transport modes, such as inland waterway transport (IWT)[4]. However, the lack of a system for the internalisation of external costs hinders the decision-making process of transport users and providers towards greener transport options.

Discussions on the strategy of internalisation of external costs started in 2006, when the European Parliament asked the European Commission to present "a generally applicable, transparent and comprehensible model for the assessment of all external costs to serve as the basis for future calculations of infrastructure charges" and for the execution of "an impact analysis of the internalisation of external costs for all modes of transport". The European Parliament asked for a stepwise implementation of a model for all modes of transport[5].

These discussions have led to several initiatives, such as the Communication adopted in July 2008 (Greening transport package) which provides a general framework of reference for the internalisation of external costs in the transport sector and the development of the first "Handbook with estimates of external costs in the transport sector" (2008). Efforts have been made to improve this handbook with the "Update of the Handbook on external costs of transport" (2014). These handbooks outline a model for the internalisation of external costs which will serve as a basis for future calculations of infrastructure charges, possibly taking into account the external costs of transport. Specifically for IWT, a discussion on internalisation of external costs has also been announced in the NAIADES II Communication.

Moreover, the White Paper on Transport 2011 states "*The **internalisation of externalities**, the elimination of tax distortions and unjustified subsidies and free and undistorted competition are therefore part of the effort to align market choices with sustainability needs (and to reflect the economic costs of 'non-sustainability'). They are also necessary to establish a level playing field between modes which are in direct competition.*"

And on page 29, one of the actions announced for the period 2016-2020 is "*proceed to the full and mandatory internalisation of external costs (including noise, local pollution and congestion on top of the mandatory recovery of wear and tear costs) for road and rail transport. Internalise costs for local pollution and noise in ports and airports, as well as for air pollution at sea, and **examine mandatory application of internalisation charges on all inland waterways on EU territory**. Develop market based measures to further reduce GHG emissions.*"

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[4] Source: http://ec.europa.eu/transport/themes/strategies/2011_white_paper_en.htm

[5] Source: http://ec.europa.eu/transport/themes/sustainable/internalisation_en.htm

Moreover, the estimation of external costs also has a growing importance in the approval of funding support for transport infrastructure projects, as external costs need to be included in the models of the Cost–Benefit Analysis (CBA). The basic rules of conducting CBAs are now included in the secondary legislation for projects between 2014-2020 and are binding for all beneficiaries[6]. The Member States plan to implement over five hundred major projects in the 2014-2020 period. Specifically for the IWT sector this aspect is highly important as it can be expected that a move towards internalisation of external costs would have a significant positive impact on IWT projects. Hence, the importance of the IWT sector in making progress in this field.

The topic of internalisation of external costs has also been an important issue for the International Transport Forum at the OECD. A discussion paper on internalisation of external effects through taxes and charges concluded that the knowledge of external costs vary greatly between countries and modes of transportation and that the uncertainties in the valuations of external costs call for a cautious interpretation of the results[7].

Based on the issues mentioned above, it can be concluded that the internalisation of external costs is of high importance and obtaining reliable results in the estimations made is crucial. However, the calculation of external costs is being hampered by the lack of EU-wide quality data. Specifically for inland waterway transport (IWT), PLATINA2 carried out a review of the currently available European datasets for external costs calculations on emissions to air and has identified **several knowledge gaps**. **Annex I** presents a summary of this review[8].

The **most critical knowledge gaps** are:

- the lack of reliable and detailed data on the **fuel consumption** of vessels active in IWT as well as lack of data for '**sailing speed**', which is one of the main parameters to make estimations on fuel consumption using models taking into account the vessel and waterway characteristics;
- the lack of reliable data on the **average tonnage of cargo carried** by inland vessels per travelled kilometre, properly taking into account the share of **empty trips**;
- the lack of **geographic details**[9] on the traffic and transport performance used in studies to determine the (external costs) impact of NOX and PM2.5 emissions by IWT.

These gaps are seen as critical because there are currently **no datasets available** on a European level and/or the values observed in the different studies show **significant variations** and have at the same time a **large impact on the final outcome** of the external costs expressed in euro per tkm.

[6] Source: http://ec.europa.eu/regional_policy/sources/docgener/studies/pdf/cba_guide.pdf

[7] Source: OECD/ITF (2013-10), Internalisation of external effects in European freight corridors.

[8] For more information, please see the full report "Review of European data sets and gap identification for external costs calculations on emissions to air by inland navigation" (PLATINA2, Deliverable 2.3). Please contact PLATINA2 project representatives if you would like to receive a copy of this D2.3 report.

[9] Detailed information on the geographic breakdown of the transport performance (and related fuel consumption and emissions) is in particular required to determine the weighted average shadow prices based on the share of metropolitan, urban and non-urban areas in the total sailing distance. There is namely a difference in the PM shadow prices for metropolitan, urban and non-urban areas.

Therefore, for these parameters, a sensitivity analysis was carried out to indicate the bandwidth of the possible results if different sources and assumptions are used.

For **other parameters**, there are datasets currently available on a European level. However, some room for improvement was identified in order to enhance the reliability of the data. These include mainly: **improvements** of the **engine information**; **further differentiation** between the **larger vessel size classes** and the measurement of **real world emissions and derived emission factors** (in g/kWh).

Based on the results of the review, several **recommendations and key actions** have been proposed in the study to close the knowledge gaps identified (see Annex I). The recommendations considered to what extent **these actions are actually feasible for implementation** taking into account the existing legal framework, the interests of stakeholders and the available resources. The **stakeholders were consulted** as regards the validation of the results of the study and to collect their feedback and suggestions about the recommended actions. In this process the stakeholders provided useful information on **possible alternative sources and solutions**, in addition to the preceding desk research by PLATINA2 in the framework of the preparation of the Deliverable 2.3 report (D2.3).

1.2 Main approach and actions carried out for the stakeholder exchange

PLATINA2 carried out different activities to encourage a **stakeholder exchange**, covering the topics of both the data needed for monitoring innovation uptake in IWT as well as for estimating the external cost of IWT navigation. This report presents the main results of this stakeholder exchange and provides recommendations for the short term (2016, 2017) on how to improve the knowledge base for external cost calculations on emission to air by inland navigation through a **roadmap**.

The stakeholder exchange included the following activities:

1. Organisation and execution of an **Expert Workshop**: PLATINA2 organised an Expert Workshop in Brussels on 5 October 2015 with policy makers, representatives from EUROSTAT and some statistical institutes. The main objective of the workshop was to present the main results of the review and to discuss the follow-up. The review report (D2.3) was sent to the participants in advance for their preparation. The next day, PLATINA2 sent to a wide group of experts the presentations held at the Expert Workshop and also the table presenting the identified actions to close the data gaps. This table was jointly developed with the participants and summarised the main result of the Expert Workshop. Subsequently the group of experts were asked to give their comments by e-mail and telephone. Based on the feedback, PLATINA2 prepared a draft paper as input for the EUROSTAT Working Group meeting. This paper was again circulated for comments.

2. Participation during a **Working Group meeting on Inland Waterways Transport Statistics**: EUROSTAT organised a Working Group meeting on Inland Waterways Transport Statistics in Luxembourg on 6 November 2015. A member of the PLATINA2 team was invited to present the results of the review and the Expert Workshop during this meeting (*agenda item 10.4*). A draft paper and presentation was circulated as input for this meeting. This paper presented the areas where feedback from EUROSTAT and NSIs is expected such as ideas on follow-up actions where EUROSTAT and NSIs could play a role. After the Working Group meeting, PLATINA2 had further bilateral contacts with experts present at the meeting that provided information on solutions available to close the knowledge gaps.

3. **Development of a draft paper for the CESNI group**: another draft paper was developed by PLATINA2 targeting specifically the possible follow-up actions to improve the information about the *engines* installed in inland waterway vessels. This paper is prepared as input for CESNI meetings to be held on 9 February 2016 and first feedback from experts was taken into account.

The results obtained from the different stakeholder exchange activities served as the basis for the development of the **final recommendations** that are presented in this document. These recommendations address the key actions needed to improve the information basis on external cost calculations and monitor the innovation uptake in IWT, as well as how to achieve this **through a roadmap**.

2. RESULTS FROM THE STAKEHOLDER EXCHANGE

2.1 PLATINA2 Expert Workshop

An Expert Workshop organised by PLATINA2 took place in Brussels on 5 October 2015 with policy makers, representatives from EUROSTAT and some statistical institutes. Representatives from the PLATINA2 consortium presented the main results of the study and the recommended measures and proposed actions. The participants provided their views on the recommended actions and further input about possible next steps and quick wins to close the knowledge gaps.

Actions relevant for the study and objectives identified by the EC

The European Commission (EC) started the workshop highlighting a number of elements that are relevant for this study and the wider background:

- **Greening of the fleet**: through the impact assessment carried out for the adaptation of the NRMM[10]. The **revision of NRMM standards** on emission limits for new engines in inland navigation vessels is relevant for this study as the ambition level for air pollutant emissions is related to the savings on external costs which are benefits for society.
- **NAIADES II Communication**:
  - one of the announced future NAIADES actions is to start a dialogue about implementation of **internalisation of external costs** in IWT. But before sensible discussions can take place and analyses can be made, the knowledge gaps in the information basis need to be improved and a common understanding is needed.
  - another NAIADES action relates to the **improvement of the data availability** (on infrastructure, actors and operations) **and the underlying datasets** (e.g. vessels, engine and waterways data) through the establishment of a Digital Inland Navigation Area (**DINA**).
  - the data collection on IWT is also relevant for the wider integration of IWT in the multimodal chain within the framework of the Digital Transport and Logistics Forum.
- **Revision of the Transport White Paper**: the review carried out by PLATINA2 will serve as input and stock taking for a new Commission White Paper on Transport.

For the short term, the EC emphasised that the objective should be to **improve the reliability of the external costs assessments on an aggregated EU-level** using regional and/or national datasets.

The primary objective for having these external cost assessments is to allow the comparison of the performance of IWT with other transport modes. At a later stage, the more detailed datasets could be improved and could be used to further discuss the theme of internalisation of external costs on more detailed level.

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[10] Non-Road Mobile Machinery directive, please see for more information: http://ec.europa.eu/growth/sectors/automotive/environment-protection/non-road-mobile-machinery/index_en.htm

Proposed actions and overall results of the discussion

Presentations were given on the reviews and the conclusions. Based on the detailed review, three actions have been identified which have the highest relevance and highest priority to close gaps:

- **Action 1:** Collect and disseminate information on **fuel consumption and sailing speeds** of vessels on waterway sections.
- **Action 2:** Collect and disseminate information on **average loading factors and empty sailings** of vessels.
- **Action 3:** Take into account the **geographic location of air pollutants** NOx and PM[11], through the use of a combination of sources.

Other possible actions needed to improve the reliability of the datasets were also considered and discussed at the workshop. For each of the actions mentioned above, the following questions were asked and discussed during the workshop:

1. **What** can be done?
   - What are the quick wins and possible voluntary actions?
   - What can be done with optimised usage of River Information Services [RIS]?
   - What can be done if legal framework is adapted?
2. **Who** can/should take action and the lead?
3. **When** can it be planned (time horizon 2016-2020)?
4. **Where** can/should measures be implemented (geography)?

Table 1 presents the overall results of the discussion points mentioned above. The following aspects mentioned during the discussions are important to highlight:

- Follow a **top-down approach** to obtain first robust results. A top-down approach is also used for the other modes of transport. The further specification and differentiation of approach and data depends on the actual purpose concerning the emission and external costs calculations. As a first estimate, **CDNI bunkering information** in combination with transport performance statistics for Western European countries could provide fuel consumption data on macro level (the grand totals). Fuel consumption per tkm could be estimated using a top-down approach for the Western European countries that provide CDNI data (except for France).
- The EUROSTAT representative highlighted that it is unlikely that the **legal framework** regarding data collection can be changed in the short term. Expanding or making the data collection for some parameters mandatory by legislation for NSIs is not a realistic option for the short term. The emphasis shall be on **voluntary data collection actions and measures**. There is a possibility to **set up such voluntary actions within the framework of the Working Group on IWT statistics coordinated by EUROSTAT.**

[11] Detailed information on the geographic breakdown of the transport performance (and related fuel consumption and emissions) is in particular required to determine the weighted average shadow prices based on the share of metropolitan, urban and non-urban areas in the total sailing distance. There is namely a difference in the PM shadow prices for metropolitan, urban and non-urban areas.

- Using **AIS data** on an aggregated and anonymised way is acknowledged as a promising approach to collect information on speed and travelled distances. However this needs further elaboration. One aspect to clarify is the current practice regarding tracking, recording and storing the vessel positions by waterway managers and public administrations.
- An option for improving the available engine data could be to further improve the **IVR database (voluntary)** or to extend the **European Hull Database (EHDB) and to add fields for engine data to the current structure (legislative).**

Table 1: Matrix on actions to close the data gaps with the highest relevance and priority

	Action 1: Collect data on fuel consumption and sailing speeds	Action 2: Collect and disseminate information on average loading factors and empty sailings	Action 3: Geographic location of air pollutants	Other actions
1. **What can be done?**				
• **What are the quick wins and possible voluntary actions?**	Use CDNI data in combination with transport performance data to obtain first estimates on fuel consumption.	Load factors could be estimated using available statistics from specific NSI's from representative IWT Member States (e.g. AT, DE).	Apply EUROSTAT typology and population densities to develop a Geographic Information System for allocation of tkm performance by vessel type.	Get more reliable engine data.
	Define and apply a common approach for collection of waterway data (currents, waterway depth).	Consult EUROSTAT and NSIs which data are available on a national level on a voluntary basis (already being collected or modelled).	Check the possibility of using TENtec as platform for GIS (see above), however TENTec is limited to waterways CEMT IV or higher.	Get better data on emission profiles of engines.
• **What can be done with optimised usage of RIS?**	Usage of anonymised AIS data to derive information on average sailing speeds, specified per waterway section and vessel type/size.	Usage of anonymised AIS data to derive information about the average total kilometres travelled, specified per type of vessel/size.	Usage of anonymised AIS data for geographic data on traffic intensities, specified per type of vessel/size to allow breakdown to countries and non-urban, urban or metropolitan areas.	*n/a*

	Action 1: Collect data on fuel consumption and sailing speeds	Action 2: Collect and disseminate information on average loading factors and empty sailings	Action 3: Geographic location of air pollutants	Other actions
• **What can be done if legal framework is adapted?**	Further differentiation in the segment of larger vessels is on short term not feasible to implement in the legal basis for EUROSTAT data.	Further differentiation for larger vessels is needed. But on short term there is no option to adapt the legal basis for EUROSTAT data to guarantee collection of additional parameters. Voluntary actions could possibly be undertaken.		Check if European Hull Database could be expanded with engine data without legal steps.
2. Who can/should take action and the lead?	CDNI data: CCNR to take the lead in the framework of the Market Observation on European IWT.	EUROSTAT/DG MOVE: possibility to set-up a voluntary taskforce. This aspect was presented during the WG meeting on IWW transport statistics (06/11/2015).	TENtec possibilities: This aspect was presented during the WG meeting on IWW transport statistics (06/11/2015).	EC and PLATINA2 to check if there are legal implications for use of EHDB.
	PROMINENT will collect data on fuel consumption by means of on board measurements (2016-2018)			IVR (voluntary action) to improve their vessel database
	AIS speed and approach for collection of related waterway data (current, depth): - possibility through a new EU funded project? - waterway data: through involvement of waterway administrations; - RIS expert group to be consulted regarding availability and possibilities to use AIS data (ship positions/ average speed over ground/ sailed kilometres) - This aspect was presented during the WG meeting on IWW transport statistics (06/11/2015).			PROMINENT results for engine data and on board monitoring for 24 vessels, possibility extended with “Green Deal” initiative in The Netherlands: on board monitoring of fuel consumption and emissions of 100 vessels

	Action 1: Collect data on fuel consumption and sailing speeds	Action 2: Collect and disseminate information on average loading factors and empty sailings	Action 3: Geographic location of air pollutants	Other actions
3. When can it be planned (time horizon 2016-2020)?	2016-2018 This aspect was presented during the WG meeting on IWW transport statistics (06/11/2015).	2016 This aspect was presented during the WG meeting on IWW transport statistics (06/11/2015).	2016 This aspect was presented during the WG meeting on IWW transport statistics (06/11/2015).	2016-2018
4. Where can/should measures be implemented (geography)?	Average fuel consumption data for Europe based on CDNI countries and extrapolated to EU level.	Relevant IWT Member States, in particular the MS with high share in the European tkm performance of IWT	Relevant IWT Member States, in particular the MS with high share in the European tkm performance of IWT	Relevant IWT Member States

2.2 Working Group meeting on Inland Waterways Transport Statistics

Draft paper

Prior to the Working Group meeting on Inland Waterways Transport Statistics organised by EUROSTAT, PLATINA2 prepared and sent a draft paper and the proposed presentation to the European Commission for further distribution towards EUROSTAT and NSIs. The aim of this paper was to inform EUROSTAT and NSI's of the results of the review and the Expert Workshop, as well as to assess whether the proposed actions (see Table 1 of section 2.1) are feasible and/or whether other solutions exist.

The draft paper included:

1) a summary of the review report (see Annex I);
2) the results of the PLATINA2 Expert Meeting held in Brussels on 5 October (see section 2.1);
3) questions on fields where input from EUROSTAT and NSIs was requested in order to improve the knowledge base for external cost calculations on emission to air by IWT.

The following **questions** were **asked to NSIs and EUROSTAT**:

- What are the possibilities of setting up a taskforce focussing on closing the main knowledge gaps identified by means of a voluntary question as described in Table 1 of section 2.1 (fuel consumption data, speed data, load factor data, geographic distribution)?
- Are there datasets already available or initiatives already planned at the NSIs and/or EUROSTAT that can be used to close the identified knowledge gaps by means of a voluntary action?
- To what extent can datasets from other official sources/models/studies be used to improve the information basis for data provided by NSIs and EUROSTAT (for example for fuel consumption, CDNI data, or fuel sales data)?
- To what extend can River Information Services (RIS) be used to collect statistics?
  - To what extent is it possible to use anonymised AIS data and can the Member States and/or NSIs track, record, anonymise and aggregate the data? Could EUROSTAT play a role in European aggregation of AIS based statistics?
  - Is the European Hull Data Base (EHDB) used by NSIs and EUROSTAT and would there be added value in extending this database with an additional field to record the engine data?
- Are there any possible alternative sources which have not been flagged yet in this report or mentioned? For example the use of big data, tracking location of mobile phones, others?
- A general/horizontal question as regards the questions above: what would be the requirement according to the NSI's and EUROSTAT to ensure a common way for data collection?

Meeting Input for Working Group on Inland Waterways Transport Statistics

A member of the PLATINA2 team was invited to present the results of the review and the Expert Workshop, during the Working Group meeting on Inland Waterways Transport Statistics on 6th of November 2015 (*agenda item 10.4*).

The presentation focussed mainly on the proposed actions of:

- collecting data on fuel consumption and sailing speeds;
- collecting and disseminating information on average loading factors and empty sailings;
- obtaining information on the geographic location of air pollutants.

After the presentation, the PLATINA2 team member asked the participants to provide feedback on the questions stated above.

The following can be concluded from the received **feedback**:

- Due to the current legal framework on data collection, in the short term EUROSTAT and NSIs can only provide input through voluntary actions and measures.
- The *voluntary* actions that will be followed up by EUROSTAT and NSIs are:
  - study the possible usage of energy statistics for fuel consumption and CO_2;
  - study the possibility and try to bring together data to reduce the lack of information about the empty trips;
  - expand the number of vessel size classes, in order to include further differentiation for the larger vessel classes.
- The use of AIS data in an aggregated and anonymised manner will not be followed up by EUROSTAT nor the NSIs. The main reason is that collecting and processing the raw AIS data and aggregating this into the needed statistical information requires extensive data collection and involves significant resource efforts which are not available.

Bilateral contact with experts following the Working Group meeting

After the Working Group meeting, PLATINA2 had further bilateral contacts with different experts present at the Working Group meeting. PLATINA2 received additional information specifically on two items:

<u>CO_2 emissions and fuel consumption:</u>

- A study[12] commissioned by EUROSTAT was made available on the method for calculating disaggregated CO2 emissions and fuel consumption from IWT and estimating the emissions at the most disaggregated level possible. After further analysis, it was concluded by both the expert and PLATINA2 that for the purpose of this study, the findings of the report are of limited use.
- Regulation (EU) No 525/2013 was mentioned during the Working Group meeting as this is the basis for the compilation of the EU GHG emissions inventory. An expert of EUROSTAT highlighted that the **National Inventory Reports (NIR)**[13] could be of particular interest for the purpose of this study, as it contains country specific information on emission factors and specific

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[12] Source: EMISIA SA (2015), Method for calculating disaggregated emissions from IWW and estimation of emissions at the most disaggregated level possible.

[13] Available at: http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/7383.php

sectors of the economy. This was also one of the datasets already reviewed by PLATINA2 in the framework of preparation of D2.3. The NIRs could be used as a first estimate for data on fuel consumption per country. These reports present information on CO2 emissions. Since this emission type has a linear relationship with fuel consumption, a first order estimate on fuel consumption per country can be derived. However, the approach followed in the NIRs is coping with the same model limitations as already identified in the PLATINA2 review report (D2.3), such as unknown real fuel consumption data and sailing speeds. Nevertheless, the NIRs could be used to further allocate the overall sum of fuel bunkered according to cross-check the CDNI data fuel bunkering information and to get a first order estimate for non-CDNI countries. It therefore improves the reliability of the estimations on fuel consumption and CO2 emissions of IWT. It can be concluded that also the NIRs could benefit from actions to increase the reliability of external cost estimations for emissions produced by inland navigation.

<u>AIS data collection</u>

One of the recommendations for closing the knowledge gaps identified is the use of AIS data in an anonymous and aggregated manner. This source of information could be used for statistics purposes and could provide an answer to the following questions:

- How many kilometres are sailed in total by different types of barges?
  As information on loaded kilometres is usually known in statistics, the total sailed kilometre values (possibly derived from AIS) could be used to make an estimate of the empty sailed kilometres.
- What are the average speeds over ground for representative sections of the IWW network?
  In combination with information on currents and flow velocities per section of the waterway the speed data could be used to calibrate a model to derive the required propulsion power and related fuel consumption.
- What are the areas with high traffic intensities and to what extent is this related to metropolitan, urban, rural areas?
  The type of sailing area makes a significant difference in the shadow prices of particulate matter (PM). Areas with high population densities are linked to high external costs as there is more damage to health.

Two aspects are of importance here: 1) which actors to involve and 2) the legal implications.

1) As mentioned before, EUROSTAT and the NSIs indicated that they will not be active in collecting AIS data. Viadonau subsequently highlighted that an alternative and more appropriate solution to collect AIS data is to directly involve the responsible RIS national authorities about this issue.

   Regarding the usage and storage of Inland AIS data through national authorities, the PLATINA2 D4.4 report states that different authorities, especially the ones who are responsible for the inland waterways, are using and proceeding AIS data taking into consideration national data protection regulations. The usage and storage of Inland AIS data through authorities is based exclusively on actions related to the fulfilment of their duties. The authorities are using AIS data only for[14]:

- Provision of a better overview of the actual traffic,
- Improvement of the traffic management and traffic safety,
- Improvement of disaster management and support of accident prevention,
- Improvement of lock management,
- **Elaboration of statistics**.

The AIS data could, therefore, be used for the elaboration of statistics with the purpose of improving the reliability of the external costs calculations on emissions to air by inland navigation.

2) From a **technical point of view it is possible to** collect and process AIS data. There are currently several commercial providers that offer such services. However, from the **legal point of view** there are severe concerns from the sector about the protection of privacy.

PLATINA2 carried out an assessment of the security and legal implications of the RIS data exchange[15]. Two alternatives to the current situation ('zero option') have been identified and validated regarding their potential chances and risks (see Table 2).

The report indicates that the **establishment of a neutral 'Clearing Centre**' at a national/regional/European level is the most promising future option to cope with the current legal barriers on data access and usage. This 'Clearing Centre' would obtain the RIS data from RIS national authorities as well as commercial enterprises, relying on a Private-Public-Partnership (PPP) model (see Figure 1). The 'Clearing Centre' would take into account the access rights of the users and guarantee data protection, based on public supervision. However, the set up and the operation of such a clearing house could require extensive effort.

This concept could be achieved by building further upon the **CoRISMA project**, involving national RIS authorities. Such a follow-up action could possibly be supported with co-funding from the European Commission (e.g. through a new CEF project).

[14] Source: Zentralkommission für die Rheinschifffahrt: Erläuterungen zur Ausrüstungsverpflichtung mit Inland AIS Geräten und Inland ECDIS Geräten oder vergleichbaren Kartenanzeigegeräten, Fassung November 2014.

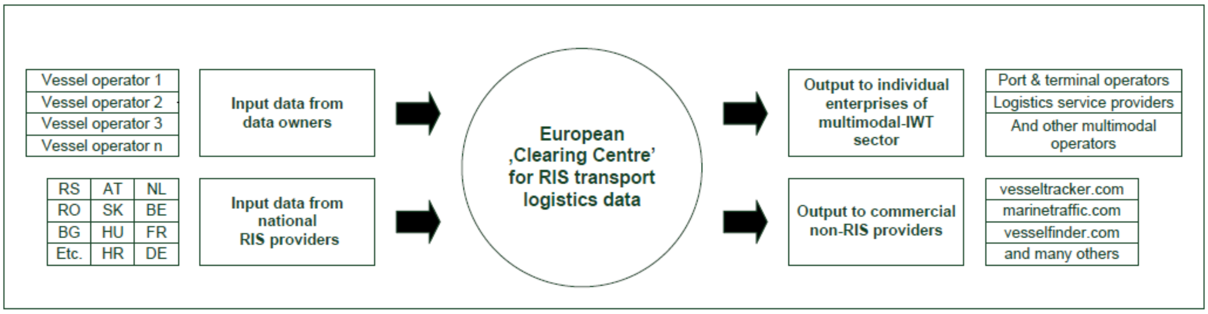
[15] For more information, see: PLATINA2 (2015), D4.4 Good practices on River Information Services for transport & logistics.

Table 2: Possible options on secure and legal RIS data exchange

Options	Description	Evaluations and risks
Option 0: **Zero option**	Remaining of the current status	**Pros:** No additional actions & expenditures **Cons**: Insufficient data protection (see: Usage of AIS-data without permission)
Option 1: **Prohibition of non-RIS providers**	Closing down of all not legal providers of RIS data through competent authorities	**Pro:** Increased legal security for data owners. **Cons:** No services available. Not assessable actions & expenditures for responsible authorities; practicability?
Option 2: **Development of a clearing centre**	Option 2a: National or regional (Danube, Rhine,...) clearing centres or Option 2b: European clearing centre	**Pros:** Assured data security for RIS TLS services **Cons:** Expenditures for the set-up and its operation

Source: PLATINA2 (2015), D4.4 Good practices on River Information Services for transport & logistics

Figure 1: European Clearing centre (Possible input & output data outline)



Source: PLATINA2 (2015), D4.4 Good practices on River Information Services for transport & logistics

2.3 Paper as input for CESNI meeting

One of the recommendations by PLATINA2 presented in the review report (PLATINA2 D2.3) is to improve the reliability of the engine databases used in IWT in order to be able to derive the average emission profile for representative vessels. Based on the research and stakeholder exchange two possible ways were identified to achieve this:

1. to **reinforce and improve** on a voluntary basis **the existing IVR database** and to add missing data and validate the available data on engines;
2. to **include type approval engine information in the European Hull Data Base (EHDB)** by means of expanding the legal basis.

The first option is considered to be a *voluntary measure*. The advantage of the expansion and validation of the IVR database is that this is already an available framework and a voluntary action might not need much effort. This voluntary option could therefore be achieved on the short term, without adaptations of the legal framework. However, since this is a voluntary action, it cannot be guaranteed that all private companies (skippers/fleet operators) will participate. The reliability of the database may therefore still remain questionable. A recent analyses in the PROMINENT project (August 2015) revealed the limited reliability of the latest version of the IVR database. The updates that were carried out in the new IVR Ships Information System have not yet solved this issue. Annex II lists examples of these knowledge gaps (under 'Specific improvements for the IVR Database').

The second option, on the other hand, would *need an amendment* of the "Appendix IV Data for the Identification of vessels" of the Technical Directive (2006/87/EC) in order to include the requirement to specify engine information in the European Hull Database. Such an amendment, should be set out by **CESNI** (see Annex II for more information). The advantage, however, is that it will be mandatory for certification authorities to collect engine information and therefore the results are expected to be more reliable than the currently available engine information provided by private parties on a voluntary basis. In addition, as the maintenance and control of the database would be done under the supervision of the European Commission and the national authorities. This is expected to result in less discussions as regards privacy concerns.

An amendment of this should be manageable with a proper specification towards CESNI of what datasets to collect, what format and a specification of the formats in order to be able to include this in the next CESNI work program.

After further consultation with experts, it was made clear that there is a limitation as regards the data entry in the European Hull DataBase. It is **possible however to add the data on the number and introduction date of the type approval in the EHDB**. Such data would only become available, once the legal basis is in force and once the Community Certificate is amended.

Another database shall provide background data linked to the try approval number such as the maximum RPM, the maximum engine power, the emission characteristics and the year of construction. This additional database could be developed with input from engine manufactures and inspection/certification authorities. It is important to take into account that an organisation should be responsible for the maintenance and control of the engine data received. The way forward and the pros and cons should be further discussed with the CESNI group and compared with the (voluntary) option to further develop the IVR database.

The draft work program of CESNI for 2016-2018 already contains two topics "Revision of the Community / Rhine certificate and amendment of the Administrative Instruction governing their issuance" and "Adaptation of ES-TRIN in relation to the content and the functions of the European hull database".

The final work program of CESNI is expected to be settled in February 2016. On the one hand, the revision of the model may allow to create new boxes, and then to collect and register relevant data regarding engines (the type approval number) with a harmonized process performed by CCNR and EU national authorities. The remaining question concerns the legal consideration to access and use data regarding certificates stored in the EHDB. In general, the data in the EHDB are only available for authorities, not for RIS providers. The Service Agreement for the European Hull Data Exchange allows for the extraction of statistical data, which may also be used by third parties or even be made public in an aggregated and anonymous manner.

In order to initiate and support these processes, **PLATINA2 prepared a draft paper as input for discussions within CESNI**. This paper could serve as input for further discussions on the importance of more reliable data on the emissions of the engines and of the emission control measures used in the vessel. A meeting is planned for 9 February 2016. **Annex II** presents the paper developed for the CESNI meeting.

3. ROADMAP TO IMPROVE THE KNOWLEGDE BASIS FOR EXTERNAL COST CALCULATIONS FOR IWT

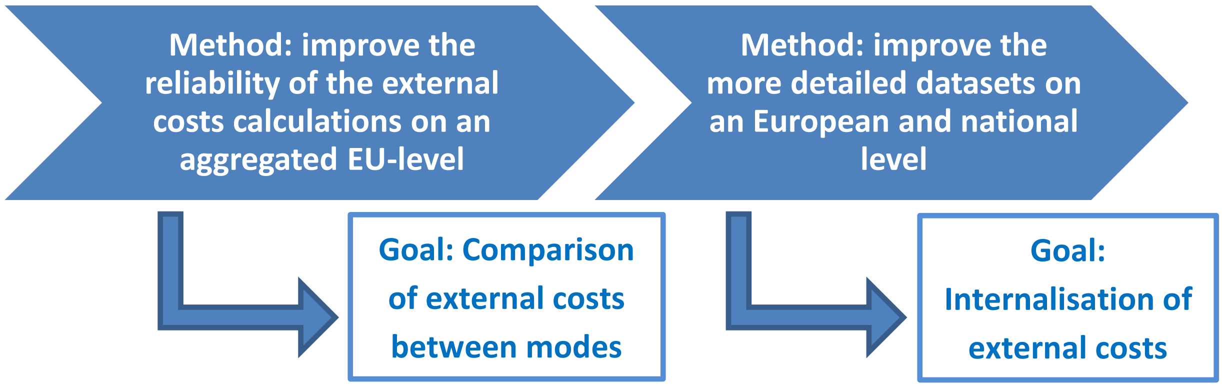
Improving the knowledge base will increase the reliability of the estimations of emissions and external costs by IWT, which in turn, will provide a more solid basis for policy initiatives aimed at the internalisation of external costs. This chapter presents a roadmap on how to achieve this main goal in the coming years by prioritising the strategic focus on a set of action areas.

3.1 Goals

The ultimate goal for improving the quality of the datasets for external costs calculations is to make it possible to internalise the external costs of transport. Reaching this main goal will require a two-step approach:

Short term goal: **improve the reliability of the external costs calculations on an aggregated EU-level** using regional and/or national datasets to enable **comparison** of IWT external cost **with other transport modes**. A top-down approach would be needed first.

Longer term goal: **improve the more detailed datasets** to allow the **internalisation of external costs** on a more detailed level.



3.2 Action areas

Based on the results of the review carried out by PLATINA2 and the discussion with the stakeholders involved in activities related to data collection, the following actions were identified and recommended:

Highest priority:

- **Action 1: Collect and disseminate information on fuel consumption and sailing speeds of vessels on waterway sections**
- **Action 2: Collect and disseminate information on average loading factors and empty sailings of vessels**
- **Action 3: Take into account the geographic location of air pollutants to determine the impact of NOx and PM emissions to air by IWT, through the use of a combination of sources**

- **Action 4: Collect better information about the engines installed in inland waterway vessels**
- **Action 5: Make further differentiation in larger vessel size classes**
- **Action 6: Collect data on real world emissions and derived emission factors (in g/kWh) through on-board measurements under actual sailing conditions**

The **first three actions are considered to have the highest priority.** The reason is that currently there are no datasets available on a European level for the mentioned parameters while at the same time the bandwidth of the possible results (if different sources and assumptions are used) show significant variations because of uncertainties in these parameters.

The next sections present per action:

- a description of the current knowledge gap (why);
- a description of the action proposed, including the required frequency of updates (what);
- the actors involved (who);
- the expected timing (when);
- the geographical scope (where).

Action 1: Collect and disseminate information on fuel consumption and sailing speeds of vessels on waterway sections

Current knowledge gap:

Fuel consumption: fuel consumption of vessels is mainly being estimated using models based on speed, vessel and waterway characteristics as input parameters. The fuel consumption in combination with emission factors determines the emission levels and external costs. However, the input data for these models to estimate fuel consumption is rather weak. As a result the reliability of model estimations of fuel consumption is questionable and the fuel consumption estimates need to be validated. Detailed data on the actual fuel consumption of vessels is however not available.

Speed: the speed values used in most studies are based on expert assumptions, as only very limited real measurement data is available. Speed is a dynamic factor and a key parameter to derive the fuel consumption estimates. Moreover a small change in speed can have a strong impact on the power requirement and fuel consumption. Therefore, accurate data is needed on speed if models are to be used in combination with waterway data, whereby the waterway data to be used have to be available and sufficiently accurate too.

Actions needed and frequency of updates required:

Short term: estimate fuel consumption on an aggregated EU level, through the following methods (or combination of methods):

- **CDNI fuel bunkering information** can be used as a first order estimate on fuel consumption on macro level by combining the data with transport performance statistics. Research and publication is already planned by CCNR in the framework of the Market Observation IWT EU.
- The **National Inventory Reports (NIR)** could be used as a first estimate for data on fuel consumption per country **in combination with the CDNI information**. The NIRs could be used to further allocate the overall sum of fuel bunkered according to the CDNI information and to get a first order estimate for non-CDNI countries.
- Usage of **energy statistics for fuel consumption and CO_2** through data collection in a **voluntary way.**
- Usage of **data from real measurements of fuel consumption obtained from studies** carried out.

Longer term:

- **Fuel consumption**: collect detailed reliable information on fuel consumption through real measurements for a representative sample of typical vessels sailing under different sailing conditions and on different types of waterways.
- **Speed**: develop a reliable model with accurate speeds and waterway information based on real operating speed data. Information on average sailing speeds, specified per waterway section and vessel type/size could be obtained from anonymised AIS data. In combination with information on currents and flow velocities this could be used to calibrate a model to derive the required propulsion power and fuel consumption. Defining and applying a common approach for collection of waterway data (currents, waterway depth) will be needed.

Recommended frequency of updates:

Short term: yearly average fuel consumption on an aggregated EU level

Longer term:

- yearly average fuel consumption per vessel category and type of waterway
- base year speed averages, taking into account different sailing conditions (upstream and downstream) and water levels (low and high water levels). For the long term, time series can be developed.

Actors to involve:

- **CCNR** for fuel consumption information in the framework of the Market Observation IWT EU.
- **UNFCCC** (United Nations Framework Convention on Climate Change) for the National Inventory Reports (NIR).
- **EUROSTAT and NSIs** for the possible usage of energy statistics for fuel consumption and CO_2 in a voluntary way.
- The **PROMINENT project** is expected to contribute to the improvement of data on fuel consumption and emissions for 24 vessels through real world measurements.
- The **"Green Deal" initiative** in The Netherlands plans to carry out on board monitoring of fuel consumption and emissions of 100 vessels from the year 2016 onwards.
- **RIS authorities** for the collection of AIS data in an aggregated and anonymised way: the possibility of establishing a **neutral 'Clearing Centre**' at a national/regional/European level could be further examined. This concept could be achieved by building further upon the **CoRISMA project**, involving national RIS authorities and possibly co funded by the European Commission (e.g. through a CEF project).
- **Waterway administrations** should be involved to obtain waterway data.

Expected timing:

Short term: >2016

- Research and publication of fuel consumption information on a macro level is already planned by CCNR in the framework of the Market Observation IWT EU.
- The National Inventory Reports are already available.
- PROMINENT will collect data on fuel consumption by means of on board measurements in 2016 and 2017.
- Green Deal" initiative plans to start measurements in 2016

Geographical scope:

Short term: average fuel consumption data based on CDNI countries and extrapolated to a EU level.

Longer term: average fuel consumption and speed data per waterway EU-wide.

Action 2: Collect and disseminate information on average loading factors and empty sailings of vessels

Current knowledge gap:

- **Load factor of laden trips**: except for some models, load factors of laden trips are only made available in the official national statistics of Germany and Austria. *On a European level*, there is no complete and reliable statistical dataset available to derive reliable estimates for Europe. Specific statistics on load factors may be obtained for some countries through, for example, by means of using specific data from vessel operators that pass locks or bridges that have to report on their vessel, journey and cargo details. These detailed datasets are currently being used for 'ad hoc' research purposes (e.g. cost benefit studies for specific sections). However, they are not used by NSI as there is no legal basis for them to do so.
- **Empty trips**: except for some models and an incomplete Eurostat table filled in by countries on a voluntary level, there is no complete and reliable database available with information on empty trips. There seems to be a bias in the data as some empty trips are not accounted for. Therefore, using such data may lead to an underestimation of the total emissions from inland shipping.

Actions needed and frequency of updates required:

Load factor of laden trips: collect and provide load factors of laden trips per country. In the meanwhile, as a first estimate the load factors could be estimated using available statistics from specific NSI's from representative IWT Member States. For example, there is already data available for Germany and Austria, which might allow for an extrapolation to the Rhine, Danube as well as the EU. However, a closer investigation is needed into which extent this may be done in order avoid erroneous assumptions. For example, the available load factors from Austria might be representative for the Upper Danube region, but possibly not for the Lower Danube sections.

Empty trips: explore options to use AIS to estimate the empty sailed kilometres. AIS can provide useful data on the total kilometres sailed by different types of barges. As information on laden kilometres is usually known, the total sailed kilometre values (possibly derived from AIS) could be used to make an estimate of the empty sailed kilometres.

Recommended frequency of updates: yearly average load factors and share of empty trips per vessel size category

Actors to involve:

- **EUROSTAT and NSIs** through voluntary actions, as the legal framework regarding data collection on EU level cannot be changed on short term. EUROSTAT and NSI indicated that they will be following up addressing the issue of lack of information about the empty trips. EUROSTAT and NSI will not be involved in AIS data collection.
- **RIS authorities** for AIS data collection.

Expected timing: Short term: >2016

Geographical scope: European level

Action 3: Take into account the geographic location of air pollutants to determine the impact of NOx and PM emissions to air by IWT, through the use of a combination of sources

Current knowledge gap: most external costs studies assume that no IWT activities occur in metropolitan or urban areas as a result of lack of accurate data on a European level. In practice, there is also traffic of vessels in urbanised and metropolitan areas (e.g. Rotterdam, Antwerp, Köln, Vienna). As a result the calculations are biased and external costs of IWT are probably underestimated.

Actions needed and frequency of updates required:

For the monetisation of external costs it is important to have detailed data on the geographic location of air pollutant emissions (especially PM). There is namely a difference in the PM shadow prices in metropolitan, urban and non-urban areas. Accurate data are needed on the share of transport and the related emissions carried out in the different sailing areas. It is recommended to make use of **Geographic Information Systems** that contain **information layers** on the **population densities**, the **IWW infrastructure** and the **transport, traffic and emission levels on these waterways**.

Subsequently an accurate weighted average can be calculated taking into account the specific air pollutant shadow prices depending on the population densities. Information layers on IWW infrastructure and population densities are already available. Detailed data on traffic, transport performance and emissions are not yet captured.

TENtec would be an appropriate European tool to accommodate the data and provide the functionality. The planned action[16] to collect data on inland waterway infrastructure for TENtec provides a clear opportunity to provide the required building blocks.

Moreover, data on the traffic intensities can be derived from AIS. Data on the transport volumes and performance can be provided by Origin-Destination flow data such as ETISplus. Both sources (ETISplus and AIS) could be used to create a reliable set of information on the transport and traffic of typical vessel type classes (fleet families).

Recommended frequency of updates: a database distinguishing sailing areas in Europe for a base year is sufficient and would need to be updated each 3 to 5 years.

Actors to involve:

- European Commission DG MOVE / TENtec
- RIS Authorities for AIS data collections

Expected timing:

- The TENtec data collection effort for IWT is planned for 2016 and could be seen as the major initiative to build upon. (Lot 2 call for tender MOVE/B1/2014-527)

Geographical scope: European level

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[16] Call for tenders, MOVE/B1/2014-527, Data collection on the Trans-European Transport Network (TEN-T) using the TENtec system, Lot 2: Inland waterways infrastructure.

Action 4: Collect better information about the engines installed in inland waterway vessels

Current knowledge gap: the current engine databases are fairly outdated, resulting in the use of model assumptions to estimate the development of the engine fleet in time.

Actions needed and frequency of updates required:

Two possible ways to **improve the reliability of the engine databases** are:

- To extend the use of the **European Hull DataBase** for type approval engine information. This involves amending the existing legal basis and would require additional administrative efforts from the national certification authorities. It is possible to add the number and introduction date of the type approval in the EHDB. With an additional database on European level background data could be captured linking this engine type approval number to other characteristics such as the engine maximum power and rpm, the specific fuel consumption and emission characteristics and the year of introduction
- To improve the current **IVR database** with more accurate and validated data on the installed engines provided by ship owners. The reliability of the database will depend on the actual participation level of the ship owners, which appeared to remain a limiting factor also after efforts made by IVR over the last year to improve the dataset. *Recommended frequency of updates:* yearly update to monitor the fleet engine development

Actors to involve:

- **CESNI** to discuss: 1) a possible start of the process of amending the legal basis of the European Hull DataBase and 2) a possible organisation that could take responsibility for maintenance and control of the additional database to provide background data linked to the type approval number of engines applied in inland vessels.
- **IVR** to explore further possibilities of improving the database.
- **Engine manufactures and inspection/certification authorities** to provide input for the additional database with background data that would need to be developed if the decision is taken to use EHDB as main reference for engine data in IWT.

Expected timing: Short term: >2016

- The draft work program of CESNI for 2016-2018 already contains the topic of “Adaptation of ES-TRIN in relation to the content and the functions of the European hull database”. A draft paper has been prepared by PLATINA2 as input for CESNI and could possibly be discussed at the meeting on 9 February 2016.

Geographical scope: European level

Action 5: Make further differentiation in larger vessel size classes

Current knowledge gap:

The current classification system used in EUROSTAT is based on an outdated fleet composition of CEMT classes. For vessels larger than 1500 tonnes only two categories are available and the dimensions of coupled units are not included. This while the vast majority of emissions is caused by large vessels. The lack of differentiation causes unreliability in the estimations.

Actions needed and frequency of updates required:

Further specification of the CEMT classes is recommended, taking into account the current largest motor cargo vessels and coupled units.

- **Short term:** expand the number of vessel size classes in a voluntary manner to include further differentiation for the larger vessel classes.
- **Longer term:** adapt the vessel classification system. This can only be done if the legal basis for EUROSTAT and NSIs is adapted.

Recommended frequency of updates: updating the classification system is only needed if new vessel types are introduced on a large scale and if the emissions produced differ significantly from the other vessel types. It is expected that updates are not needed for a period of 10 years.

Actors to involve:

- EUROSTAT and the NSIs indicated that they will be following the issue of expanding the number of vessel size classes, in order to further differentiate them. This will be a voluntary action in the short term.
- For a more permanent solution, the legal framework will need to be adapted. It is important to acknowledge that adapting the classification system of the vessels is a task that involves more stakeholders than just EUROSTAT and NSI's. International organisations, such as UNECE and the Member States are also needed. Platform PIANC has started an initiative on this issue.

Expected timing:

- **Short term:** through the voluntary action of expanding the number of vessel size classes in 2016/2017
- **Longer term:** unknown as adapting the vessel classification system requires an amendment in the current legal framework and involves different stakeholders.

Geographical scope: European level

Action 6: Collect data on real world emissions and derived emission factors (in g/kWh) through on-board measurements under actual sailing conditions.

Current knowledge gap:

Road transport engines are tested closer to the real activity cycles than IWT engines. The NOx and PM emission factors for IWT are derived from the stationary test cycle ISO 8178. Particularly for PM emissions, the emission factors used in many studies have been mainly based on expert estimates and/or very limited measurements (for older engines) or by using the CCNR II emission standards as default values (for newer engines). For LNG vessels there are also no reliable emission factors known.

Actions needed and frequency of updates required:

Real testing under *actual sailing conditions* is needed in order to develop a reliable database with IWT dedicated emission factors on a European level.

Recommended frequency of updates: base year average per building year category and update at least every 5 years and/or in case of new European emission standards

Actors to involve:

- The **PROMINENT project** is expected to contribute to the improvement of data on fuel consumption and emissions produced by executing real world measurements for 24 vessels.
- The **“Green Deal” initiative** in The Netherlands will carry out on board monitoring of fuel consumption and emissions of 100 vessels.

Expected timing: Short term: >2016

- PROMINENT will collect data on fuel consumption by means of on board measurements in 2016 and 2017 for the Rhine and Danube.
- “Green Deal” initiative is planned to be starting measurements in 2016 in The Netherlands.

Geographical scope: relevant IWT Member States

ANNEX I: SUMMARY OF THE REVIEW OF EUROPEAN DATA SETS FOR IWT EXTERNAL COSTS CALCULATIONS (DELIVERABLE 2.3)

Background and objectives of the study

Although Inland Waterway Transport (IWT) has an advantage compared to other modes as regards the overall external cost profile (including safety, congestion, noise), the air pollutant emissions resulting from burning fuel (NO_x and $PM_{2.5}$) are relatively high compared to road and rail transport. Together with the climate change emissions (mainly CO_2) these emissions to air cause the vast majority of external costs of IWT that have been reported in various European studies.

The external cost estimation for the emissions to air of inland waterway transport (IWT) expressed in euro per ton kilometre depends significantly on the assumptions and datasets used in the calculations. A comparison carried out between different European IWT external cost studies indicated that, although the studies followed a common methodology, the estimated external costs differed by a factor of four[17]. The observed differences are the consequence of the datasets chosen for the calculation of external costs and the assumptions regarding the value of parameters. Many assumptions are made for the estimation of external costs, due to lack of statistics and/or to simplify the calculations.

It shall be remarked as well that the assessment of emissions and the external costs for IWT is not as straightforward as for other land transport modes. In IWT there are much more different conditions and situations. For example there is a wide range of different vessels in terms of size, type and engines and also a wide range of different waterways in terms of dimensions and water conditions (dynamic waterway depth and flow velocities). As a result, the estimations of external costs for IWT need much more effort and differentiation compared to other modes if the same reliability level needs to be reached (e.g. the value for external costs of emissions to air in euro per tkm).

Given the relatively large differences in outcomes of IWT external costs calculations and its implication in policy development, it is important to assess the availability and quality of the datasets used in order to improve the reliability of the external cost calculations on a European level.

The **main objective** of this study is therefore to **review the quality of the datasets used** for the calculation of emissions and external costs for IWT at an EU level **and identify the knowledge gaps** for emissions to air specifically. Subsequently the study **provides views on the gaps could be closed.** The study provides answers to the following questions:

- Which main parameters are needed for the estimation of external costs for IWT?
- What are the key factors influencing these parameters?
- What is the level of differentiation for the parameters identified and what is their impact on the outcome?
- What type of specific information is needed per parameter in terms of data collection?

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[17] Source: CE Delft, Assessment of external costs of inland waterway transport in the Marco Polo Calculator, Delft, February 2012.

- To what extend is the required information currently available on a European level?
- How can the reliability of the currently available datasets be improved on a European level?
- How can the gaps be closed for parameters that are currently not being measured and/or monitored on a European level?
- What is the recommended recurrence as regards the measurements and monitoring of the datasets?

Methodology

Scope

Tank To Wheel (TTW) **emissions to air** for **freight cargo** have been investigated. Or more appropriate for vessels: **Tank To Propeller**. The emissions resulting from the "Well to Tank" processes (such as emission due to transport of fuel from refineries to bunker locations) have not been taken into account. Also other externalities such as accidents, noise, space occupation and congestion are discarded. The reason is that these elements are usually assessed as relatively low and/or negligible in overall external cost calculations for IWT on a **European level**. The strict focus on TTW emissions to air on European level allowed a more in-depth analysis.

General theoretical outline

For the identification of the main parameters a general theoretical outline has been developed based on the outlined methodology and the parameters used in the 'Handbook on External Costs of Transport'[18]. As a first step the parameters are identified that are needed for the calculation and the data requirements taken into account the variety of circumstances and situations that occur in inland navigation, resulting in a certain bandwidth of possible values. Subsequently the available datasets were identified and compared with the requirements resulting in the identification of parameters for which the data reliability is missing on EU level and/or needs to be improved. Finally conclusions are drawn and recommendations are presented on how to close the gaps.

The IWT external costs in this methodology are expressed in euros per tkm, as it provides information on the emissions produced in relation to the distance travelled and weight transported. This makes it possible to compare externalities between transport modes while this type of indicators are used as well for Cost Benefit Assessments, e.g. in Impact Assessment studies.

In order to structure the various calculation steps, different information fields and their parameters have been distinguished:

Logistics parameters:

- Loading capacity of vessels
- Loading factor of laden trips
- Loaded kilometre factor

[18] Sources: (1) CE Delft, et al. (2008). Handbook on estimation of external costs in the transport sector. Produced within the study Internalisation Measures and Policies for All external Cost of Transport (IMPACT); (2) Ricardo-AEA, et al. (2014). Update of the Handbook on External Costs of Transport.

Energy consumption:

- Waterway parameters: depth, width and current
- Vessel related parameters: vessel size, draught, installed power and specific fuel consumption

The interactions between the waterway and vessel related parameters provide input on:

- Operational speed and the respective power needed

Vessel related parameters also depend on the logistics data (e.g. loading factors influence draught).

Emission parameters:

- Emission factors: these are the units of mass of pollutant produced per energy consumed, generally expressed in g/kWh (power output of the engine) or g/MJ (fuel consumption).

Parameters for the monetisation of emissions:

Each emission type has a different impact on the human health, crops, buildings and the biosphere. In order to use a common monetary unit, information is needed on the following parameters:

- Cost factors per unit of a pollutant, also known as 'shadow prices' and the underlying factors:
  - Monetary values (i.e. income elasticity of willingness-to-pay and macro-economic parameters)
  - Sailing environment (influenced by the population densities along the waterways).

Aggregation

To convert the external costs from €/vkm into €/tkm, information is needed on the average load of vessels (including the impact of empty trips). To calculate weighted average external costs per tkm on an aggregate level (e.g. per corridor or EU average), input is needed on:

- Ton-kilometres (tkm) per region or country
- Vessel kilometres (vkm) per region or country

Both parameters also allow the user to calculate the total externalities (in tonnes) as well as the total external costs (in monetary value) on a regular basis.

Results

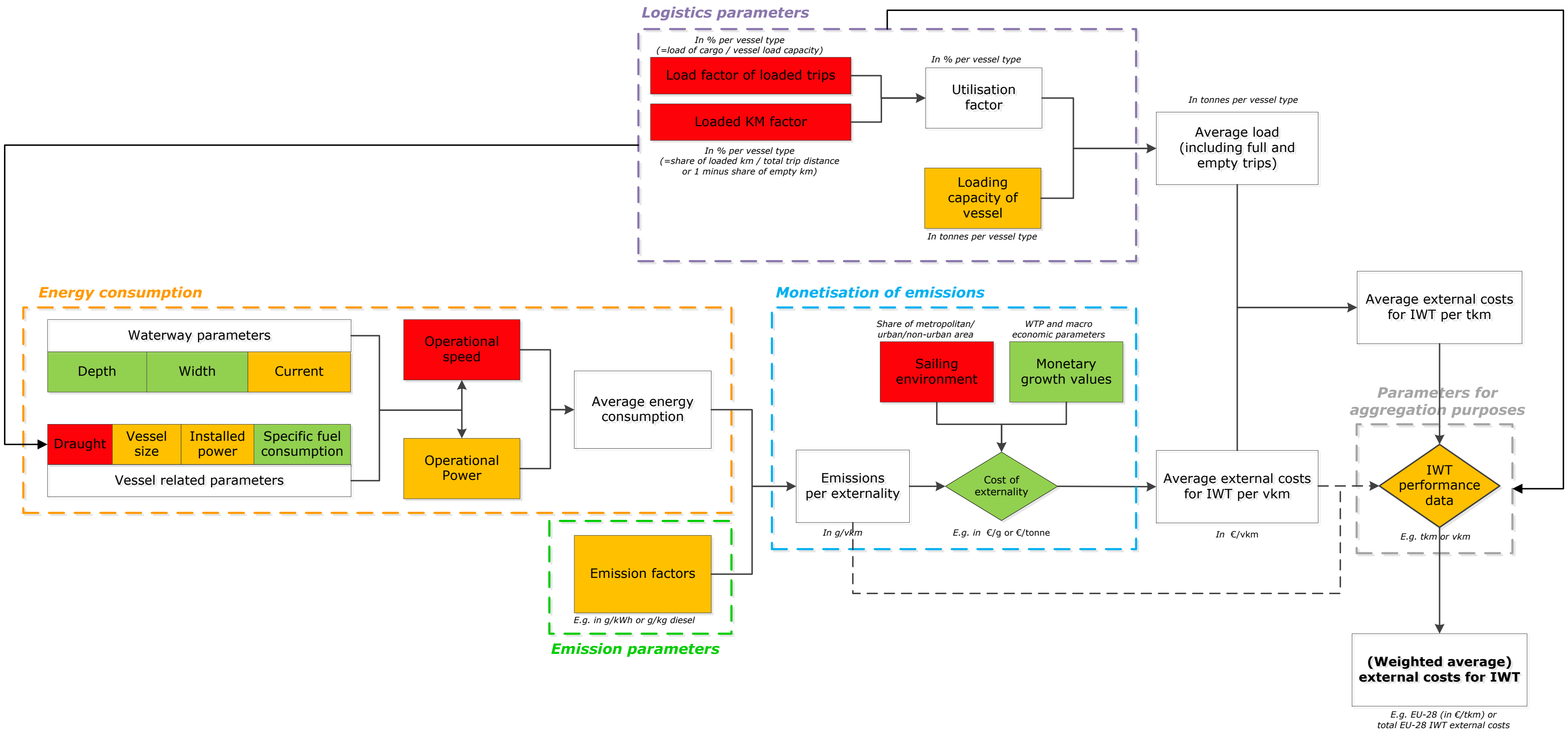
Table 1 present an overview of the availability of the datasets required and the frequency for updates advised. It identifies several **knowledge gaps**, which are also illustrated in the methodological framework developed for the assessment and presented in **Figure 1**. This schematic overview shows the elements that require attention to improve the quality of the dataset (*see red and orange colours*).

Table 1 Required and available datasets on a European and Member State level

<table>
<tr><th colspan="3" rowspan="2">Required data per type of parameter</th><th rowspan="2">Recommended frequency of update</th><th colspan="4">Available at:</th><th rowspan="2">Comments</th></tr>
<tr><th>EUROSTAT</th><th>NSI's</th><th>Waterway managers</th><th>Other sources</th></tr>
<tr><td colspan="2" rowspan="3">Logistics parameters</td><td>Loading capacity of vessels (fleet data)</td><td rowspan="3">Yearly average per vessel size category</td><td>X</td><td>X</td><td></td><td>IVR; EHDB</td><td>EUROSTAT: only two categories for large vessels: 1500-3000 t. and above 3000 t.</td></tr>
<tr><td>Load factor (laden trip)</td><td></td><td>DE;AT</td><td></td><td>Models*</td><td>* Models: TREMOD, BIVAS, Vaart!Vrachtenindicator</td></tr>
<tr><td>Loaded / empty km</td><td>X</td><td></td><td></td><td>Models*</td><td>EUROSTAT: incomplete dataset; provided for some years by some NSI voluntarily</td></tr>
<tr><td rowspan="11">Energy consumption</td><td rowspan="10">Raw data behind energy consumption</td><td>Water depth</td><td>Canals/regulated rivers: base year average is sufficient
Free flowing rivers: quarterly to yearly average using daily data</td><td></td><td></td><td>X</td><td></td><td></td></tr>
<tr><td>Water width</td><td>Base year average is sufficient</td><td></td><td></td><td>X</td><td></td><td></td></tr>
<tr><td>Current</td><td>Canals/regulated rivers: base year average is sufficient
Free flowing rivers: quarterly to yearly average using daily data</td><td></td><td></td><td>X</td><td></td><td></td></tr>
<tr><td>Vessel size (fleet data)</td><td rowspan="3">Yearly update to monitor fleet development</td><td>X</td><td>X</td><td></td><td>IVR; EHDB</td><td></td></tr>
<tr><td>Draught</td><td></td><td></td><td></td><td>See also 'load factor'</td><td></td></tr>
<tr><td>Installed power</td><td>X</td><td></td><td></td><td>IVR; research studies</td><td>Incomplete and unreliable databases</td></tr>
<tr><td>Specific fuel consumption (sfc)</td><td>Base year average per building year and power range category is sufficient</td><td></td><td></td><td></td><td>Research studies</td><td>Spread in the observed sfc values is relatively limited</td></tr>
<tr><td>Operational speed</td><td>Base year average taking into account the specific sailing conditions (e.g. low water/high water) is sufficient</td><td></td><td></td><td></td><td>Research studies</td><td>Speed data in research studies is now mainly based on rough assumptions</td></tr>
<tr><td>Required propulsion power</td><td>After developing a model and database with operational speeds and the respective required power for waterways, updates are only needed for new vessel types if introduced on a large scale</td><td></td><td></td><td></td><td>Research studies</td><td>Rough estimations using
available power-speed profiles</td></tr>
<tr><td colspan="2">Direct energy consumption</td><td>Yearly average per vessel category</td><td></td><td></td><td></td><td>CDNI; research studies</td><td>CDNI data: only on macro level
Data from research studies: mainly model estimations</td></tr>
</table>

Required data per type of parameter		Frequency of update advised	Available at:				Comments
			EUROSTAT	NSI's	Waterway managers	Other sources	
Emission parameters	Air pollutant emission factors	Base year average per building year category and update at least every 5 years and/or in case of new European emission standards (e.g. impact of after treatment systems)		X		EMEP/EEA; TREMOVE	Only based on laboratory tests, no real world emissions are taken into account
	Climate change emission factors			X		IPCC; NIS; TREMOVE	CO_2 emission is lineairy related to fuel consumption. If fuel consumption is known, CO_2 emission can also be known
	Engine type data for the inland fleet	Yearly update to monitor the fleet engine development				IVR; models**	** Emissie Registratie en Monitoring Scheepvaart (EMS) and TREMOD
Monetisation of emissions	Cost factors ('shadow prices')	Base year average per pollutant				Research studies	Different studies are available
	Income elasticity of willingness to pay	Base year average is sufficient				Research studies	Examples of scientific literature: IMPACT [2008] and NEEDS [2004-2009]
	Macro-economic parameters (real GDP per capita, PPP, CPI, discount rates)	Yearly averages to update shadow prices to a specific price levels	X	X			Sources: Eurostat; Prognos; European Central Bank; IMF; World Bank and NSI's
	Typology of area based on population density	Base year average is sufficient required and shall be updated each 5 or 10 years depending on population development	X	X			
	IWT sailing area	A database with differentiated sailing areas in Europe for a base year is sufficient			X	Research studies	Share metropolitan/urban/rural areas in research studies: based on assumption that IWT activities is ≥95% in rural areas
Aggregation	Tonne-kilometres	Yearly average per vessel size category	X	X			No distinction is made between different vessel size classes
	Vessel-kilometres		X				Eurostat table (B2): incomplete dataset; provided on a *voluntary way:* • Belgium (2007 to 2010; 2013) • Czech Republic • Luxembourg (up to 2010) • Hungary • The Netherlands (up to 2011): partial • Romania (starting from 2011): partial

Figure 1 Main gaps identified based on the general theoretical outline used for the review of datasets



Green: reliable dataset available on a European level
Orange: improvements needed on the current dataset to enhance the reliability
Red: no dataset available on a European level

The following more detailed conclusions were drawn with respect to the important issues that require attention for the distinguished categories:

Logistic parameters

- **The load factor of a laden trip will vary in reality depending on the available water depth. In particular at free-flowing sections, detailed information needs to be available to derive the external costs. Information on load factors is however rather weak.** In some countries there are datasets available and these could be used as a first basis to estimate European values (e.g. data from Germany and Austria) by means of extrapolation. Implementing this would not be too burdensome, as most National Statistics Institutes (NSIs) rely on shipping documents or port information.
- Another aspect that determines the average load per vessel kilometre is the share of empty sailings in the overall travelled distance of the vessel. This share will depend on the economic market circumstances and the supply of cargo for vessels (in particular affecting the return trips). It is however concluded that there is a **huge gap regarding information on the empty sailings by vessels**. The Eurostat data on vessel kilometres is voluntary and only filled by a small amount of countries. As a consequence, there are no data checks on this table and therefore, data quality cannot be assured. Most NSIs state that gathering information on empty trips is not possible because of lack of data as only the laden trips are officially recorded.
- **Further differentiation with regard to ship sizes** for the logistic parameters presented by Eurostat and the national statistical offices is recommended, especially for large vessels. For vessels larger than 1500 tonnes only two categories are available in the statistical overviews. However, this is the class that has by far the highest fuel consumption, emissions and external costs. Therefore, further specification of the CEMT classes is recommended, taking into account the current largest motor cargo vessels and coupled barges. For this process it is important to note that adapting the classification system of the vessels is a task that involves several stakeholders (not only Eurostat), such as Member States and international organisations such as UNECE.

Energy consumption:

- Data on **real fuel consumption** for typical IWT vessels sailing on specific waterways is completely missing. The same is true for data **about sailing speed.** The sailing speed is however a key parameter for a model based approach to estimate the required operational propulsion power and the related fuel consumption for representative vessels. Based on the fuel consumption data the resulting emissions to air can be estimated. And if it is known where the vessel operates, the external costs can be estimated reliably as well. Real operating speeds are widely unknown, in particular at free flowing sections of rivers. It shall be noted that the river Rhine has a large share in the volume transported in the EU and is largely free flowing. Previous studies have used too simplified assumptions based mainly on expert assessments. A reliable database with average speeds per waterway section and differentiated by vessel type is required for the more detailed analysis enabling more reliable results on the emissions and external costs.
- **Specific values may differ from waterway to waterway.** If the aim is to estimate external costs per waterway section and/or corridor, all the parameters and their specifications per waterway section and/or corridor will need to be checked. The focus for data collection improvements shall take into account the Rhine corridor due to the high share of transport performance in Europe and the identified gaps linked to the free flowing sections. Given the rather stable waterway depths

and currents on canals and regulated waterways, measurements for a specific base year would be sufficient. For free flowing sections, on the other hand, much more frequent updates for the waterway levels and currents are needed.

- **Information on the installed power and the type/age of engine of the active fleet is not very reliable** while this is needed to estimate fuel consumption (its specific fuel consumption in gram fuel per kWh) and the related emission profile of the engine (NO_x and $PM_{2.5}$ emission per kWh).

Emission parameters

- **More detailed information is needed on the real NOx and $PM_{2.5}$ emission factors for engines.** The IWT emission factors for NOx and $PM_{2.5}$ are currently based on stationary test cycles and not on real sailing situations. As different test cycles show different results, the real emission factors for these air pollutants most likely differ from the current values. Special attention is needed for the estimation of PM emission factors. The PM emission factors used in many studies have been mainly based on expert estimates and/or limited measurements (especially for older engines), resulting in significant differences of the PM emission factors presented in different studies.
- **Emission factors for LNG engines are hardly known yet.** As conversion to LNG is seen as a major development, direct measurements over a period of time is advised to determine the emission factors of LNG engines. So far, PM and CH4 (methane slip) emission factors have only been estimated based on literature and expert views.
- **Information on auxiliary engines is missing:** modern IWT vessels often have several powerful auxiliary engines on board. Nevertheless, no information or data is available on the actual use of this equipment and therefore rough assumptions are generally made on the load and time of operation of these engines.

Monetisation

- The shadow prices to apply to calculate the external costs per tonne pollutant in euro are assumed as being the same for all transport modes. **The identified gaps therefore do not only affect the estimations of the IWT external costs, but of other modes as well**. However, when comparing the total external costs at an aggregated level, the absolute value may show large differences depending on the relative share of emissions to air (e.g. share of NOx, PM, CO_2) which is quite different in modern Trucks (Euro VI) compared to inland waterway vessels.
- **There are also large differences between countries as regards the shadow prices**. Therefore, in order to calculate a reliable weighted average for the EU, detailed information is required that presents the breakdown of the inland waterway transport performance for various geographic regions in Europe.
- **Detailed information on the geographic breakdown of the transport performance (and related fuel consumption and emissions) is in particular required to determine the weighted average based on the share of metropolitan, urban and non-urban areas**. The shadow prices for PM emission show a very large bandwidth between metropolitan and non-urban areas which makes it even more important to apply reliable data on the geographic breakdown between these areas in order to end up with a reliable weighted average for all areas together.

Aggregation

- In order to prepare aggregated figures for Europe on the external costs and to determine the weighted average value on the external costs for emissions to air per tonne-kilometre, transport information is required on the breakdown of the transport performance. It can be concluded that information on the tonne-kilometres is known through detailed Eurostat statistics on a European level and on Member State level. This information can be specified to regional transport flows and certain vessel types (self-propelled vessels vs. push barges, liquid cargo vs. dry bulk). However, **no distinction is made between different vessel size classes**.
- The **largest gap within this information field is the availability of data on the average number of kilometres sailed with an empty vessel.** It is concluded that **no complete and reliable datasets are available on a European level** presenting information on **vessel kilometres.** Eurostat presents a table with data on total vessel kilometres, which is only filled in by a small amount of countries in a voluntary manner. As it is a voluntary table, data quality cannot be assured and many Member States do not provide the data. The information is not differentiated to vessel size classes either, which is also a gap.
- Besides some of the structural gaps mentioned above, it was also concluded **that significant information about IWT performance gets lost when translating information from a single dataset per trip (where available at national statistical offices) to the highly aggregated Eurostat statistics**. It is recommended to make more accurate and differentiated information available about the **average load of laden trips**. This information can be estimated, where possible, using the raw data available at local/regional public infrastructure managers (e.g. waterway managers or port authorities).

Impact of main gaps identified in external cost calculations

For the **parameters with currently no datasets available** on a European level (*see red coloured gaps of Figure 1*), a sensitivity analysis has been carried out to indicate the bandwidth of the possible results if different sources and assumptions are used. For these parameters significant variations in bandwidth of values have been observed between the different studies. These observed variations are presented in **Table 2** for each set of parameters.

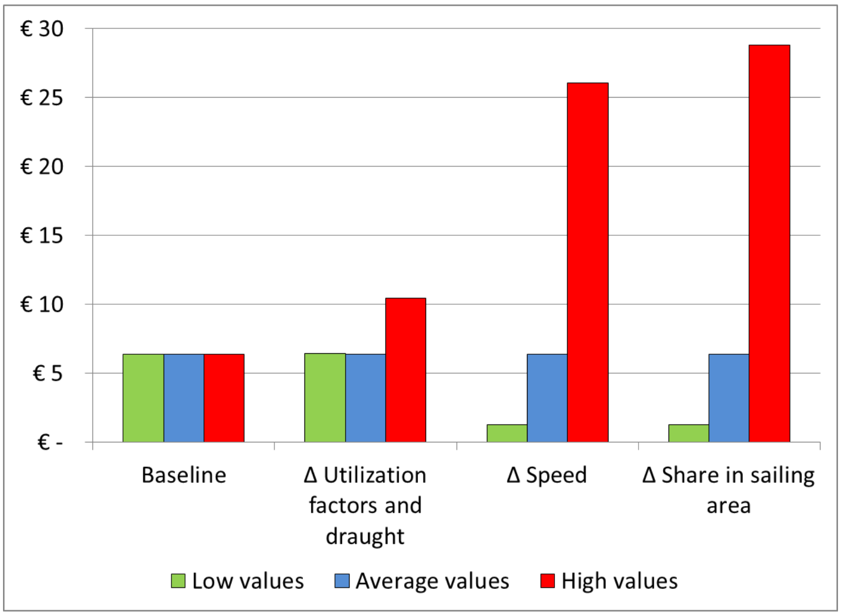
The impacts of these **extreme values** lead individually to the **lowest and highest external costs** per tkm, as shown in **Figure 2**. It exemplifies the level of severity of the gaps identified with each step taken in the overall calculation method. Obviously, the reality lies *somewhere in between the extreme values*. It also shows that especially the **choice of speed has a large impact on the results** with a relatively small change from 15 km/h to 18 km/h.

As it is burdensome to collect detailed fuel consumption data from the field for various waterways and vessels the application of a calibrated model seems sensible. For such a model based approach the conclusion is that the **actual sailing speed is a very critical parameter as regards the outcome on the calculation on fuel consumption.** This parameter has the largest impact on the possible bandwidth of external costs. It is therefore also quite remarkable that in particular **for this parameter there is no reliable database available on a European level** and in general assumptions are used to assess the fuel consumption. Therefore, from the five main gaps identified in this study (*see red coloured gaps in Figure 1*), it is recommended to focus first on collecting better data for speed and/or directly for fuel consumption by means of a dedicated study. This will improve the reliability of the external cost calculations significantly, while not increasing the reporting burden on NSIs for the short term.

Table 2 Bandwidth of values observed during assessment for a large cargo vessel sailing on the Rhine in Germany

	Extreme values observed leading to lower external costs per tkm	Base line situation (average values used in IWT external cost studies)	Extreme values observed leading to higher external costs per tkm
Utilization factor (load factor x load km factor)	62%	52%	25%
Load factor of a laden trip	75%	68%	55%
Speed	8 km/h	15 km/h	18 km/h
Sailing environment	100% non-urban	5% urban and 95% non-urban	14% urban metropolitan, 53% urban, 33% non-urban

Figure 2 Sensitivity analysis of main gaps identified (in $€_{2011}$/1000tkm)



Recommendations on most important gaps identified

One of the aims of this study is to show ways to enhance the reliability of the external cost calculations of emissions to air caused by inland waterway transport. Several gaps and weaknesses were identified in this study. In summary, the most significant issues that need to be addressed are:

- the lack of reliable and detailed data on the **fuel consumption of vessels;**
- lack of reliable data on the **average tonnage carried by inland vessels** per travelled kilometre, properly taking into account the **share of empty trips**;
- **lack of geographic detail to determine impact of NOx and $PM_{2.5}$ emissions by IWT.**

The ultimate goal is to improve the reliability for all the parameters identified, for all sailing areas and for all the vessel types. However, a trade-off will emerge between the level of accuracy and the necessary effort in terms of data collection and thus funding. Therefore, priorities will need to be established.

A starting point is tackling first the data collection of parameters with the largest gaps and the highest impacts. The most important ones, linked to the five main gaps identified are:

- **Speed and fuel consumption**: fuel consumption is highly sensitive for the actual speed that the vessel has in the water as the consumption grows exponentially with the speed increase. More detailed and accurate information on sailings speed and the fuel consumption specified to type of waterways and geography is considered to be the parameter with the highest priority. This is especially important given that no dataset is currently available for this parameter on a national or European level while speeds may strongly vary depending on market and waterway situations. The following possible methods for collecting data on speed could improve the reliability of external cost calculations:
  - **Real measurements** of fuel consumption and speed (and the respective operational power) through a representative sample of typical vessels sailing under different sailing conditions and areas. Data could be collected from shipping lines, ship owners and averages can be derived. The data from real measurements shall also be used to feed and calibrate a database/model with average fuel consumption figures per waterway section and sailing direction taking into account the currents and water levels.
  - **Model based assessments** using static information on vessel dimensions, installed power and as well as dynamic data on the water levels and currents (waterway managers) and sailings speeds based on AIS data (aggregated and anonymised) or data on sailing speeds by means of GPS tracking, voyage planning systems or interviews.

- **Loading factors:** no reliable information on load factors is known at a European level. As a result it is questionable how reliable the calculations are on the estimations of emissions and external costs expressed per tonne-kilometre. However, a first improvement (a quick win) could be made by usage of the existing datasets by the German DESTATIS institute and Austrian statistics office. Data from these national offices and extrapolation towards other countries can be used as a first step to improve the reliability of the load factor data of laden trips for Europe. As regards the empty sailings there is a big lack of data which needs to be closed. A possible way to collect data on empty sailings is to use the Automatic Identification System (AIS) data to gather information on the total number of kilometres sailed on the European waterway network and per Member State. In combination with statistical information on the laden trips it can give a better view on the actual share of empty sailings in order to derive the average load per travelled kilometre.

- The shadow prices of NO_x and PM highly depend on the geographic location. There can be large differences between EU countries and areas (non-urban vs metropolitan). It is therefore important to carefully take into account the geographic location of the fuel consumption and emissions. In particular for the improvement of the reliability of the **external cost for $PM_{2.5}$ emissions, an in-depth analysis of the sailing environment is advised.** The use of a common typology for the different areas is advised. The share of metropolitan, urban and non-urban areas can be defined using: 1) statistical information on the population densities per NUTS 3 region in combination with 2) a qualitative assessment using GIS map information (especially for the NUTS 3 regions with the largest surface area). Given that these shares are not expected to change much over time, a regular update is not needed. Evidently, indicating the shares of metropolitan, urban and non-urban sailing areas will not directly indicate where the actual IWT activities take place. To monitor the IWT activities in Europe, statistical Origin-Destination information is needed or monitoring where traffic takes place. Aggregated AIS data regarding the traffic intensities per waterway/area for different vessel classes could also be used to derive a reliable weighted average.

It can be concluded that several recommendations point towards increased usage of **AIS**. The use of this existing tool to generate statistics could have a significant improvement on the reliability of external cost calculations, while keeping data collection efforts and costs relatively low. The position of vessels marked could systematically be tracked, recorded, anonymised and aggregated.

Real measurements for a representative number of cases are the next best option, but reaching a reliable number of measurements could result in relatively high data collection costs. Using assumptions based on expert judgement is an alternative to keep the data collection costs low, however, the reliability could be questioned. Regarding the choice between the options the trade-off between accuracy and costs shall be taken into account. From the perspective of maximising the cost-effectiveness, the efforts shall be focussed on those countries and waterways with the following characteristics:

- **A lot of transport by IWT** expressed in tkm (and consequently a high share in the external costs);
- Where the **shadow prices for $PM_{2.5}$ and NO_x emissions are high** (high GDP levels, high share of urban/metropolitan areas);
- **Where parameters change dynamically** (e.g. free flowing sections of waterways);
- **Where currently the available data is relatively weak.**

Therefore, it is recommended to give most attention in improvement of the datasets for the following areas:

- Countries such as Germany, The Netherlands, Belgium, France where IWT activities have the largest ton kilometre performance and high external costs impacts (shadow price).
- Larger waterways in these countries that obtain a high share in the transported volume.
- Free-flowing sections within this network, since the values of parameters may change significantly. This requires a large sample size of data to ensure reliable figures.
- Densely populated areas along the major waterways (high impact to inhabitants).

It can be concluded that this concerns a significant part of the Rhine delta where priority should be given to the reliability of data for those waterway sections that belong to metropolitan and urbanised areas (e.g. Rotterdam, Dordrecht, Nijmegen, Duisburg, Dusseldorf, Koln, Bonn, Koblenz), since the shadow costs for $PM_{2.5}$ are much higher compared to average while also lot of IWT transport takes place in or close to these metropolitan areas.

Eventually it can be considered to expand the legislative basis for statistics on a European level. For example, to make the data providing for information on empty trips mandatory and to further differentiate the vessel types and regional areas (e.g. breakdown to metropolitan, urban, non-urban) areas as well as collection of information on emission profiles and engines installed in IWT vessels including emission control systems. The latter (engines and emissions) could probably also be linked to a possible extension of the legal base for the **European Hull Database**.

ANNEX II: PAPER INPUT FOR CESNI ENGINE INFORMATION

"NEED FOR BETTER INFORMATION ABOUT THE ENGINES INSTALLED IN INLAND WATERWAY VESSELS"

Introduction

The reduction of external costs of transport is high on the political agenda. A discussion on internalisation of external costs for Inland Waterway Transport is announced in the NAIADES II Communication. The calculation of the external costs is however being hampered by the lack of EU-wide quality data. Therefore, before sensible discussions can take place and analyses can be made, the knowledge gaps in the information basis need to be closed and a common understanding is needed.

Specifically for inland waterway transport (IWT), PLATINA2 has carried out a review of the currently available European datasets for external costs calculations on emissions to air and has identified **several knowledge gaps as regards engine information**.

What is the problem?

The emissions produced by an IWT vessel are primarily a function of:

- the energy consumed (under specific waterway and load conditions);
- the emission factors of an engine.

For a reliable external costs calculation, data is needed to provide answers to the following questions:

- What is the specific fuel consumption of the engines on board of a vessel in terms of grams of fuel per kWh?
- What is the emission of NO_x and $PM_{2.5}$ expressed in grams of fuel per kWh?

NOx and PM emission factors depend mainly on the technical characteristics of the engines and the possible emission control measures installed. NO_X emissions are mainly caused by the high temperatures and pressures in the combustion engines, which causes the nitrogen present in the atmosphere to combine with oxygen. For slow speed engines a longer period at higher temperatures occurs, which results in better combustion efficiency but higher NO_X emissions. PM are products of incomplete combustion and wear and tear of vehicle parts[19].

In 2003, TNO carried out an assessment of different engine characteristics in order to select the most important parameters to derive the emission factors for IWT. The assessment took into consideration the significance of the parameters (i.e. correlation with energy consumption/emissions) and their

[19] Source: Klein, J. et al (2006). Methods for calculating the emissions of transport in the Netherlands.

manageability (i.e. availability in relevant databases)[20]. The study concluded that the parameters building year/age of the engine, engine speed (rpm) and power (total, per cylinder and per litre) are significant as well as manageable.

It is recommended by PLATINA2 to ensure collection of information on the emission characteristics and building years of the engines installed in IWT vessels, as it can be used to forecast the development of the engine fleet from a base year situation using data on the engine renewal rates. This approach can also be used to make annual projections of the engine fleet, if the engine database cannot be updated on a yearly basis. Through the distribution of the age and type of engines installed in the European IWT fleet and its development in time, weighted average emission factors can be estimated and forecasted on a yearly basis (e.g. according to vessel types and sizes).

The analysis made in PLATINA however identified the following problems concerning the currently available datasets (see also PLATINA2 Deliverables (drafts) D2.3 and D2.4):

Concerning the energy consumption:

- ***Information on the installed power and the type/age of engine of the active fleet is not very reliable*** *while this is needed to estimate fuel consumption (its specific fuel consumption in gram fuel per kWh) and the related emission profile of the engine (NO_x and $PM_{2.5}$ emission per kWh).*

Concerning the emission parameters

- ***More detailed information is needed on the NOx and $PM_{2.5}$ emission factors for engines.*** *The IWT emission factors for NOx and $PM_{2.5}$ are currently based on stationary test cycles and not on real sailing situations. As different test cycles show different results, the real emission factors for these air pollutants most likely differ from the current values. Special attention is needed for the estimation of PM emission factors. The PM emission factors used in many studies have been mainly based on expert estimates and/or limited measurements (especially for older engines), resulting in significant differences of the PM emission factors presented in different studies.*
- ***Emission factors for LNG engines are hardly known yet.*** *As conversion to LNG is seen as a major development, direct measurements over a period of time is advised to determine the emission factors of LNG engines. So far, PM and CH4 (methane slip) emission factors have only been estimated based on literature and expert views.*
- ***Information on auxiliary engines is missing:*** *modern IWT vessels often have several powerful auxiliary engines on board. Nevertheless, no information or data is available on the actual use of this equipment and therefore rough assumptions are generally made on the load and time of operation of these engines.*

[20] Source: Oonk, H., J. Hulskotte, R. Koch, G. Kuipers, J. van Ling (2003). Methodiek voor afleiding van emissiefactoren van binnenvaartschepen, TNO-MEP, R2003/437, version 2, November 2003.

What is needed specifically?

An update and completion of the information about installed engines with their characteristics is needed. Although databases like IVR are useful tools that present some engine information on a European level, there is a need of regular updating in order to ensure the comprehensiveness and reliability of the data. Several studies have partly filled the gaps through information obtained by means of interviews, assumption based on expert knowledge and consistency checks using limited national sources.

Therefore, one of the recommendations by PLATINA2 is to improve the reliability of database of the engines used in IWT in order to be able to derive the average emission profile for representative vessels.

More specifically the following information would be needed as regards the engines under ideal circumstances:

Main engine:

- Type of fuel (e.g. diesel, LNG, etc.);
- Building year of the engine;
- Emission characteristics of the engine (e.g. in gram pollutant/kWh);
- Engine speed (in rpm);
- Engine power (in kW and volume in litres per cylinder);
- Engine specific fuel consumption;
- For LNG: type of gas engine (Spark Ignited Lean Burn, Dual fuel low or high pressure) and information on the methane slip of the engine.

Auxiliary engine:

- Power (in kW);
- Building year of the engine.

Frequency of update:

- General engine information (e.g. type of fuel, building year of engine, engine power): ideally, the information becomes available whenever any engine is changed, the least is a yearly update of the engine database in order to remove older engines and add new ones.

Emission control measures:

- Emission control measures used in the vessel (e.g. SCR, DPF, etc.).
- Impact of the emission control measures on pollutants (e.g. % reduction of a specific pollutant).

Frequency of update:

- Installed emission control measures: yearly update of the engine database to follow the developments.
- Impact of the emission control measures: direct engine measurements for a base year and update at least every 5 years and/or when a new emission control measure is developed.

In practice, if the data should be retrieved from the Community Certificate, several pre-conditions need to be considered before deciding on measures:

- Certification authorities will only agree on providing data on engine emissions characteristics, if they come directly from an officially certified test bench. As a consequence, only the references to the certification will be entered in the Community Certificate instead of any emission characteristics versus the operational parameters.
- Up until now, there is no legal requirement to include the data in the Community Certificate in a harmonized way. Consequently, this needs to be agreed respectively regulated and then enter into force. Afterwards, a significant implementation period (it could add up to several years, possibly even 10) can be expected for the first update. Once, engines are renewed, entry is possible immediately.

Consequently, the data from above would need to be changed accordingly.

Possible ways for obtaining the data are:

1. to reinforce and improve on a voluntary basis the existing IVR database and to add missing data and validate the available data on engines;
2. to include engine information in the European Hull Data Base (EHDB) by means of expanding the legal basis, linked to an additional to be developed database with more specific engine data on the background.

The advantage of the expansion and validation of the IVR database is that this is already an available framework and a voluntary action might not need much effort. This voluntary option could therefore be achieved on the short term, without adaptations of the legal framework. However, since this is a voluntary action, it cannot be guaranteed that all private companies (skippers/fleet operators) will participate. The reliability of the database may therefore still remain questionable.

The advantage of the second option (EHDB) is that the data will be mandatory to collect by the certification authorities and therefore more reliable than the provision by private parties. In addition the maintenance and control of the database is done under the supervision of the European Commission and the national authorities and therefore will result in less discussions as regards privacy. However, a precondition is the existing legal basis (=the amendment of the data for identification of vessels) and additional administrative effort for the national certification authorities.

After further consultation with experts, it was made clear that in EHDB itself it is *possible to add (only) the data on the number and introduction date of the type approval*. Such data would only become available, once the legal basis is in force and once the Community Certificate is amended. An additional database would be needed on an European level to 'link the type approval number to be recorded for each vessel in EHDB to background information about this specific engine. This background data concerns information for at least: maximum power, maximum RPM, emission characteristics and year of introduction.

Specific improvements for the IVR Database

The quality and reliability of this IVR database is questionable and recent analyses in the PROMINENT project (August 2015) revealed limited reliability of data. The updates recently carried out in the new information system have not yet solved this issue. The current IVR database has the following limitations which could specifically be addressed by means of voluntary actions:

- The database does not include all the engine data needed and the information available is outdated. For example, there is limited updated information available in the database on the building year of the engines.
- The database coverage is limited to engine information for Western-European countries: NL, BE, FR, LU, CH, DE, CY and MT. Engine information for the Eastern-European fleet sailing on rivers, such as the Danube, Elbe and Odra are not included in the database.
- Specifically for:
  - France: the IVR database provides limited fleet information for passenger vessels compared to the VNF register.
  - Germany: the fleet data in the IVR database is incomplete and not fully updated due to limitations regarding privacy issues. This is especially the case for the passenger vessels and push boats[21].

A possible expansion of the European Hull Data Base with rows providing engine information

As mentioned before, it is possible to expand the European Hull Data Base with data on the number and introduction date of the type approval[22]. This is in line with the current model of the Rhine vessel inspection certificate. Both the Rhine vessel inspection certificate, as well as the Community Certificate, do not provide boxes for accurate information regarding engines on board.

An additional database would be needed on European level to link the type approval number to more detailed engine information for at least: maximum RPM, maximum engine power, emission characteristics and year of introduction. This additional database could be developed with input from engine manufactures and inspection/certification authorities. Some inspection bodies (in NL - Commissie van Deskundigen), in particular NL and FR, register data regarding engines on their national database. This process is performed when the certificate is issued or renewed. The data concerns in particular the brand, the rate power and the type-approval number. It is important to take into account that an organisation should be responsible for the maintenance and control of the engine data received. This should be further discussed with the CESNI group.

At present, the required data mentioned above are not mandatory for the EHDB update provided by competent authorities of CCNR and EU member states. Indeed, the scope of data required for update to EHDB is defined by the annex P of the RVIR (“data for the identification of the vessel”) or by the Appendix IV of the Annex II of the directive 2006/87/CE. The EHDB IT structure is also based on these data. Consequently, one would have to change the “Appendix IV Data for the identification of a vessel” of the 2006/87/EC, the technical directive and include the requirement to provide the type approval and introduction date of the engine. This Appendix will move to the technical standard for inland vessels, which will be set out by CESNI. An amendment of this should be manageable with a proper specification of what datasets to collect in what format and a specification of the formats.

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[21] Source: PROMINENT (2015), List of operational profile and fleet families (D1.1).

[22] As an example, see section C of the CCNR database for engine type-approvals: http://rv3.ccr-zkr.org/40-en.html.

The technical requirements in Europe will be harmonized with a uniform standard, called ES-TRIN. The RVIR and the new EU directive could refer to this standard in a near future. Adoption of ES-TRIN by the CESNI Committee is expected at the end of November 2015. The "data for the identification of the vessel" is integrated as Annex 2 of ES-TRIN.

The draft work program of CESNI for 2016-2018 contains the 2 following topics: "Revision of the Community / Rhine certificate and amendment of the Administrative Instruction governing their issuance" and "Adaptation of ES-TRIN in relation to the content and the functions of the European hull database".

The final work program is expected in February 2016. On the one hand, the revision of the model may allow to create new boxes, and then to collect and register relevant data regarding engines with an harmonized process performed by CCNR and EU national authorities. On the other hand, modification of Annex 5 of Directive 2006/87/EC may allow to create new mandatory data to be provided in the EHDB. Such process requires an accurate database of type-approvals according to the RVIR, the directive 87/68, as well as the future regulation NRMM. Moreover, considering the additional work for inspection bodies, the support of CESNI Members is a sine qua non condition.

Furthermore, the remaining question is the legal consideration to access and use data regarding certificates stored in the EHDB. Indeed, in general, such data in EHDB are only available for authorities, not for RIS providers. The Service Agreement for the European Hull Data Exchange allows for the extraction of statistical data, which may also be used further or even be made public in an aggregated and anonymous manner.

ANNEX OF PAPER: BACKGROUND INFORMATION

Installed Power

Eurostat presents aggregated engine power information on a country level:

- Power (in kW) of self-propelled vessels by load capacity for 6 size categories: <250; 250-399; 400-649; 650-999; 1000-1499; 1500-3000 and >3000 tonnes (*iww_eq_power_lo*);
- Power (in kW) of self-propelled vessels, tugs and pushers by date of construction for 5 building periods: <1950; 1950-1969; 1970-1979; 1980-1989; >1990 (*iww_eq_power_ag*);

However **the database is incomplete, as information is only provided for a limited number of countries.** Moreover, as filling this dataset is done on a *voluntary* basis, no thorough quality check is carried out by Eurostat. Eurostat prepares some time series for these statistics.

More detailed information on average power installed for different ship types can be found in the **IVR Ships Information System** online database. However, the information might not be always reliable because the ship owner is not obliged to update the information, if a new engine is installed[23]. The reported power installed is often outdated with the result that the fuel consumption is overestimated, if only based on this information.

Information has also been presented in different studies, such as studies carried out by IFEU[24], PLANCO[25] and TNO[26]. They made assumptions about the installed engine power and adjusted the information of the IVR database about engine power. Engine information based on IVR data and can also be found in the study “Contribution to impact assessment of measures for reducing emissions of inland navigation” by PANTEIA, et al. (2013). The data used in this study was based on the IVR database and was adjusted in 2012 based on interviews with ship owners and by means of consistency checks with fleet registers from the Netherlands. Based on the IVR database it is also possible to be more accurate as it gives information on the type, age and total power of each engine installed. The vessel might have one engine with 1000 kW or 2 with 500 kW. The fuel consumption of the 1000 kW vessel can be lower as the specific fuel consumption of the engine can be lower and the resistance due to appendages may be also reduced. Moreover, different engines may have different emission profiles as well.

Depending on the vessel size, -types and –configuration, the installed power may vary significantly. The larger the vessel, the larger the installed power and thus the higher the fuel consumption will be (in absolute terms). But also the larger the vessel is, the wider the bandwidth of the engine power (in kW) observed per vessel type is. Therefore, especially for the larger vessels more specific engine information is needed when collecting data. Moreover, attention should not only be paid to the

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[23] The exchange of the main engine occurs regularly depending on the intensity of use and the respective life expectancy. Larger ships operating 24/7 and transporting the majority of cargo in the European network have a relative short exchange rate (every 12 to 15 years) compared to the smaller ship types.

[24] IFEU (2013). Aktualisierung der Emissionsberechnung für die Binnenschifffahrt und Übertragung der Daten in TREMOD.

[25] Verkehrswirtschaftlicher und ökologischer Vergleich der Verkehrsträger Straße, Schiene und Wasserstraße

[26] TNO (2012). EMS-protocol, Emissies door Binnenvaart: Verbrandingsmotoren, version 4.

installed power in kW, but also to the type of the drive train (e.g. hybrids such as diesel-electric propulsion) and the possible usage of alternative fuels (e.g. LNG).

Specific fuel consumption

The specific fuel consumption for newer engines is roughly between 180 to 200 g/kWh and older engines between 220 and 235 g/kWh (depending on the source used[27]). In general, since the bandwidth is not very large and often the details on the engine population in IWT is missing, most studies use an average specific fuel consumption of about 200 g/kWh. An improvement would be to further differentiate according to the power and age of the vessels in order to calculate the specific fuel consumption for various vessel types. For example, it can be taken into account that large vessels will use more modern engines as the vessels are younger and engines will be more often replaced. As a result the larger vessels will have a lower specific fuel consumption compared to older small barges. Even more advanced would be also to take into account the load conditions of the engine, but this will require a lot of detailed data.

The fuel efficiency of a diesel engine is given by the specific fuel consumption (sfc), which is expressed in grams fuel needed for every kWh. The specific fuel consumption has declined in time due to the gradual transition from the naturally aspirated engines towards the newer supercharged engines. It shall be noted that the specific fuel consumption is changing with the engine load. Engines will have different characteristics how efficient they perform under load conditions. Usually, the brake specific fuel consumption in g/kWh is given as function of rate of revolutions for a pre-defined propeller curve. The characteristic also depends on the size of the engine: usually low-powered engines have a high specific fuel consumption e.g. 210 g/kWh and highly-powered engines a low specific fuel consumption of e.g. 190 g/kWh.

IVR DATABASE

Main engine

Engine related information on a European level[28] can be found in the IVR Ships Information System. The new information system includes fields for the following parameters[29]:

- Number of main engines
- Total kW of main engines
- Manufacturer
- Type of engine
- Retrofit engine
- Main engine total Hp

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[27] Source: VBD (2004). Technische und wirtschaftliche Konzepte für flußangepaßte Binnenschiffe. Europäisches Entwicklungszentrum für Binnen- und Küstenschiffahrt Versuchsanstalt für Binnen-schiffbau e.V & TNO (2012). EMS-protocol, Emissies door Binnenvaart: Verbrandingsmotoren, version 4.

[28] For the Netherlands, Germany, Belgium, France, Switzerland, Luxembourg, Romania and Slovakia.

[29] Source: http://www.ivr.nl/fileupload/ISIS/ISIS_IVR-Database_Moduls_2014.pdf

- Main engine total kW
- Main engine year of construction
- RPM
- Propulsion type (i.e. diesel; diesel-electric; electric; schottel propulsion system)
- Main engine fuel type (i.e. bi-fuel; bio-fuel; diesel; LNG; other)

The quality and reliability of this database is questionable and also analyses in the PROMINENT project revealed limited reliability of data. The updates recently carried out in the new information system have not yet solved this issue. Information has also been presented in different studies, such as studies carried out by IFEU, PLANCO and TNO. Engine information based on IVR data and can also be found in the study “Contribution to impact assessment of measures for reducing emissions of inland navigation” by PANTEIA, et al. (2013). The data used is this study was based on the IVR database and was adjusted in 2012 based on interviews with ship owners and by means of consistency checks with fleet registers from the Netherlands.

Auxiliary engine

Information on the power and building year of auxiliary engines on a European level is available through the IVR Information System. The new information system includes fields for the following auxiliary engine parameters:

- Manufacturer auxiliary engine 1
- Auxiliary engine 1 kW
- Auxiliary engine 2 Manufacturer
- Auxiliary engine 2 kW
- Availability of nozzle
- Availability of bow thruster
- Bow Thruster – kW

The quality and reliability of this database as regards the auxiliary engines is low. For example, for all the IWT vessels with data on the main engines available in the IVR database of 2013, information on the building year and power (in kW) of bow thrusters is only given for 4% of these vessels.

Due to the limited impact of auxiliary engines in the total emissions and the lack of engine data, the tendency in most studies has been to either exclude these engines from the analysis or to use an increment factor (between +5 and +15%)[30] of the fuel consumption of the main engine to estimate the environmental impacts of auxiliary engines. However, a study by DTU (2004)[31] indicated that there are large variations in these factors and large deviation of values in all CEMT classes. For example, CEMT class II and III vessels showed auxiliary engines with an average power capacity of 40% of the main engine. However, it remains unclear which share of the power capacity is actually being used in practice.

[30] Source: IFEU (2013). Aktualisierung der Emissionsberechnung für die Binnenschifffahrt und Übertragung der Daten in TREMOD; TNO (2010). Methodologies for estimating shipping emissions in the Netherlands.

[31] Source: DTU (2004). Collected Data and Resulting Methodology for Inland Shipping, ARTEMIS project.

Emission control measures

The new IVR information system includes a field for the exhaust treatment systems installed in IWT vessels (i.e. particulate filter, catalyst with ureum or unknown)[32]. The quality and reliability of this database is still unclear.

[32] Source: http://www.ivr.nl/fileupload/ISIS/ISIS_IVR-Database_Moduls_2014.pdf.