MARKET REPORT 2014-2017

Main features and trends of the European Inland Waterway Transport sector

European Commission

CCNR
CENTRAL COMMISSION
FOR THE NAVIGATION OF THE RHINE

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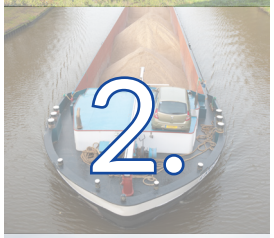
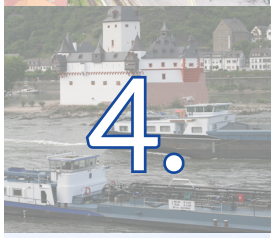
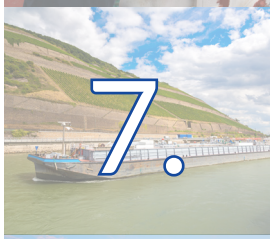






Executive summary

The inland navigation sector has experienced several exogenous activities over the last five years in the European Union. While the overall economic situation has improved in Europe – with the Eurozone GDP increasing from 9.6 trillion euros in 2012 to 10.1 trillion euros in 2016 – some sectors have faced difficult conjectural situations, such as the agricultural sector in 2016. Between 2012 and 2016 the transport performance of goods on inland waterways decreased by 2%. But this decrease, partly explained by low water periods both in 2015 and in 2016, remains a one-off occurrence and no structural decreasing trend should be derived from this five-year evolution. In fact, looking at a longer period evolving over 20 years, the European Union inland navigation transport performance has increased at an average annual rate of 1% with a modal share remaining at around 6%. The inland navigation transport performance evolution is characterised by a small long-term increase, influenced by two main external factors: the economic situation affecting transport demand and the environmental conditions affecting available transport capacity.

The inland navigation sector has proved to be resilient to these external factors over the last five years. After low water periods in 2011, 2015 and 2016, the levels of inland navigation transport performance have since caught up. This catch-up phenomenon is even more significant for growing market segments such as the transport of containers on inland waterways.

In this context, and taking into account the significant impact of the economic situation and environmental conditions, it is challenging to measure the direct impact of public policy measures on the inland navigation transport evolution on the European scale. In other words, impacts were not significant enough to overshadow the impact of positive and negative economic shocks or the impact of low water periods. However, at the local level, a proper use of positive economic fluctuations (for example, the construction works for the Grand Paris development) or voluntary structural development, can lead to an increase in inland navigation transport and to a modal shift towards goods transport on waterways. In addition to bottleneck removals and proper infrastructure maintenance, the development of inland navigation indeed requires the development of associated economic activity that will drive transport demand and the development of intermodal platforms and services aiming at an efficient logistic chain.

The evolution of the fleet and, in particular the evolution of newly built vessels and greening measures associated with these new vessels, are also covered in this report. The share of new inland navigation vessels that were equipped with at least one greening measure (either concerning exhaust gas after treatment, hull form optimisation or propulsions systems optimization) increased between 2014 and 2016 from 54% to 61%. Innovation is present on new vessels. However, the number of new vessels (31 in 2016) remains limited compared to the overall inland navigation fleet in Europe which is approximately 13,500 vessels. Furthermore, only nine vessels out of 187 that were built in the period 2014-2016 had an emission performance that is comparable to the Stage V emission standards imposed by the NRMM for new engines as of 2019.

Innovation in inland navigation, and in particular innovation contributing to greener and more efficient inland navigation sector, are expected to contribute to environmental benefits. However, they might also have an economic cost burden and even present a negative economic business case for companies, if the required investment has a limited impact on operational costs decrease. In these cases, global cost-benefit analyses should be carried out and, if innovative measures were to be positive, enhanced intra-industry cooperation should be supported to enable these measures to spread at a faster pace. However cooperation should not be limited within freight inland navigation transport. Synergies between freight and passenger inland navigation transport could be leveraged. Passenger transport on inland waterways actually increased significantly over the last five years. Between 2012 and 2016, the number of passengers on European river cruise vessels increased annually by 13% on average. Furthermore the new vessel building rate and the share of greening measures are both more important in the passenger transport sector where the growing environmental awareness among customers plays an incentive role.

Inland navigation transport is a key element of the logistic chain in Europe and essential for several European economic sectors. This explains, for example, why inland navigation was the most resilient mode of transport during the economic crisis in 2009 and in 2010. Furthermore, European inland navigation contributes to solve road congestion in urban nodes and to tackle current environmental challenges. This is especially true given that this mode of transport has proved its reliability and safety in the past. Ambitious objectives in terms of modal shift and of fleet greening could enable inland navigation to be an even stronger driver for a sustainable transport in Europe.

1. INLAND NAVIGATION CONTEXT

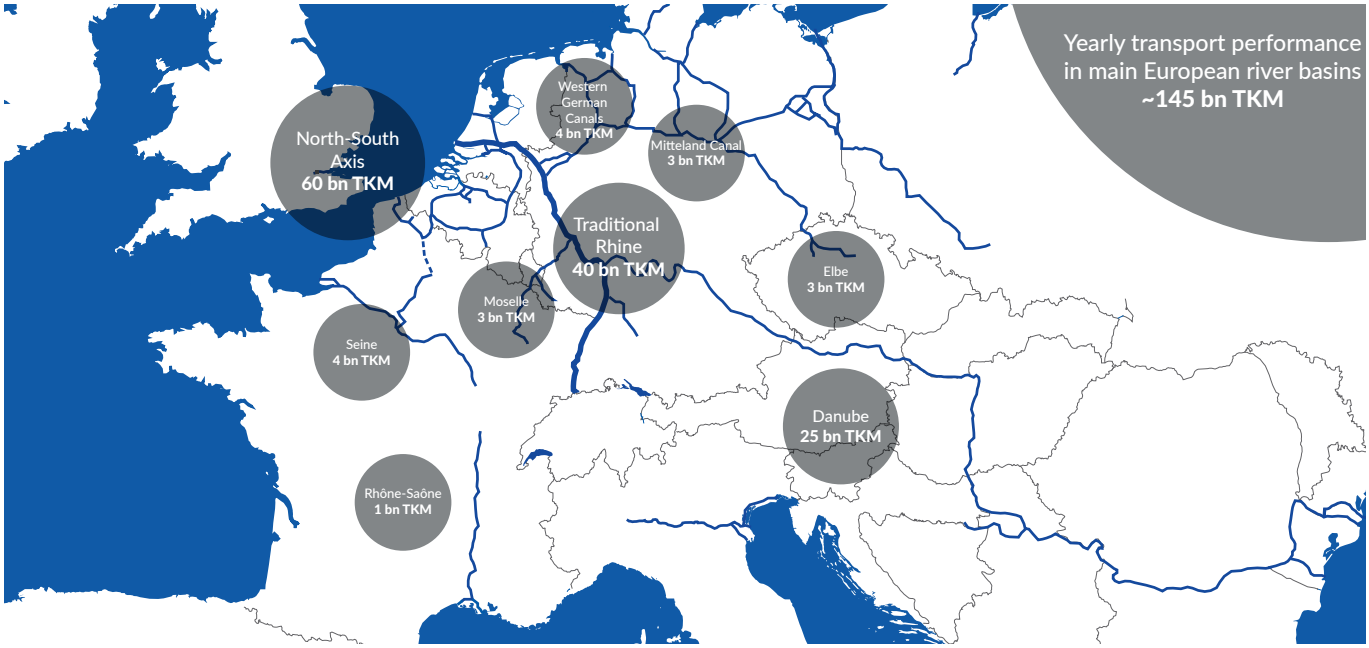
1.1 GEOGRAPHICAL CONTEXT

Inland navigation activity is very concentrated in Europe with two countries, Netherlands and Germany, representing 71% of total European goods transport performance on European inland waterways. More generally, the European Union Rhine countries (Belgium, Netherlands, France and Germany) represent about 85% of total inland navigation goods transport performance while the European Union Danube countries (Bulgaria, Croatia, Hungary, Austria, Romania and Slovakia) account for 15% of goods transport performance on European inland waterways. Other countries account for almost today less than 0.5% of European goods transport by inland navigation.

In terms of river basins, the Danube, the Rhine and the large network of waterways in the Netherlands, Belgium and North of France (North-South axis) represent 86% of the total European inland navigation transport performance.

Figure 1: Main European river basins and associated annual transport performance

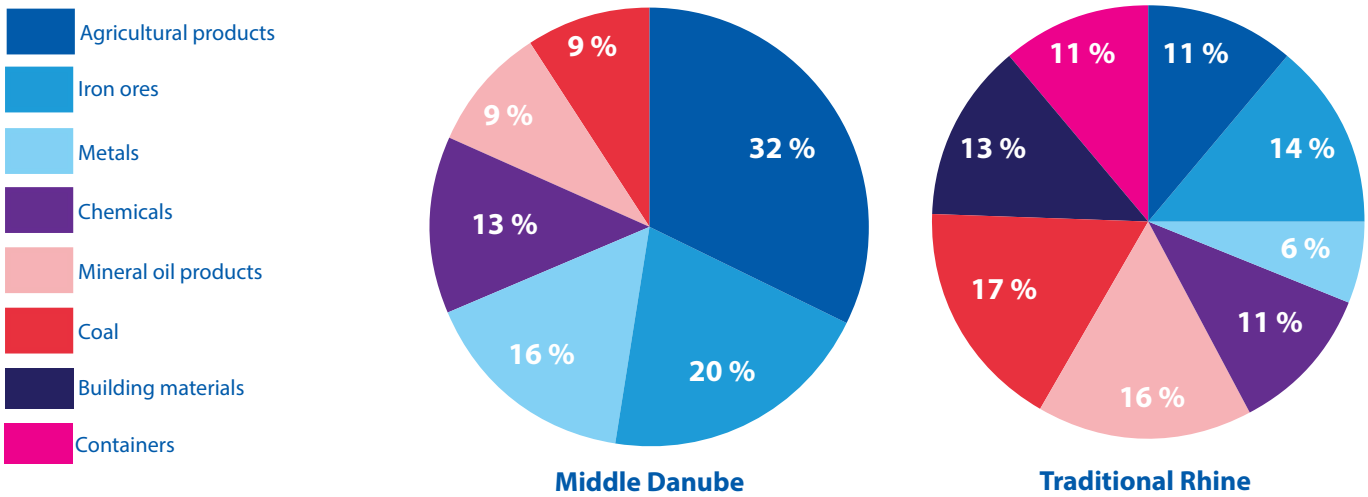
Source: Eurostat, Destatis, VNF, Moselle Commission, CCNR analysis



Notes: Traditional Rhine is the Rhine running from Basel to the Dutch-German border/ North-South Axis is the dense network of waterways covering the North of France, Belgium and Netherlands (including the Dutch Rhine) / Only river basins with more than 1 bn TKM yearly transport performance are highlighted.

Figure 2: Share of transported products on the Middle Danube and on the Traditional Rhine

Source: Destatis, Danube Commission



Agriculture and the steel industry are the two activities that count the most in inland navigation. More than 80% of goods transported on the Danube are related to these sectors. On the Rhine, inland navigation transport is more diverse with a significant share of transport supporting the building industry, the energy industry and more generally any logistic chain with container transport requirements.

1.2 ECONOMIC CONTEXT

Figure 3: GDP evolution in the Eurozone – past evolution and outlook (GDP in billion euros)

Source: Oxford Economics

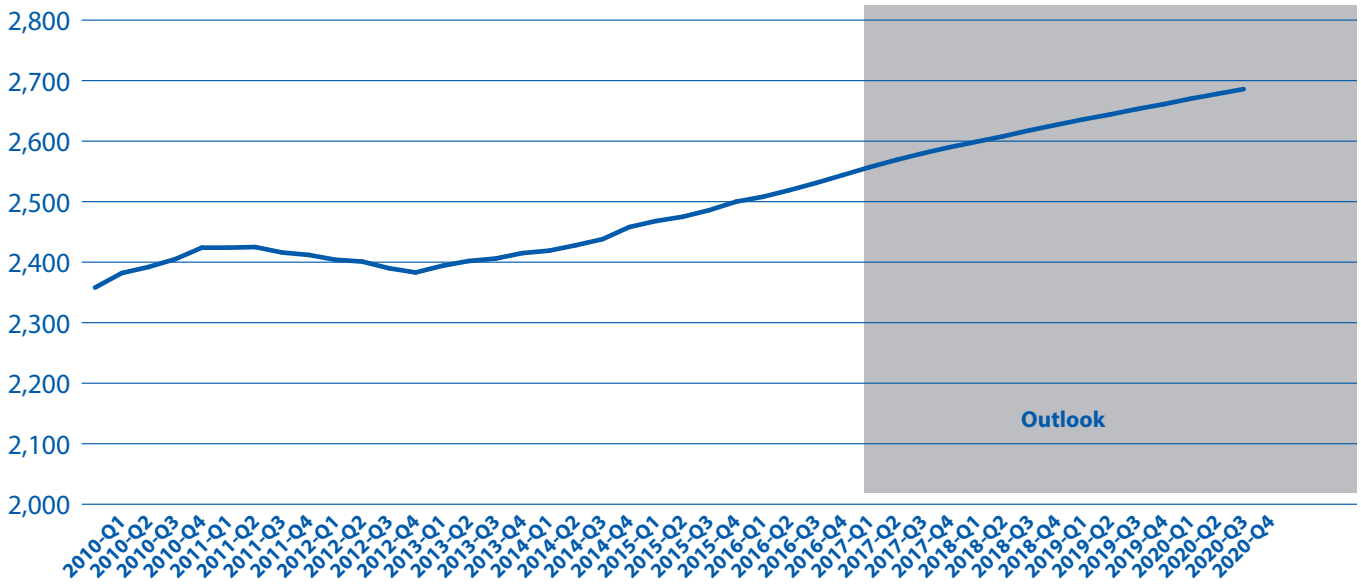
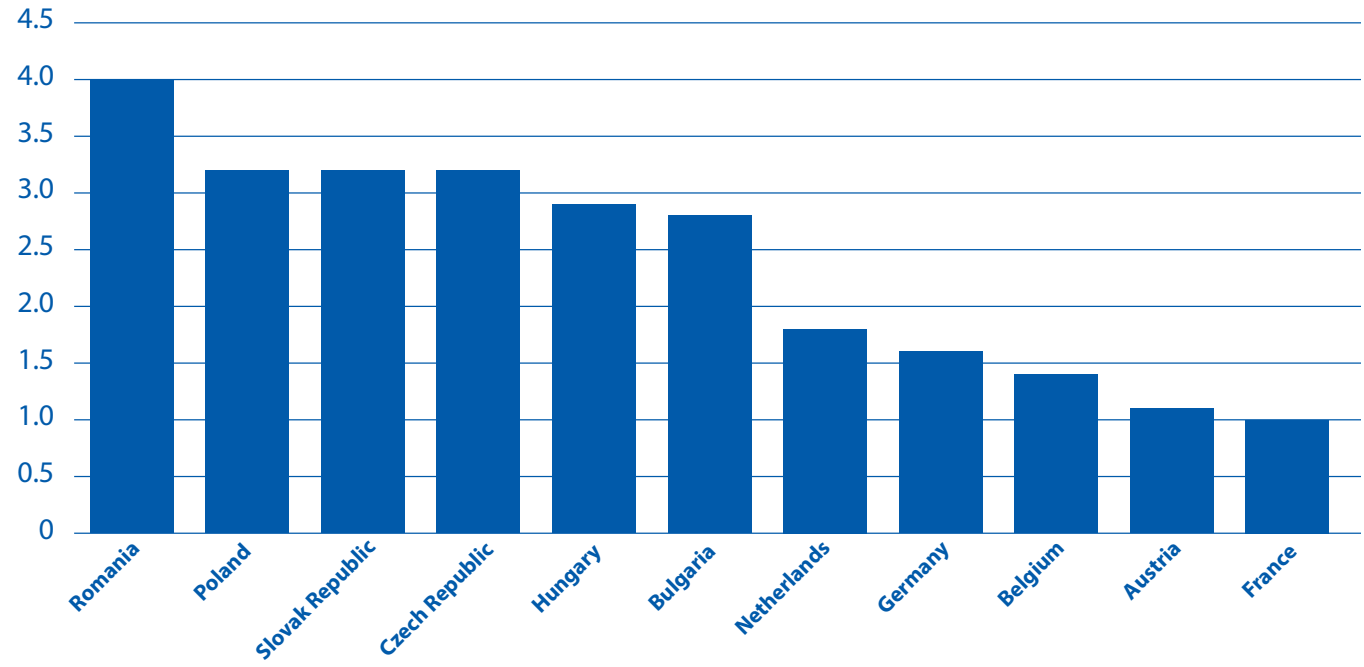


Figure 4: Average annual GDP growth between 2013 and 2016 in main European IWT countries (Index 100 in 2010 – based on GDP, constant prices and exchange rates)

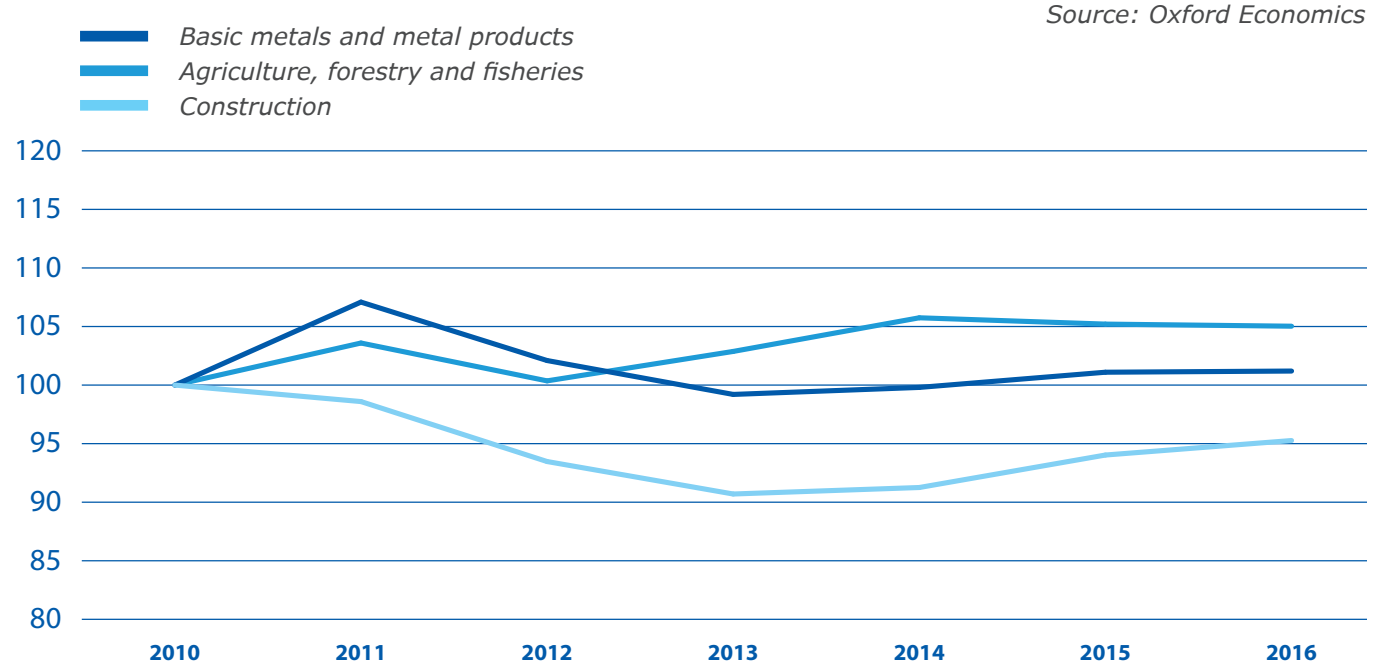
Source: Oxford Economics



Since 2013, GDP evolution in the Eurozone has been characterised by a rather limited but stable growth trend with a yearly GDP growth between 1% and 2%. It is assumed that this evolution will continue until 2020. Deviations from this growth trend would arise in the case of major financial crises in the Eurozone.
Eastern Europe countries experienced higher economic growth than Western Europe countries with an average annual GDP growth over the last 3 years ranging from 2.8% to 4.0%, while Western Europe countries' yearly GDP growth remained below 2%.

Figure 5: EU gross output of activities contributing to inland waterways goods transport (Index 100 in 2010 – based on EU gross output)

Source: Oxford Economics



Industry heavily reliant on inland navigation has not evolved in the same way over the last few years. Similar to GDP evolution, gross output of construction, metal products and agriculture products has increased since 2013 at an average annual rate of between 0.5% and 1.7%.
But this growth, especially for the construction sector, followed a continuous decrease that impacted inland navigation transport of building materials. Still, construction is now on a more positive path and is expected to remain so in the coming years; the average yearly growth for this sector is expected to be 1.9% up until 2020, and inland navigation activity should benefit from this upward tendency.
Agriculture output remained stable in 2016 compared to 2015 at the European level but this European view hides some specific national and regional evolution. Concerning agriculture output in 2016, it decreased for example by 6% in France while it increased by 18% in Hungary, these conjectural evolutions being mainly due to meteorological conditions throughout the year (source: Oxford Economics).

1.3 ENVIRONMENTAL CONTEXT

It is important to highlight the evolution of the water level over the last years because of its impact on inland navigation activity. Having a direct influence on the maximum loading degree of vessels, river water levels have an impact both on the volume transported and on the freight rate.

Figure 6: Container transport and water level on the Rhine

Source: Destatis, WSV, BfG

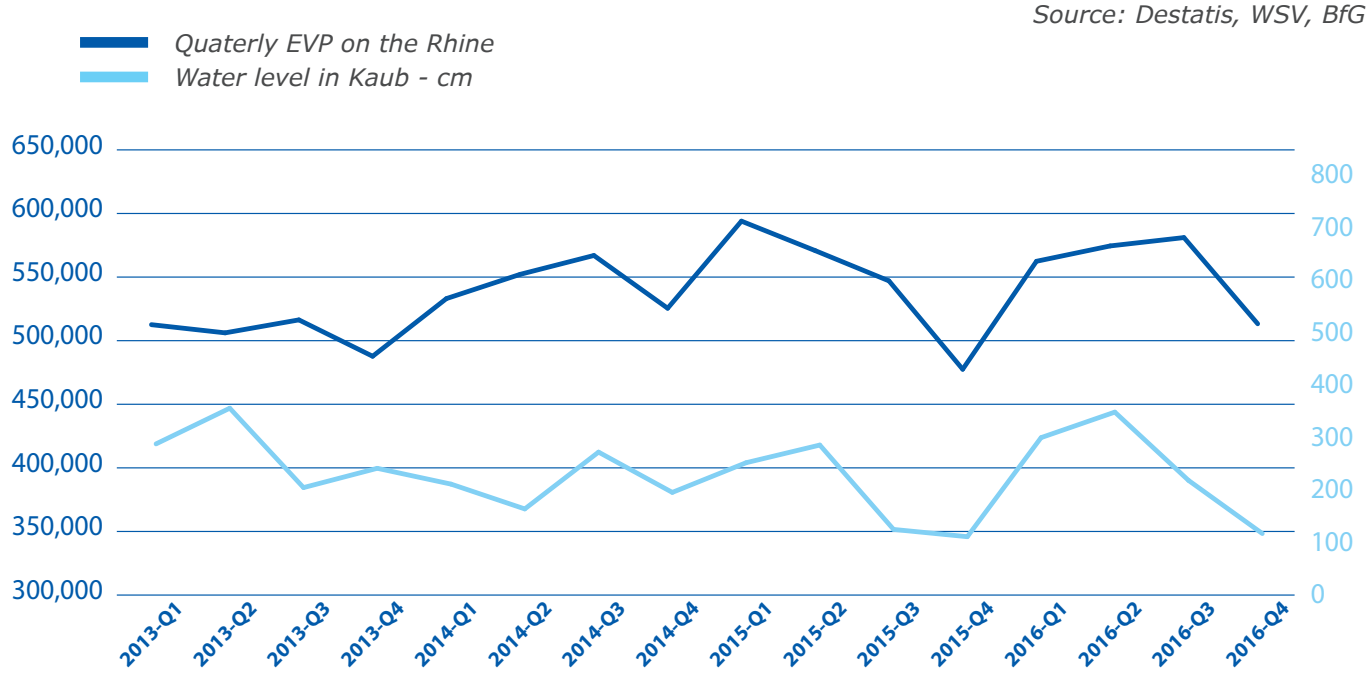
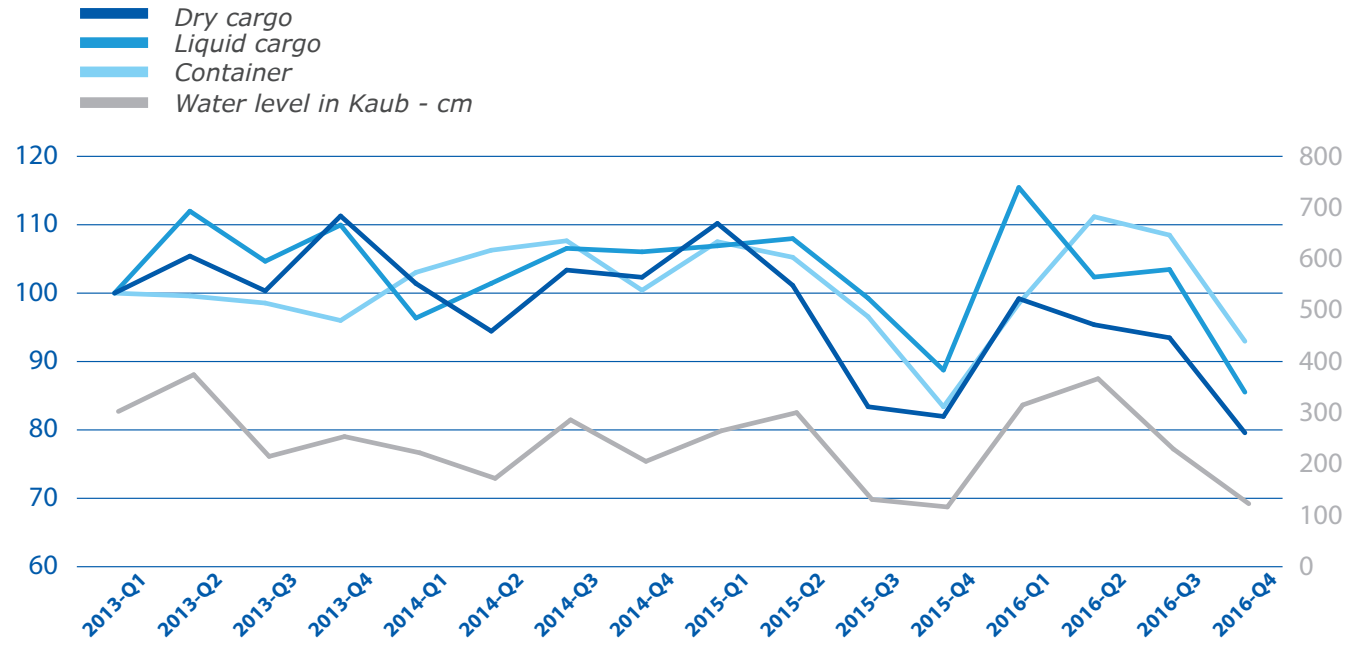


Figure 7: Dry cargo, liquid cargo and container transport and water level on the Rhine (Index 100 in 2013 Q1 for Rhine transport – based on quarterly transport performance)

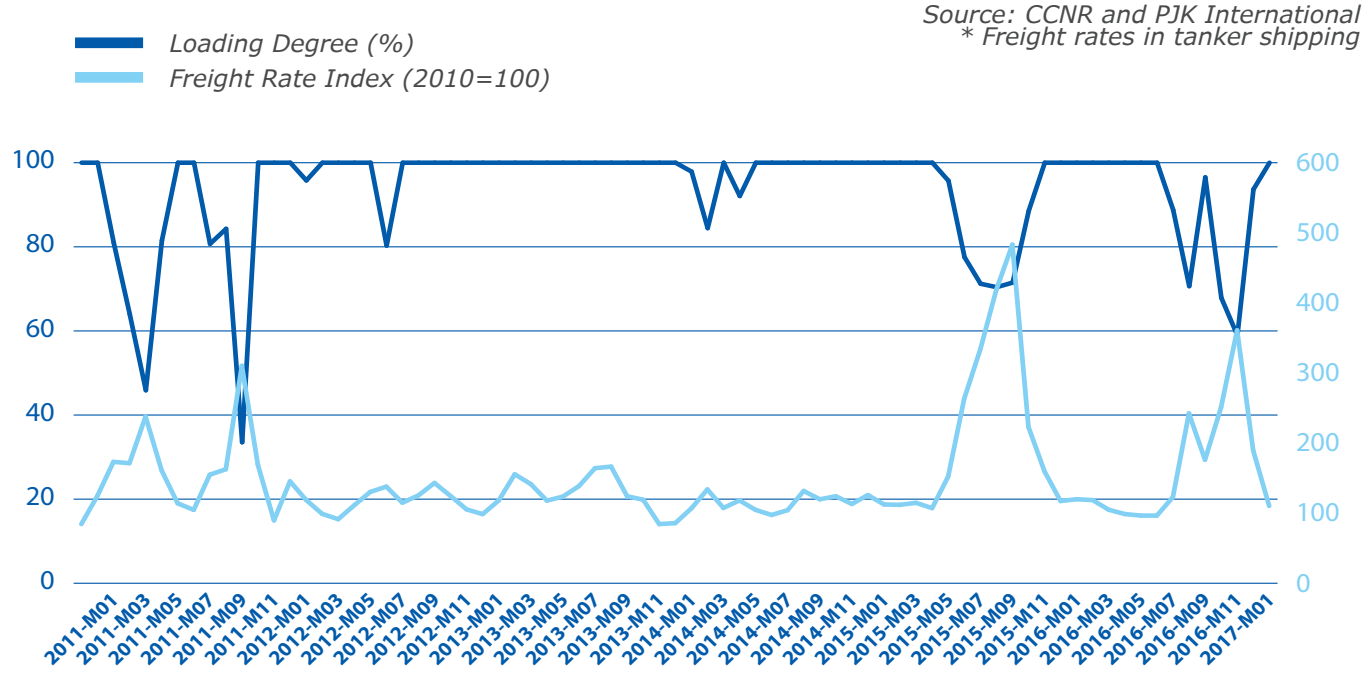
Source: Destatis, WSV, BfG



Since 2013, the Rhine river has experienced two lasting periods of low water level that have had a significant impact on volumes transported through inland navigation, at the end of 2015 and at the end of 2016. While all the segments of transport were impacted, it is nonetheless interesting to note that segments of liquid cargo and containers quickly returned to the previous level of volumes transported in 2016, even surpassing it, while dry cargo segment traffic did not return to its initial level and was impacted throughout the whole of 2016. Hysteresis effect is greater for dry cargo inland navigation transport and, despite improving water conditions, the transport performance remains lower for a longer time period.

*Figure 8: Maximum loading degrees at Kaub (Middle Rhine) for vessels with a draught of 2.5m compared with Freight Rate Index**

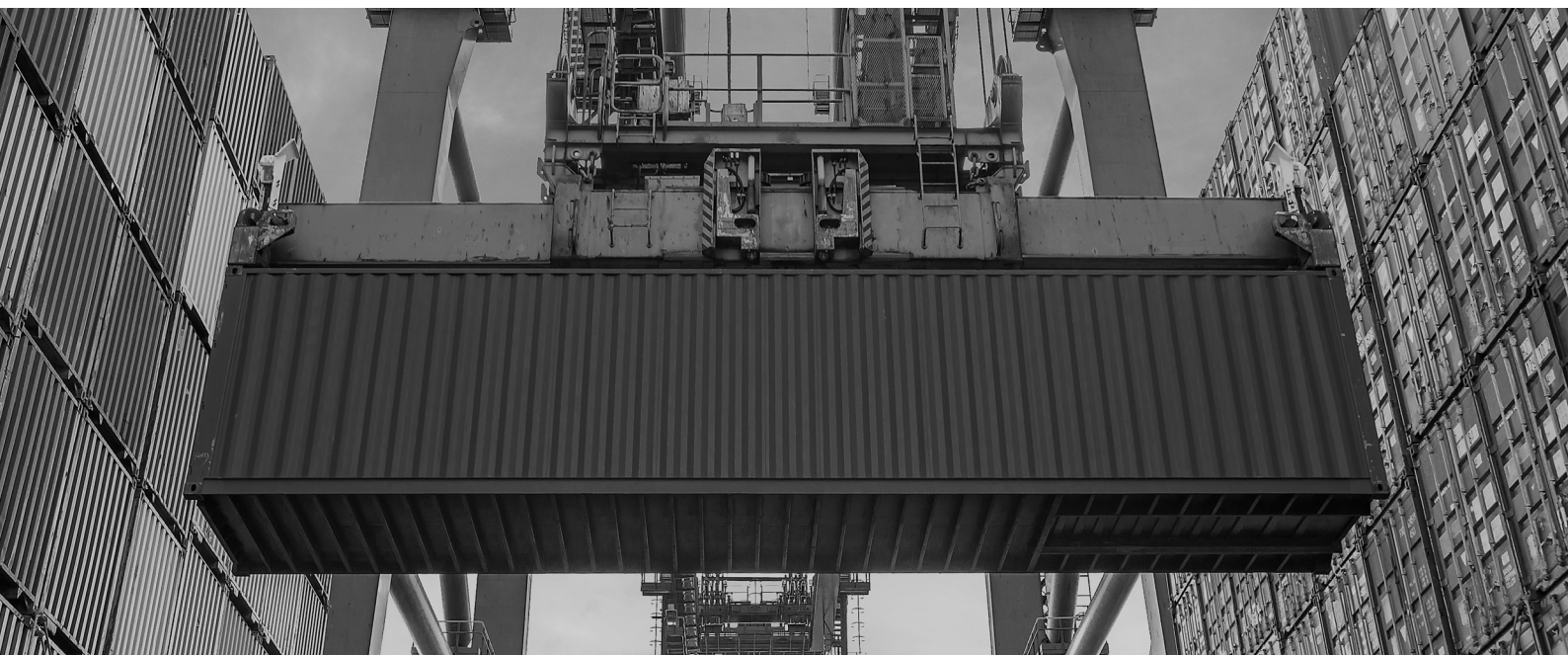
Source: CCNR and PJK International
** Freight rates in tanker shipping*



From the beginning of the implementation of NAIADES II in 2014, the Rhine river registered two significant low-water periods at the end of 2015 and at the end of 2016 that raised some concerns concerning the increased frequency of these low water periods on the impact on inland navigation activity and competitiveness.

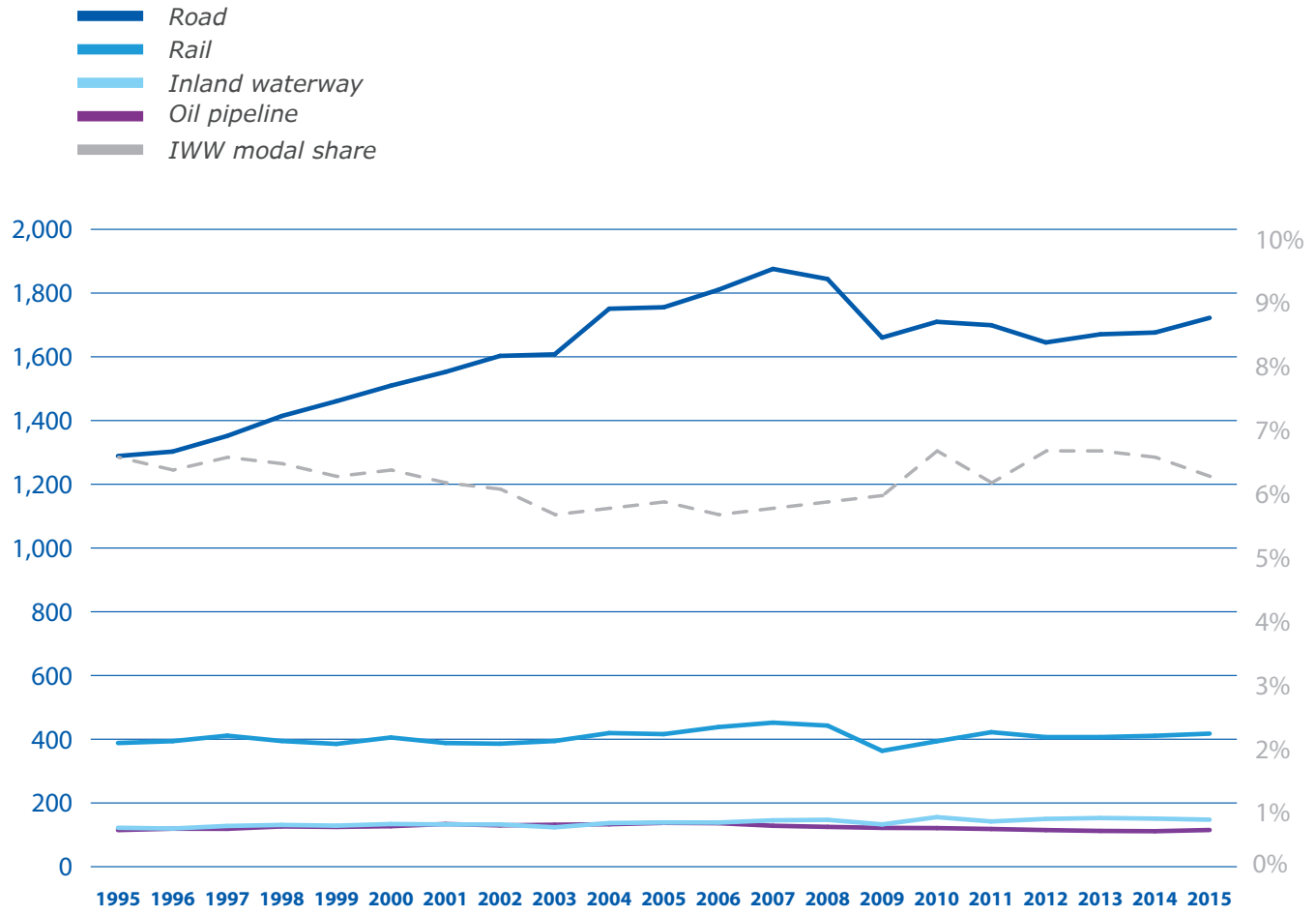
The expected impact of climate change is analysed regularly. Some analyses are conducted in the frame of European Union financing such as the projects concerning climate change in the Danube Transnational Program[1] or the projects conducted by the Joint Research Centre.[2] Other projects are coordinated by International Organisations such as the RheinBlick 2050 project,[3] coordinated by the CHR (International Commission for the Hydrology of the Rhine Basin). This scientific research project rendered its conclusions in 2010: while impacts of climate change on river flows can be expected in the far future (between 2071 and 2100), no clear signal of increased periods of low flows and high flows can be derived from the analysis in the near future (until 2050). This report contains limitations and uncertainties and it will need to be updated with latest water conditions data. This will actually be carried out once again, after the end of 2017, in order to keep monitoring closely past changes and expected future changes in river flows. Such monitoring is crucial in order to better anticipate impacts on inland navigation and thus anticipate measures to adopt.

[1] *http://climate-adapt.eea.europa.eu/countries-regions/transnational-regions/danube*
[2] *https://ec.europa.eu/jrc/en/research-topic/climate-change*
[3] *http://www.khr-chr.org/en/project/impact-regional-climate-change-discharge-rhine-river-basin-rheinblick2050*



1.4 MULTIMODAL CONTEXT

Figure 9: EU 28 freight transport performance by mode of transport (billion TKM)
Source: Eurostat



Taking into account all types of goods and all countries in the European Union, the modal share of inland navigation has remained around 6% over the last 20 years (taking into account road transport, rail transport, pipeline transport and inland navigation transport). It ranged between 5.5% in 2003 and 6.5% in 2010, 2012 and 2013. From this very high-level view, inland navigation seems to be one of the most resilient transport modes in periods of economic crisis since its modal share increased between 2007 and 2010. However, this modal shift from road to inland waterway transport during those three years was not robust and durable because the inland navigation modal share decreased between 2013 and 2015 from 6.5% to 6.1%.

Of course, one would need to go deeper into detail in order to draw conclusions because inland navigation modal share varies a lot from one country to another and from one product segment to another. These differences are illustrated in the next two graphs and can be explained by many factors (availability of waterways network, presence of industries requiring inland navigation transport). A more specific analysis on modal share evolution will be conducted in chapter 2, part 2.5.

Figure 10: Inland waterway transport modal share per country (in % based on transport performance – inland waterway, road and railway transport taken into account)

Source: Eurostat

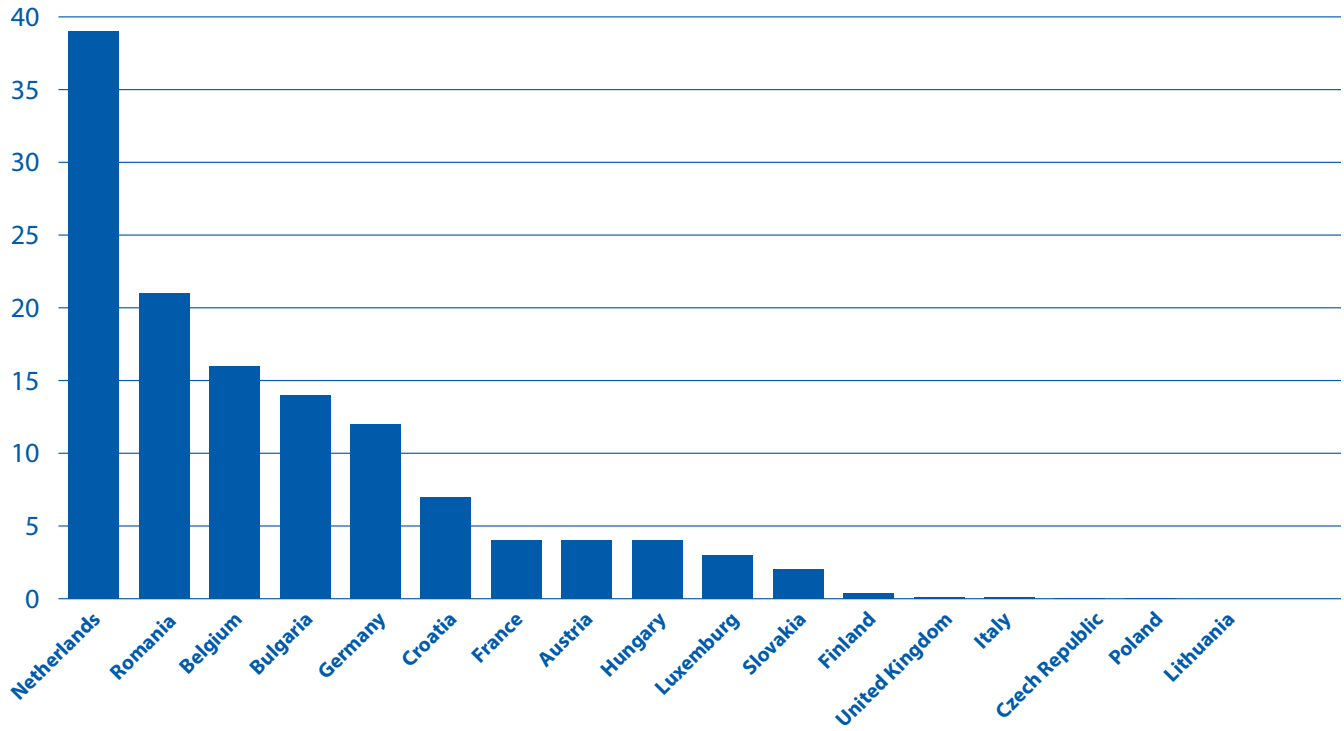
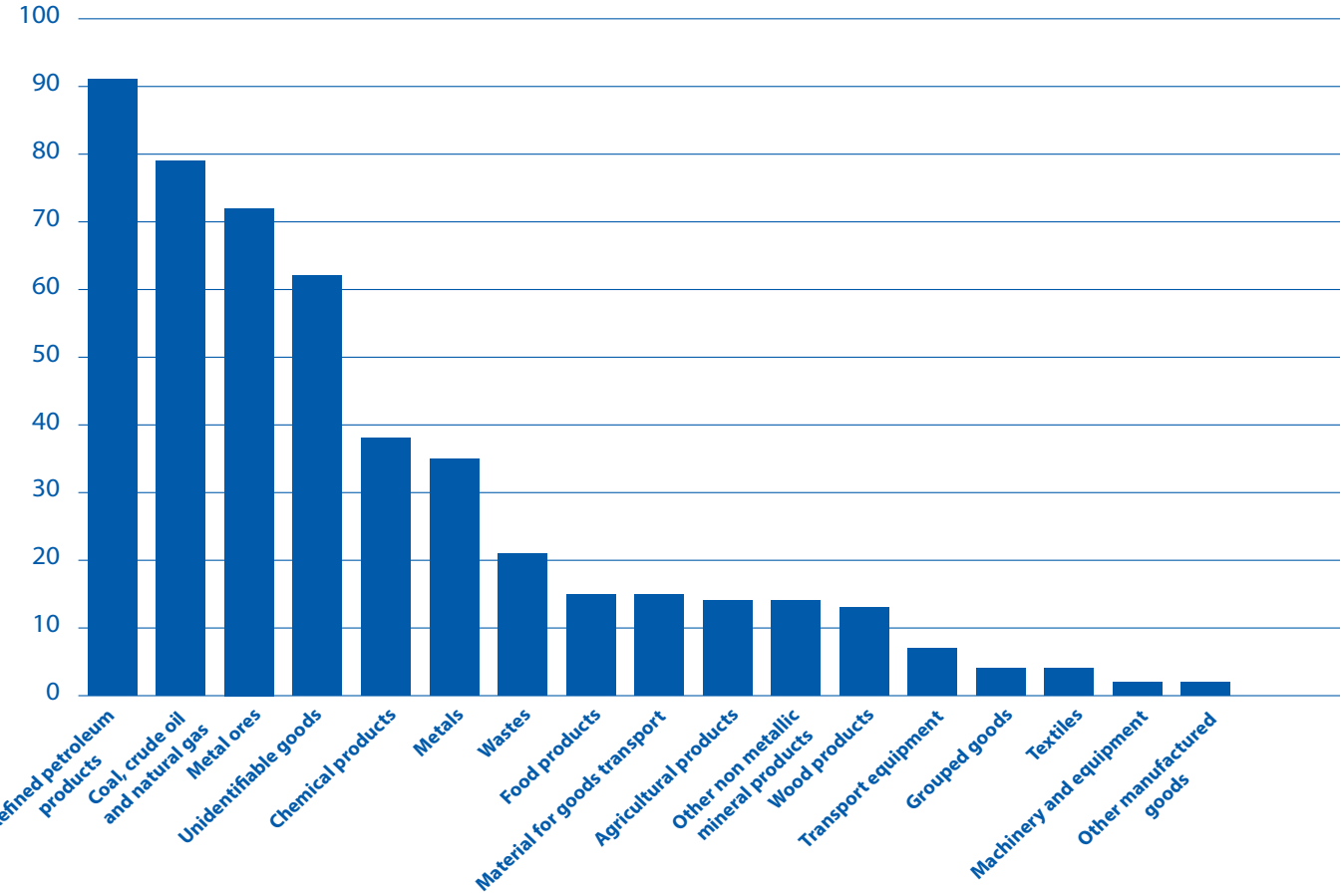


Figure 11: Inland waterway transport modal share per type of goods in the Netherlands (in % based on transport performance – inland waterway, road and railway transport taken into account)

Source: Eurostat

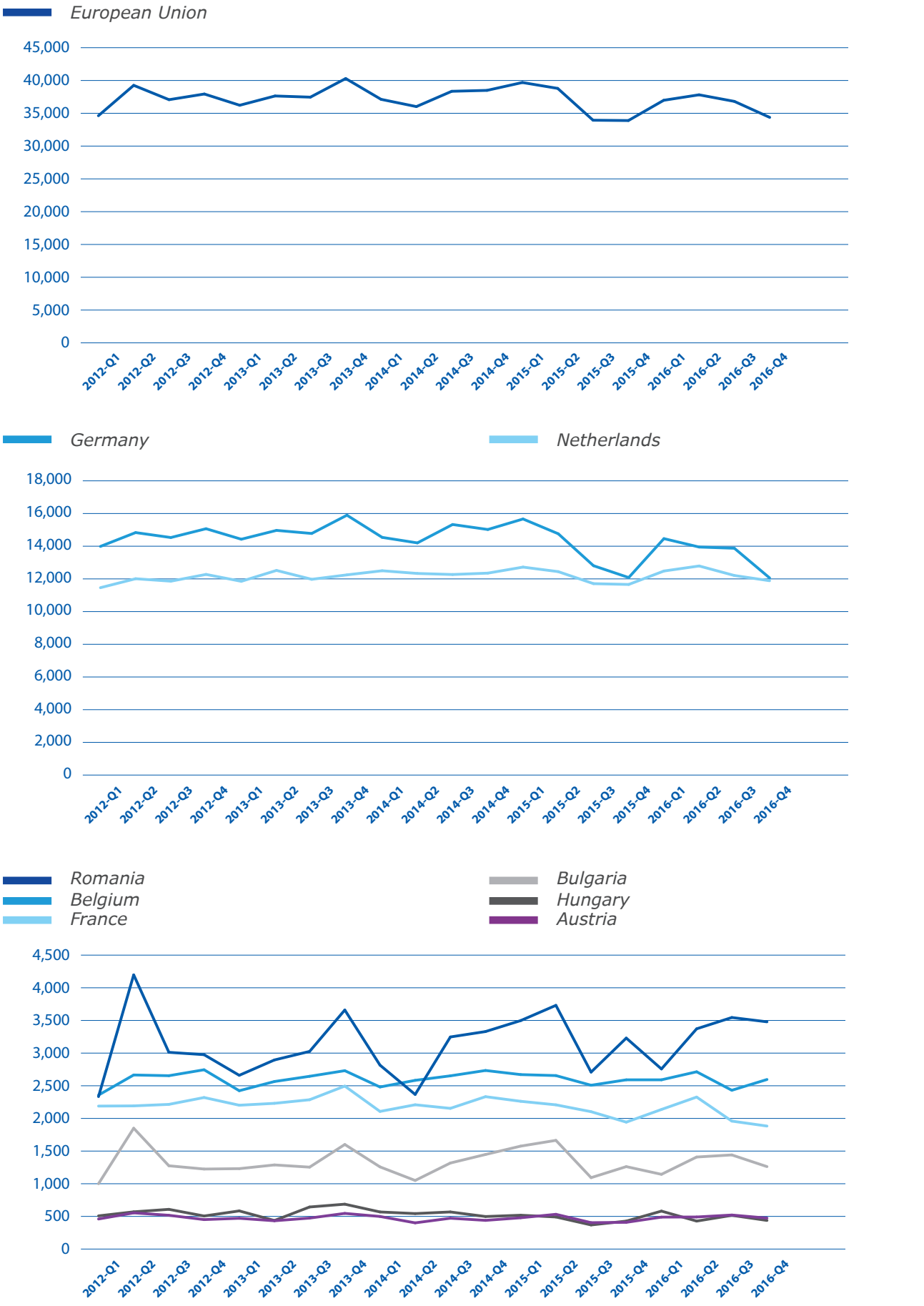


2. FREIGHT TRAFFIC EVOLUTION

2.1 GENERAL TRAFFIC EVOLUTION

Figure 12: Quarterly transport performance evolution in the EU and in main IWT EU countries (transport performance in million TKM)

Source: Eurostat



2 | Freight traffic evolution

The total IWT transport performance in the European Union reached 145 billion TKM in 2016 and decreased by 1% compared to 2015, with the most important decrease from eight main IWT European countries being observed in Luxemburg, France and Germany, with respectively 19%, 2.5% and 1.7% decrease in transport performance in 2016 compared to 2015. Overall in Europe, the evolution of inland navigation transport performance oscillated between 145 and 152 billion TKM over the last five years, lower yearly transport performance being registered in 2015 and in 2016. These two years actually experienced lasting low water periods that negatively affected the maximum loading degrees and, as a consequence, overall transport performance.

Despite low water periods and external economic shocks, the level of inland navigation transport performance in Europe remains rather stable with quarterly transport performance levels being in a 20% range over the last five years. This stability over time demonstrates robustness towards external shocks, whether environmental or economic. This feature is strongly influenced by transport performance in the Netherlands and Belgium where the difference between the higher level of quarterly performance and the lower one is respectively 12% and 16% over the last five years. This reaches 30% in France and Germany and goes up to more than 80% in Danube countries like Romania and Bulgaria.

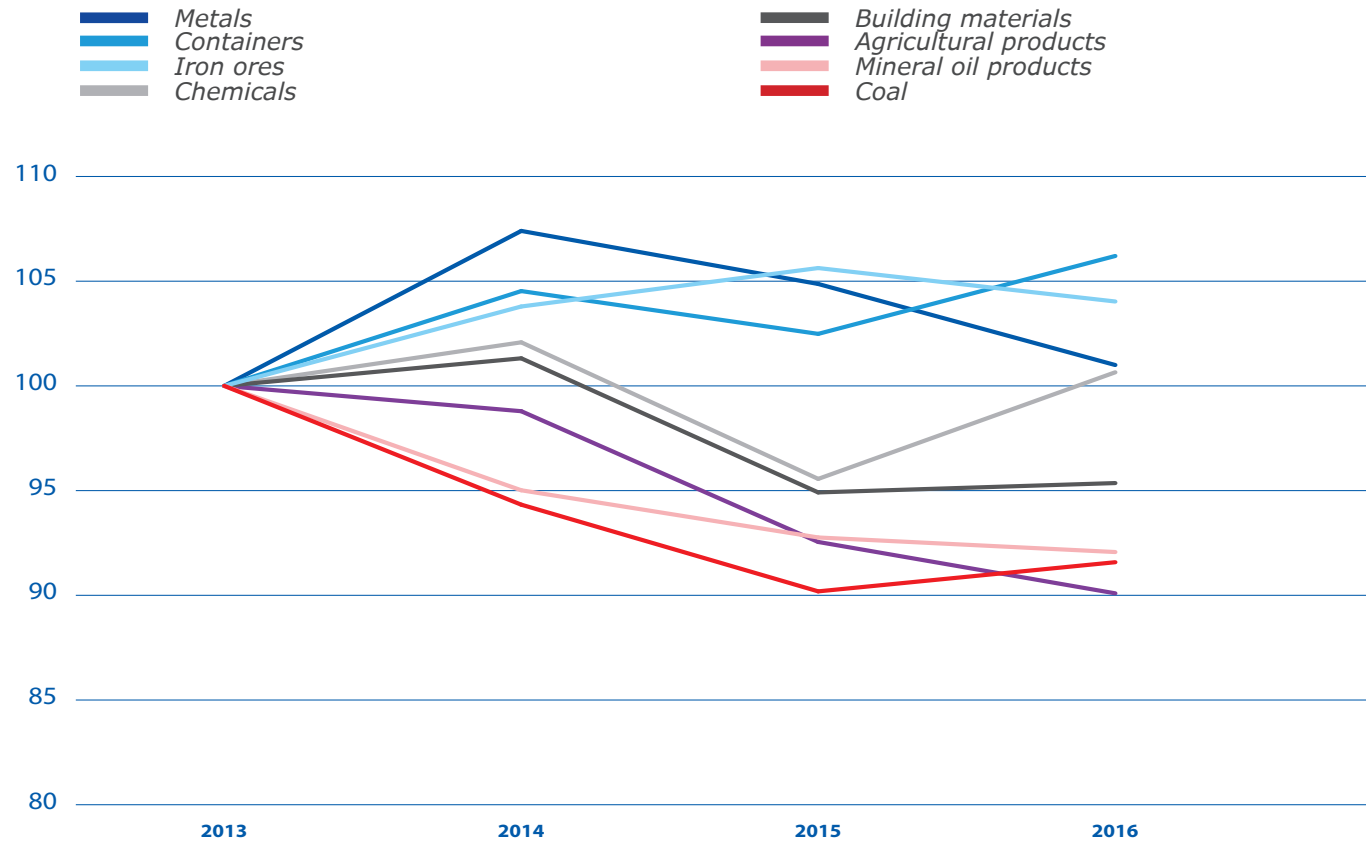
The higher transport performance volatility in the Danube region can be explained by several factors. The higher specialisation of inland navigation transport weakens the sector to external economic shocks. And actually, in the Middle Danube, agriculture and the steel industry account for more than 80% of goods transported. Another factor can be the state of infrastructure and of maintenance. Maintenance efforts are performed on a national and multinational level with bilateral agreements and commitments on maintenance or with European-financed programmes financed through the Connecting Europe Facility (Fairway Danube Project) and the Danube Transnational Program (Danube Stream project).

Looking precisely at the 2016 market situation, concrete explanations for transport performance evolution can be derived. Luxemburg and France, in particular, are two countries where inland navigation activity strongly relies on the transport of agriculture products, and the bad harvests in 2016 therefore significantly impacted inland navigation traffic in those two countries. The transport of agricultural products represents 25% of inland waterways transport performance in France, and this transport decreased by more than 20% in 2016 compared to 2015 (Source: VNF data).

The evolution of transport performance in Germany and the Netherlands also highlights the effect of the two periods of low water in the Rhine region at the end of 2015 and at the end of 2016. A difficult recovery of volume transported in 2016, especially on dry cargo segments, largely explains the transport performance decrease in Germany in 2016.

Figure 13: Yearly evolution of volume of goods transported by IWT by type of goods in the Rhine area (Index 100 in 2013 based on yearly volume transported on the Traditional Rhine)

Source: Destatis, CCNR analysis



Inland navigation transport evolution differs from one transport segment to another. Because of the high level of variance on the Danube, Rhine transport evolution will be taken into account in order to compare the evolution for different transport segments and to isolate trends.

The transport of coal, mineral oil products and building materials has undergone similar development over the past four years. While the volume transported in 2016 was in the same order of magnitude compared to 2015 (between +2% and -1% between 2015 and 2016), the volume transported in 2016 was significantly lower than in 2013 and in 2014. This is due to the fact that the low water periods, even if they were limited in time in 2016, were not compensated by dynamic activity during the rest of the year. Still, the long-term evolution appears to be quite different for these three segments. The volume of building materials transported on the Rhine has nearly halved over the last 20 years, but an expected increase in the house building industry over the coming years, especially in the Netherlands and in France, could support the transport of building materials. The decrease has not been as great for the mineral oil products segments but it also decreased from approximately 35 million tonnes transported 20 years ago to 28 million tonnes transported in 2016. Coal transport on the Rhine has been pushed by the increasing coal import from Germany. But a shift in German energy public policies towards renewable energies has started to trigger a decrease in coal transport that is expected to continue over the coming years.

Transport of chemical products and containers are two segments that have experienced a significant increase over the last 20 years. The volumes transported on the Rhine have almost doubled for chemical products and tripled for containers. The volumes are not even impacted so much during years experiencing low water periods; the volumes transported remained the same for chemical products in 2016 compared to years 2013 and 2014 and even increased for containers.

The situation of the transport of agricultural products is particular because it was strongly and negatively impacted by the bad harvest in 2016. This explains the decrease of close to 10% in 2016 compared to years 2013 and 2014. Apart from this conjectural event that impacted the agricultural product segment in 2016, the long-term evolution of transport of this type of goods is rather positive, being one of the most dynamic segments of the cargo segment over the last ten years.

The comparison of the evolution of metals and ores transport is interesting because the transport activity for these two types of goods is mainly driven by the steel industry. Looking at the long-term past evolution, it appears that ores transport has decreased while metals transport has remained stable; this can be explained by the fact that the steel industry has increased the efficiency of use of raw materials[4]. But looking at the evolution since 2013, the ores transport evolution is positive while that of metals transport is not so positive (it should be noted that the evolution has a limited order of magnitude, +4% for ores transport between 2013 and 2016 vs +1% for metals transport). An explanation could be that the metals transport segment is more sensitive to modal shift towards road transport, in particular in periods of low water. Storage capability increase can be used more easily for ores than for metals because of quality issues.[5]

2.2 SPECIFIC CASES

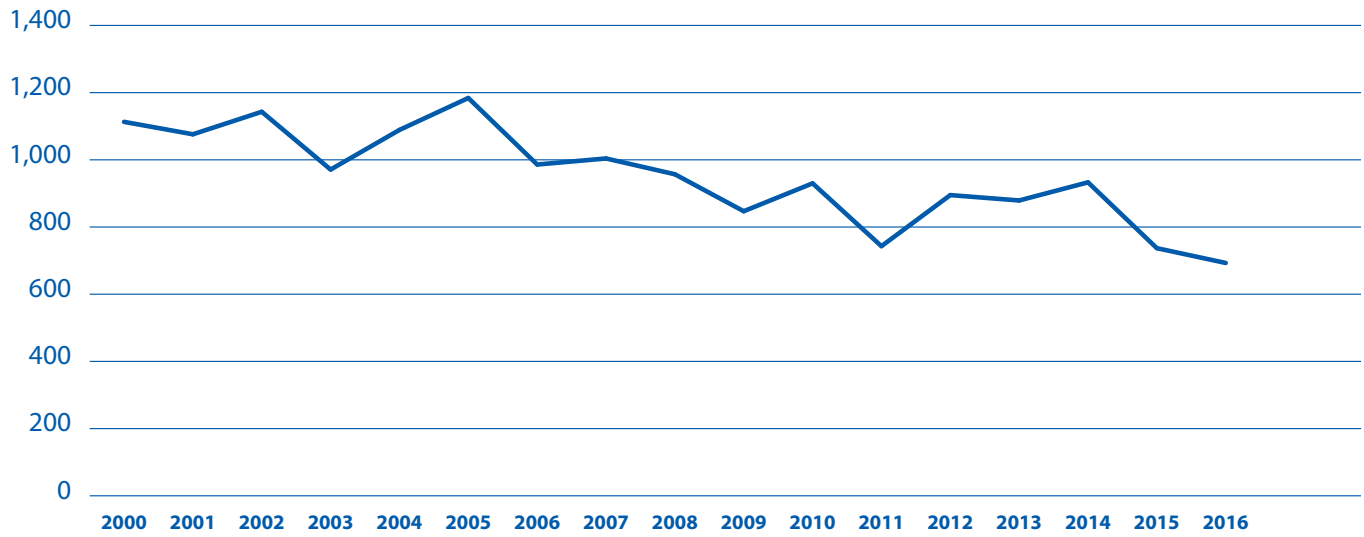
Danube - Main Canal

The Main-Danube Canal connects the Main and the Danube in Bavaria, in the south of Germany. This canal was completed in 1992 and connects two major European rivers the Rhine and the Danube. The canal channel is adapted to vessels up to 190 meters long and 11.45 meters wide and gives the possibility for these vessels to go from the North Sea to the Black Sea via the Rhine, the Main and the Danube.

While the level of transport performance is aligned with initial forecasts and reached nearly 1.2 billion tonne-kilometers in 2005, it has been decreasing since then, going down to nearly 50% of this value in 2016.

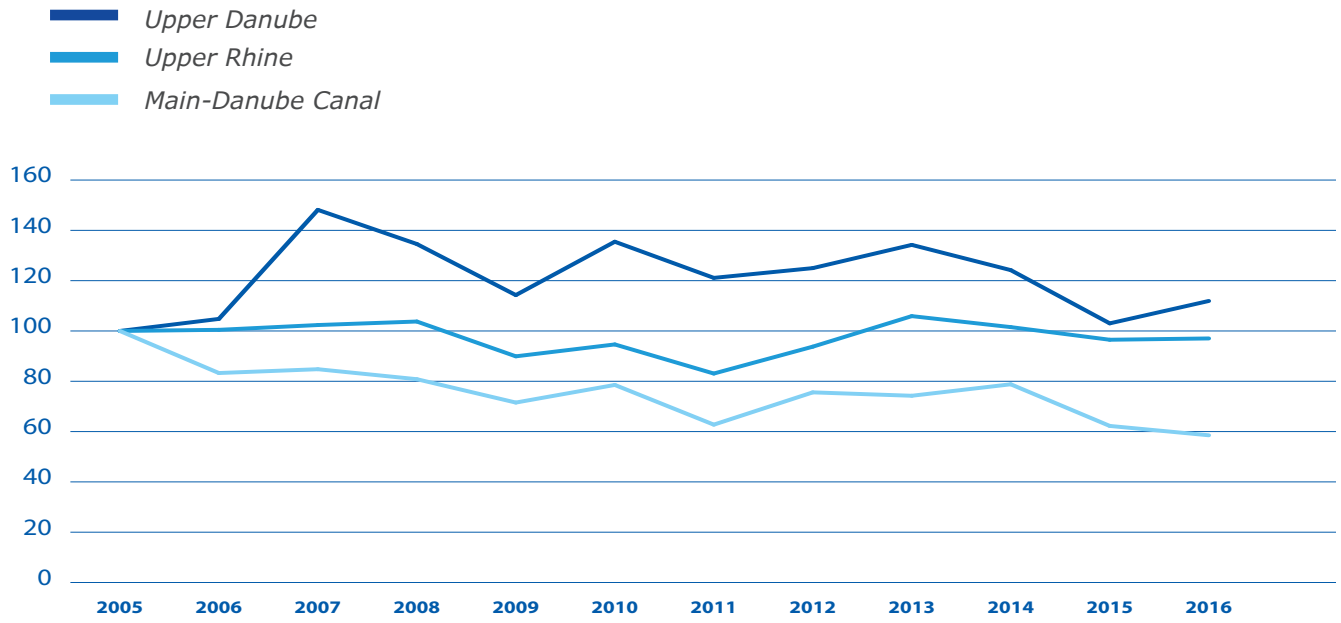
Figure 14: Main-Danube Canal transport performance in million TKM

Source: Destatis



[4] Source: German Steel Industry association – report "Ways of efficiency in the steel industry" (2010)
[5] Source: Market Observation Report of the German Federal Office of Goods Transport

Figure 15: Main-Danube Canal, Upper Rhine and Upper Danube transport performance index since 2005
Source: Destatis, Eurostat



Note: Upper Rhine transport performance is related to transport performance between Rheinfelden and Bingen/ Upper Danube transport performance is related to transport performance on the Austrian Danube

This development is all the more interesting in that traffic performance on the Upper Rhine has remained rather stable over the same period and traffic performance on the Upper Danube has even increased during that time.

Several explanations can be raised to explain the traffic decrease on the Main-Danube Canal even though one should be aware that multiple factors are at stake. Some reasons are actually not limited to the evolution on the Main-Danube Canal and are factors that impact the traffic on a larger scale. 2009 traffic was impacted because of the effect of the economic crisis; 2011, 2015 and 2016 traffics were impacted because of the effect of lasting low water periods.

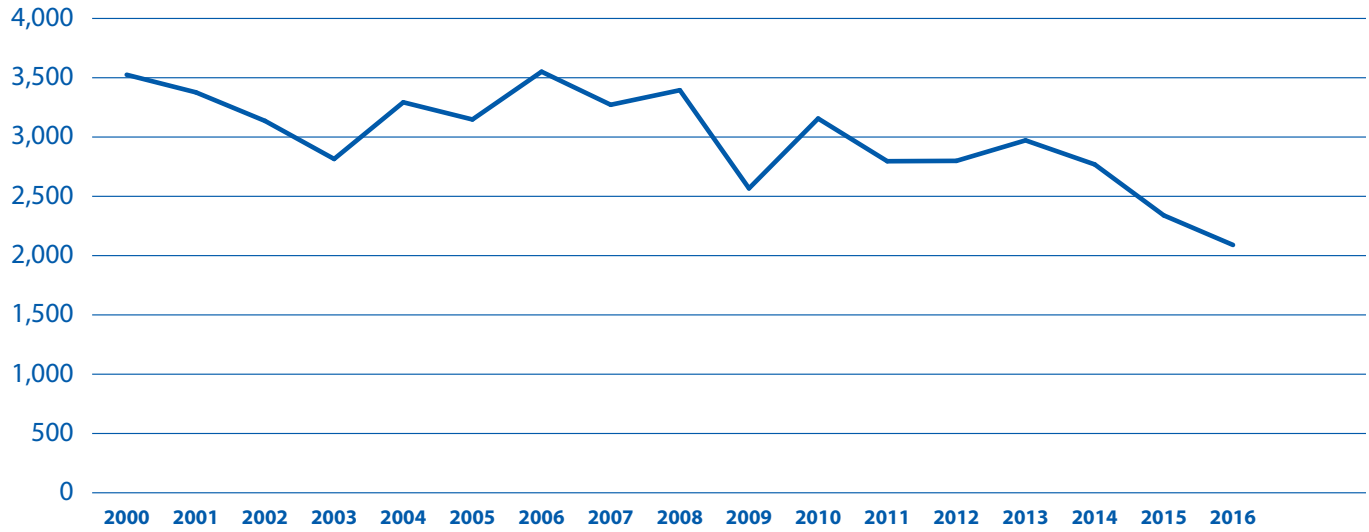
But some other explanations are more specific to the Main-Danube Canal and could explain the divergence between the Main-Danube Canal traffic on the one hand and the Upper Rhine and Upper Danube traffic on the other hand. While only 3% of the European fleet built before 1992 was not compatible with canal channel size, 13% of the European inland navigation fleet built after 1992 and in service today is not compatible with the canal. This is mainly due to width issues with many new vessels having a width greater than 11.45 meters (source: IVR). Even if this does not explain the observed decrease, this could have a limiting effect on growth potential.

External regional, economic and environmental factors are more suited to explain transport decrease since 2005. The closure of coal power plants leading to the decline of coal transport, and warmer winters leading to mineral oil transport impacted inland navigation transport. Furthermore, in addition to low water periods that are also experienced on the Rhine and the Danube, the canal is also subject to icy periods that can hamper traffic. The beginning of years 2010, 2011, 2012 and 2017 were for example significantly impacted by ice barriers for periods ranging from 10 to 30 days (source: WSV). The transport of metal products and transport of agricultural products decreased roughly by the same extent between 2005 and 2015, respectively by 45% and by 40% (source: WSV). But the reason for this decrease is not only due to developments in the economic context, in particular for agricultural products transport. Actually, Danube countries today mainly ship their agricultural products to the Black Sea. This explains, to a certain extent, the increase of the traffic on the Danube but a decrease on the Main-Danube Canal.

Moselle

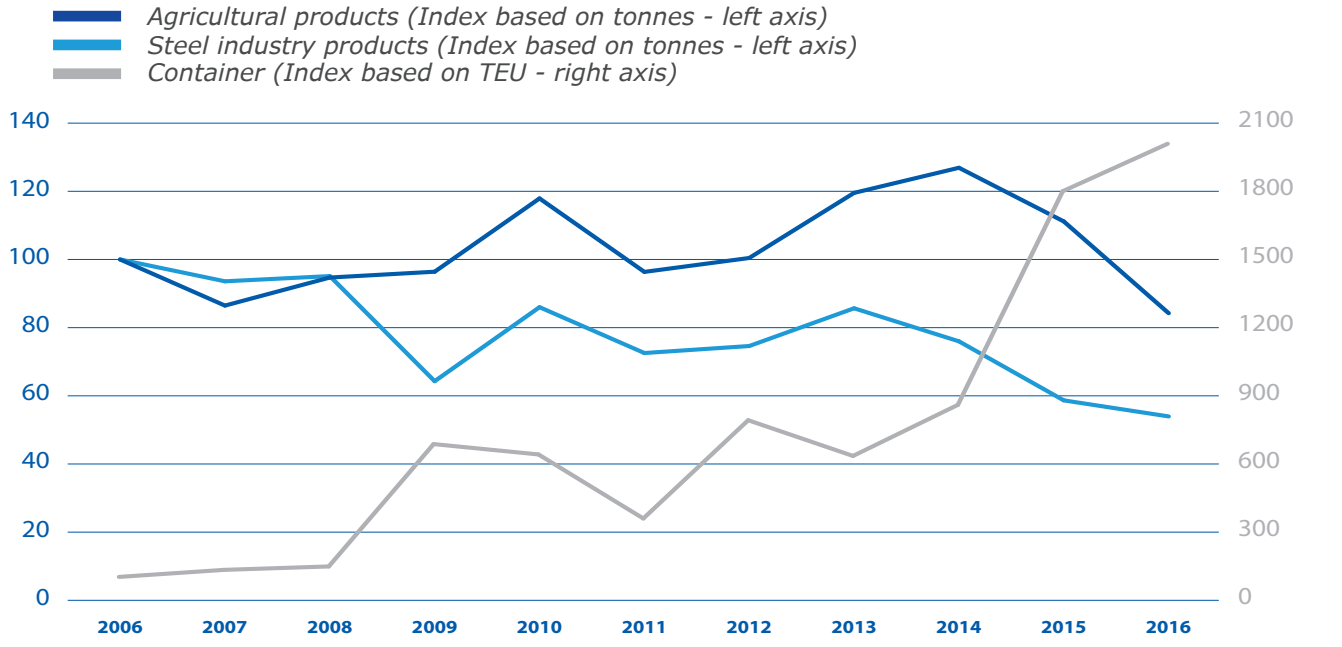
The Moselle runs from Eastern France to Germany through Luxemburg, and inland navigation transport mainly relies on agricultural products, raw materials for the steel industry and more and more on container transport. However, over the last decade, the transport performance on the Moselle has decreased by 30%.

Figure 16: Moselle transport performance in million TKM
Source: Destatis



The main explanation is the evolution of the economic context in the region with the closure of several important steel production plants. Between 2006 and 2016, over 10 years, the transport of products related to the steel industry has decreased by 46% on the Moselle (source: Moselle Commission). This segment represented 60% of the volume of goods transported on the Moselle; this significant share explains the impact on the overall transport performance on the Moselle.

Figure 17: Evolution of agricultural products, steel industry products and container transport volumes on the Moselle (Index 100 in 2006)
Source: Moselle Commission



Note: all data is based on Koblenz lock and container data, taking into account full and empty containers

Actually, transport evolution on the Moselle is more positive if we focus on other transport segments. The transport of agricultural products is on a slightly positive trend (although it was strongly impacted in 2016 by bad harvests during the summer of 2016 in France).

Similarly, container transport has been booming since 2008. Container transport is the most dynamic segment; while it had doubled between 2014 and 2015, container traffic increased by 12% between 2015 and 2016. But absolute transported volumes remain very small compared to steel industry products and cannot compensate the decrease due to steel activity decrease.

2.3 CONTAINER TRAFFIC EVOLUTION

The Moselle is not the only river where container transport is increasing. Container transport is today very concentrated in four countries (Netherlands, Germany, Belgium and France) and is the fastest-growing segment on the Rhine.

Figure 18: Distribution of container transport performance on inland waterways in 2016 in the EU
Source: Eurostat

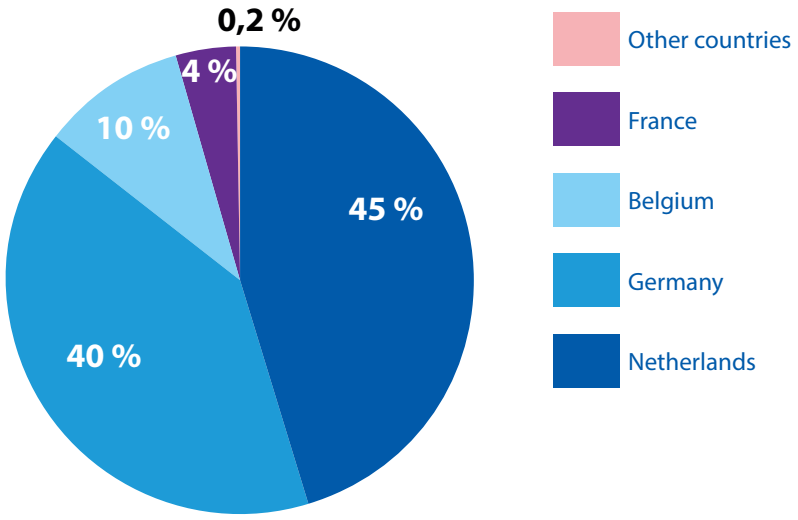
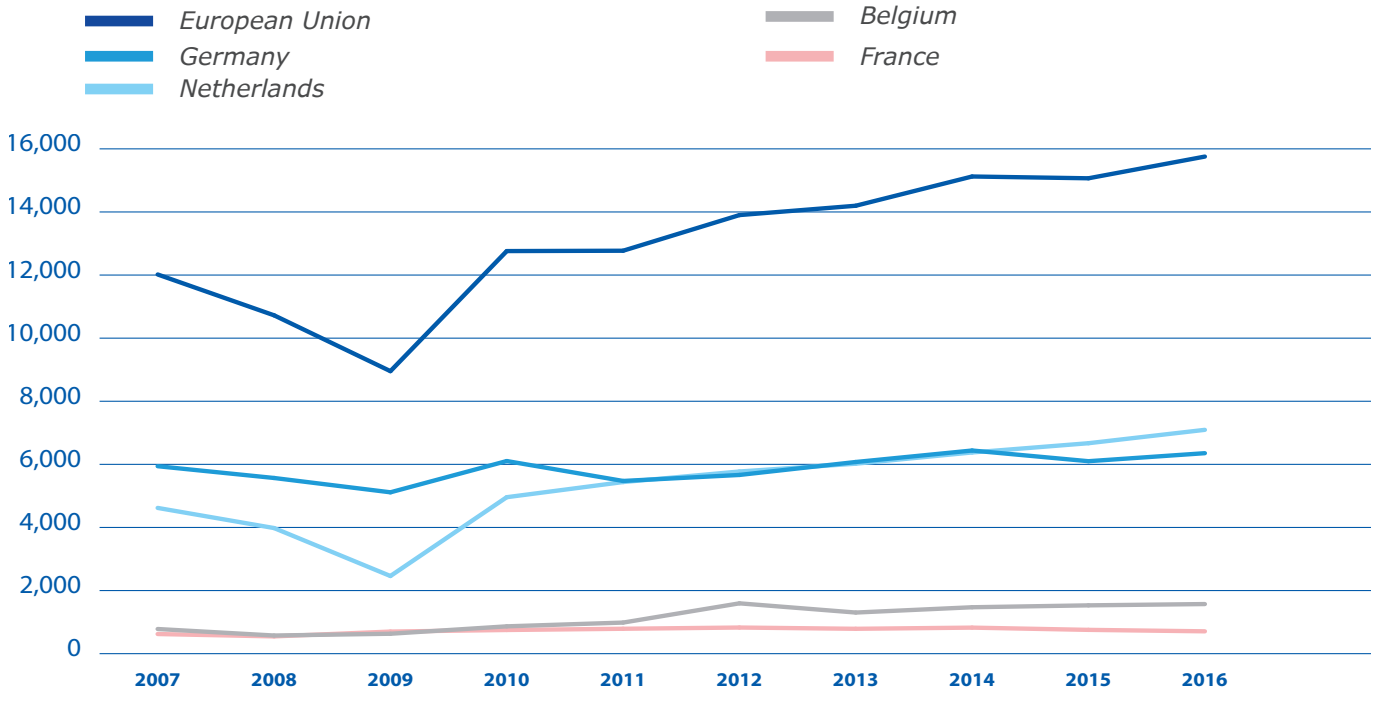


Figure 19: Container transport performance on IWW in the EU (transport performance in million TKM)
Source: Eurostat



Container transport on inland waterways is almost exclusively present in the Netherlands, Belgium, Germany and France with a share of European Union transport performance higher than 99%. Rhine area infrastructures and good connections with the two major European sea ports for container traffic, Rotterdam and Antwerp, partly explain dynamic container transport on inland waterways in the Rhine area.

Container traffic occupies a major place in the economy of inland navigation. On a European scale, over 15 billion TKM were transported by inland waterways in 2016, an increase of 31% over 10 years. Compared to 2015, the transport of containerised goods increased by 4.6%. This current increase is partly due to main sea ports activity; 36% of the container hinterland transport in the Port of Rotterdam was ensured by inland navigation in 2016 and current port policies aim at increasing the inland navigation modal share (source: Port of Rotterdam).

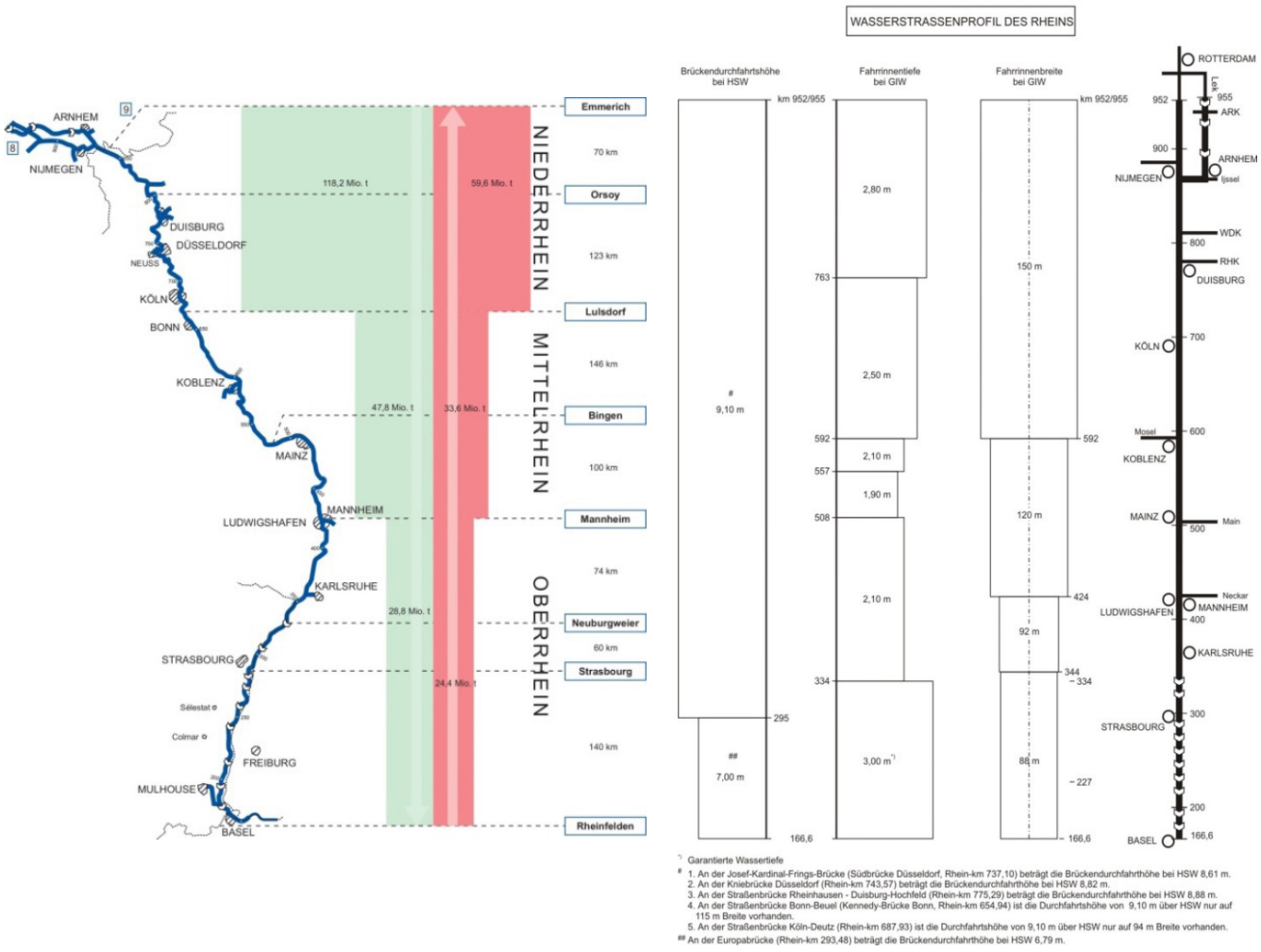
2.4 BOTTLENECK MANAGEMENT

As we have seen previously, inland navigation transport is subject to economic and environmental external shocks. Robustness towards economic shocks requires diversification and adaptation. In particular, some segments are not expected to give much growth potential in the future while other transport segments such as container transport, waste transport and more generally urban transport related to the circular economy are growing segments. Inland navigation will need to adapt and to penetrate new markets to find new growth vectors.

Inland navigation transport will be all the more competitive if it is reliable. Inland navigation therefore needs to reduce negative externalities due to environmental shocks. Of course, rivers have to be considered as evolving transport ways and cannot be fully regulated, but anticipation, maintenance, rehabilitation and efficient bottleneck management can help reduce externalities.

Figure 20: Transport volume in 2013 on the Rhine and waterway profile of the Rhine

Source: CCNR



Garantierte Wassertiefe

1. An der Josef-Kardinal-Frings-Brücke (Südbrücke Düsseldorf, Rhein-km 737,10) beträgt die Brückendurchfahrthöhe bei HSW 8,61 m.
2. An der Kniebrücke Düsseldorf (Rhein-km 743,57) beträgt die Brückendurchfahrthöhe bei HSW 8,82 m.
3. An der Straßenbrücke Rheinhausen - Duisburg-Hochfeld (Rhein-km 775,29) beträgt die Brückendurchfahrthöhe bei HSW 8,88 m.
4. An der Straßenbrücke Bonn-Beuel (Kennedy-Brücke Bonn, Rhein-km 654,94) ist die Durchfahrtshöhe von 9,10 m über HSW nur auf 115 m Breite vorhanden.
5. An der Straßenbrücke Köln-Deutz (Rhein-km 687,93) ist die Durchfahrtshöhe von 9,10 m über HSW nur auf 94 m Breite vorhanden.

An der Europabrücke (Rhein-km 293,48) beträgt die Brückendurchfahrthöhe bei HSW 6,79 m.

Bottlenecks on the TEN-T network were identified in the context of the European Commission's corridor activities and can be found in the TEN-T corridor studies[6] and work programmes[7]. Although the term bottleneck is commonly used in publications,[8] it might lead to misunderstanding or superficial understanding of underlying issues. Hence, it seems more appropriate to use a broader definition and to refer to capacity and performance issues instead, as already adopted in the corridor work programmes regarding inland waterways. Solving bottlenecks related to capacity and performance issues can cover compliance with TEN-T fairway criteria but also replace old lock doors, adapt groynes, improve fairway stability, automation of infrastructure, resize pump stations, improve berth and emergency access and all other issues that lead to improved inland waterway transport capacity and performance.

In the figure above, the transport volume on the Rhine is put next to the waterway profile of the Rhine. Although some parts of the Rhine may not comply with criteria laid down in the TEN-T regulation for draught[9] and some parts were identified as bottleneck in the respective corridor study, for example a stretch with a fairway depth of 1.90 m[10] at the Middle Rhine, a significant transport volume can be seen on the Rhine. This shows that qualitative criteria such as reliability and predictability – and economic demand factors – are as important as quantitative criteria (current TEN-T criteria) for the generation of transport volumes. A study by the German waterways and shipping administration also indicates that even without measures to alleviate impacts of identified capacity issues, transport on the Rhine is expected to increase from 2010 to 2030 by 25%. Hence, to identify performant navigation, an analysis of quantitative fairway parameters like fairway depth, headroom of bridges and fairway width might not be sufficient. Qualitative parameters in interaction with external effects like market demand and fleet structure need also to be taken into account amongst other things.

In 2001, a major project on the deepening of the Moselle fairway was completed. From 1992 to 1999, the sections from Koblenz to Richemont were deepened from originally 2.70 m to a depth of 3.00 m. Although fairway conditions improved on the Moselle, figure 16 shows that transport performance on the Moselle dropped in the following years. This example indicates that when markets are in transition, in this case a shift from steel to new cargo segments, measures to alleviate impacts of identified capacity issues do not immediately lead to an increase in transport performance/transport volume. In this case, external market factors need to be taken into account in planning measures as well. In general, the pre-dominantly long-haul nature of inland waterway transport also has to be taken into account – improvements of individual waterway stretches are the basis for an overall international network improvement which can only be reached step-by-step. In 2017, Flanders transported more than 72 million tonnes on its waterways, an increase by 6.5% in comparison with 2016, including an increase of container transport by 11.5%. Traffic has been growing every year since 2012. Continuous investment in maintenance, regeneration and upgrade of the inland waterway infrastructure is combined with a proactive policy promoting the use of inland waterway transport in new market segments.

To ensure efficient, reliable and safe navigation, the European Commission and Member States should agree on a common definition for criteria related to capacity, performance and service levels as well as methods and procedures for identifying bottlenecks. Based on this, a refined analysis of the TEN-T waterway network could be developed and critical issues could be identified.

Maintenance, rehabilitation and regeneration are key actions towards inland navigation reliability and performance. The aim is to extend the life of existing infrastructure, reduce the need for radical and expensive interventions and significantly improve the performance in order to increase reliability, availability, enhance climate resilience and welcome new transport concepts along transnational corridors. Any financial support ensuring more efficient maintenance, rehabilitation and regeneration activities can be helpful and cause positive results but one should bear in mind that these are long-run activities, part of an investment life cycle approach.

[6] For example: Rhine-Alpine Core Network Corridor Study, Final Report, December 2014, page 79
[7] For example: Rhine Alpine, Second Work Plan of the European Coordinator Paweł Wojciechowski, December 2016
[8] UNECE also identifies bottlenecks in the Inventory of Most Important Bottlenecks and Missing Links in the E Waterway Network (Resolution No. 49) (ECE/TRANS/SC.3/2017/5)
[9] Instead of referring to draught (measurement for ships), it is more appropriate to refer to depth of the navigable channel or fairway depth instead (measurement for infrastructure).
[10] Reference water level is the equivalent water level GlW (Gleichwertiger Wasserstand) which is available on minimum 345 days per year.

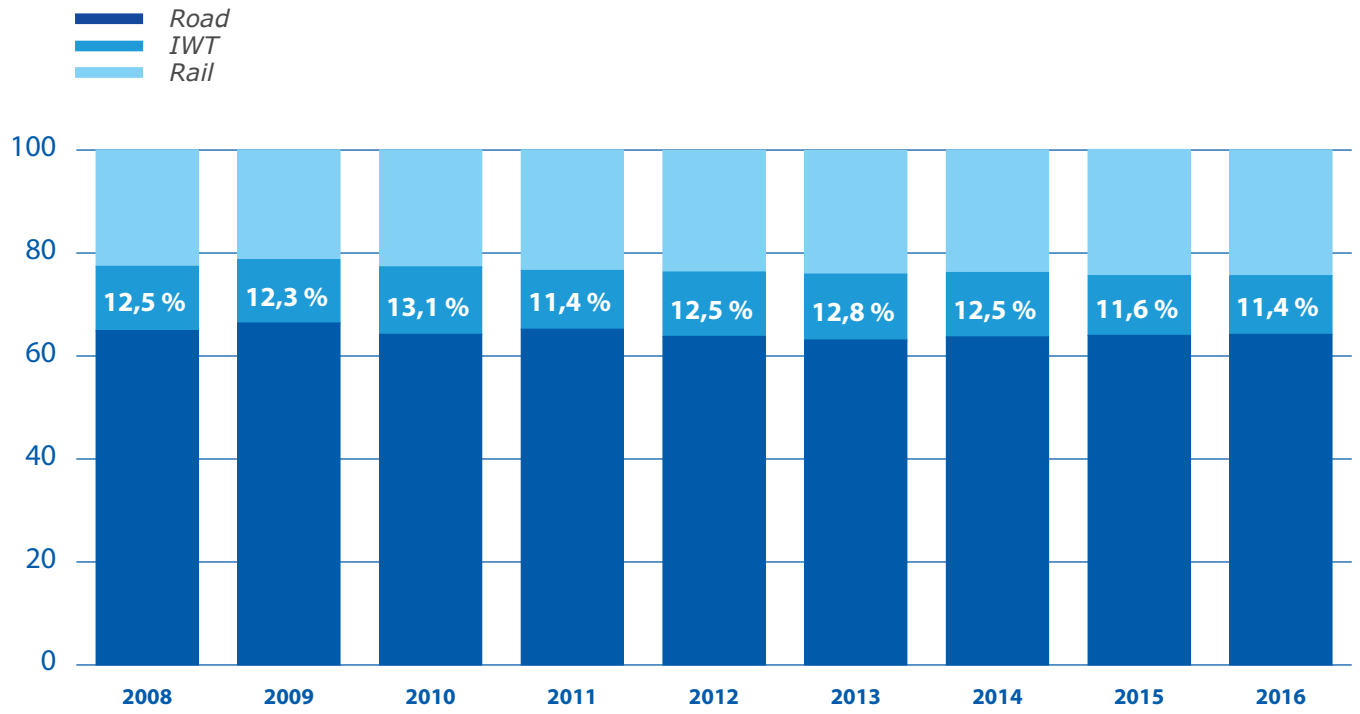
2.5 IWT MODAL SHARE EVOLUTION – FOCUS ON GERMANY AND ROMANIA

Evolution of IWT modal share for Germany

Germany is the country with the highest transport performance in inland shipping in the EU, with a share of around 37 %. The evolution of IWT's modal share in this country is therefore analysed in detail. The overall modal share of IWT stood at 11.4 % in 2016, and was therefore above the EU average.

One explanation for the evolution since 2008 is the occurrence of low water periods in the years 2011, 2015 and 2016. IWT's modal share decreased in these years compared to previous years. But, looking at the low water year 2011, we see an almost immediate recovery of IWT in the following years 2012 and 2013 (see following figure). In 2016 this recovery (from the low water year 2015) was not possible, as 2016 was again marked by a low water period in late autumn.

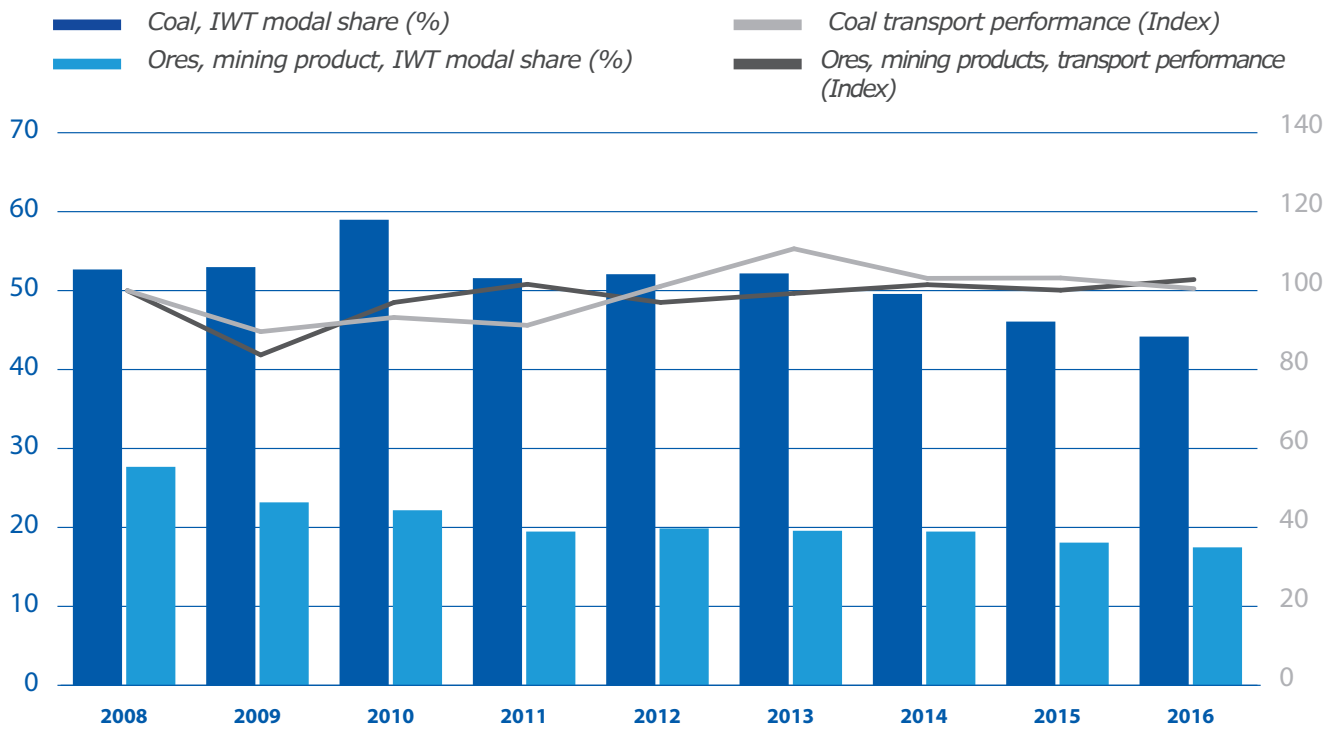
Figure 21: Overall modal split evolution in Germany
Source: CCNR based on Eurostat data on transport performance



A detailed analysis of all twenty NST 2007 product segments reveals that IWT lost market shares in traditional mass cargo segments. This concerns the transport of coal, ores, and other mining and quarrying products. Within coal transport, market shares were lost to rail, while shares were lost to road for mining and quarrying products (products related to the building industry). At the same time, the transport performance of these two NST 2007 segments stayed more or less constant between 2008 and 2016 (see following figure).

Figure 22: IWT modal share evolution for coal, ores, mining products and transport performance evolution for these segments (sum of IWT, rail and road) in Germany

Source: CCNR based on Eurostat

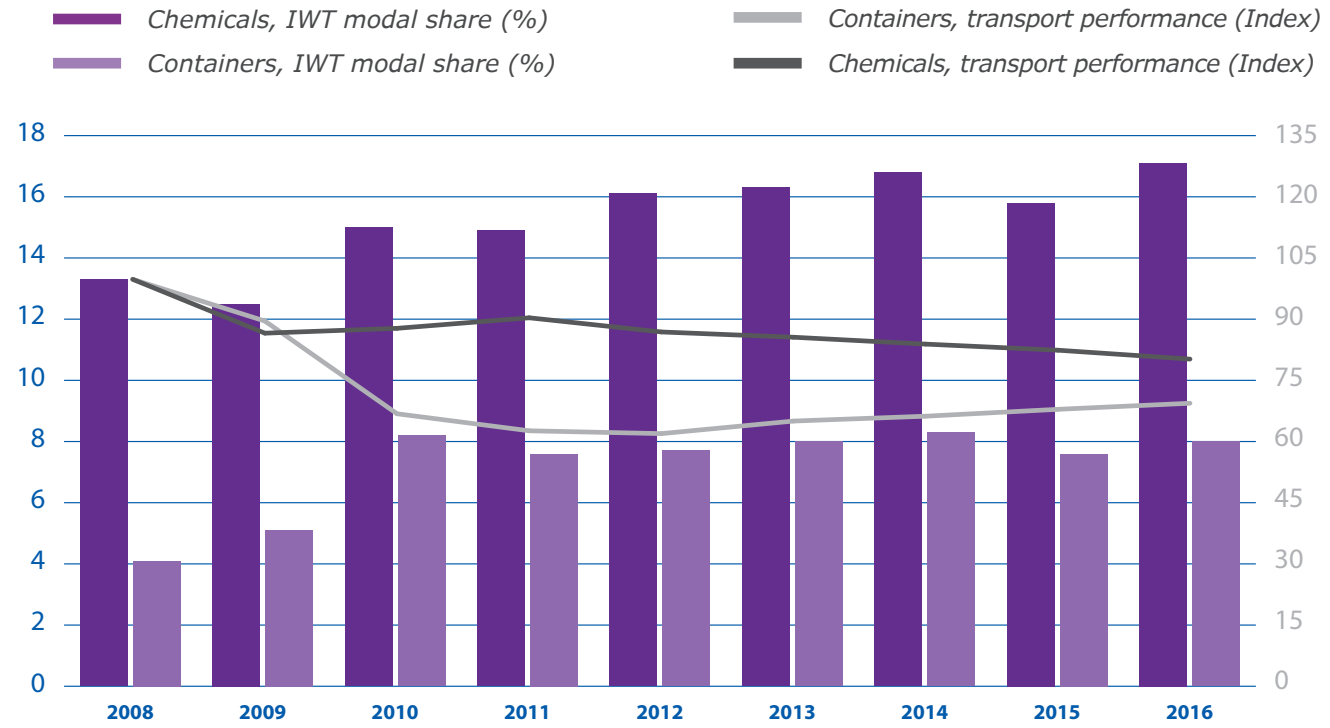


Two important segments where IWT has gained market shares are chemicals and containers. Although the container market suffered heavily from the economic crisis 2008/2009, recovery has been taking place since 2011, from which IWT is benefitting.

For chemicals, the rising IWT market share is taking place against the background of a slightly shrinking overall transport market for chemicals; the transport performance of all three modes has been following a declining trend since 2011. This reduces, to some extent, the volumes that IWT can gain in this segment.

Figure 23: IWT modal share evolution for chemicals, containers, and transport performance evolution for these segments (sum of IWT, rail and road) in Germany

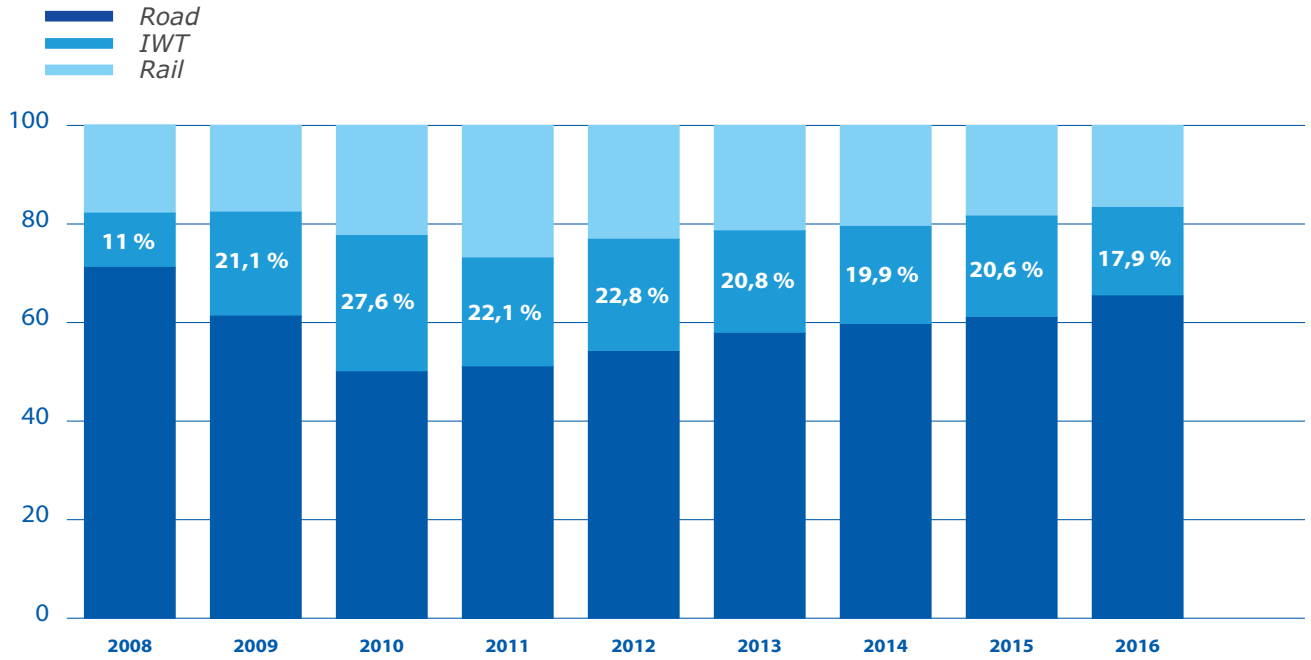
Source: CCNR based on Eurostat



Evolution of IWT modal share for Romania

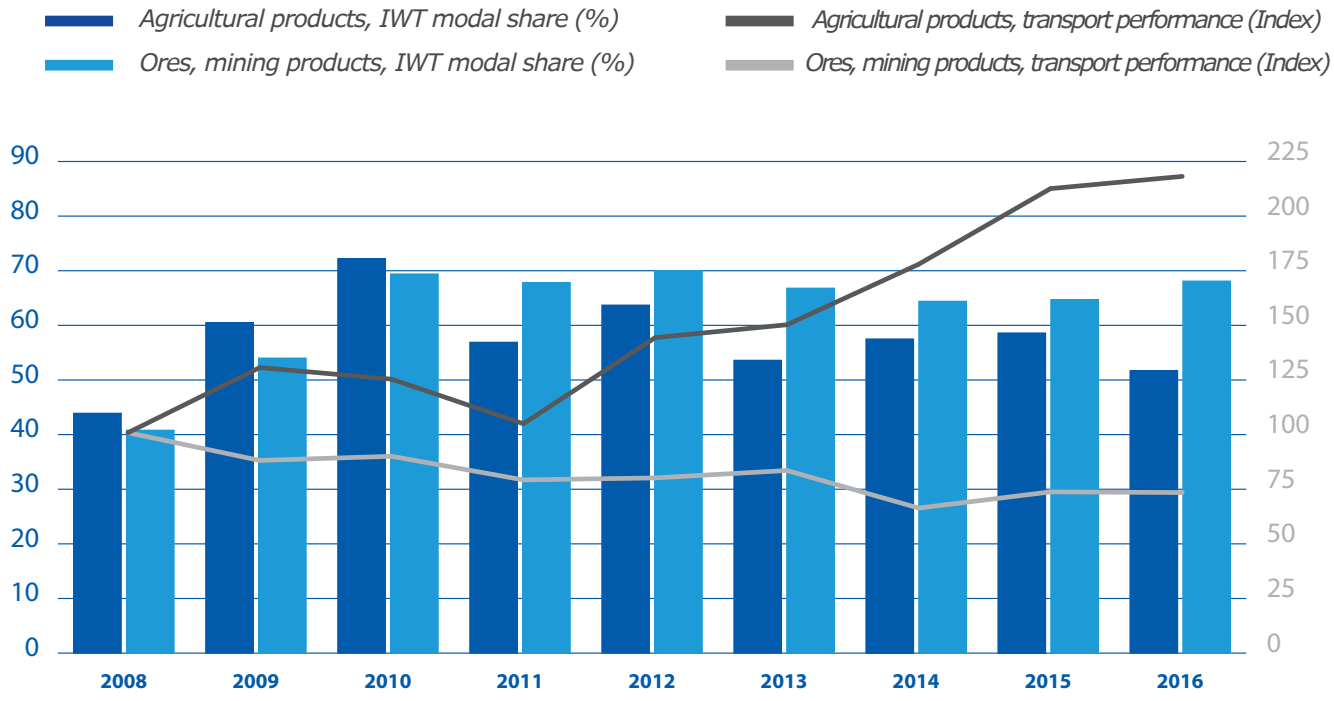
Romania is the country with the highest IWT transport performance of all Danube countries. In 2016, it had a share of 9 % in overall EU transport performance. The overall modal share of IWT has decreased since 2009.

Figure 24: Overall modal split evolution in Romania
Source: CCNR based on Eurostat data on transport performance



The two most important segments of Danube navigation are agricultural products and steel industry related products. In the following figure, we see that IWT has lost market shares within agricultural products transport. At the same time, the total transport market for agricultural products has increased strongly in Romania: its value doubled between 2011 and 2016. Due to the loss of market shares, IWT could not benefit sufficiently from this growth.

Figure 25: IWT modal share evolution for agricultural products, ores and mining products and transport performance evolution for these segments (sum of IWT, rail and road) in Romania
Source: CCNR based on Eurostat data on transport performance

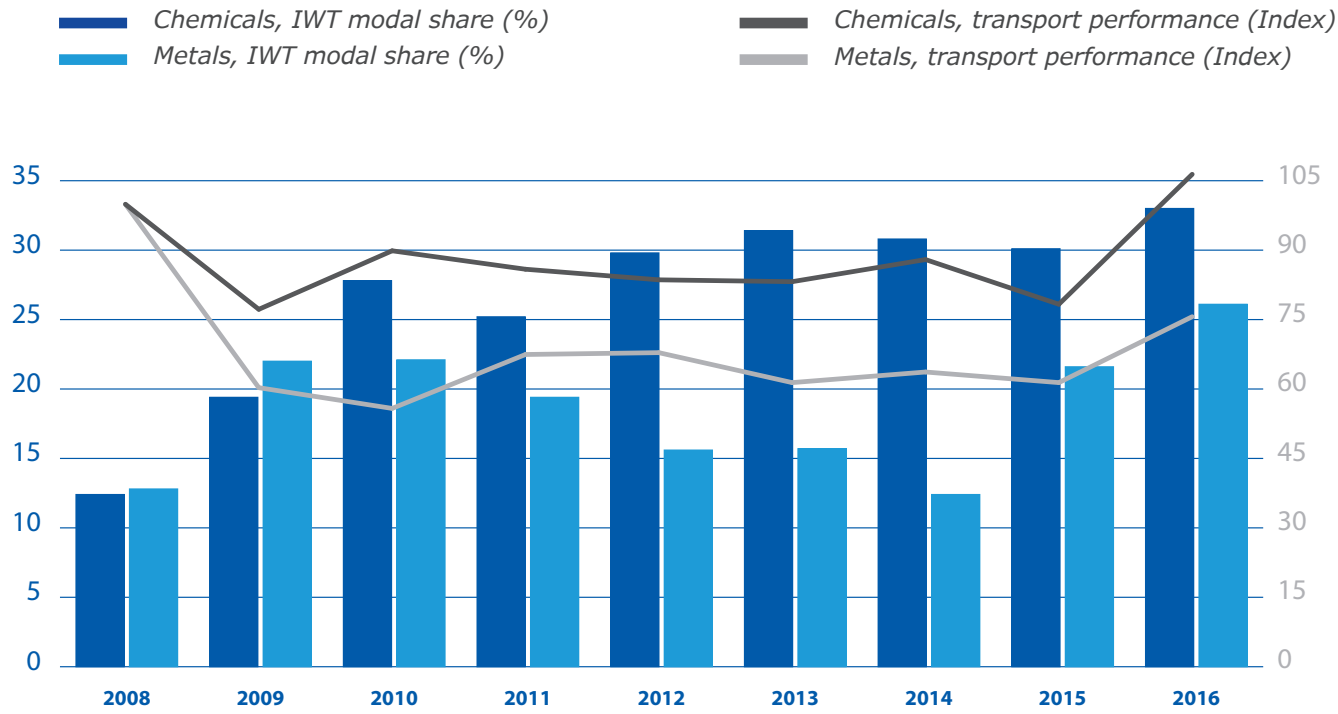


The total transport performance for ores and mining products has decreased in Romania, which can be explained by the structural crisis of the steel industry in the lower Danube area. The IWT market share in this segment has remained more or less constant in recent years.

Parallels between Germany and Romania do not only exist with regard to dry mass cargo segments, but also with regard to liquid cargo segments. Also in Romania, IWT has gained market shares for chemical products. Nevertheless, the total transport market for chemicals has been growing only recently in this country.

Another product segment, where IWT gained market shares in recent years in Romania (since 2014) is metals. The total transport performance for metals suffered heavily from the economic crisis 2008/2009, but has stabilised since then, and increased in 2016.

Figure 26: IWT modal share evolution for chemical products, metals and transport performance evolution for these segments (sum of IWT, rail and road) in Romania
Source: CCNR based on Eurostat data on transport performance



3. PORT TRANSSHIPMENT

©Upper Rhine Ports

3.1 INLAND WATERWAY TRAFFIC IN MAIN SEAPORTS AND INLAND PORTS

Seaports

Large seaports are important transshipment places not only for maritime vessels, but also for inland vessels. As they represent the interface between maritime trade and hinterland transport, their role is crucial for the modal share of inland shipping within the transport market.

In the three largest European seaports, Rotterdam, Antwerp and Hamburg, inland shipping has high modal shares for bulk traffic, and partly also for container traffic. In Rotterdam, IWT's share in hinterland traffic is 86% for dry cargo, 40% for liquid cargo and 36% for containers. The modal share of IWT in Antwerp is similar, while it is lower in Hamburg, especially for container traffic.

In 2016, inland waterway traffic in the three biggest European seaports amounted to 267 million tonnes in total, which corresponded to the level in 2015, but was 3.4% higher than in 2013.

In Hamburg, IWT even grew by 6% between 2013 and 2016, and in Rotterdam and Antwerp by 3%. The higher growth rate in Hamburg can be explained by catching-up effects, as inland shipping has a quite low market share of 2% within container hinterland traffic in Hamburg.

Table 1: Evolution of inland waterway traffic in the three major European seaports (million tonnes)

Source: port of Rotterdam, port of Antwerp, Statistical Office of Hamburg and Schleswig-Holstein

Port	2013	2014	2015	2016	2016/2015	2016/2013
Rotterdam	153.0	157.9	163.0	158.1	-3%	+3%
Antwerp	94.3	96.5	91.5	97.3	+6%	+3%
Hamburg	10.8	11.6	12.1	11.5	-5%	+6%
Total	**258.1**	**266.0**	**266.6**	**266.9**	**+/- 0%**	**+3.4%**

Rhine ports

A large number of important inland ports with a high level of traffic are located along the Rhine. Also the largest European inland port, the port of Duisburg, and the third largest European inland port, the ports group RheinCargo, which operates seven ports in Cologne, Neuss and Düsseldorf, are to be found here.

In the three largest Rhine ports (Duisburg, RheinCargo and Mannheim), inland waterway traffic amounted to more than 82 million tonnes in 2016, which was 3.4% higher than in 2015 and 6.6% above the level of 2013.

Table 2: Evolution of inland waterway traffic in the three major largest Rhine ports (million tonnes)

Source: Destatis and RheinCargo

**RheinCargo is a port and logistics company operating seven ports in Cologne, Neuss and Düsseldorf*

Port	2013	2014	2015	2016	2016/2015	2016/2013
Duisburg	49.4	54.4	54.1	55.6	+2.7%	+12%
RheinCargo*	19.1	18.4	17.4	18.1	+4.5%	-5.2%
Mannheim	8.8	8.5	8.2	8.7	+5.9%	-0.7%
Total	**77.3**	**81.3**	**79.7**	**82.4**	**+3.4%**	**+6.6%**

If we look at the ten major Rhine ports (10 ports with the highest inland waterway traffic), the result in 2016 was 1.7% higher than in 2015 and 1.6% above the level of 2013.

For the container segment, the growth of waterside ports traffic is in general more dynamic. The major Rhine ports for container traffic are the port of Duisburg, the port of Germersheim and the port of Basel.

Germersheim is located on the Upper Rhine, and is highly specialised in container traffic due to the presence of the production and logistics centre of a large German automobile company. The company produces trucks, and the trucks are transported (in parts) in containers on the Rhine towards oversea markets.

Container traffic increased very strongly in 2016 (by around 25%) in each of the three biggest container ports along the Rhine. In other container ports, growth was not as spectacular, but nevertheless mostly positive. The total result in the ten largest container ports along the Rhine was 3.7% higher than in 2015 and 9.4% higher than in 2013.

The strong increase of container traffic in Rhine ports shows the potential for further growth of container traffic in this part of Europe.

Table 3: Evolution of container traffic by inland shipping in the three major largest Container ports along the Rhine (TEU)

Source: Destatis and ports mentioned

Port	2013	2014	2015	2016	2016/2015	2016/2013
Duisburg	409,293	476,179	475,461	514,649	+8.2%	+25.7%
Germersheim	125,351	140,153	152,574	157,531	+3.2%	+25.7%
Basel	104,945	104,482	102,916	131,705	+28.0%	+25.5%
Total	**639,589**	**720,814**	**730,951**	**803,885**	**+10.0%**	**+25.7%**

Danube ports

The Danube ports registered a strong increase in inland shipping transport in 2016, due to the recovery of the water levels compared to 2015. This recovery enabled large amounts of iron ores and coal to be transported again on the Upper, Middle and Lower Danube as provision for the steel industry along the Danube.

For the Upper Danube, this concerns the steel industry in Linz/Austria; on the Middle Danube it concerns the steel industry in Smederovo/Serbia, and on the Lower Danube the steel industry in Galati/ Romania. All of the three largest inland ports along the Danube are specialised in the transshipment of steel related goods (iron ore, coal, metals), a fact that confirms the importance of this market segment for the Danube ports.

Table 4: Evolution of inland waterway traffic in the three major largest Danube ports (million tonnes)

Source: Danube Commission

Port	2013	2014	2015	2016	2016/2015	2016/2013
Izmael	2.7	3.1	4.8	5.7	+17.7%	+114%
Linz	4.7	4.3	3.8	4.0	+4.7%	-16%
Galati	5.0	3.5	3.0	3.3	+11.0%	-33%
Total	**12.4**	**10.9**	**11.6**	**13.0**	**+11.7%**	**+4.6%**

3.2 WATERSIDE TRAFFIC IN INLAND PORTS PER GOODS SEGMENTS

The structure of the waterside traffic of most European inland ports is characterised by a certain specialisation on particular goods segments, for example on liquid cargo, building materials, the steel industry or agricultural products.

In many cases, this form of specialisation is determined by regional industrial clusters, or the abundance of certain raw materials or agricultural products in the region surrounding the port.

In 2016, we can observe the following results for the waterside traffic per groups of ports:

- Inland ports with a specialisation on sand, stones and building materials: +3%
- Inland Ports with a specialisation on liquid cargo: +0.2%
- Inland ports with a specialisation on the steel industry: +4%

Sand, stones & building materials

This product segment acted as growth driver in 2016. In many European inland ports, the traffic of sands, stones and building materials is promoted by large infrastructure projects, and growing activity in the building industry.

In Paris, dynamism is created by the construction of new metrolines within the urban project “Grand Paris Express”. This project leads to an additional transport demand for building materials, and inland shipping will be involved in the delivery of sand and building materials for the related construction work.

The positive evolution in other ports can be explained by increasing building activity in the Netherlands and France, leading to more transport demand for sands, gravel and stones on the North-South axis. Most of the Belgian ports export large volumes of sand, gravel and building materials to the Netherlands and to France.

Liquid cargo

Liquid cargo traffic is very high along the Rhine, with its refineries and chemical industry around Cologne and Ludwigshafen. Also the hinterland traffic from refineries in the ports of Rotterdam and Antwerp has to be considered, as the example of the Swiss Rhine ports in Basel shows: 42% of the imports of mineral oil products of Switzerland are delivered on the Rhine to Basel.[11]

The liquid cargo cluster is responsible for a large amount of inland waterway traffic. However, the growth prospects are rather mixed for this segment. While further growth can be expected for chemicals, the outlook for mineral oil products is less positive, due to the ongoing reduction of the consumption of petroleum products (fuel, heating oil).

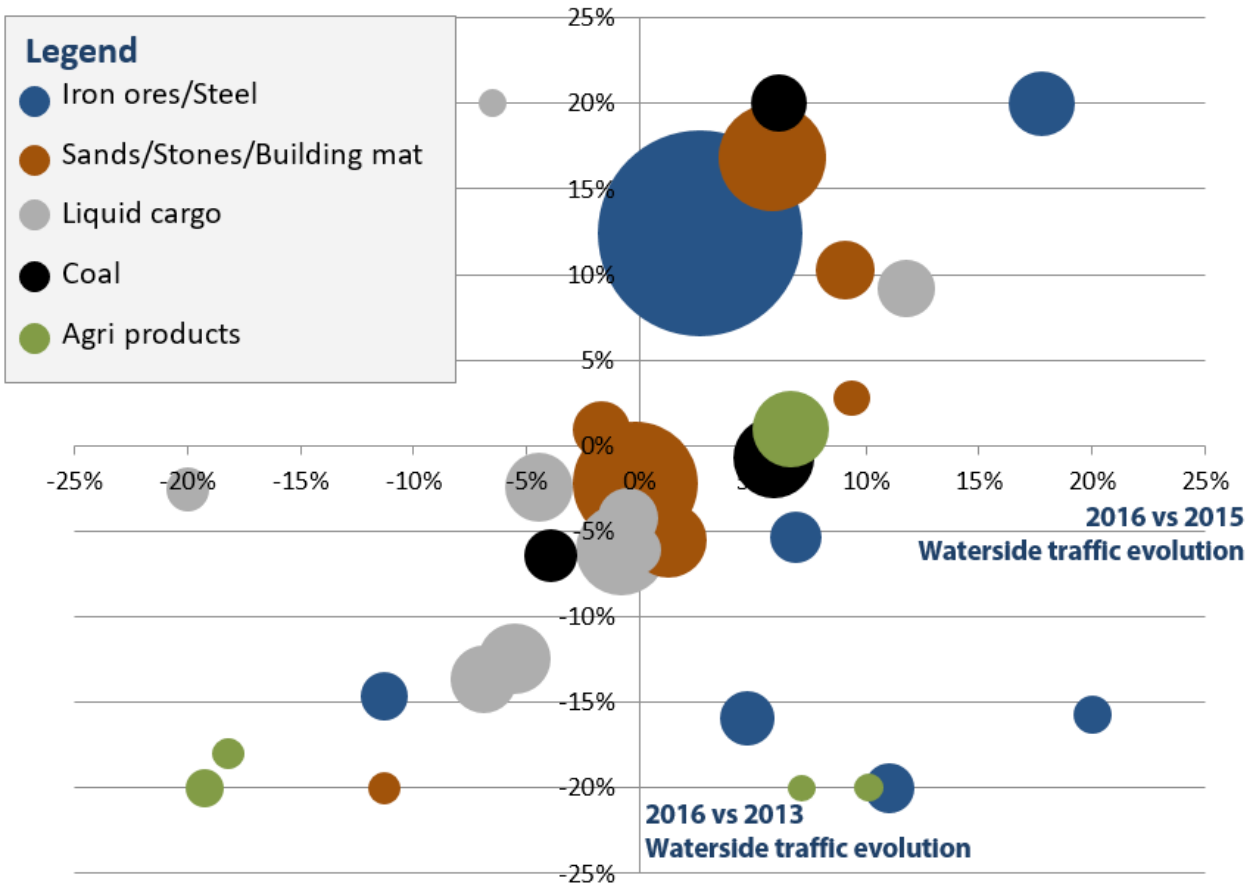
Steel industry

In 2016, this segment registered an overall growth of almost 5 % in the specialised ports. Like the segment of sands, stones and building materials, the steel segment acted as a growth driver for European ports traffic in 2016.

A lot of Danube ports are specialised in the steel segment. These Danube ports increased their waterside traffic in 2016 for iron ores and coal mainly due to better water level conditions compared to 2015. Similar effects were also present at the upper Rhine, as this stretch of the Rhine had also suffered from low water levels in 2015.

[11] Source: Swiss Association for Crude oil and petroleum products

Figure 27: Clusters based on inland ports specialisation
Source: CCNR analysis, ports mentioned, Destatis, Danube Commission



Notes: Max and min evolution capped at 20% / Bubble size proportional to 2016 inland port waterside traffic / All EU inland ports with yearly waterside traffic > 1 mio tonnes

In addition to the comparative evolution due to inland ports specialisation, it is also interesting to note that between 2013 and 2016, bigger inland ports had a tendency to experience higher growth than smaller inland ports. This can be partly explained with the fact that bigger ports, in addition to efficient multimodal infrastructures enabling greater flexibility, can enforce active policies favouring inland port activity. A few examples with a focus on particular ports will be given in the next part.

3.3 FOCUS ON PARTICULAR PORTS

Ports of Paris

In the ports of Paris, 75% of waterside traffic is made up of sands, stones and building materials. These materials are required for the building industry in the agglomeration of Paris, and with the further urban growth in Paris, a positive evolution can be foreseen for the future.

In addition to this, the construction of new metrolines within the urban project “Grand Paris Express” leads to a further increase in the transport demand for these materials. Inland shipping will be involved in the delivery of sand and building materials for this construction work, as the port has signed an agreement with the public company that is in charge of carrying out the project “Grand Paris Express”.

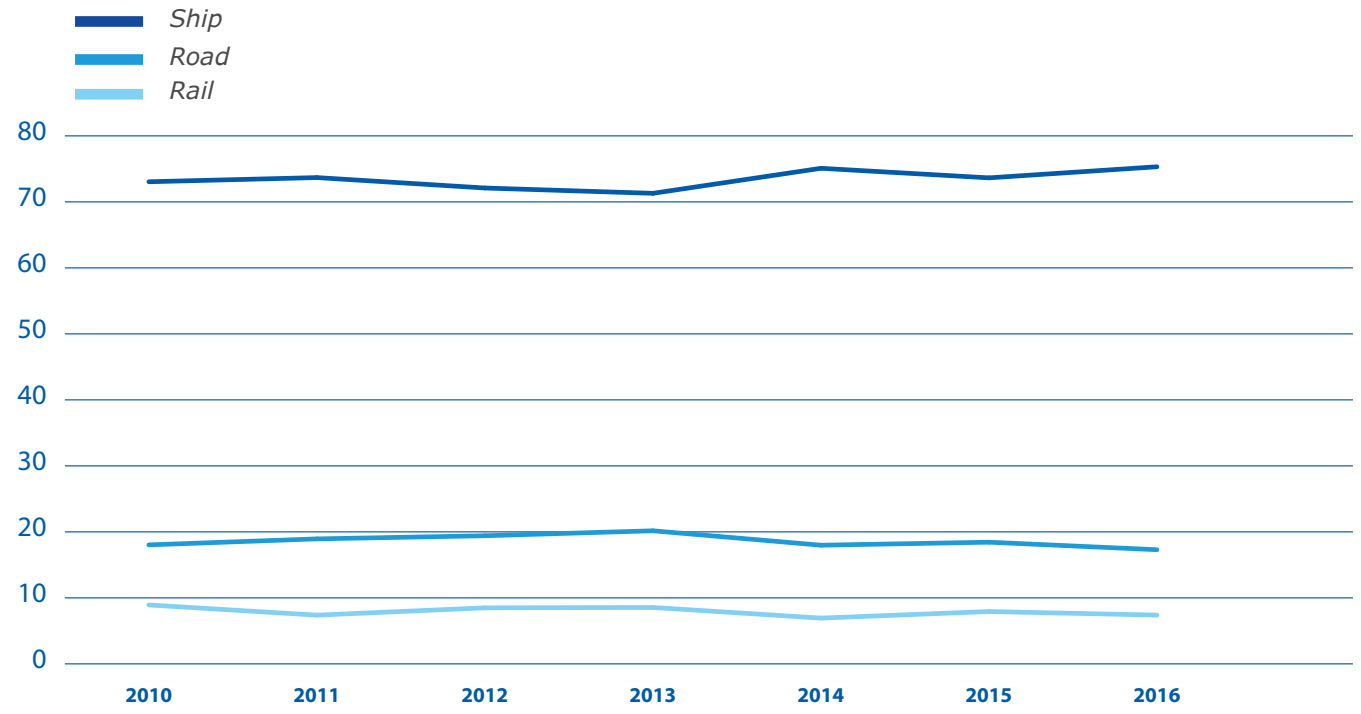
The Ports of Paris also launched initiatives to promote further urban container transport on the Rivers Seine and Oise: Best practice-examples include the delivery of goods for supermarkets in the heart of Paris. The benefits for the city of Paris consist of a reduction of emissions, fewer traffic problems and fewer accidents and related social costs.

Port of Liège

The Belgian port of Liège is in a favorable geographical position, integrated in the heart of the European inland waterway network. Since 2000, inland shipping has increased its modal share from 67% to 75%. Between 2011 and 2016, the rise was from 72% to 75%.

The reason for this success story can be seen in a diversification of port activities, notably towards renewable energies and containers. The renewable energy segment contains biomass and biofuels transshipment for an electricity power plant and a biofuel plant.

Figure 28: Modal split in the port of Liège (in %)
Source: Autonomous Port of Liège



Upper Rhine ports collaboration

The Upper Rhine region is an area with a dense network of large inland ports and industrial centres. In this border region of three countries (France, Germany, Switzerland), stretching from Basel/ Switzerland to Bingen/Germany, the following are to be found:

- the second largest French inland port (Strasbourg)
- the third largest inland port along the Rhine (Mannheim)
- four of the five largest container ports along the Rhine (Basel, Germersheim, Mainz, Wörth)
- important European inland ports for liquid cargo (Ludwigshafen, Karlsruhe) and the steel segment (Kehl).

In order to strengthen their cooperation, to identify growing market segments and to work out a common investment strategy for the future port development, major inland ports of the Upper Rhine region set up a project called "TEN-V-Project Upper Rhine – A connected corridor" in the year 2012. The project, co-financed by the EU, came to important conclusions at the end of 2014.

The studies conducted within this project came to the conclusion that container traffic should have the highest development potential in the region, and is expected to almost double its volume by 2025. For other markets, an intermediate growth outlook was identified, namely for biomass & wood and heavy cargo & RoRo traffic. Market segments with a limited growth potential are, according to the study, chemicals and metals.[12]

In the context of the project, the Upper Rhine ports have set up a common digital infrastructure, the RheinPorts Information System (RPIS). RPIS is a traffic management platform connecting all major stakeholders in container barge handling in order to enhance the overall efficiency of inland container handling. Important elements of RPIS are that:

- Barge operators can reserve slots at all terminals along the Upper Rhine through one single system.
- Terminals receive slot reservation requests for all barges through RPIS and send a reply once the terminal planning is ready. The barges finalise their round-trip schedule at the Upper Rhine after receiving the slot confirmations of all terminals connected to RPIS.
- RPIS users will be actively informed about barge positions and delays based on real-time information within RPIS.

RPIS is the first barge reservation system for inland ports and thus sets a milestone for the modernisation of inland waterway transportation.

[12]Source:Upper Rhine ports — A connected corridor. Marktentwicklung, Kapazitäten und Vernetzung der Oberrheinhäfen. Strasbourg, October 2014

4. FLEET AND MARKET STRUCTURE

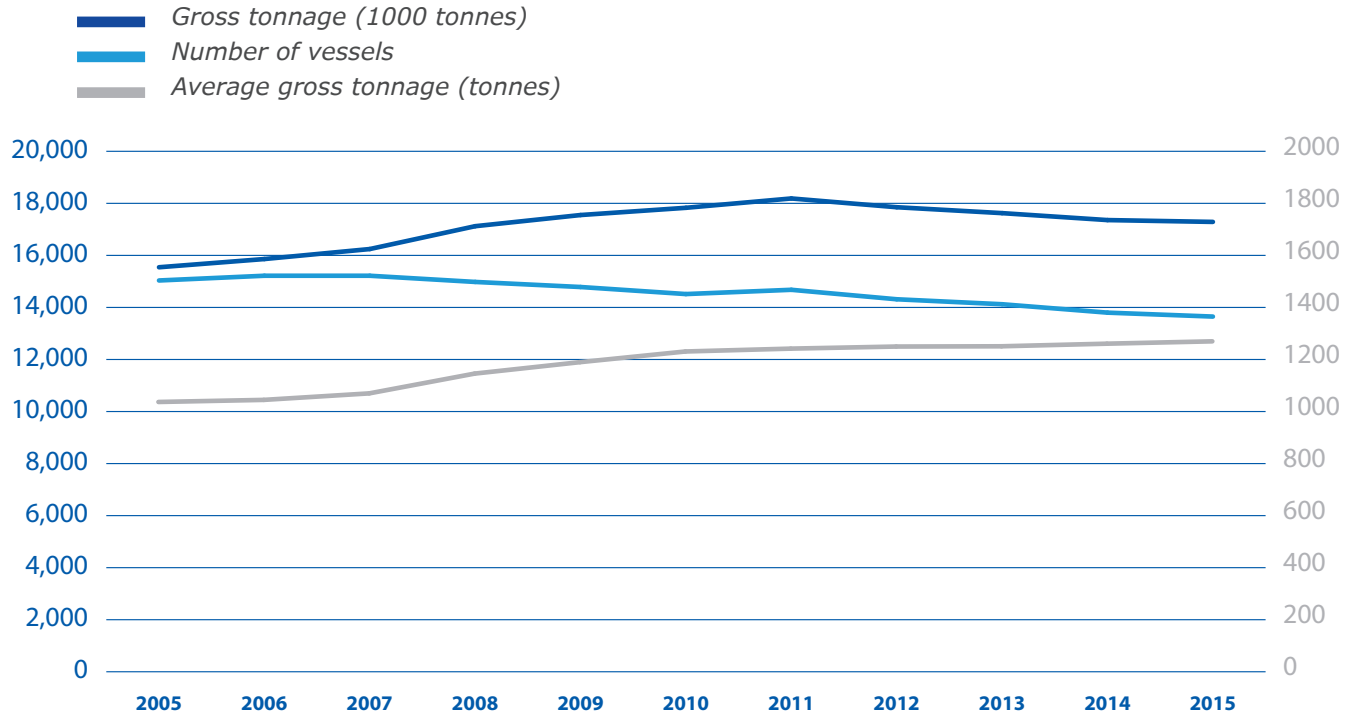
4.1 FLEET SIZE EVOLUTION AND STRUCTURE

In Europe, there are more than 13,500 freight vessels offering inland freight transport services (dry cargo, tanker cargo and push & tug vessels) with a total loading capacity of 17 million tonnes. The main sector of activity of the European inland fleet is dry cargo; 73% of the European fleet operates in this segment.

In 2015, a total of about 7,300 and 2,600 dry cargo vessels operated respectively in the Rhine and Danube countries. In tanker shipping, the structure differs slightly because this sector has significantly more activity in the Rhine region than in the Danube one. About 1 550 tanker vessels were active on the Rhine as compared to 216 vessels operating in the Danube area. The push & tug fleet represented a higher percentage than tanker vessels in the Danube fleet structure, showing that push & tug shipping is still a predominant market in the Danube region.

Figure 29: Evolution of the fleet in Europe (number of dry cargo, tanker cargo and push & tug vessels)

Source: Danube Commission, National Offices, CCNR calculation



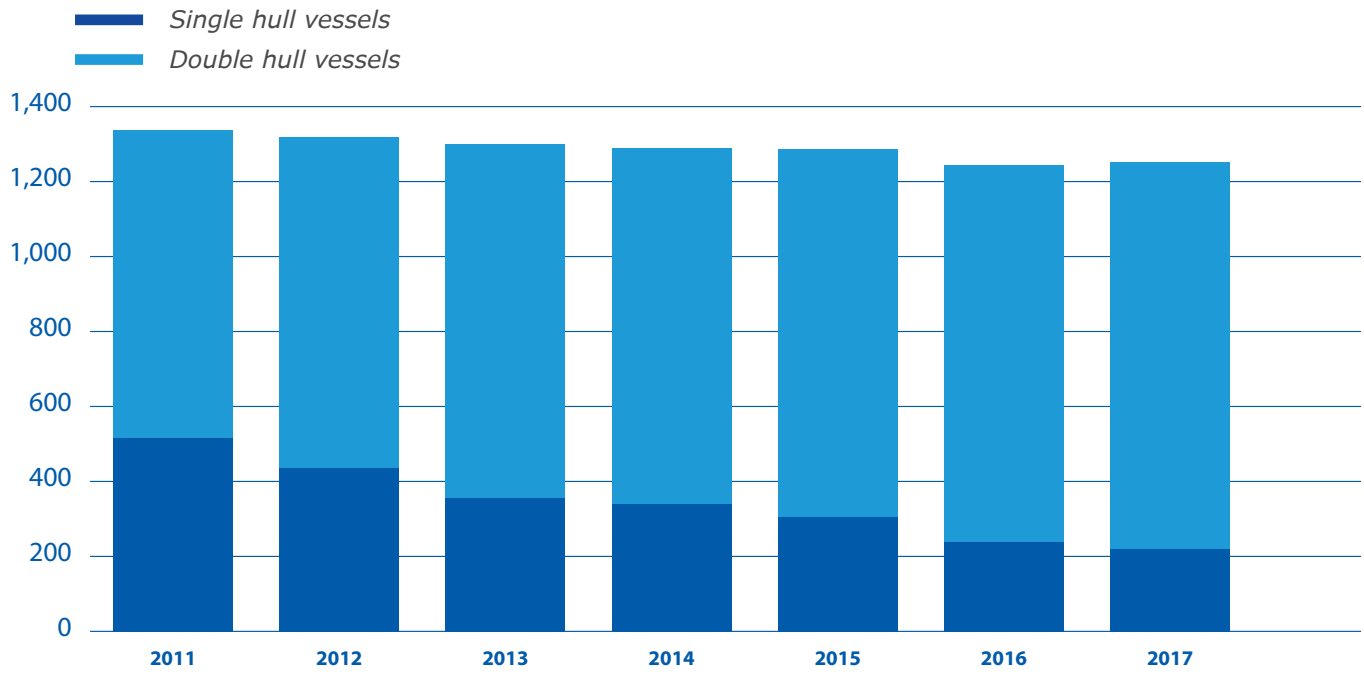
Note: Fleet registered in Rhine and in Danube countries

In the last decade, the evolution of the fleet has been marked by a reduction in the total number of vessels operating (-9%) but an increase in the available loading capacity (+11%) and the average loading capacity (+23%). This is explained by the fact that smaller vessels left the market and new vessels with a higher loading capacity entered the market, particularly between the years 2007 and 2009, when vessel construction rates were very high.
Since 2013, both the total number of vessels and the total available gross tonnage have decreased but the decrease rate is smaller for the gross tonnage and, as a consequence, the average tonnage of European vessels has increased by 2%.

In **tanker shipping**, the evolution of the fleet in the last decade has been influenced by the change from single hull to double hull vessels. Safety requirements make it mandatory to use only double hull vessels for dangerous goods transports from 2019 onwards. This regulation was anticipated many years before, so that double hull vessels were introduced in great numbers, especially before 2010. Over the years, a lot of the single hull vessels have been phased out.

The restructuring can be followed by looking at the data from the European Barge Inspection Scheme (EBIS). EBIS currently inspects 1,251 tanker vessels, representing about 83% of the total European inland tanker fleet. In 2011, 61% of the vessels inspected by EBIS were double hull vessels, and this share increased to 82% in 2017. Due to this restructuring from single to double hull, the European tanker fleet has been modernised and now fulfills higher safety standards.

Figure 30: Number of single hull and double hull tanker vessels in Western Europe
Source: EBIS



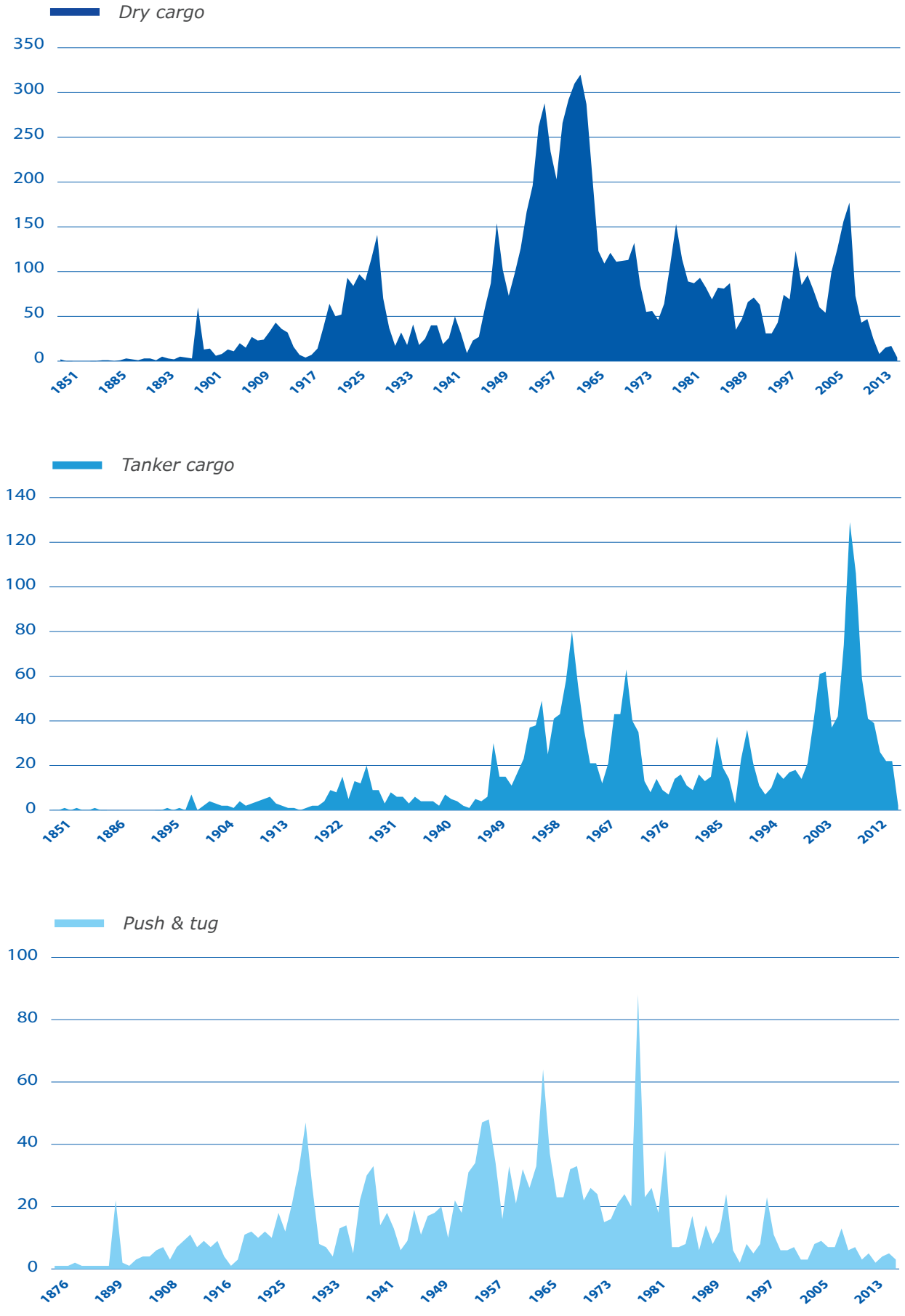
4.2 AGE OF THE FLEET

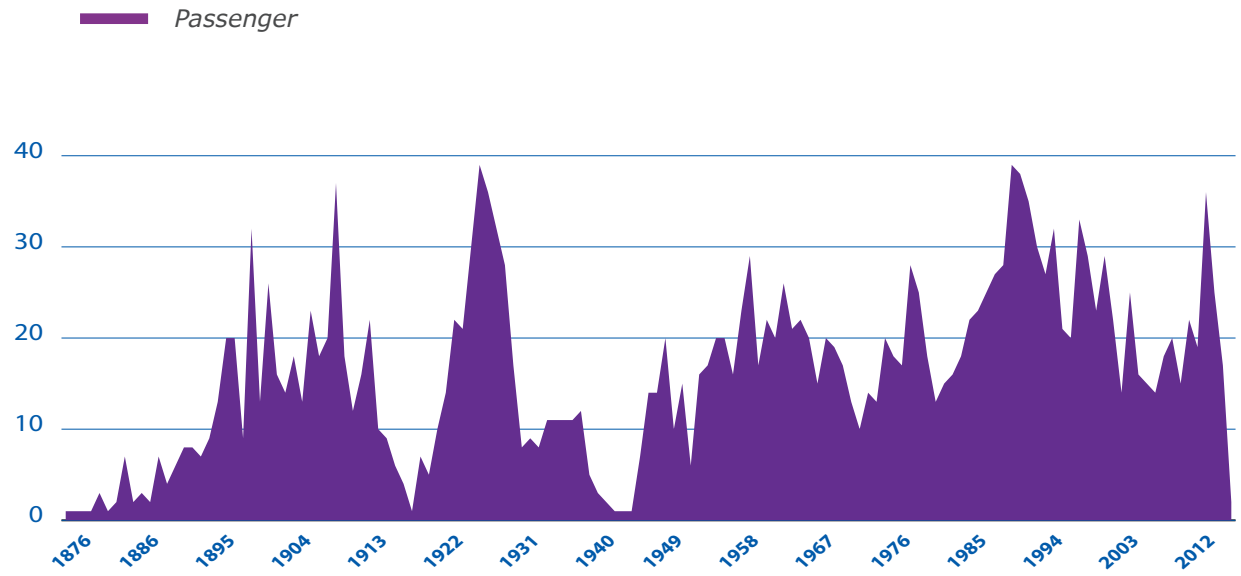
Rhine countries

The Western European market is characterised by a relatively old fleet. In Belgium, Germany and the Netherlands, about half of the active IWT vessels were built more than 50 years ago. In France, these vessels represent approximately 80% of the total fleet. There are still some vessels (15% of the European fleet) which were built more than 75 years ago, particularly present in the Netherlands and Germany.
Switzerland is the country that has the newest fleet (87% of the vessels were built in the last 35 years) which is mainly due to a wave of new river cruise vessels in the years 2010-2016. The Luxembourg fleet is also quite modern (65% of the vessels were built in the last 35 years) but the new vessels concerns mainly tanker shipping.

Figure 31: The Rhine fleet in 2017 by sector of activity and year of construction (number of vessels)

Source: IVR, CCNR calculation





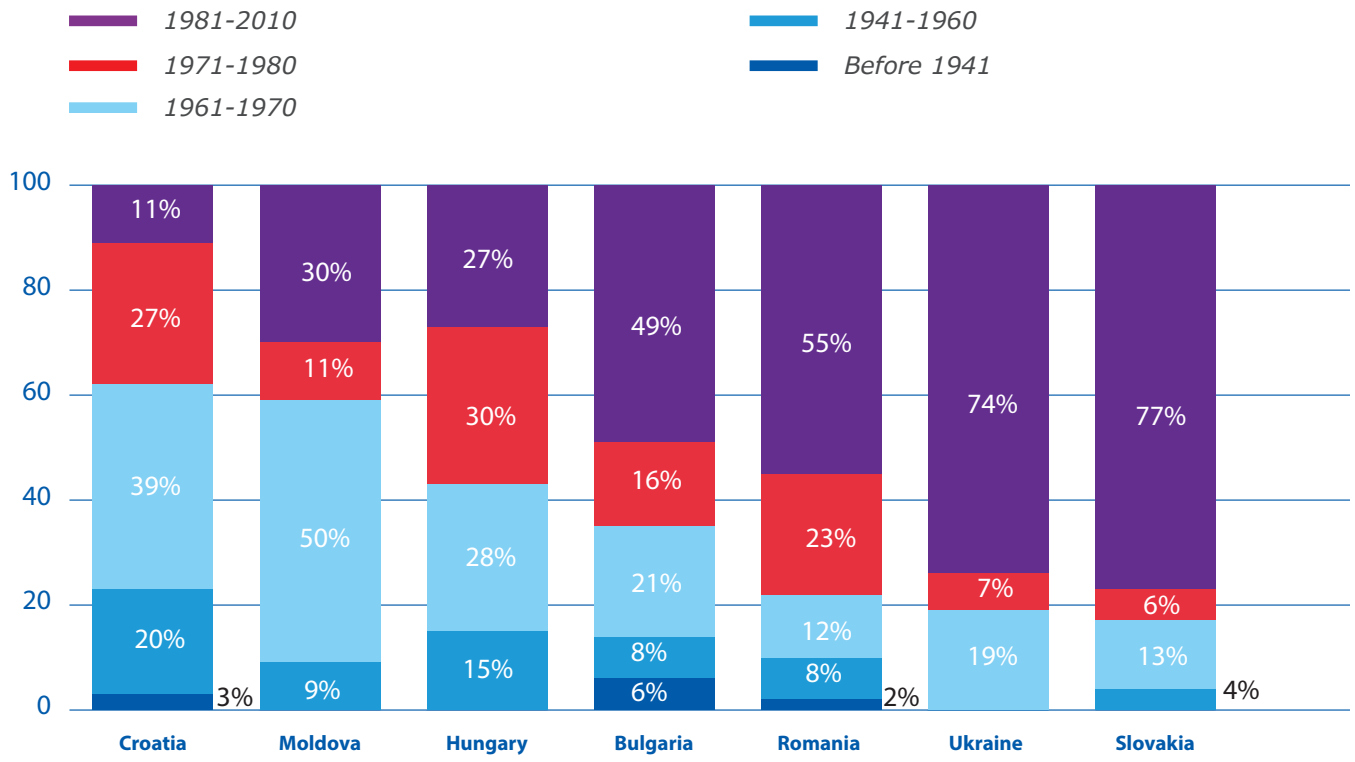
Note: Rhine fleet meaning here the fleet registered in Rhine basin countries (Belgium, France, Germany, Luxemburg, Netherlands and Switzerland)

Danube countries

In the Eastern European market, some differences can be found between countries characterised by an older fleet (Croatia, Moldova and Hungary) and countries with a newer fleet (Bulgaria, Romania, Ukraine and Slovakia).

Figure 32: The Danube fleet by year of construction (% based on number of vessels)

Source: Danube Commission



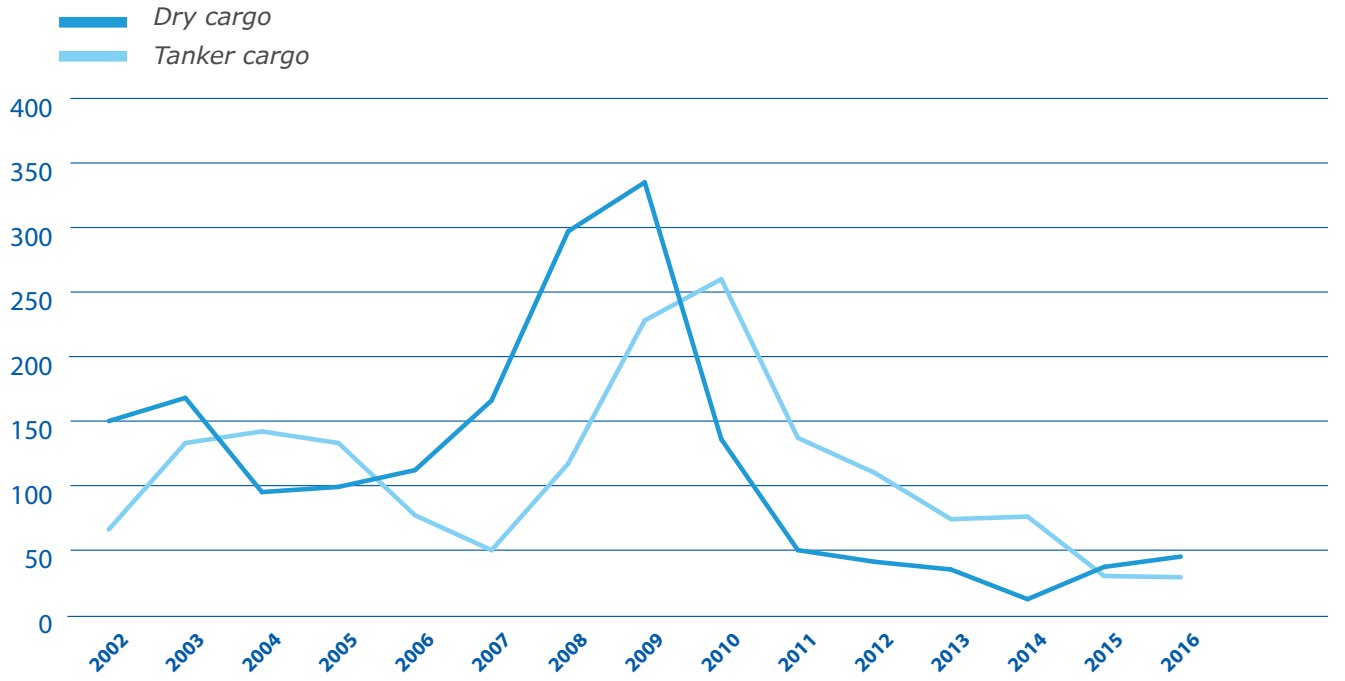
In Danube Countries, the percentage of the oldest vessels (those which were built more than 75 years ago) is much lower than in Rhine countries, representing only 2% of the total fleet.

In Bulgaria and Romania, about half of the fleet was built in the last three decades. In these countries, most of the companies operate in freight transport, and their vessels are relatively new compared to the dry cargo fleet in Rhine countries. Ukraine and Slovakia have the most recent fleet; most of the existing vessels are less than 30 years old.

4.3 NEW VESSEL CONSTRUCTION AND GREENING

The new building activity during the last decade was marked by a wave that had its peak around the years 2008 and 2009 for dry cargo vessels, and around 2009 and 2010 for tanker vessels. After these years, the newbuilding activity fell for several years. Only in 2015 and 2016, recovery set in for the dry cargo vessels, and a certain stabilisation for the tanker vessels.
In line with this transformation, modernisation of the fleet took place, as the newer vessels are more productive and efficient than the old ones.

Figure 33: Newbuilding activity in dry cargo tanker shipping (tonnage 1000 t)
Source: IVR



Note: Newbuilding activity in Rhine basin countries (Belgium, France, Germany, Luxemburg, Netherlands and Switzerland)

In addition to this modernisation, a certain greening activity can be observed. For the years 2014, 2015 and 2016, a detailed analysis of all newly built vessels delivers interesting insights.

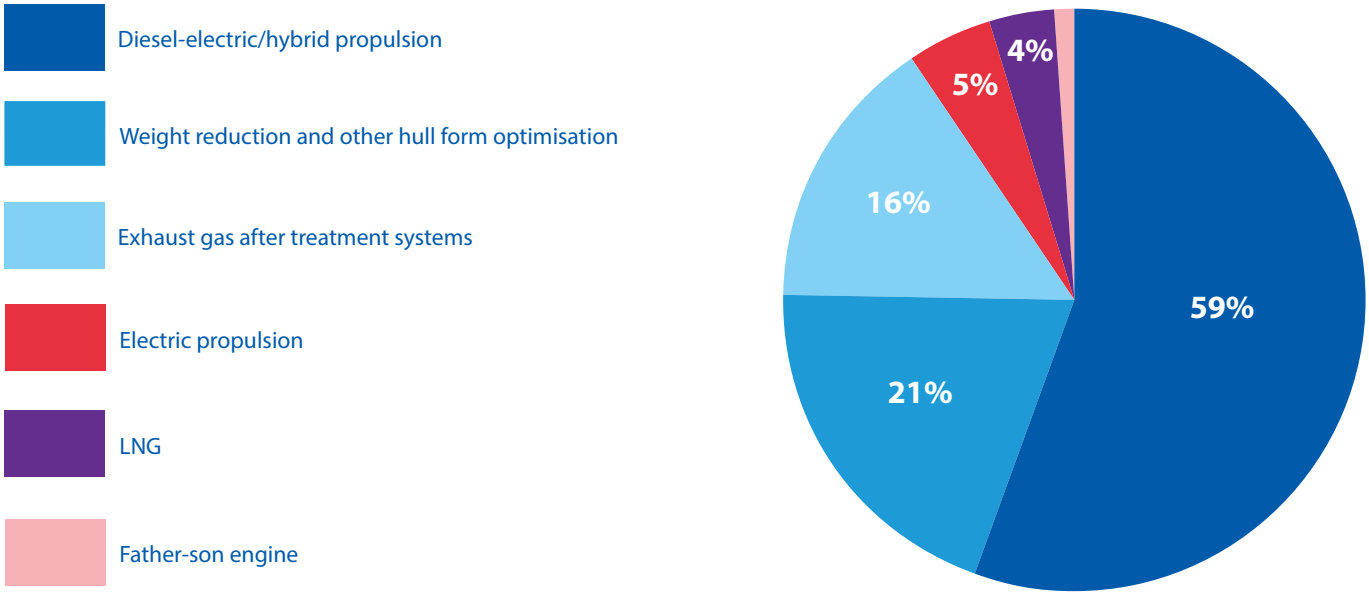
Table 5: Newly built vessels 2014-2016 in Western Europe
Source: IVR and Hader River Cruise Handbook

Vessel type	2014	2015	2016	2014-2016
Self-propelled tankers	26	17	20	63
River cruise vessels	31	28	20	79
Other vessels	8	6	31	45
Total	65	51	71	187

For the 187 new vessels that came on the market in these three years, a total number of 106 greening measures could be observed.[13] Some vessels were equipped with only one greening measure, others with two or even three measures. The following figure shows all the greening measures by type and frequency.

Figure 34: Greening measures by type and frequency observed for the newly built vessels 2014-2016 (units)

Source: CCNR based on IVR, Hader River Cruise Fleet Handbook, Binnenvaartkrant and Scheepvaartkrant



The category of weight reduction and hull form optimisation includes 10 new tanker vessels. This innovative new type of tanker vessel, developed by a Dutch shipyard, weighs 10% less and can therefore increase its loading capacity by 150 tonnes. In combination with the use of two smaller engines instead of one big engine, this leads to a significant decrease in fuel consumption. A series of 16 units of these tankers came on the market before March 2017, and ten of them in the years 2014-2016. The development of such innovative vessels, and the construction in large series, is certainly a promising approach for the inland shipping sector overall.

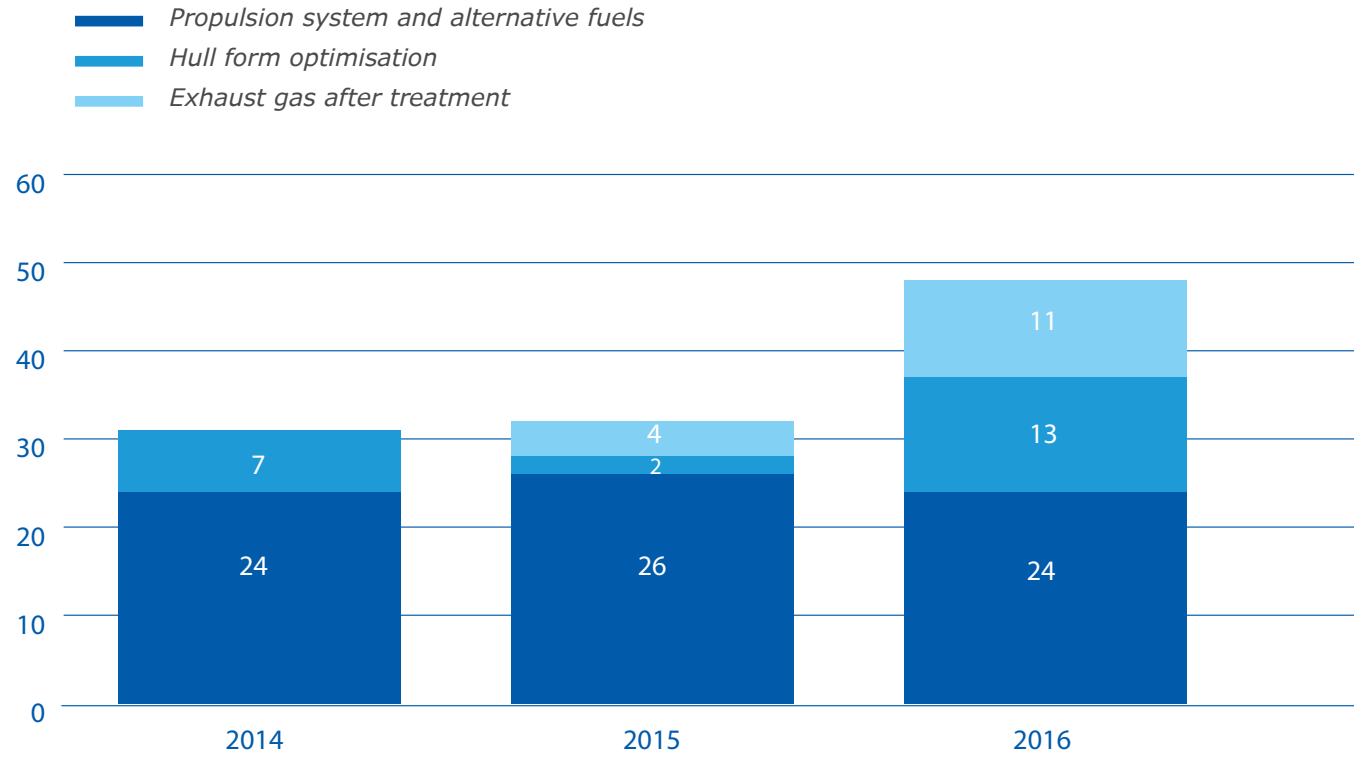
The other 11 cases of hull form optimisation include the use of a flexible tunnel for the propeller[14], innovative measures like air lubrication[15] or a four-propeller system.[16]
Exhaust gas after treatment systems refer to Selective Catalytic Reduction systems (SCR) and to Particulate Matter Filters (PMF), and both systems reduce the amount of pollutant emissions in a very significant way.[17]

Purely electric propulsion is almost entirely observed for day trip vessels, where it was introduced for several newly built vessels in 2016, especially for day trip vessels and local ferries in Amsterdam.

[13]These measures were observed by gathering information for each vessel. Sources used are the Dutch shipping journals Binnenvaartkrant and Scheepvaartkrant that provide detailed information about newly built vessels.
[14]A flexible tunnel increases the efficiency of the propeller both under low water conditions as well as under normal water conditions. This leads overall to less fuel consumption.
[15]Air lubrication reduces the resistance of vessel under water and leads to less fuel consumption.
[16]Within a four-propeller system, only two propellers can be deployed when water levels are low. The use of four propoellers is reserved for operation in deeper water, where it increases the efficiency of the vessel.
See: Pauli, G. (2016), «Emissions and Inland Navigation», in: Green Transport Logistics — The quest for Win-Win Solutions. Springer 2016

Figure 35: Number of greening measures by type and frequency observed for the newly built vessels 2014-2016

Source: CCNR based on IVR, Hader River Cruise Fleet Handbook, Binnenvaartkrant and Scheepvaartkrant

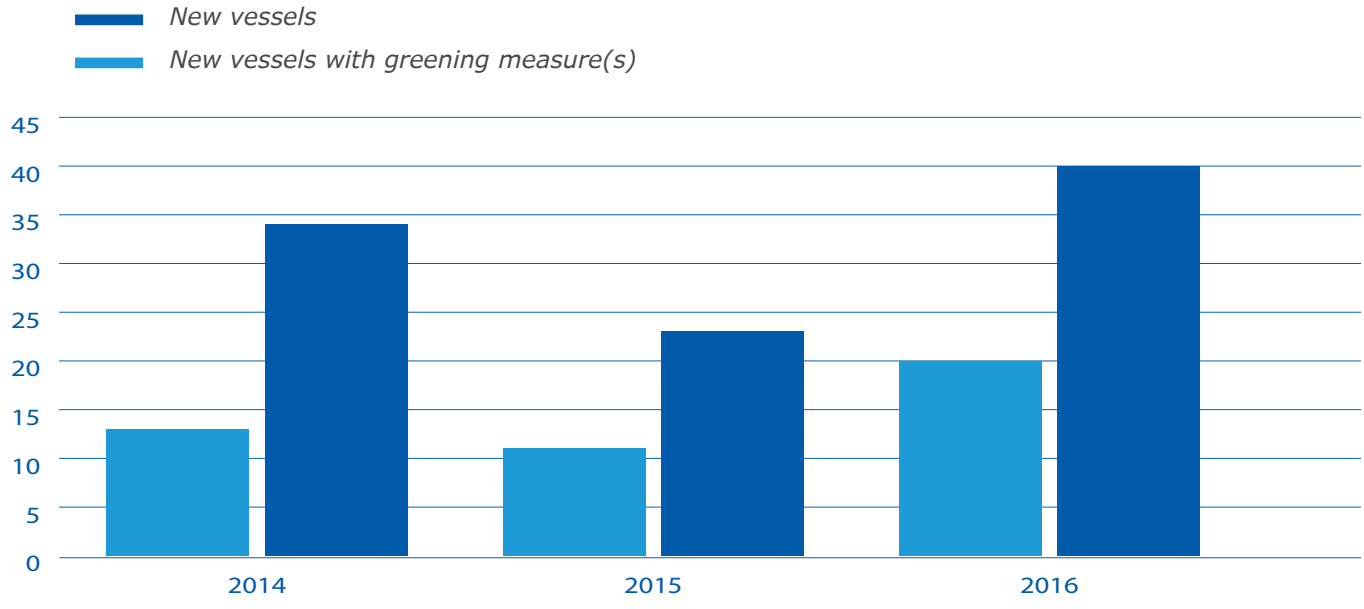


The number of greening measures observed for the newly built vessels increased from 31 cases (2014) to 32 cases (2015) and to 48 cases (2016).

We will now compare the number of vessels equipped with at least one greening measure with the number of newly built vessels per year. We will distinguish between cargo vessels and passenger vessels in order to highlight the different intensity of greening between these two sectors.
For the cargo vessels, the share of vessels that were equipped with at least one greening measure was 38% in 2014, 48% in 2015 and finally 50% in 2016. The relative intensity of greening therefore increased between 2014 and 2016. The following two figures show the absolute number of cases.

Figure 36: Number of vessels with at least one greening measure and newly built cargo vessels (2014-2016)

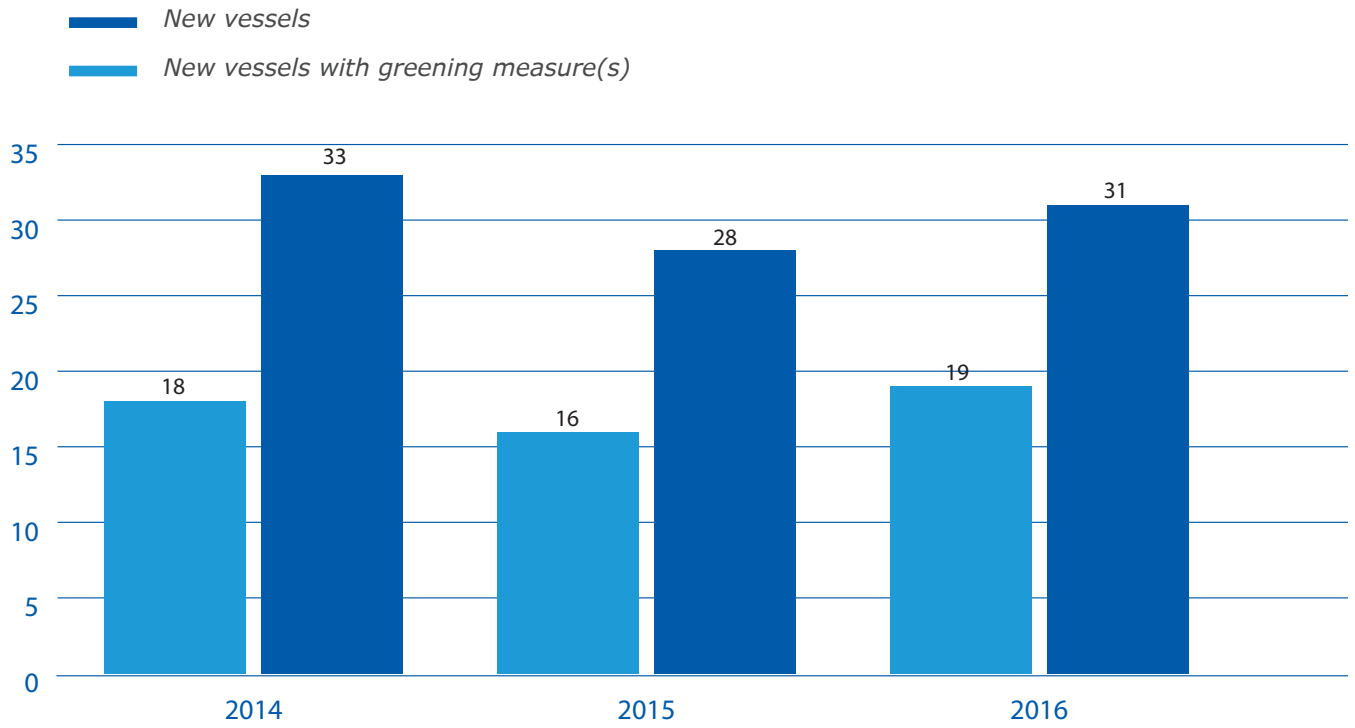
Source: CCNR based on IVR, Hader River Cruise Fleet Handbook, Binnenvaartkrant and Scheepvaartkrant



For the passenger vessels, the share of vessels that were equipped with at least one greening measure was 54% in 2014, 57% in 2015 and finally 61% in 2016. The relative intensity of greening therefore increased also for passenger vessels between 2014 and 2016. Additionally it can be seen that the greening rate was generally higher in passenger shipping than in goods transport.

Figure 37: Number of vessels with at least one greening measure and newly built passenger vessels (2014-2016)

Source: CCNR based on IVR, Hader River Cruise Fleet Handbook, Binnenvaartkrant and Scheepvaartkrant



It is interesting to see how many newly constructed vessels in 2014-2016 actually had emission levels that fulfill the new emission standards that will be compulsory for new engines from 2019 onwards (Stage V standards).

For a vessel equipped with a CCNR II engine, one possibility to attain a similar environmental performance as this Stage V level is to implement both exhaust gas after treatment measures (SCR and PMF) on a vessel. This was, in fact, the case for eight new vessels in 2014-2016. The other possible option is a mono-fuel liquefied natural gas (LNG) engine, which was observed only in one case. So overall, only nine out of 187 new buildings in the years 2014-2016 had an emission performance that was comparable to the Stage V emission standards, which will be in place for new engines in new or existing vessels from 2019 onwards.

One main reason for this low share is the high amount of investment that is needed to implement exhaust gas after treatment technologies. Besides, these systems lead to slightly higher operational costs, so there is no commercial incentive for companies to invest in them. Concerning LNG, the incentive to invest in them has decreased significantly, with falling fuel prices for conventional propulsion systems. In addition to the high costs of these technologies, the majority of IWT companies are small companies, with limited financial capacities.

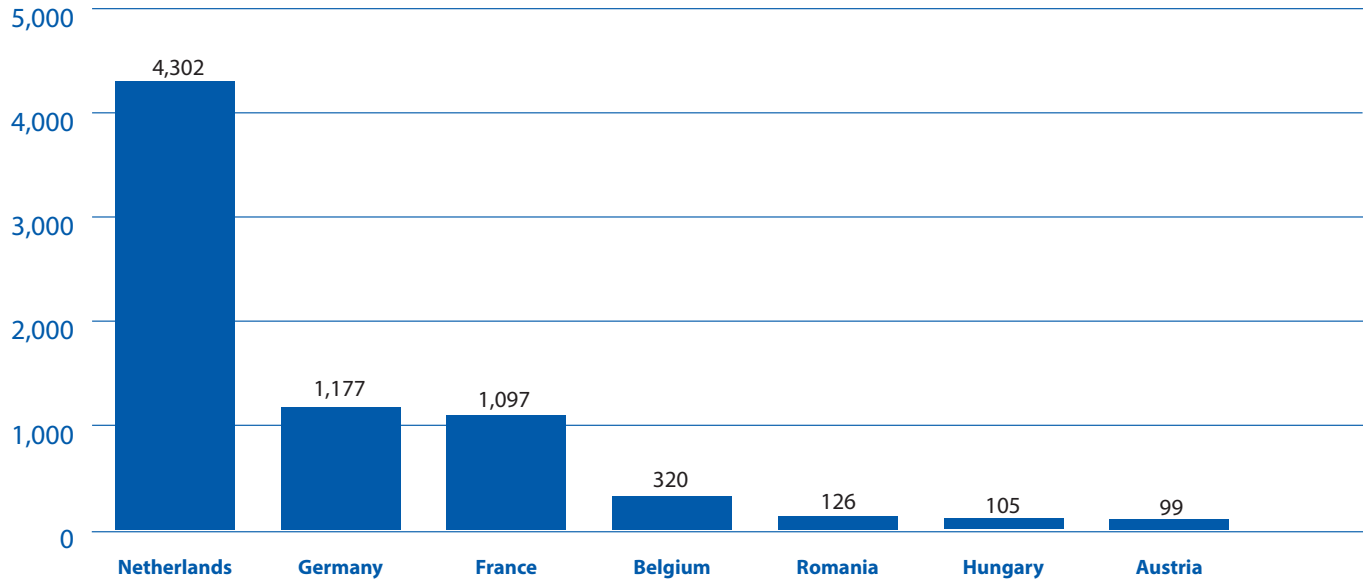
This last financial and market structure aspect is important, as new engines, that will comply with the stricter Stage V standards from 2019 onwards, will be more expensive than engines complying with the current CCNR II emission level. In order to prevent a standstill of new construction, innovation and greening from 2019 onwards, public policies and public actions could be undertaken.

5. COMPANY ACTIVITY

5.1 OVERALL STRUCTURE

In Europe, there were almost 10 000 inland waterway companies operating in the market in 2014. In the EU overall, 60% of the companies are active in goods transport, and 40% in passenger transport.

Figure 38: Number of companies in main European IWT countries (units)
Source: Eurostat, National Statistical Offices

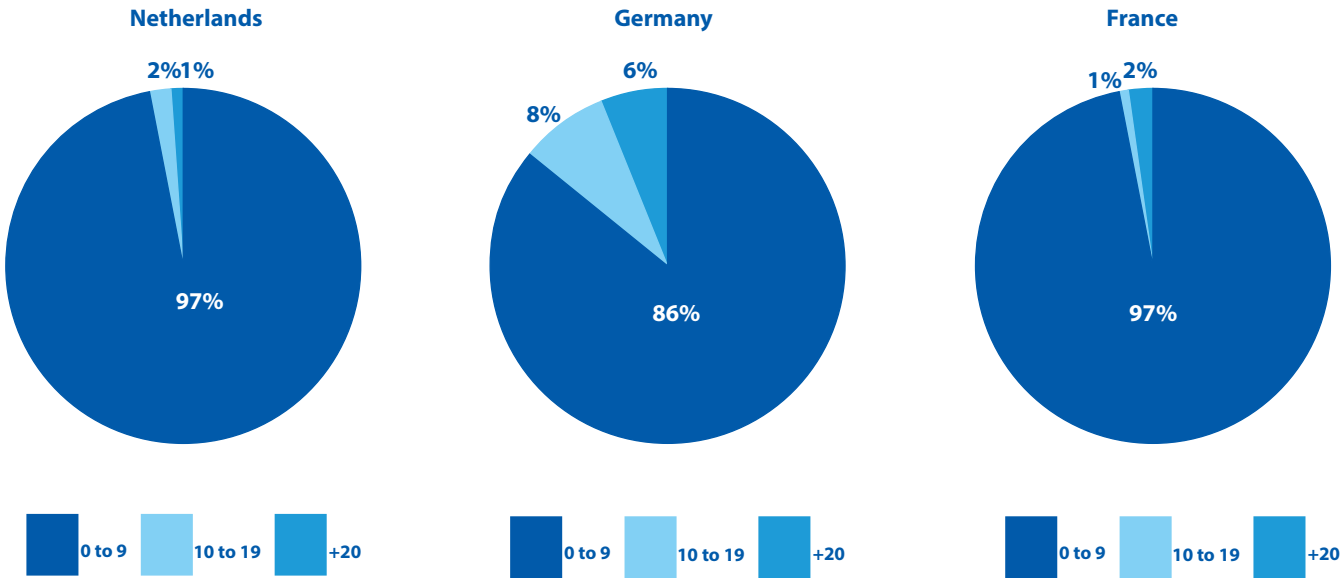


The Western European inland shipping sector is characterised by high fragmentation, with the majority of companies being small family businesses owning or operating one or two vessels. On the other hand, the companies in the Danube region are mostly bigger for mainly historical reasons: In the Danube region, the previous state-owned enterprises became privately owned but the large size of the companies remained. At present about 14 large companies, with more than 20 vessels each, dominate the market.

The fragmentation in Western Europe can be seen for the structure of the company sector in the Netherlands, Germany and France. In all of these countries, the number of companies that have up to nine employees is significantly high. The exception in Western Europe is Switzerland, where these enterprises represent only about 66% of the total number of IWT entities. Switzerland has a larger share of bigger enterprises, mainly active in passenger shipping (53% of all Swiss IWT companies) and in tanker shipping.

Figure 39: Companies by number of employees in 2014 (% over the total)

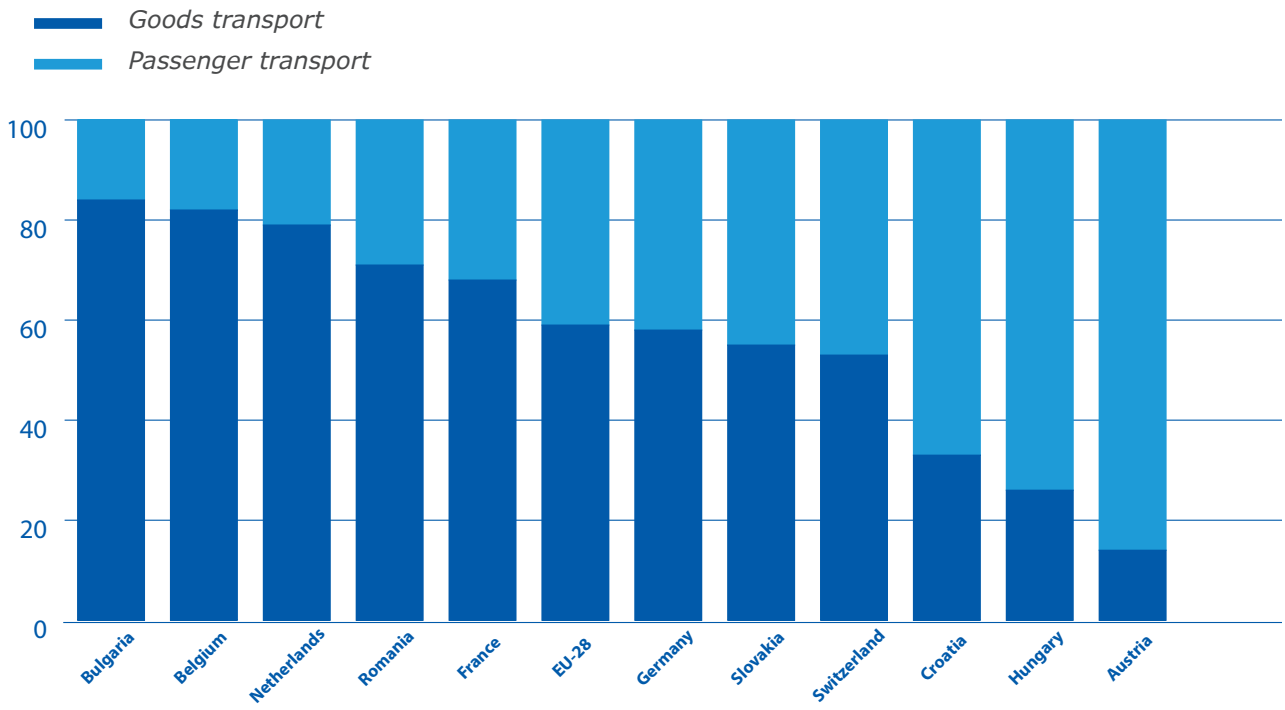
Source: CBS, Destatis, INSEE



The share of companies active in goods transport and in passenger transport differs quite strongly from one country to another.

Figure 40: Share of companies active in goods transport and in passenger transport in European IWT (%)

Source: Eurostat, National Statistical Offices

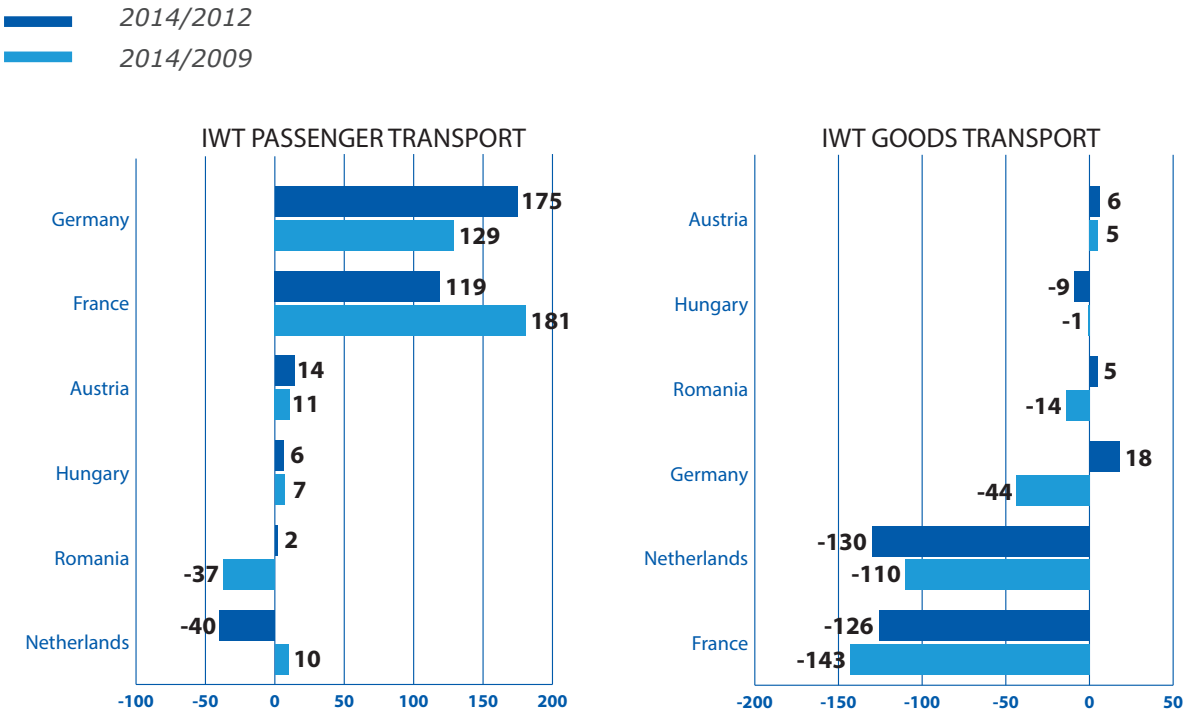


In Europe, the total number of IWT companies active in goods transport decreased between 2012 and 2014, but the number of companies active in passenger transport went up (source: Eurostat). This evolution reflects the different trends between goods and passenger transport.

These trends may be highlighted for particularly important IWT countries:

Figure 41: Evolution of the number of companies active in IWT (units)

Source: Eurostat; data for the Netherlands: CBS



The evolution in the number of companies active in goods transport was overall less positive than in passenger transport. This was certainly the case for France and the Netherlands, where many small companies ceased their activity between 2009 and 2014. A decrease was also observed for Germany and Romania, when 2014 was compared with 2009, but the recent development was positive in these countries: from 2012 until 2014 the number of new companies created was higher than the number of companies that ceased their activity. Austria is the only country where the evolution was positive over the whole period 2009-2014.

For the whole of Western Europe (Belgium, France, Germany, Netherlands, Switzerland), the rising number of passenger shipping companies (+269) did compensate the reduction in the number of goods transport companies (-226): The total number of IWT companies in Western Europe increased between 2012 and 2014 by 43 units.

Also in the Danube region (Bulgaria, Austria, Croatia, Hungary, Romania, Slovakia), the overall evolution between 2012 and 2014 was still positive, with an additional number of 20 units. Also here, the number of passenger transport companies increased, and the number of goods transport companies decreased.
In the Danube region, passenger transport includes not only day trip excursions and river cruises, but passenger vessels are still very much used for commuter traffic. Mostly these commuter traffic companies are very small. An example is the Hungarian company sector. In 2014, there were 78 passenger and 27 freight transport companies; however, the total annual turnover was 17.8 million euros and 58.1 million euros respectively. This means that most passenger transport companies are small and offer day trip or commuting services along the Danube in Budapest.

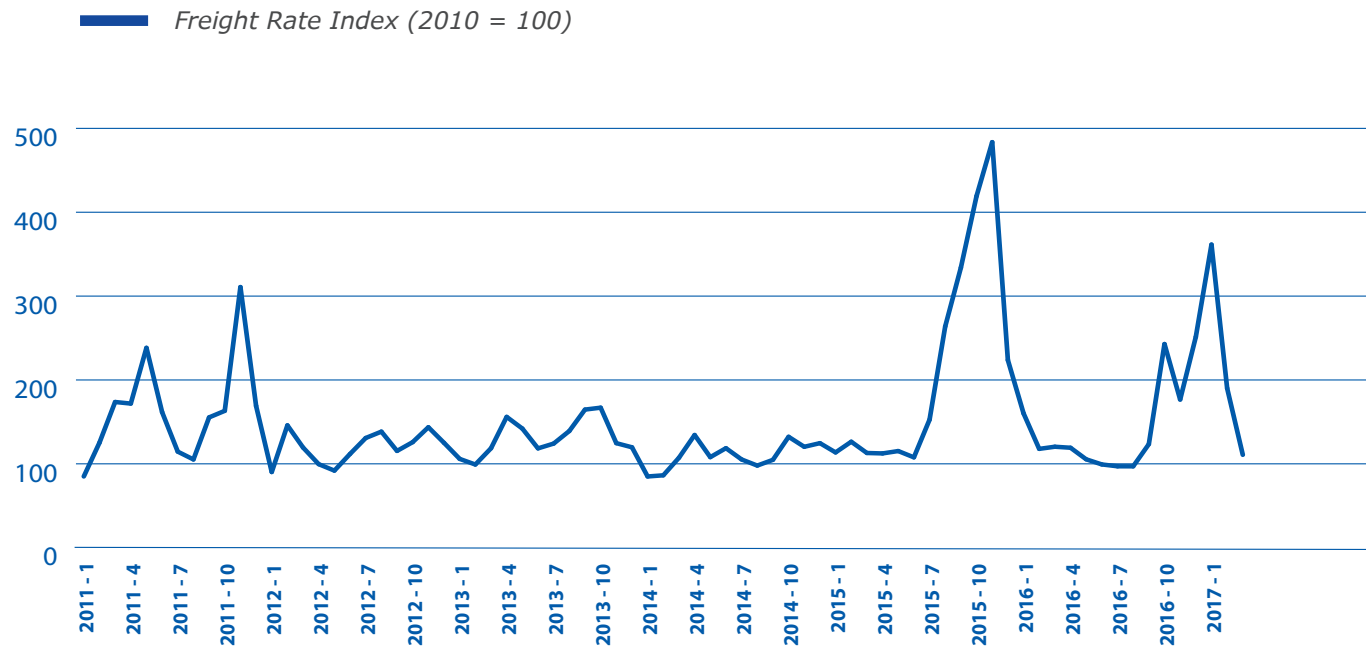
5.2 EVOLUTION OF FREIGHT RATES AND TURNOVER

As in any other industry, the turnover evolution in inland shipping rests upon two influencing factors: the evolution of the output (in IWT the transport performance) and the evolution of prices. However, in inland shipping, prices (or freight rates) have a very strong impact on turnover. This is due to the fact that in IWT, prices have variations that are much stronger than the variations in transport activity. The strength of the variations of the price level is a consequence of natural factors: transport prices are heavily influenced by water levels, as a restriction in water levels reduces the available loading capacity of vessels and leads to a restriction of the supply side of the market.

The following figure shows evolution of freight rates in tanker shipping and highlights the impact of low water periods at the end of 2015 and 2016 on inland navigation freight rates. In September/October 2015 and in November/December 2016, price levels were four to five times higher than in normal times.

Figure 42: Freight Rate Index evolution between January 2011 and March 2017*

Source: CCNR and PJK International
** Freight rates in tanker shipping*



The intense low water period in 2015 explains largely the evolution of turnover between 2015 and 2016 for Western Europe. Indeed, for the Netherlands and for Germany, we observe a decrease in turnover by 7.5% and 11.1% respectively, as water levels in 2016 recovered, and prices were consequently lower on average in 2016 than they had been in 2015.

For other countries, like Austria and Hungary, the connection between water levels and prices/ turnover is less relevant. First of all, in Danube shipping, freight rates are mainly determined by bunker fuel costs. And secondly, passenger transport plays a larger role in Austria and in Hungary, and for passenger shipping, low water levels do not have such a direct effect on prices or turnover.

Table 6: Turnover evolution 2016/2015

Source: CBS, Destatis, Eurostat
** % shares are for 2015*

Country	Share in total turnover of ...*		Total turnover evolution 2016/2015
	goods transport	passenger transport	
Netherlands	92%	8%	-7.5%
Germany	81%	19%	-11.1%
Austria	34%	66%	+2.0%
Hungary	73%	27%	+1.3%

Compared to the average turnover in the period from 2010 until 2015, the result in the Netherlands was 3.7% lower (source: CBS). However, turnover per inland navigation freight transport company increased slightly due to a stronger decline in the number of companies during this period (source: Eurostat).

In Germany, the turnover result can be split between a decrease of 15% in goods transport turnover and an increase of 5.4% in passenger transport turnover. In terms of turnover per employee, Germany has the highest productivity among Rhine countries with about 350,000 euros turnover per employee (2014 figures, source Eurostat).

According to surveys conducted by the German Federal Office of Goods Transport (BAG), the turnover evolution within goods transport differs according to market segments. Within the dry cargo shipping segment, a decrease was predominant, especially on the Rhine market, where small companies operate under difficult market conditions, facing a high degree of competition. In container shipping, however, companies experienced rather stagnating turnover figures.
In Austria, turnover was 2% higher than in the previous year, but its level was still far below the values of the years 2013 and 2014. In Danube countries, Austria traditionally registered the highest turnover per passenger transport enterprise with about 650,000 euros on average during the period 2009-2014.

Turnover in the Hungarian inland shipping industry was on the rise during the year 2016, but this was mainly due to the usual seasonal variations in goods transport. Over the whole year, the result was 1.3 % higher than in 2015. The turnover in Hungary was about €250k per passenger transport entity over the same period.

6. WORKFORCE AND LABOUR MARKET

6.1 QUANTITATIVE EVOLUTION

The total number of employees in the European Union is approximately 44,000 both for the transport of goods and for the transport of passengers on inland waterways.

Figure 43: Western Europe countries (Belgium, France, Germany, Netherlands)
Source: CBS, Destatis, Eurostat

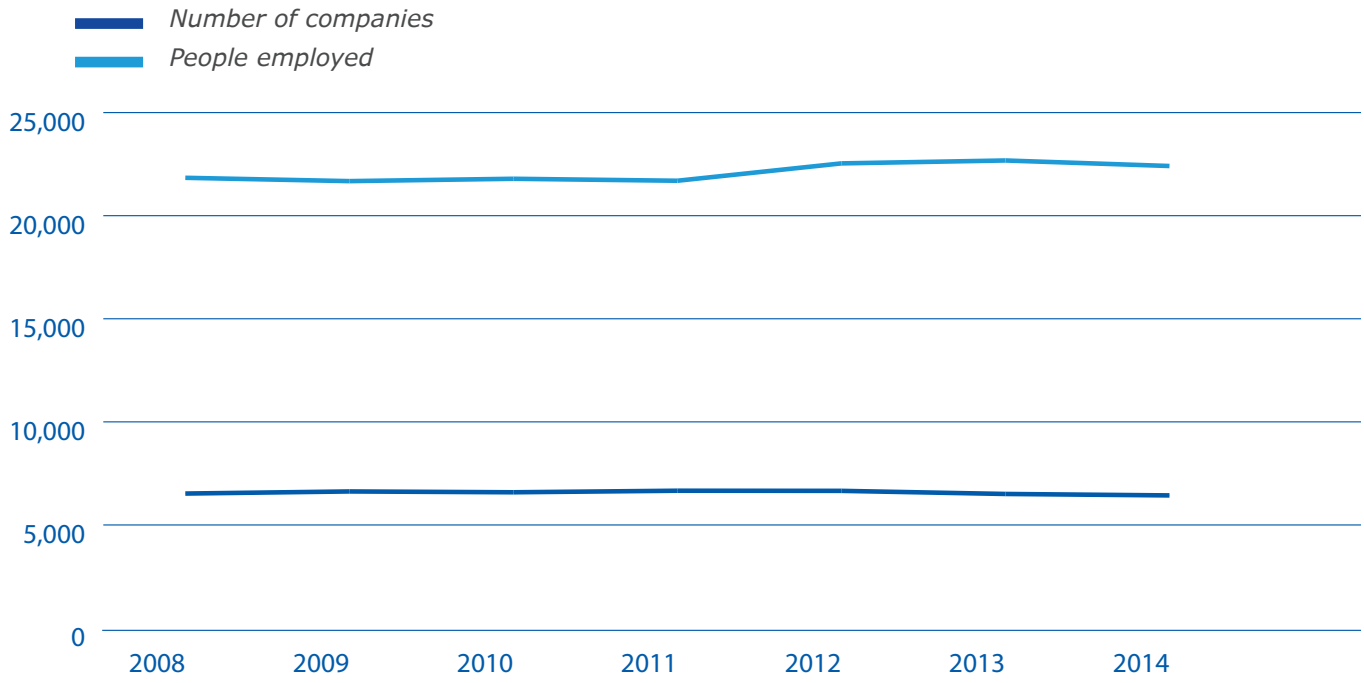
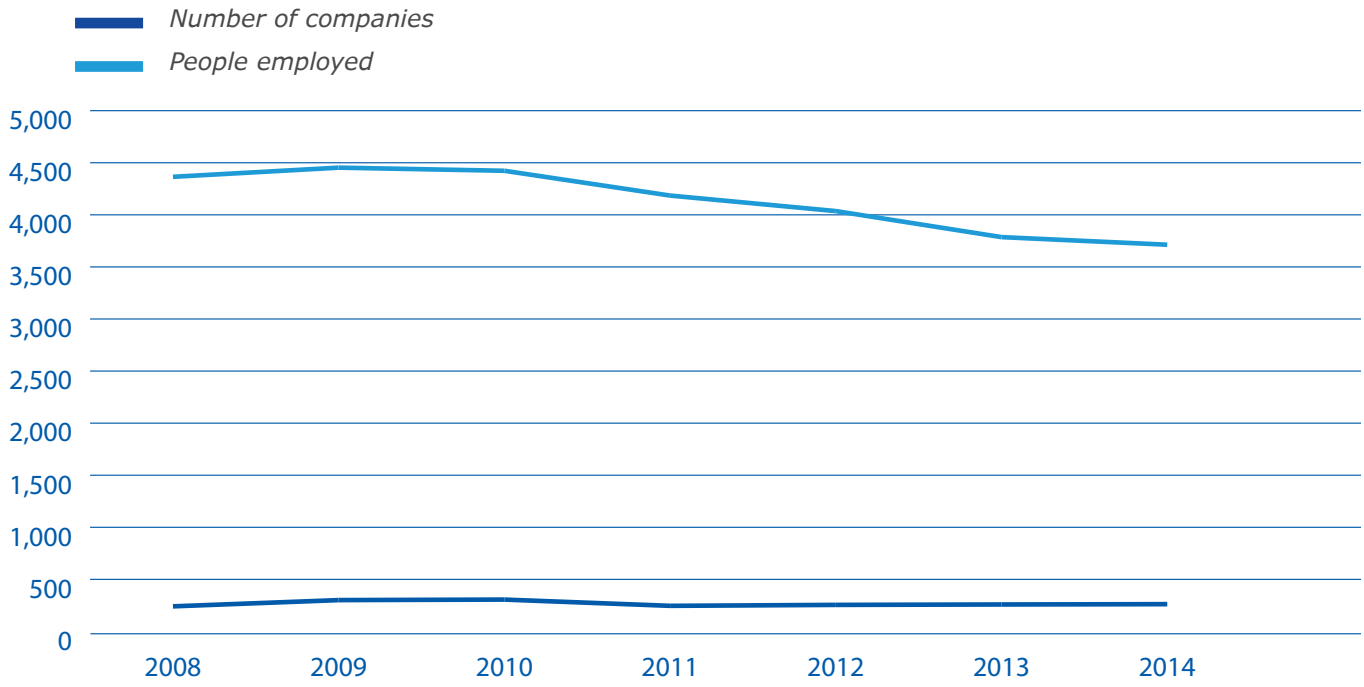


Figure 44: Eastern Europe countries (Bulgaria, Hungary, Romania)
Source: Eurostat

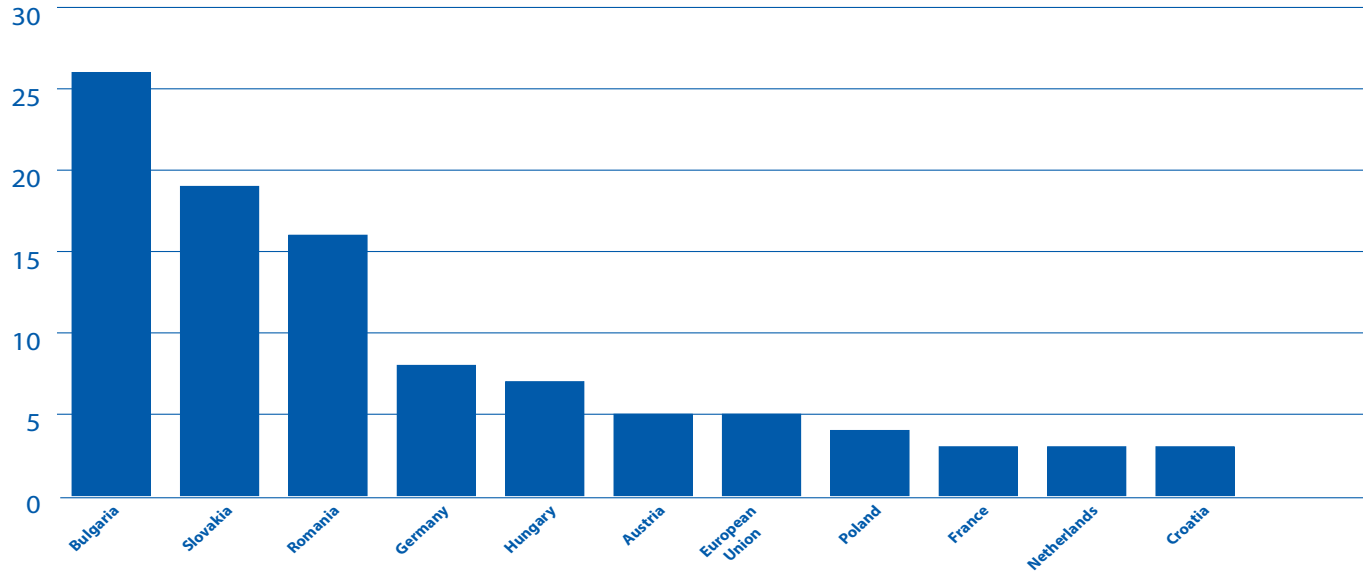


The number of employees working in the inland navigation sector remained rather stable in Western Europe, despite the economic crisis in 2008 or despite the low water period that impacted the traffic, as in 2011 for example. This observation highlights the robustness of IWT positions in Western Europe. On the other hand, the situation is not the same in Eastern Europe where the number of workers in the field of inland navigation has decreased since 2010.

The evolution at stake is actually not the same in Rhine countries and in Danube countries. The Rhine countries' inland shipping sector is characterised by a fragmented market with several small family businesses owning or operating a limited number of vessels. But the number of employees per company is increasing in Rhine countries and we observe a consolidation process with a total number of companies decreasing since 2011. On the contrary, in Danube countries the market structure is impacted by previous state-owned companies and is, as a consequence, more concentrated. A fragmentation process is to be observed. The number of companies has slightly increased since 2011 even though the total number of employees has decreased.

Figure 45: Number of employees per company per country

Source: Eurostat

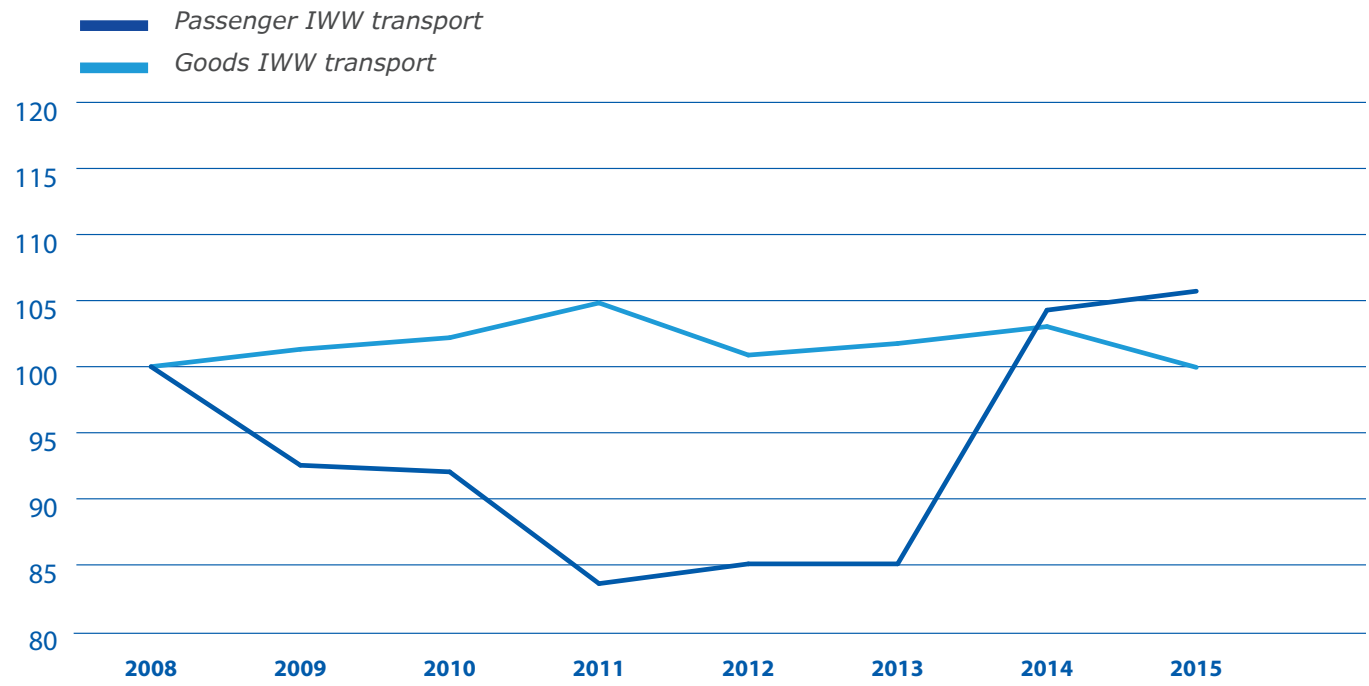


On average in the European Union, there are five employees per company belonging to the inland navigation sector (transport and goods transport taken into account). Of course, this number is largely influenced by Germany and the Netherlands where there are respectively 86% and 97% of the companies that have fewer than 10 employees.

One should also highlight the difference between goods transport and passenger transport. In 2015, goods transport represented 52% of the inland navigation employees, while passenger transport represented 48%. Their weight in terms of the labour market is today equivalent in Europe but the evolution over the past years is different. While the size of the workforce is characterised by stability of the segment of goods transport, the passenger transport sector successively registered a significant negative impact with the economic crisis in 2008 and a 25% increase between 2013 and 2015. In addition to the increase in the passenger transport workforce since 2013, one should also note that positions in inland navigation passenger transport are less and less impacted by seasonal breaks, leading to more stable career opportunities. Technological reasons, such as the use of modern cruise vessels or the use of single paddlewheel, and social reasons, with a wider offer of cruise types, have considerably extended the service period for passenger transport.

Figure 46: Evolution of employment in passenger and goods inland waterways transport (Index 100 in 2008)

Source: Eurostat

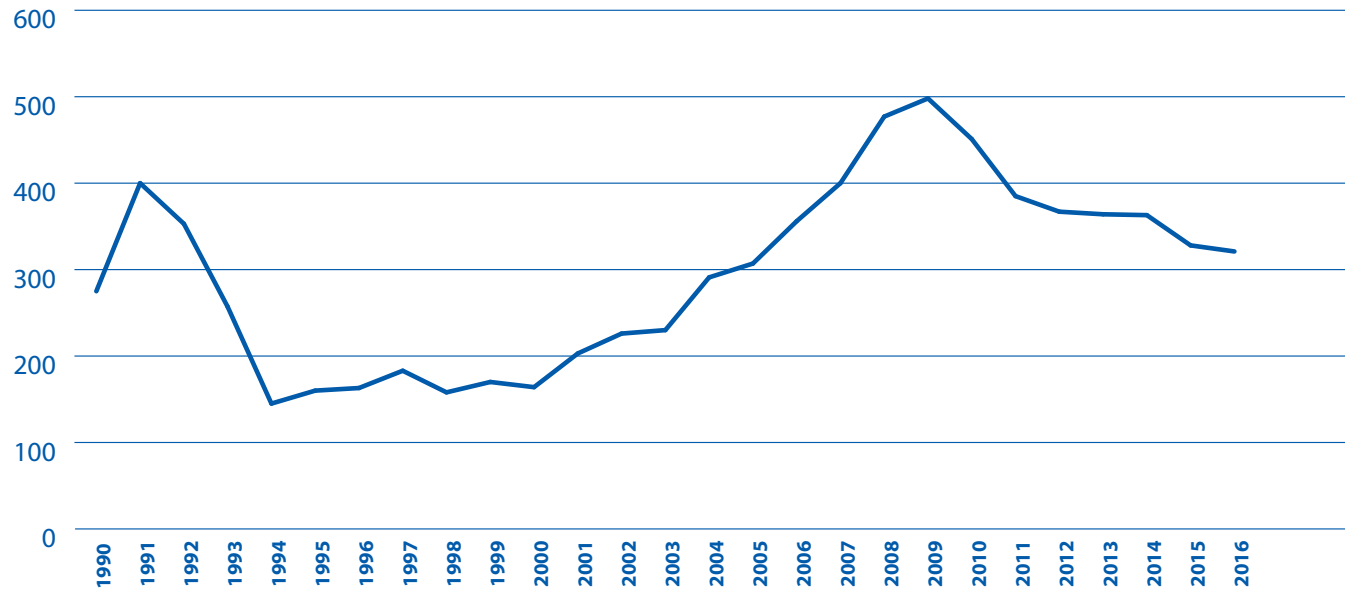


6.2 IWT SECTOR ATTRACTIVENESS

Inland navigation workers are a key driver for inland navigation dynamism and it is very important for inland navigation to be attractive enough, especially towards young talents with entrepreneurial and innovation-oriented mindsets. The graph on the next page shows the evolution of number of apprentices in Germany in the inland navigation sector. Following a strong decrease in the 1990s, the number of apprentices in the inland navigation sector increased in Germany between 2000 and 2009 in a catch-up effect. As in other sectors, the number of apprentices decreased between 2009 and 2016 with the number of young people taking up university education increasing. However, for the first time in the last decade, 2016 saw a considerable increase of 10% in the number of new apprentice contracts in inland navigation in Germany.

Figure 47: Number of apprentices in the inland navigation sector in Germany

Source: German Chambers of Commerce and Industry (Deutscher Industrie- und Handelskammertag)



In Germany, the percentage of workers between 16 and 25 years old increased substantially between 2005 and 2011, partly because of public funding for quality training (source: Arbeitsmarkt- und Berufsforschung - IAB).

EDINNA conducted a survey of new entrants to inland navigation training schools in 2015. Replies received from the Netherlands, Romania, the Czech Republic and Serbia showed an increase in the number of new entrants to the sector between 2009 and 2015. Even though not all EDINNA members filled in the questionnaires for students on Operational Level (boatman) and Management Level (boatmaster), schools with a relatively large number of students reported increasing numbers of students such as the Dutch boatman classes at Ijmuiden from 100 (2009) to 111 (2015) and Rotterdam 56 (2009) to 118 (2015), the Romanian school CERONAV from 164 (2009) to 221 (2015) and the Czech school from 32 (2009) to 41 (2015). The Belgrade school saw an increase in Management Level education and a decrease in Operational Level students.

The average age of qualified crew members is rather high with respectively 41% and 38% of qualified workers in inland navigation being older than 55 in Germany and older than 50 in Belgium[18]. A similar situation can be noticed in the Netherlands.

A shortage of qualified personnel is particularly noticeable at Management Level. Boatmasters are often requested to have additional skills for tanker vessel or LNG operation. Furthermore, a lot of highly qualified personnel are needed in the emerging passenger navigation market.

6.3 NEW DIRECTIVES CONCERNING WORKING TIME AND PROFESSIONAL QUALIFICATIONS

The future of inland navigation will also depend on its ability to attract talents from coming generations.

The transposition of the working time directive 2014/112/EU at the end of 2016 has made IWT jobs more attractive. Employees can rely on predictable working patterns and have a right to a regulated amount of free time. The directive is based on a Social Partners' agreement, which guarantees that it takes into account the specific needs of the sector.

[18]2011 data for Germany (Institut für Arbeitsmarkt- und Berufsforschung - IAB) and 2014 data for Belgium (Office National de la Sécurité Sociale - ONSS)

Some 31,000 mobile workers in inland waterway transport or a total of 73% of all persons working on board inland waterway vessels are covered by the directive[19]. The EU working time directive applies to employees belonging to the nautical crew and to other shipboard personnel on board passenger vessels. It allows for a daily working time of 14 hours with a maximum working time of 84 hours per week. The average weekly working time of 48 hours can be achieved by taking into account free time over a 12-month period. For employees in seasonal traffic of passenger vessels (operation up to nine months a year), specific shift pattern can be applied, allowing for more consecutive days on board to be compensated by more free time for each day worked on board. The choice offered to passenger vessel operation does not only meet specific needs for 24-hour passenger service and vessel operation by night time during the tourist season but also an increasing share of third country nationals on board cruise vessels with less time spent at home during the tourist season.

The future directive on the recognition of professional qualifications in inland waterway transport[20] as informally agreed on by co-legislators in trilogue on 27 June 2017 also increases the attractiveness of jobs in inland waterway transport by enhancing labour mobility, by setting harmonised competence standards developed by CESNI[21] for all Union waterways, and by introducing a competence-based approach to allow for harmonised levels of education, training and assessment of knowledge and skills throughout Europe.

Two elements will largely contribute to more flexibility in the EU labour market: for the first time, competencies for a boatman are defined on an international level (instead of the traditional experienced-based approach) and, for the first time, Member States will define stretches with specific risks that require special knowledge according to a transparent set of criteria (instead of a national approach without common criteria), easing access to the European inland waterway labour market and still maintaining the high level of safety achieved in inland waterway transport over the last decades mainly favoured by River Commissions.

With a view to increasing the attractiveness of the sector even more, Social Partners have proposed short term changes in manning requirements they agreed on after a round table debate initiated by the Dutch presidency of the Central Commission on Navigation of the Rhine (CCNR) which adopted most of the Social Partners´ proposals in 2016. With a view to a more in-depth revision of CCNR manning requirements in a European context, Social Partners are currently carrying out a study on changes in workload over the last years (Towards A Sustainable Crewing Systems, TASCS) which will table a report in January 2019. Afterwards, a new legal instrument on manning could be assessed. Social Partners wish for a European legal instrument on manning requirements which will apply to all qualifications defined in the directive on professional qualifications and which will be easy to enforce. They also strive for a streamlining in definitions of working time, rest time and navigation time which, according to the existing legal definition and respective aims, need further alignment.

[19]ECORYS study on impact of social partners agreement 2013
[20]For Commission proposal, see document COM (2016) 82 final of 18 February 2016
[21]CESNI = European committee for drawing up common standards in the field of inland navigation created by CCNR in 2015

7. EMISSIONS IN INLAND NAVIGATION

7.1 INTERMODAL COMPARISON OF EMISSIONS

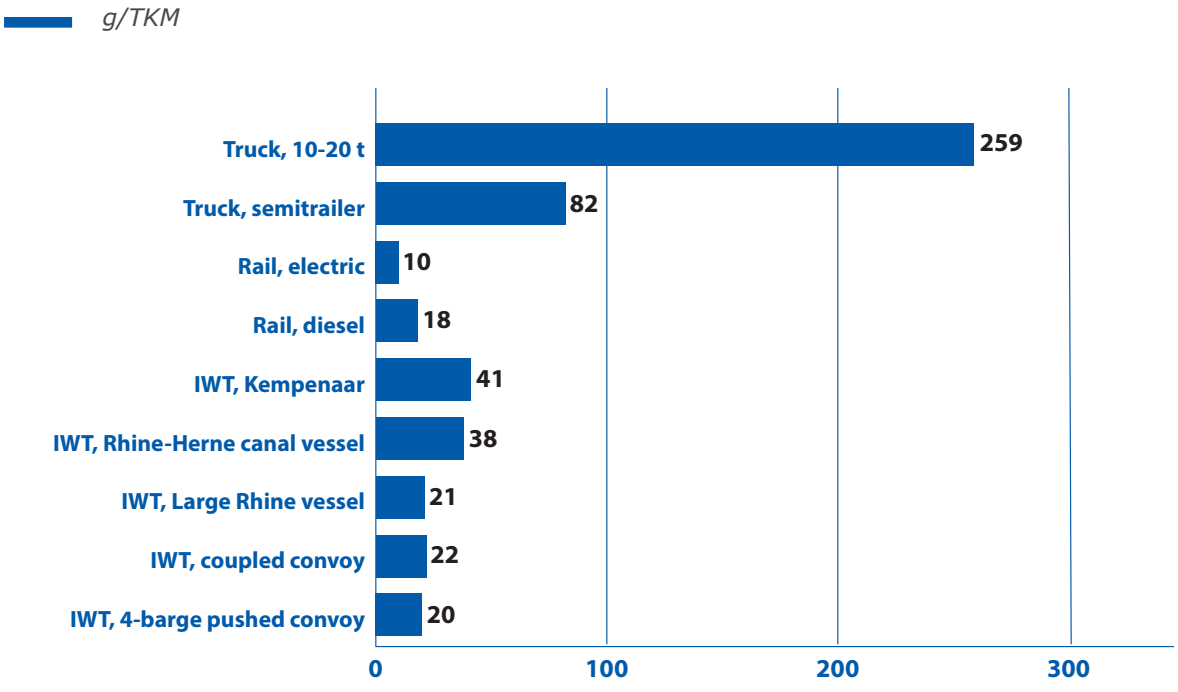
Although inland waterway transport has the advantage of economies of scale, due to the large capacities of ships compared to trains and trucks, the emissions of inland vessels are attracting more and more concern and attention. This is less the case for greenhouse gas emissions, but much more the case for pollutant emissions. These emissions are harmful to nature and human beings, which is relevant both for the personnel working in IWT as well as for populations in densely populated areas, living alongside inland waterways (in port areas or cities).

For comparing emissions between IWT, road and rail, a study published by the research institute CE Delft is used as a reference.[22] The study contains values for CO_2 emissions and main pollutant emissions per tonne-kilometer, for different vessel and vehicle types.

For PM[23], the emissions due to wear-and-tear were also taken into account. These emissions are caused by abrasion from tyres, brake linings and road surface. They are relevant for trucks, where they can be in the same magnitude as the PM emissions from engines.
The following figures show the emission factors according to CE Delft for the different vessel, train and truck types. Within IWT, it is straightforward to see the influence of the vessel size: larger vessels have lower fuel consumption values per tonne-kilometer and therefore lower emissions per tonne-kilometer than smaller ones. Four-barge pushed convoys have the lowest values of the vessel types presented here.

Figure 48: Representative emission factors for CO_2, bulk transport

Source: CE Delft (2016), STREAM Freight transport 2016. Well-to-well emissions approach



[22]CE Delft (2016), STREAM Freight Transport 2016 — Emissions of freight transport modes
[23]Particular Matter Emissions due to combustion or wear-and-tear

Figure 49: Representative emissions factors for Particular Matter (PM), bulk transport

Source: CE Delft (2016), STREAM Freight transport 2016. Well-to-well emissions approach

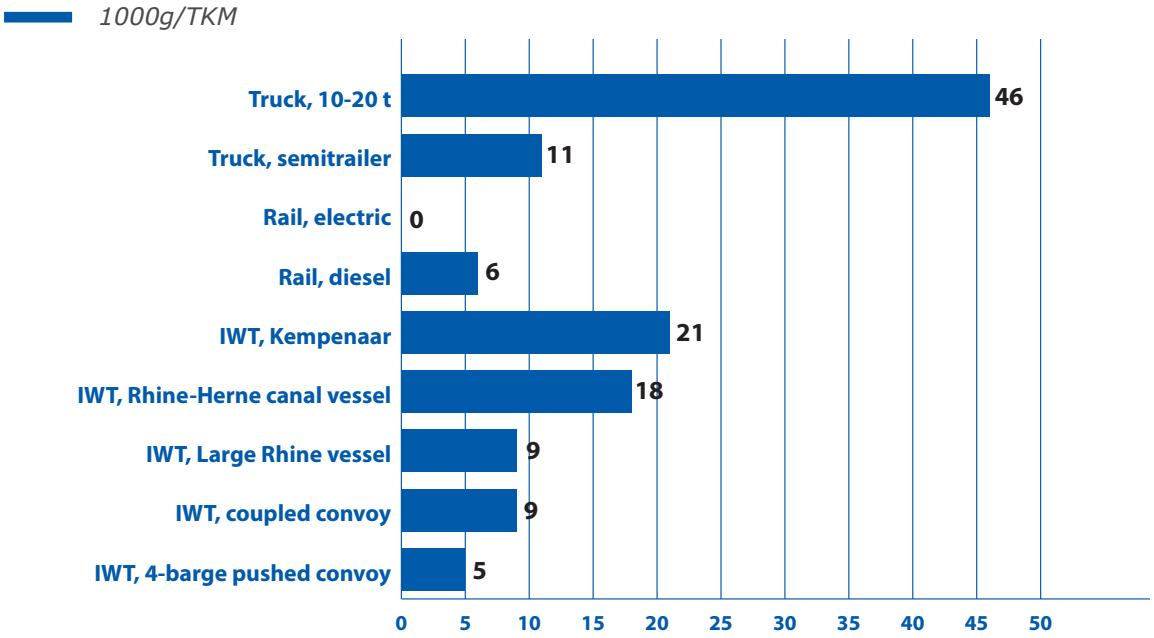
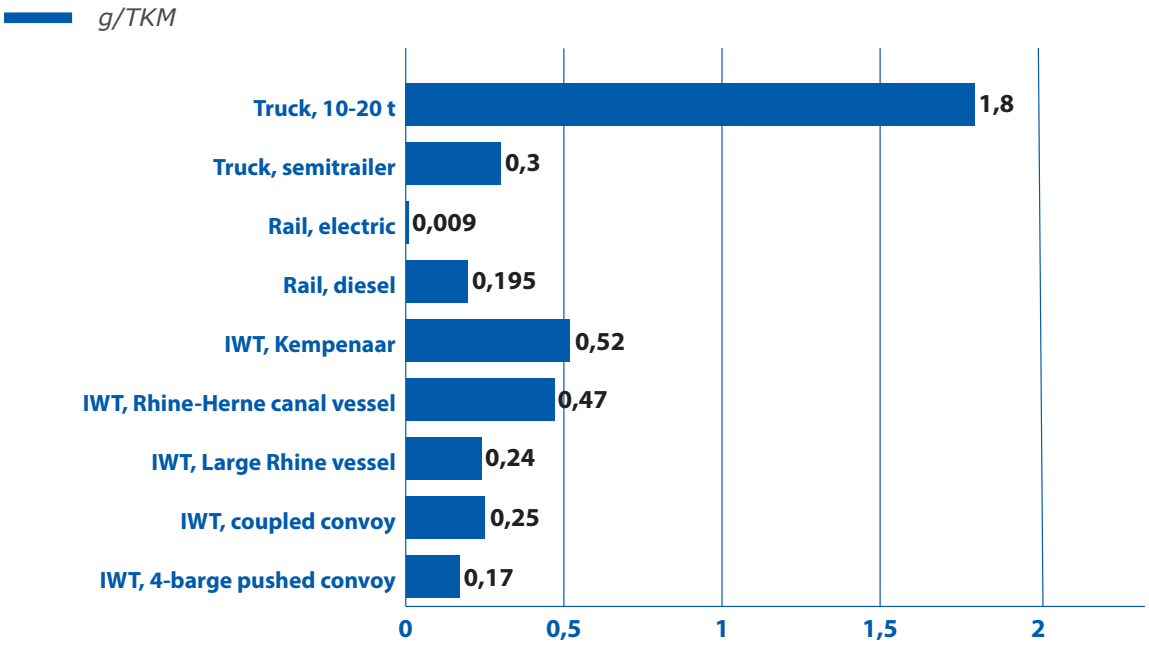


Figure 50: Representative emissions factors forNitrogen oxides (NOx), bulk transport

Source: CE Delft (2016), STREAM Freight transport 2016. Well-to-well emissions approach



The following conclusions can be drawn:

- Overall, IWT has higher CO_2 and pollutant emissions than railways, as 80% of railway goods traffic is based on electric traction today.
- The comparison between IWT and road traffic delivers different results, dependent upon the vessel or vehicle type. However, the most representative vessel types in terms of their share of transport performance (large Rhine vessel and Rhine-Herne canal vessel) have clearly lower CO_2 emissions than trucks, and about the same level of pollutant emissions.

From the results, the overall conclusion seems to be that IWT vessels emit relatively few greenhouse gases, but can have rather high values for pollutant emissions, when compared to railways and trucks. Therefore, it is worth thinking about emission reduction measures specifically for the IWT sector. The next chapter will analyse these measures.

7.2 MEASURES FOR REDUCING FUEL CONSUMPTION AND EMISSIONS IN IWT

Emission reduction measures in inland shipping can be categorised into three main groups: technical measures, operational measures and measures related to traffic and transport management. Based on a literature review, for most of the options within the three groups, the reduction potential (in terms of reduced energy consumption compared to a conventional diesel engine without any greening measures), the applicability (new construction/retrofit), the approximate costs, and the approximate payback time were investigated. A synoptic overview of the investigation results can be found in the following table. It has to be said that the indicated costs and payback times are only a broad indication, and can differ, depending on particular technical and economic circumstances. The payback times are of course influenced by fuel price variations.

Table 7: Technical, operational and traffic management measures for reducing energy consumption in IWT

Source: Own compilation based on DNV GL (2015), Pauli (2016), Development Centre for Ship Technology and Transport Systems (DST), Hazeldine, Pridmore et al. (2009)

Area	Measures	Applicability	Decrease of energy consumption	Additional costs (€)	Payback time (years)
Technical	Father-and-son engine[24]	New and retrofit	10%	150,000	7-8
	Diesel-electric propulsion	Only new vessels	10%	200,000	10
	Electric propulsion	Only new vessels	10%	300,000	15
	Liquefied natural gas (LNG)	New and retrofit	No	New: 1,000,000 Retro: 1,400,000	16-20
	Particular matter filter (PMF)	New and retrofit	No	500,000	-
	Selective catalytic reduction (SCR)	New and retrofit	No	500,000	-
	Flexible tunnel	New and retrofit	10%	60,000	1.5-3
	Optimised hull form	New and retrofit	10%	150,000	3-4
	Weight reduction by composite materials	Only new vessels	5-15%	Increase in hull costs by 30%	10-15
Operational	Speed reduction/ smart steaming	All vessels	10-30%	250 euros for a training course	0.1-0.2
	On-board information systems/ journey planing		10%	Low costs	<1
	Optimal maintenance		5%	Low costs	<1
Traffic and transport management	Reduction of empty trips		High	No general quantification possible	
	Improving interface in seaports		High		
	AIS/RIS/ Inland ECDIS		High		

[24]This system consists of a combination of a smaller and a larger engine, which are deployed depending on the navigation situation and according to their optimal power range. For the energy demanding upstream transport, only the larger engine can be active, while the smaller one can be inactive. For downstream transport, when less power is needed, only the smaller engine could be deployed. Overall, this system leads to savings in fuel consumption.

7.3 AMOUNT OF GREENING MEASURES IN IWT IN 2014-2016

In the light of the greening measures presented in the table above, it is interesting to compare this with the actual amount of greening that was observed in recent years.

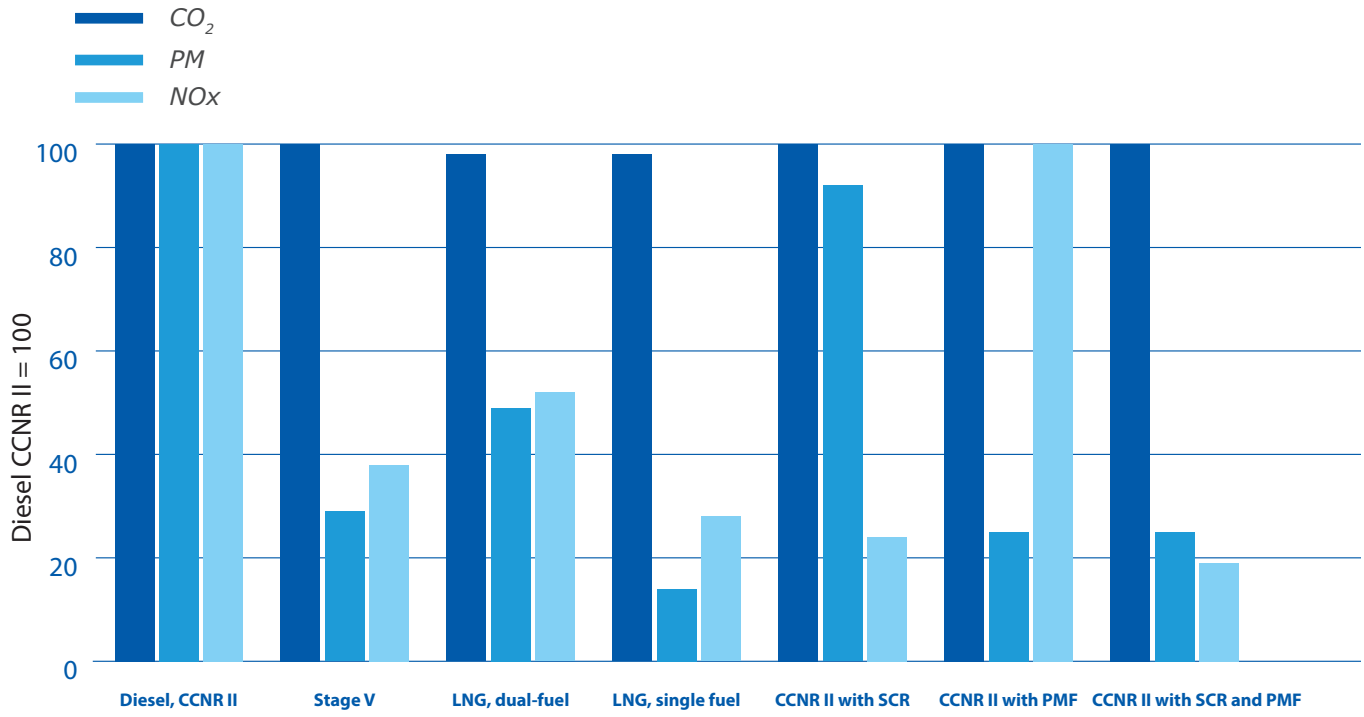
A detailed analysis of the 187 self-propelled cargo and passenger vessels that came on the market in the years 2014, 2015 and 2016 shows a total number of 111 greening measures.[25] More than half of all greening measures were related to diesel-electric propulsion. 21 cases contained weight reduction and other different sorts of hull form optimisation. However, measures enabling the emission performance demanded by the Stage V emission standard to be reached (emission standard for new engines in new and existing vessels from 2019 onwards) were not very frequent (16 greening cases out of 111 in total in 2014-2016, on 9 vessels out of 187 new vessels in total). A possible reason for this result could be the high costs of these measures. The measures enabling emission standards comparable to the Stage V standard to be attained are the installation of both exhaust gas after treatment systems or the installation of a mono-fuel LNG system.

SCR reduces nitrogen oxides NOx by 85-90% and PMF reduces particulate matter by 90-95%. Therefore, these systems are very efficient at reducing pollutant emissions. But for a single engine of some 1000 kW, which is a common engine size for a self-propelled vessel in Europe, the price for exhaust after treatment systems is almost as high as the price for a new engine.[26] Besides, PMF can lead to slightly higher fuel consumption levels by 2-3%.[27]
LNG's main advantages are a significant reduction of pollutant emissions (80% for NOx, 75% for PM).[28] But in 2014-2016 only in four cases were new vessels equipped with LNG propulsion, and only one with a LNG mono-fuel system. Again, a main reason could be the high investment costs of LNG and the long payback time, especially as the oil and diesel prices fell strongly from 2014 onwards.
Currently, most projects for LNG vessels are partly publicly funded, for example by the LNG Masterplan Rhine-Main-Danube, a large research project that has received 40 million euros of EU funding. Its vision is that LNG will be transported by IWT from LNG terminals in seaports to LNG hubs (serving as bunkering stations) in the hinterland. Economically, it can be expected that investment costs for LNG will go down with more vessels using LNG, and the availability of LNG will develop as more bunkering stations become available.

The new emission limits (Stage V) that will apply for new engines from 2019 onwards[29] can only be met with the following technologies: monofuel LNG propulsion or engine with both exhaust after treatment systems. The compliance of new engines to Stage V will be demonstrated by type-approval certificate. This is shown in the following figure, where the reference emission level is the CCNR Stage II level, which was applied for new engines in 2007.

[25]This information was gained by analysing each new vessel, on the basis of detailed sources in shipping journals Binnenvaartkrant and Scheepvaartkrant, where all new vessels are described in detail.
[26]Source: Pauli (2016)
[27]Source: European Commission (2013) Commission staff working document – Greening the fleet: reducing pollutant emissions in inland waterway transport
[28]The effects on greenhouse gas emissions are not positive, as methane slip occurs when the combustion process is not perfect. Methane slip is very harmful for global warming – its global warming potential is about 28 to 34 times higher than that of CO_2 (Pauli 2016).
[29]Regulation (EU) 2016/1628 of the European Parliament and of the Council of 14 September 2016 on requirements relating to gaseous and particulate pollutant emission limits, and type-approval for internal combustion engines for non-road mobile machinery.

Figure 51: Comparison of emission limits according to Stage V and CCNR II with different greening options
Source: CE Delft (2016)



In theory, many emission reduction measures for IWT exist, but their application is often very costly, and therefore difficult to implement in a market structure with a high share of family businesses. Perhaps the measure with the highest and quickest return on investment (both in economic and in ecological terms) are operational measures, such as the reduction and optimisation of speed, on-board information systems, journey planning and automatic channel guidance systems.

Incentives for sustainable shipping are also important. The port of Rotterdam has introduced a system of port dues which is giving incentives for greener vessels. The different types of vessels that are liable to pay inland port dues are classified into five categories. Depending on the relevant category, either the basic tariff or a raise or discount on the basic tariff will be applied. In addition to this, vessels that do not have a CCNR II engine will be banned from entering the port area from 2025 onwards.[30]

Very recently it was decided that protection of the atmosphere would be incorporated into the CDNI-Convention[31] and provisions on the handling of gaseous residues of liquid cargo were adopted.[32] This international harmonised regulation will avoid an estimated 95% of harmful degassing from vessels into the atmosphere within the scope of CDNI.

7.4 A SCENARIO FOR FUTURE EMISSION REDUCTION IN IWT

According to a detailed analysis of the emission profiles of IWT engines in the inland fleet, the German research institute IFEU came to the conclusion that inland navigation has reduced its emissions since 1970 by 80% for PM10 and by 40% for NOx.

But for future emission reduction, rail and road traffic are strong competitors for IWT. For rail traffic, this is due to the high share of electric traction, which, in combination with a rising share of renewable energies in the electricity sector, leads to permanent emission reduction. For road traffic, new emission standards appear at a higher frequency than in the IWT sector.

[30]Source: Port of Rotterdam (https://www.portofrotterdam.com/en/shipping/port-services/shipping-regulations); https://www.portofrotterdam.com/en/file/1216/download?token=EtLoNpMe (page 44 — Article 13.2)
[31] CDNI = Convention on the Collection, Deposit and Reception of Waste Produced during Navigation on the Rhine and Inland Waterways
[32]http://www.cdni-iwt.org/en/actualites/

In cooperation with the CCNR, the IFEU institute developed a scenario for the evolution of emissions in IWT until the year 2035. The assumptions for these scenarios are shown in the following table:

Table 8: Assumptions under the IFEU scenario for emission reduction

Source: IFEU (2016)/CCNR (2012)

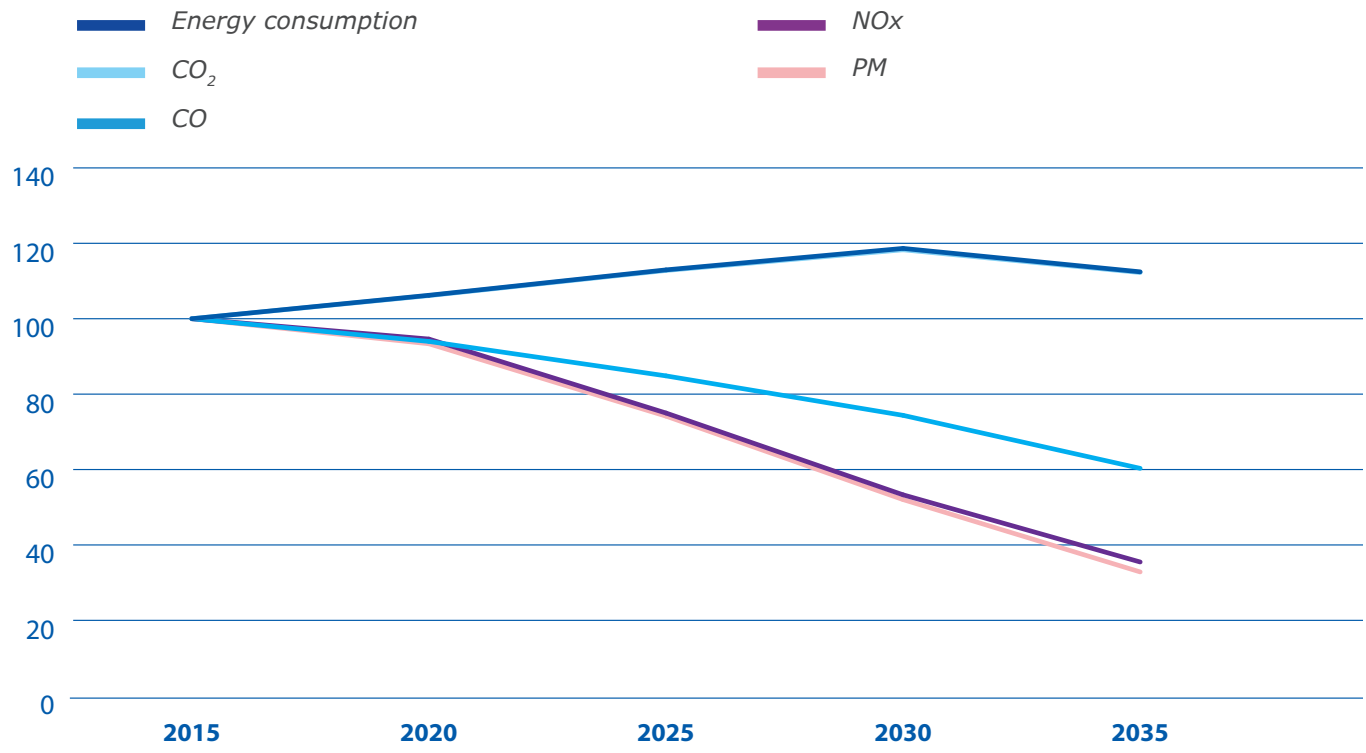
Parameter	Value under reference scenario
Total transport performance until 2035	Growth of 1.0% per annum
Share of LNG vessels	3-5% in 2020, 23-24% in 2035
Specific energy consumption of vessels	Reduction of 0.75% per annum (0.5% due to technical measures, 0.25% due to to operational measures)
Average life time of engines	Engines before 1990: 38 years Engines after 1990: 12 years

While the annual growth of transport performance increases fuel consumption and emissions, the reduction of the specific energy consumption of vessels, and the rising share of LNG vessels have a reducing effect on fuel consumption and emissions.

As the growth rate for transport demand is slightly higher than the rate of reduction of energy consumption, the scenario results in an increase of energy consumption until 2013, and a decrease after that. On the other hand, the level of pollutant emissions falls over the total time frame, due to the introduction of new vessels that have emission levels comparable to the stricter emission standards Stage V.

Figure 52: Emission reduction in IWT according to the IFEU scenario (Index 2015=100)

Source: IFEU and calculation CCNR



8. PASSENGER TRANSPORT

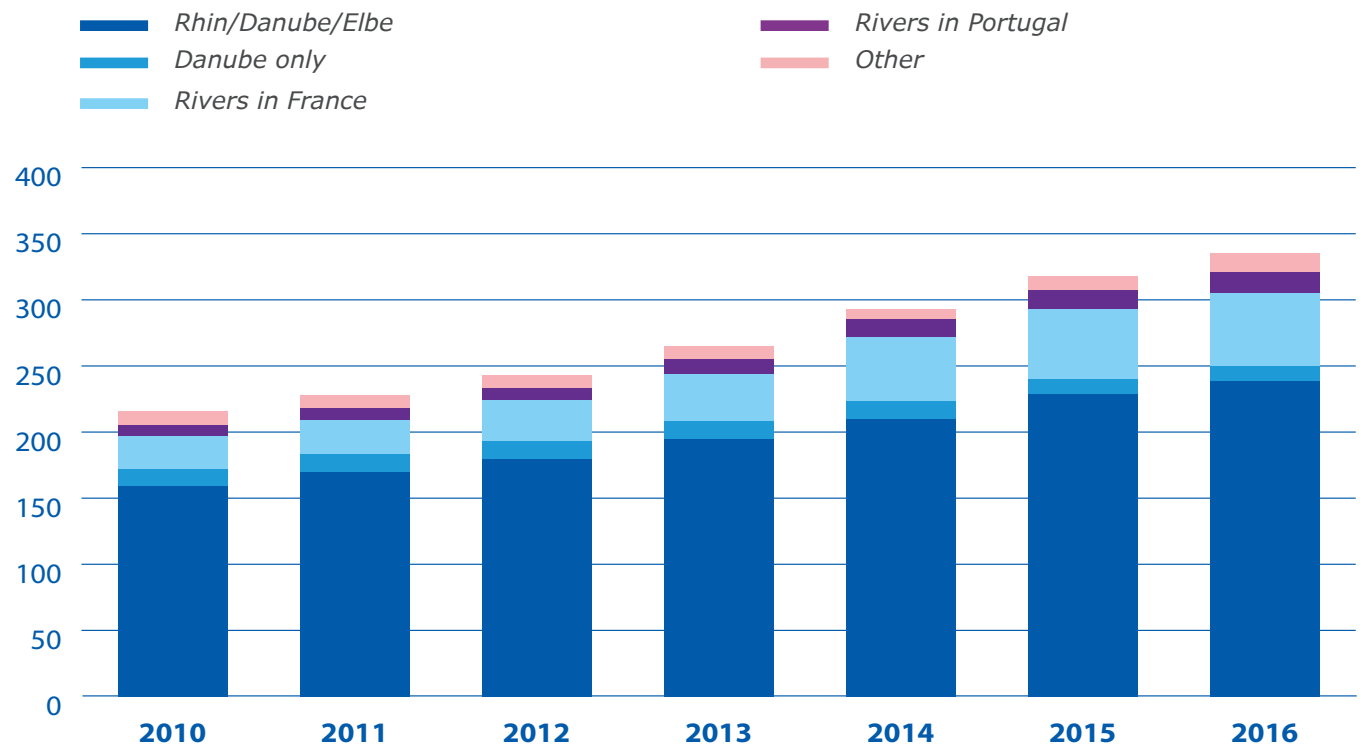
8.1 PASSENGER TRANSPORT FLEET

In the river cruise segment, the EU has increased its fleet capacities tremendously over the last 11 years. In 2016, there were 335 active cruise vessels operating in the EU, which represented 39% of the worldwide river cruise fleet, compared to 24% in 2005.

Vessels active on the Rhine (including tributaries), the Danube and the Elbe represent 75% of active vessels in the EU. Vessels active on rivers in France account for 16%, with a rising trend. Vessels on Portuguese rivers (Douro) have a share of almost 5%. From a technical point of view, these vessels are foreseen for operation only in these regions.

Figure 53: Number of river cruise vessels in the European Union by region of operation (2010-2016)

Source: CCNR

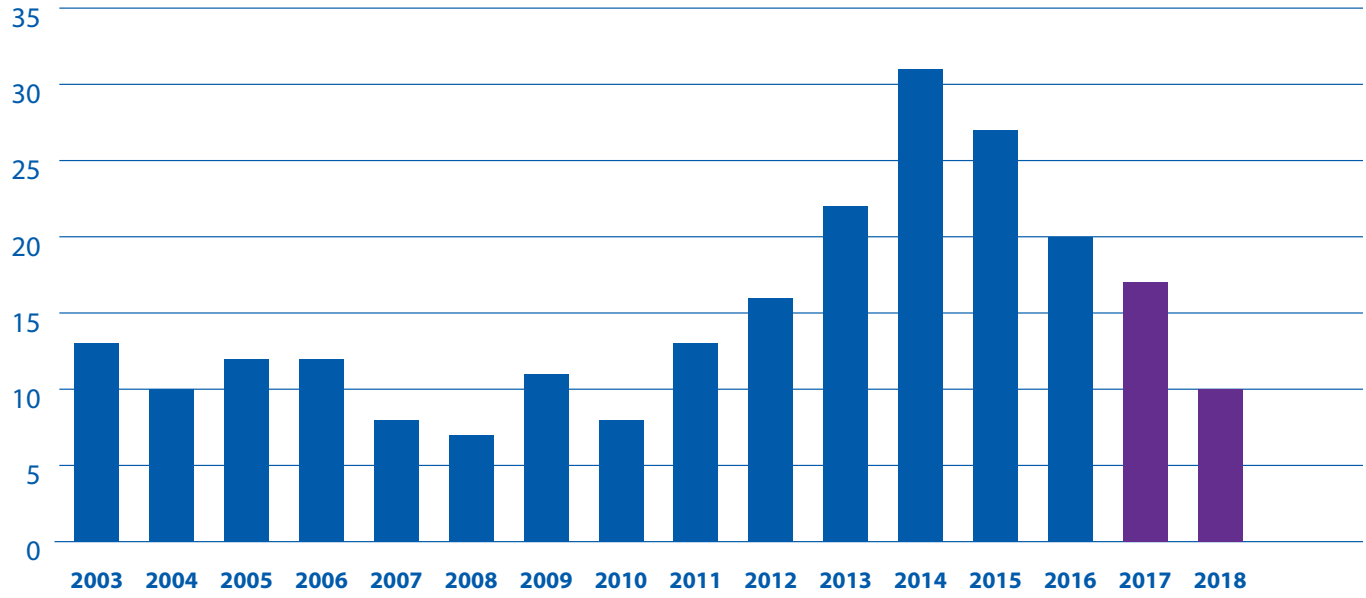


The construction rate is more important in passenger transport than in goods transport. In Europe, 20 new river cruise vessels were put into service in 2016, out of 31 newly constructed vessels worldwide – that represents a significant share of 70%. However, for the years 2017 and 2018, the number of new vessels coming on the European market is expected to decrease slowly: 17 new vessels are foreseen for 2017, and 10 for 2018.

*Figure 54: New river cruise vessels for the European market (2003-2018)**

Source: Hader & Hader 2016

** Values for 2017 and 2018: forecast based on order books*



The year 2017 will be characterised by regional diversification: for the first time, almost half of the new ships (47%) will not be employed on the Rhine-Main-Danube system, but on the Douro, Rhône and Seine.

Diversification is also taking place for the Rhine itself: travel routes for river cruises have been extended from the Rhine to its tributaries (for example the Main). From the operators' viewpoint, this diversification makes economic sense, as concentrating on only one river can be risky. This applies especially to new vessels.

Not only does the geographical scope change, but also the thematic spectrum is broadened, in order to reach a younger audience: more and more theme tours are offered, e.g. river cruises to the most beautiful Christmas markets along the Rhine or culinary cruises on the Rhône, where regional specialties can be discovered.

Moreover, the operators have also noticed the growing environmental awareness among their target groups, coupled with an increasing interest and demand for so-called "green cruising". Therefore, they have successfully introduced several greening technologies in their new vessels, like diesel-electric engines and post-combustion filters. The predominant greening measure in the river cruise sector, at least for the years 2014-2016, was diesel-electric propulsion. This measure was introduced by the market leading company for all of its new vessels starting in 2013. As that company makes a high share of all new vessels, many diesel-electric river cruise vessels have been introduced in recent years. For the newly built river cruise vessels, the share of vessels that were equipped with a diesel-electric propulsion system was 58% in 2014, 50% in 2015 and finally 30% in 2016.[33] The decrease of the share is due to the decrease in the construction rate of the market leading company which equips all its new vessels with a diesel-electric system. These new propulsion systems lead to gradual green modernisation of the river cruise fleet. Apart from the benefits for the environment, these new technologies also improve the comfort of the passengers on board, in terms of a reduction of noise and local pollutant emissions.

In the wake of the overall goal of increasing its sustainability, certain operators are creating new concepts for expanding their offer for different waterway profiles. For example, on the river Elbe, one of the leading European companies (with a fleet of 45 ships) introduced a vessel with a single paddlewheel propulsion. This allows navigation in shallow waters and thus, navigation becomes possible with only 5 to 10 centimetres of water under the hull and allows continued operation on the river Elbe despite frequent periods of low water conditions. Moreover, this system ejects less water, which results in a much sustainable cleaner flow (source: Neopolia 12/2016).

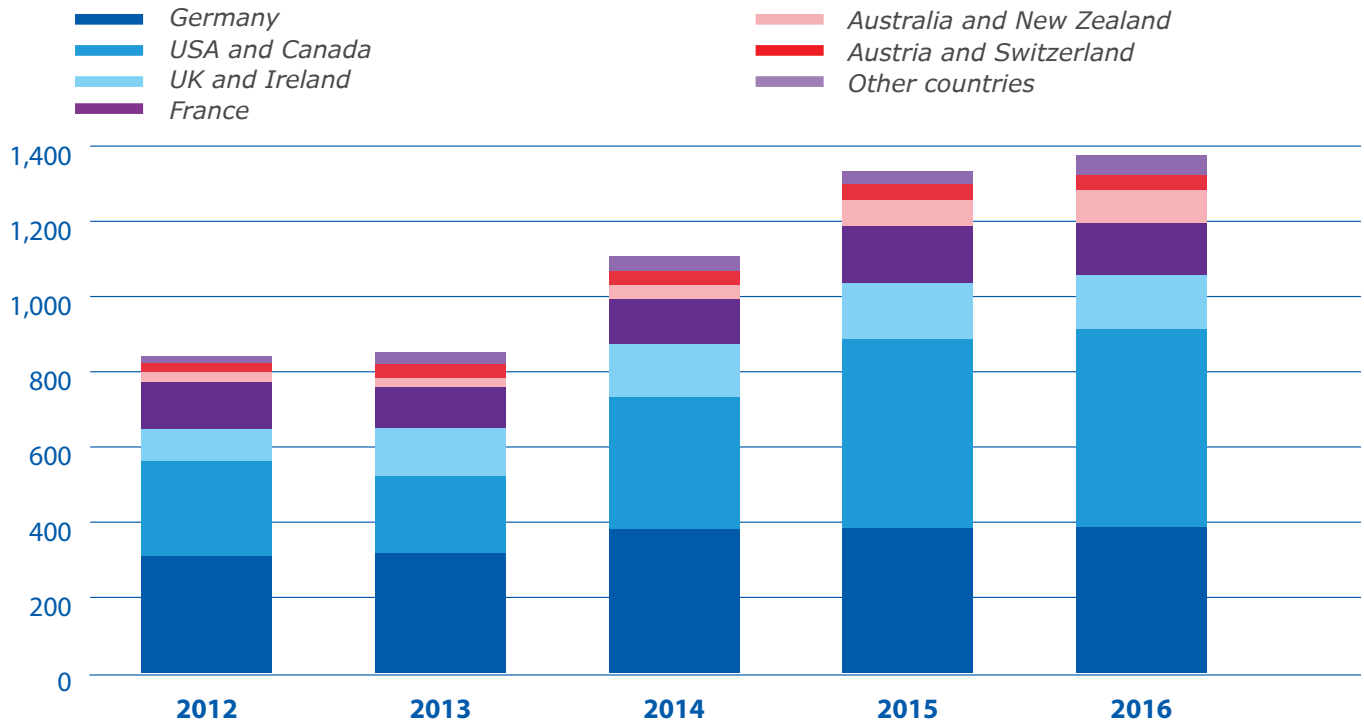
[33]Source: CCNR analysis based on data from Hader & Hader river cruise fleet handbook and shipping journals Scheepvaartkrant and Binnenvaartkrant

8.2 PASSENGER TRANSPORT DEMAND

In 2016, a total of 1.36 million river cruise trips were taken on inland waterways in the EU, which corresponds to an increase of 2.7% compared to the previous year. In 2015, however, an increase of 17% had taken place within only one year. The reduction in the growth rate is explained by the above-mentioned effects of terrorism on the travel behaviour of foreigners, especially US-American tourists.

Figure 55: Number of passengers on European river cruise vessels per country of origin (1000 passengers)

Source: IG River Cruise



With a share of 39% of all river cruise tourists in Europe, US-Americans and Canadians were again the most important source market in 2016, as in 2015 (38%). German tourists were again in second place in 2016, with a share of 28% (29% in 2015).

Considering global demand evolution, the market for river cruises is independent of other shipping markets, as it is less exposed to fluctuations in industrial production. However, travel intensity is strongly influenced by the effects of temporary and regional influences such as weather conditions (i.e. icing in the winter season). Nevertheless, thanks to the use of modern cruise vessels and new technologies, for example propulsion with a single paddlewheel, it is possible to extend the service period considerably, so that the season break lasts only from January to March/April.

There is only a very general connection between the demand for river cruising and global economic development. In principle, dependencies linked to the purchasing power are usually influenced or even replaced by regional political events, intra-industry trends such as an expansion or constriction of the supply chain (i.e. cancellation of cruises due to closures) and marketing measures.

Furthermore, the Rhine, thanks to its navigable tributaries, offers several different travel itineraries, which makes it attractive for repeaters, tourists that travel repeatedly to the same destination.

Another positive aspect of the Rhine is its geographical proximity to important global airports such as Amsterdam, Basel, Frankfurt and Cologne. This geographical situation offers a considerable advantage for foreign passengers (especially from overseas) arriving by plane. Thus, distant source markets can also easily be operated.

From the point of view of navigation, the Rhine offers the best conditions for three-floor passenger vessels up to a length of 135 m, not least because the water level for cruise ships is rarely too low and locks can only be found on the Upper Rhine.

Another aspect to be taken into consideration, not only for the construction of new vessels, is the number and size of locks. Especially on the river Elbe and Moldau, newly constructed vessels can gain in length but cannot exceed a width of more than 10.0 meters in order to respect the constraints of navigation.

The Danube, together with the Rhine, is the most important European river for the cruise sector. On the Danube, there is a cluster of ports that play a significant role in river cruising. These main ports are Passau (Germany), Vienna (Austria), Bratislava (Slovakia), Budapest (Hungary) and Belgrade (Serbia). River cruises on the Danube can be split into two major types of journeys:

- **Short distance cruises** from Passau to Vienna, Bratislava and Budapest, with a duration of 5 to 8 days. They represent the most common type of Danube river cruise in terms of number of passengers transported (565,000 passengers in 2016 compared to 534,000 in 2015; (+5.7%).

- **Long distance cruises** from Passau to the Danube delta region with a duration of 14 to 16 days. For these cruises, there were 87,000 passengers in 2016, compared to 83,000 in 2015 (+4.7%).

Concerning the nationality of the vessels, Switzerland has by far the highest share of all states. Together with Malta, France and the Netherlands, in 2016, the Swiss flag accounted for 70% of the total number of river cruise vessels that were active in the short distance trip segment between Passau, Vienna, Bratislava and Budapest. In 2015, this share had been 74%, and 72% in 2014. River cruise vessels flying the German flag had a share of 15% in 2016, compared to 17% in 2015 and 16.5% in 2014. Vessels flying the Bulgarian flag accounted for 7% in 2016. Overall, this means that vessels with a nationality from outside the Danube region account for the large majority of river cruise trips on the Danube.

The European river cruise industry continues to contribute significantly to the added value of inland shipping in 2016. It guaranties 13,971 jobs directly on ships and a further 3,540 jobs within shipping companies operating on land. In addition, more than 11,000 jobs are linked to the river cruise industry, i.e. suppliers, ports, excursion agencies and other service providers on land.

9. WAY FORWARD

9.1 MARKET QUALITATIVE OUTLOOK

After the catch-up process for agricultural products transport that will occur during the year 2017, stable development is expected for the end of 2017 and in 2018, assuming that harvest results will be on a multi-annual average. This outlook is aligned with the EU agricultural products output which is expected to increase by 0.5% in 2017 and 0.7% in 2018.[34]

Steel production in Germany increased only slightly (+2%) during the first six months of 2017 compared to the same period in 2016. But the number of new orders decreased slightly compared to the previous year.[35] Therefore, the slight increase observed during the first semester of 2017 is not expected to announce further steel production increase in 2017 and 2018. And the outlook for the steel segment is rather oriented towards stable development or a slight increase due to the reinforcement of the competitive position of the EU.
Coal is faced with declining demand in the energy sector. In Germany, the consumption of coal decreased by 5% in 2016 compared to 2015. Strongly rising prices for steam coal in the second half of 2016 also contributed to this decline. The present trends are supposed to continue. The outlook for coal remains on a decreasing trend.

The transport of sands, stones and building materials is promoted by rising construction activity in Western Europe, especially in the Netherlands and in France. Large new infrastructure projects contribute to this evolution that will benefit the inland navigation sector in the next two years.
The world trade indicator (RWI/ISL index) followed a stable upward trend during 2016 and the first quarter of 2017, reaching a growth rate of 5% between the first four months of 2017 and 2016. Consequently, maritime container traffic growth is robust, which lays the basis for a continuation of further growth for container transport on inland waterways.
The oil price has shown rather strong fluctuations in 2017, but has been on a downward trend overall, reflecting the growing oil supply from non-OPEC countries. Although a declining oil price can stimulate transport demand for mineral oil products, the long-run trend in this segment is rather downward orientated. The long-term domestic oil demand in the EU is expected to decrease, and this demand is expected to decrease respectively by 0.3% and 0.4% already in 2017 and in 2018.[36] The impact should be limited for inland navigation transport in 2017 and in 2018, and stable development is foreseen.

It is expected that chemical production will remain overall stable in 2017, or grow only very modestly (+1% forecast in Germany). Therefore, the outlook for chemical transport is stable as well, with the possibility of a slight increase.
The transport of waste, boosted by the emergence and growth of the recycling and circular economy can be an opportunity for inland navigation in general and inland ports in particular. Concerned goods could, for example, be scrap metals, household waste and regenerated building materials, meaning that several inland navigation transport segments could benefit from new economic opportunities offered by current trends.

9.2 NAVIGATING FORWARD

Several examples have highlighted the added-value of cooperation between inland navigation stakeholders over the last three years. Efficient communication and cooperation have led to several on-going success stories such as the implementation of CESNI in the regulation area. Innovative projects financed by the European Union also required a large amount of cooperation from different stakeholders which turned out to be fruitful. One example of this are the promising results already delivered and those expected from Prominent projects.[37] Projects financed by the European Union in the Danube region could also be highlighted. Danube SKILLS, supported by the Danube Transnational Programme, enabled information dissemination around the latest version of the Directive on recognition of professional qualifications in inland navigation[38] and was greatly appreciated by social partners and EDINNA. This cooperation should be further favoured and should, as much as possible, include companies and more generally market players. The implementation of EIBIP is going in the right direction from this point of view.

[34]Source: Oxford Economics
[35]Source: German Steel Association
[36]Source: Oxford Economics
[37]http://www.prominent-iwt.eu/wp-content/uploads/2016/11/Newsletter-PROMINENT-october-2016.pdf
[38]http://www.interreg-danube.eu/approved-projects/danube-skills/news

Market players need to be integrated early in the process related to innovation projects because they will be the main players enabling penetration of innovative solutions into the market. Despite the development of several innovative solutions, market penetration is indeed lacking for there to be a significant impact on greening or on inland navigation competitiveness.

Public forces can help positive innovations to spread in the market through incentives, but the future inland navigation market situation is expected to be mainly driven by market incentives and public concerns (competitive gains through innovation, growing awareness of shippers' logistic chains' environmental impact, measures to limit emissions in urban centres, etc.).

In addition to developing innovation incentives, public forces should ease penetration into the market by removing administrative bottlenecks. The innovation process requires prototyping and, as a consequence, specific authorisations for new types of vessels and new types of propulsion to go on waterways. Such decisions are, for example, still pending and expected for vessels with methanol and hydrogen propulsion systems, and such processes could gain in efficiency.
Praised collaboration should actually concern not only inland navigation stakeholders but logistic chain stakeholders. Many innovations, in particular digital innovations, and many efficiency gains are located at the border between transport modes, and need several transport modes players to cooperate. The TEN-T corridors governance is aligned with this requirement and could promote such multimodal collaboration.

Despite the weight of traditional industries, such as steel industries and the agricultural industry in inland navigation transport demand, future inland navigation growth and development is expected to be supported by new market demand, and the inland navigation sector should be ready to take advantage of these new opportunities. Container transport already represents approximately 15% of the volumes transported on the Rhine, and current growth rates highlight further development potential. Inland ports could play a key role in the development of the circular economy. Waterways in the heart of main European cities could also play an increasing role in order to ensure an alternative urban distribution of goods. First best-practise examples do exist, for the distribution of consumer goods in the heart of Paris by inland container barges. IWT is not only an interesting option for the distribution of consumer goods, but also for the transport of building materials for large infrastructure projects in big cities, enabling a reduction of traffic problems and emissions.

Another future market for IWT, also related to urban areas, is the commuter traffic in big cities. Apart from the potentials of transporting passengers for touristic purposes in big cities, the commuter traffic by IWT would have very beneficial impacts on the reduction of emissions and traffic problems in urban areas.

These developments, together with ambitious efforts to further decrease greenhouse gas and pollutants emission, should give a primary role to inland navigation in the future European multimodal transport network.

In order to meet the future traffic demands (including those from new emerging markets), IWT needs more qualified personnel.

Inland navigation developments leading to increased competitiveness and decreased environmental impact will ensure sustainable inland navigation development. This development will highly benefit from close integration in the multimodal logistic chain and will participate in higher-level objectives.

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