WP 1: Markets & Awareness

D 1.7:

Report on market transfer conditions Market Analysis Danube Corridor

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Users and readers of the study are very welcome to share feedback, suggestions and experiences regarding inland waterway transports and potential of modal shift towards inland navigation in the Danube Corridor!

Important note: This study evaluates data on production and trade volumes of all Danube riparian countries. It includes data based on a national scope. In other words, the market analysis for e.g. Germany, contains data for the whole country and not only for the German Danube Corridor.

This study is based on numerous national and international data. The author of this study can therefore not guarantee the accuracy of all primary data used in the compilation of this document

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1. Introduction

Work Package 1 of the PLATINA II project aims at identifying the new markets for inland waterway transport (IWT) in order to facilitate a targeted modal shift towards inland waterway transport in the most promising market segments. This market analysis will help decision-makers across Europe to create favorable conditions for the use of IWT in the identified sectors e.g. by lifting administrative burdens for particular transport segments or by providing financial incentives for investments in cargo-specific handling and storage equipment.
At the same time this market analysis will form a starting basis for regional meetings with logistics stakeholders organized by the PLATINA II project team to practically verify the analyzed potential and to identify partners for realizing an actual modal shift. The proactive discussion with the logistics sector will encourage mutual learning between public and private decision-makers and will provide solid arguments for a public support for sector-specific modal shift.

In the Danube Region a market analysis does not have to start from scratch - Platina II will not reinvent the wheel: Within the EU project “Upgrading of Inland Waterway and Sea Ports (INWAPO)“ co-financed by the EU’s Central Europe Program, viadonau in 2012 conducted a national market review analysis, identifying nine market segments with the highest potential for inland waterway transport. This market review was particularly focusing on transports relevant for the Austrian industry, meaning that the scope was limited to transport flows from and to and within Austria.

Based on these results, viadonau with the support of CRUP (focusing on the Croatian market) executed the extended and updated market analysis for the Danube corridor described in this report. The study identifies new promising market segments and sets the basis for a regional cooperation between stakeholders from the Danube logistics sector. With the aim of covering the whole Danube corridor, viadonau soon discovered that the data needed for a targeted transnational market observation is – if even available – widely scattered across different institutions and sources. This analysis therefore forms an important step towards setting up a comprehensive market observation tool for IWT on the Danube by exploring useful data sources and establishing contact with the required contact persons from the logistics sector, statistical offices and relevant associations.

This report represents the midterm report on the PLATINA II deliverable 1.7 „Report on market transfer conditions“ and provides the basis for the task „Organising regional meetings with all stakeholders to verify the market potential“, as set out in the Work Package 1 Inception Report.

- **Structure and methodology**

In this study seven cargo groups with 28 different products in total were analyzed. Each chapter includes a brief explanation of the products followed by the field(s) of application in order to show the possible target markets.
A detailed comparison of the production volumes of the particular cargo in all Danube riparian countries illustrates the significance in terms of output of each country.

The aim of the subsequent examination of import and export volumes of the respective product shows the intensity of trade activities from which a potential of inland navigation can be derived for the specific product. Namely, high imports and exports of a particular product in a particular Danube country may lead to the assumption that IWT may play an important role however, in order to verify or discard the hypothesis trade relations were analyzed regarding the trading partners. Meaning that, e.g. in case Germany imports large volumes of rapeseed in general; a closer look at imports from Danube countries was taken.

The analysis of trading relations among all Danube countries regarding every cargo group was not conducted due to the large efforts and high resources that would have been necessary. Instead, the potential of two to max. four countries with the highest output resp. highest trading activities were evaluated per cargo group. The market analysis also integrates an evaluation regarding specific requirements of the transported cargo, locations of production and processing sites within 90 minutes truck travel time, the direction of transport flows and existing infrastructure conditions dependent on the availability of data.

Additionally, the market analysis highlights outstanding good practice examples for the use of inland waterway transport and defines sector requirements for a shift towards IWT. Finally, the conclusion gives a brief summary of the identified segments and illustrates the potential of the cargo groups at a glance by using a traffic light system (green/yellow/red). The classification of the potential is based on production volumes, trading activities in general and trade relations with Danube riparian countries in particular.

2. Inland waterway transport

In its function as transport axis the Danube connects key production and sales markets that have significant European importance. The waterway makes a major contribution to strengthening the transport network within the Danube Region but also to connect this macro-economic area via the sea ports along North Sea and Black Sea to the rest of the world.

In comparison to other means of transport, several factors underline the advantages of inland waterway transport (see figure 1). With regard to the specific energy use for example, an inland vessel covers a distance of 370km to transport one ton of bulk cargo while a truck only covers 100km with the same amount of energy.[1] In that way, IWT contributes directly to the achievement of the EU Growth Strategy 2020 goals set by the European Commission in reducing energy consumption and greenhouse emissions.[2]

But if it comes to supporting an effective modal shift to inland waterways it makes sense to look into the most important arguments from a customer's point of view in more detail:

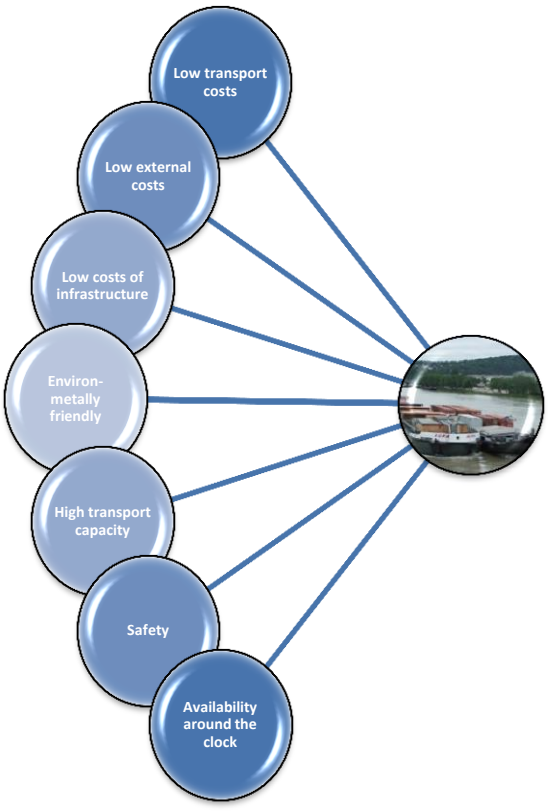


Figure 1: Advantages of IWT[3]

- **Low transport costs**

The Danube waterway is of particular importance as a cost-effective transport mode for the industrial sites that are located along the Danube corridor. Especially for resource-intensive industries such as

[1] viadonau (2013a), p.18
[2] European Commission (2014)
[3] European Commission (2014)

the steel, agro- or petrochemical industry the Danube plays an important role for the transport of raw materials and semi-finished products. In addition to these transports of dry and liquid bulk cargo, Danube navigation over the last years also gained additional market shares in the segment of project cargo and high-quality general cargo due to the increasing size and weight of the goods produced in the energy, building and engineering sector (e.g. generators, transformers, concrete components).

- **High transport capacity**

Another advantage of IWT - with strong influence on the above mentioned transport costs – is its capacity to transport large quantities of goods as well as/or larger and heavier loading units per transport unit. A single convoy with four lighters for example can m move 7,000 tons of cargo which corresponds to a load of 175 railway wagons each containing 40 net tons or 280 trucks each containing 25 net tons. Consequently, IWT is for example ideal for transportation of bulk goods with low value over long distances.

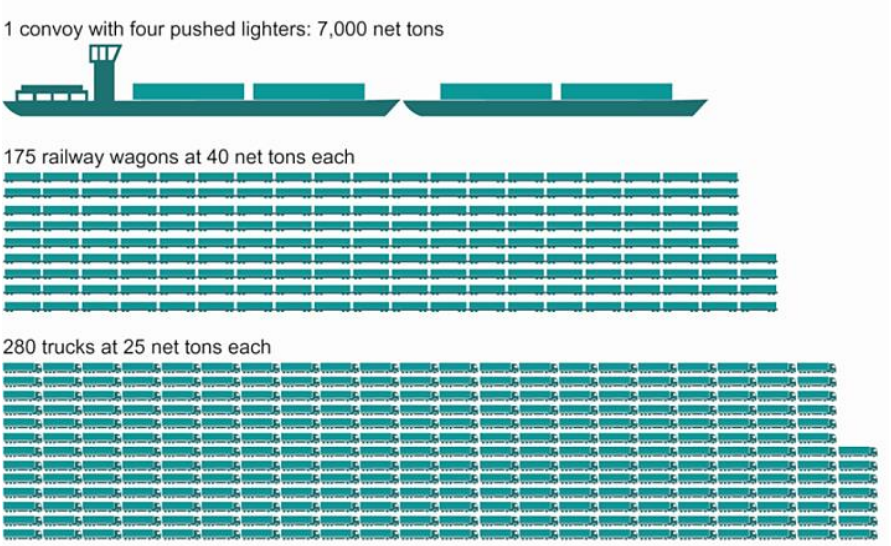


Figure 2: Transport capacities - comparison[4]

- **Availability around the clock**

Inland vessels can in general navigate on the Danube waterway around the clock (24/7). Compared to road transport which is affected by weekend and night driving bans implemented in various European countries, inland waterway transport has a competitive advantage as it is not subject to any administrative regulations hindering the constant flow of goods as such.

- **Environmental friendliness and safety**

Choosing the most environmentally friendly and safest mode of transport can also be an economic success factor and not only another marketing measure. The introduction of an IWT transport solution causing lower external costs and ensuring a higher level of safety for the transported goods can be a decisive factor in bidding processes and price negotiations. Inland navigation also has the lowest specific energy consumption of all land transport modes offering possibilities for cost reductions in many market segments.

3. Requirements for a modal shift towards IWT

One of the most important tasks of Work Package 1 in the PLATINA II project is also to define market transfer conditions which are most favorable for achieving a modal shift towards inland navigation. In

[4] viadonau (2013a), p.19

addition to the opportunities offered in specific market segments, this report will also look at barriers which have to be overcome by targeted and coordinated measures of public and private stakeholders. The following list of requirements for an effective modal shift was elaborated on the basis of discussions with shippers' representatives and will be complemented by cargo group-specific requirements in the following chapters.

- **Reliable waterway infrastructure**

Larger cargo volumes per vessel or convoy improve the relation between freight revenues and costs and thus the overall competitiveness of inland waterway transport. This implies that there is a direct relationship between fairway conditions, the load factor of vessels and ultimately the competitiveness of this mode of transport. In order to enable Danube navigation to make use of its key strengths waterway maintenance and ensuring reliable fairway depths remains an indispensable task of all Danube countries ("waterway management is the most effective modal shift").

The recommended minimum fairway parameters for European waterways – including the Danube – are listed in the European Agreement on Main Inland Waterways of International Importance (AGN) of the United Nations Economic Commission for Europe.[5] With regard to the fairway depths to be provided by waterway administrations, the AGN makes the following provisions: On waterways with fluctuating water levels the value of 2.5 meters minimum draught loaded of vessels should be reached or exceeded on 240 days on average per year. However, for upstream sections of natural rivers characterized by frequently fluctuating water levels due to weather conditions (e.g. on the Upper Danube), it is recommended to refer to a period of at least 300 days on average per year. Currently minimum fairway conditions cannot be guaranteed on some sections of Danube resulting partly from poor planning, partly from the lack of adequate maintenance equipment and finally from a lack of financial resources.

As a consequence thereof, this market analysis takes also into consideration that cargo groups which are rather "critical on volume" and less "critical on weight", such as e.g. some products in the agricultural sector or in the chemical industry are more flexible regarding the available fairway depth than heavier goods such as metallic raw materials. The study also analyses overlaps between seasonal fluctuations in waterway conditions and cargo-specific transport patterns (e.g. transport demand in certain months of the year) which can additionally support the optimal use of inland waterway transport on the Danube.

- **Efficient infra- and superstructure in ports and transshipment sites**

From the point of view of the shipping industry, Danube ports and transshipment sites shall be equipped with efficient infra- and superstructure. A ports' infrastructure is formed by quay walls, rail tracks and roads as well as other paved surfaces while the superstructure is built on the infrastructure and includes e.g. cranes, warehouses and office buildings.

The performance of port transshipment equipment is in general defined by the maximum lifting capacity as well as the hourly and/or daily output of each individual crane. With Lift-on-Lift-off transshipment (Lo-Lo) by cranes, the hourly output is estimated according to the number of crane cycles per hour, the capacity of the grabbers used and the specific weight of the goods handled. The daily output of a port determines the time which an inland vessel spends in a port, thereby influencing the total costs of inland waterway transport.

[5] Parliament Republic of Austria (2014)

In addition different cargo groups require different handling and storage facilities. In general, it is distinguished between general cargo or break bulk on the one hand and bulk cargo on the other hand.[6]

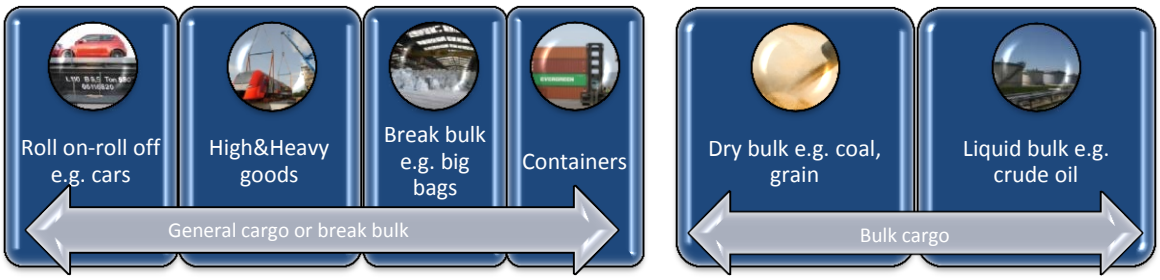


Figure 3: Cargo groups[7]

The availability of adequate, cargo-specific handling and storage equipment at a certain location is therefore – in combination with the overall service quality provided in ports (opening hours, flexibility, etc.) - a decisive factor concerning the question whether a modal shift towards inland waterway transport can be achieved or not. The infra- and superstructure of ports along the Danube are displayed in the annex 1 of this study. This chapter gives a concrete overview of the available handling facilities and connections to road and rail networks.

- **Time-efficient and flexible administration processes**

Long-winded and inflexible administrative processes and paperwork can be a significant competitive disadvantage for inland waterway transport on the Danube thus preventing a modal shift towards IWT. The administrative bottlenecks that from the vessel operators' perspective cause the biggest time losses and highest operational costs can be summarized into three main areas: administrative bottlenecks related to customs clearance, controls of the border police and navigation surveillance. Especially on the external EU-borders along the Danube (Serbia, Ukraine) administrative procedures for freight transport on water were found to take long and consequently cause additional costs for operators.

In order to solve some of the most pressing administrative barriers for Danube navigation and to support modal shift more effectively, control authorities and shipping companies should enter a more intensive dialogue how control procedures can be implemented in a flexible and at the same effective way. A harmonization of administrative procedures in all Danube countries should also be a mid-term objective in order to ensure seamless transport chains and a higher competiveness compared to road and rail transport.

4. Transport volumes on the Danube

There are two key factors which influence the volume of the realized inland waterway transports. The capacity resp. navigability of the Danube River is mainly determined by nautical conditions (low water, floods, ice) and maintenance of the waterway, as already mentioned above. The year 2011 for instance, can be classified as an unfavorable year for inland navigation due to long low water periods as well as drought in autumn months.

On the other hand, far reaching economic developments on regional, national and global scale such as the global economic crisis in 2009 have great impact on transported volumes. Furthermore,

[6] viadonau (2013a), p.79
[7] viadonau (2013a), p.81

difficulties which occur in large companies with inland navigation as an important means of transports are clearly reflected on generated transport volumes in the whole region.

In 2012 the total volume of transported cargo on the Danube accounted for 37.2 mil tons which is a slight decrease of 1.8% compared to 2011. As stated in the following figure, the development of the volumes shows that in 2009, due to the worldwide economic and financial crises Danube transports decreased in all countries. After the increase in 2010, volumes again dropped partly caused by the closure of big steel producers e.g. US Steel Smederevo, Serbia.

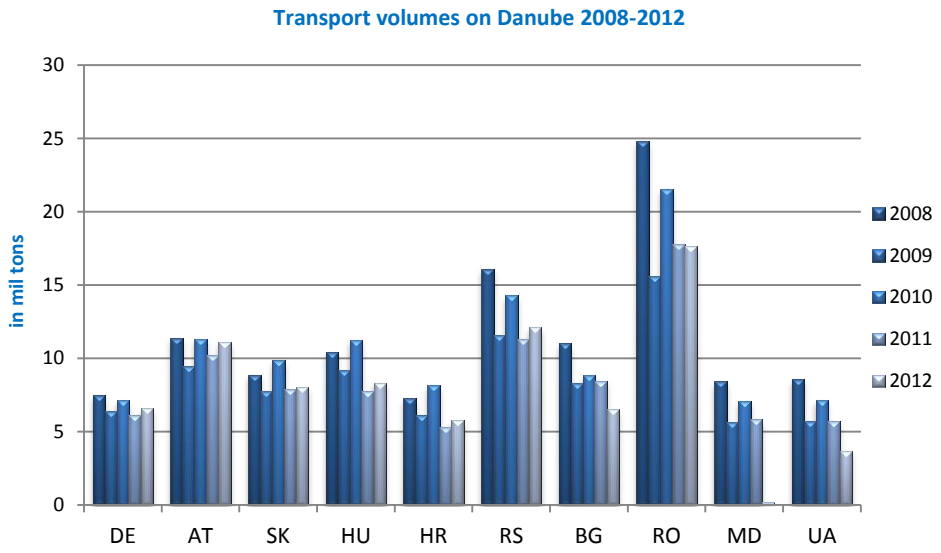


Figure 4: Transport volumes Danube region 2008-2012[8]

In 2012, the largest transport volumes including exports, imports, domestic transport and transit were achieved by Romania with 18 mil tons (-1.0% compared to 2010) and Serbia with 12 mil tons, which is an increase of 7% compared to 2010.
From the graphic above, it can be concluded, that there are parallel developments in the national transport volumes in the observed period of time. Volume declines in 2009 and 2011 are present in every single country due to unfavorable economical and waterway conditions which arouse in 2009 and 2011.

As already mentioned in the introduction, the purpose of this study is to detect unused potentials of the cross border inland navigation in the entire Danube region, for that reason it is necessary to evaluate the IWT cross border flows of goods resp. exports and imports of Danube riparian countries, while transit and domestic transport do not play an essential role.

As illustrated in table 1, in 2012, Hungary had the leading position in exports on the Danube which accounted for round 4 mil tons of goods shipped, followed by the Ukraine, with 3.5 million tons and Serbia (3.10 mil tons).
Regarding imports on the Danube, the biggest share of imports were achieved by Romania and Austria. These two countries also realized the largest volumes in exports and imports in total with 8.56 mil tons resp. 7.14 mil tons.

[8] Calculation: viadonau

Exports & imports on the Danube 2012 (in 1,000 tons)										
DE	AT	SK	HU	HR	RS	BG	RO	MD	UA
Exports										
1.03	1.62	2.29	3.99	0.26	3.10	1.08	2.82	0.01	3.48
Imports										
2.06	5.52	0.20	1.34	0.31	2.31	1.69	5.74	0.17	0.15
Total Exports + Imports										
3.09	7.14	2.49	5.33	0.57	5.41	2.77	8.56	0.18	3.63

Table 1: Exports & imports on the Danube in Danube countries in 2012[9]

Share of exports + imports in total transport volumes 2012																			
DE		AT		SK		HU		HR		RS		RO		BG		MD		UA	
47%		70%		31%		64%		10%		45%		49%		43%		5%		99%	
Exp.	16%	Exp.	15%	Exp.	29%	Exp.	48%	Exp.	4%	Exp.	26%	Exp.	16%	Exp.	17%	Exp.	6%	Exp.	95%
Imp.	31%	Imp.	50%	Imp.	2%	Imp.	16%	Imp.	5%	Imp.	19%	Imp.	33%	Imp.	26%	Imp.	94%	Imp.	4%

Table 2: Share exports + imports in transport volumes 2012[10]

Table 2 shows the share of exports and imports in total transport volume, illustrating the importance of foreign trade in IWT.

In Ukraine, exports and imports amounted 99% of the total transported cargo on the Ukrainian Danube, while the remaining 1% is allocated to transit and domestic transports. Ukraine is almost exclusively export oriented.

Austria has also high cross border cargo flows with 70%, while 50% of these shares are allocated to import activities which are the highest share of imports in the whole Danube region. Hungary is export oriented and had trade flows amounting to 64% of the total transported cargo. Croatia and Moldova have low shares in exports / imports due to intensive transit transports.

4.1. Water transshipment at Danube ports and transshipment sites

The only figures regarding transshipment volume in the entire Danube region are provided by the Danube Commission. Consequently, deviations from national recorded transshipment volumes might occur due to different calculation methods.
According to the Danube Commission, 40 mil tons of goods were handled in all Danube ports in 2012, which is 9 mil tons less than in 2011. The strongest cargo group was the NST 2007[11] group 03 which includes “Metal ores, peat and other mining and quarrying products” and which amounted for 12 mil tons resp. 30% of total transshipment volume in 2012. The main drivers for this cargo group were Romania, Austria and Serbia.
The second strongest group was “Products of agriculture, hunting, forestry and fishing” NST group 01 which accounted for 6.8 mil tons resp. 17% of the total transshipment turnover. Agricultural products had their focus in Hungary and Serbia.
Coke and refined petroleum products (Group 7) had a share of 12% in total cargo turnover with Austria, Hungary and Serbia in the leading positions.

Goods which are not defined are summarized in Group 19 and they have a share of 11%.
Coal and lignite; crude petroleum and natural gas accounted for 10% in 2012 with Ukraine’s share of 50%. Other important countries were Bulgaria and Hungary.

[9] viadonau (2014), p.40
[10] Own calculation based viadonau (2014), p.40
[11] NST 2007: see annex 2

CARGO TURNOVER OF ALL DANUBE PORTS in 2012 -2011 (statistical data form ST-12)

Thous.tonnes

Nomenclature NST-2007		UA [1]	MD [2] (2010)	RO	BG (2010)	RS	HR	HU (2011=2010)	SK	AT	DE [3] (2010)	Total	%
01	2012	378	*	953	317	1 860	33	2 622	148	507	*	6 818	16,9
	2011	*	*	1 455	317	1 345	13	2 921	114	652	*	6 817	17,1
02	2012	1 648	*	353	723	206	49	548	40	262	*	3 829	9,5
	2011	*	*	584	723	228	51	697	37	157	*	2 477	6,2
03	2012	1 340	*	3 119	116	2 683	132	43	1 634	3 189	*	12 256	30,3
	2011	*	*	1 886	116	4 529	44	352	1 784	3 206	*	11 917	29,8
04	2012	6	*	14	21	*	5	74	*	318	*	438	1,1
	2011	*	*	33	21	2	33	150	1	328	*	568	1,4
05	2012	*	*	33	*	*	*	*	*	*	*	33	0,1
	2011	*	*	*	*	*	*	*	*	*	*	0	0,0
06	2012	4	*	181	17	5	*	5	*	16	*	228	0,6
	2011			114	17	7	*	3	*	6	*	147	0,4
07	2012	121		242	388	1 071	12	1 032	632	1 462	*	4 960	12,3
	2011		*	411	388	1 008	11	1 385	776	1 417	*	5 396	13,5
08	2012	266	*	201	65	508	247	297	334	745	*	2 663	6,6
	2011	*	*	*	65	357	185	299	285	754	*	1 945	4,9
09	2012	38		*	65	55	30	25	108	7	*	328	0,8
	2011	*	*	6 870	65	57	13	19	133	37	*	7 194	18,0
10	2012	212	*	1 215	91	380	84	337	7	477	*	2 803	6,9
	2011			1 386	91	362	50	315	109	512	*	2825	7,1
11	2012	0	*	3	30	9	4	8	35	27	*	116	0,3
	2011	*	*	*	30	4	1	15	36	2	*	88	0,2
12	2012	*	*	*	*	2	*	19	39	1	*	61	0,2
	2011		*	*	*	3	*	23	16	0	*	42	0,1
13	2012	*	*	*	1	16	*	*	*	*	*	17	0,0
	2011	*	*	*	1	46	*	*	*	*	*	47	0,1
14	2012	*	*	274	*	590	*	36	21	4	*	925	2,3
	2011	*	*	*	*	8	*	89	29	4	*	130	0,3
15	2012	*	*	*	*	*	*	*	*	*	*	0	0,0
	2011	*	*	*	*	*	*	*	*	*	*	0	
16	2012	*	*	*	*	*	*	4	*	5	*	9	0,0
	2011	*	*	*	*	*	*	4	1	3	*	8	0,0
17	2012	*	*	*	*	1	*	*	*	2	*	3	
	2011	*	*	*	*	*	*	*	*	*	*	0	
18	2012	*	*	*	*	*	*	*	*	*	*	0	
	2011	*	*	*	*	*	*	*	*	*	*	0	0,0
19	2012	*	*	4 534	23	8	*	*	*	42	*	4 607	11,1
	2011	*	*	*	23	2	*	*	*	29	*	54	0,1
20	2012	13		23	244	2	*	61	2	*	*	345	0,9
	2011	*	*	16	244	10	*	32	16	*	*	318	0,8
TOTAL	2012	4 027	371,0 [2]	11 145	2 101	7 396	596	5 111	3 000	7 062	*2 512*	40 438 [4]	100
	2011	*6 536* [1]	371,0 [2]	12 753	2101	7 968	401	6 304	3 337	7 110	*2 512*	49 395 [5]	
In % to 2011		61,6	100	87,4	100	92,8	148,6	81,1	89,9	99,3	100	81,9	

Figure 5: Cargo turnover NST-2007 all Danube ports[12]

[12] Danube Commission (2014), p.16,17

In order to illustrate the national differences in the importance of single commodity groups for Danube navigation, three countries were chosen to serve an example for the year 2012 namely, Austria, Romania and Ukraine. The reason for this selection were Austria's large import volumes on the Danube, Romania's leading position in total transported cargo volume and Ukraine's strong export orientation.

4.1.1. Transport volumes in Austria

As already described Austria is import oriented in IWT. For that reason following evaluation was conducted: Austrian IWT accounted for 10.7 mil tons in 2012 which was a plus of 7.8% regarding 2011 and nearly equaled the volume of 2010. In 2012, similar to 2011 more than 27% of the transport volume on the Austrian Danube section was allocated to the group "Ores and metal waste", namely 2.9 mil tons.

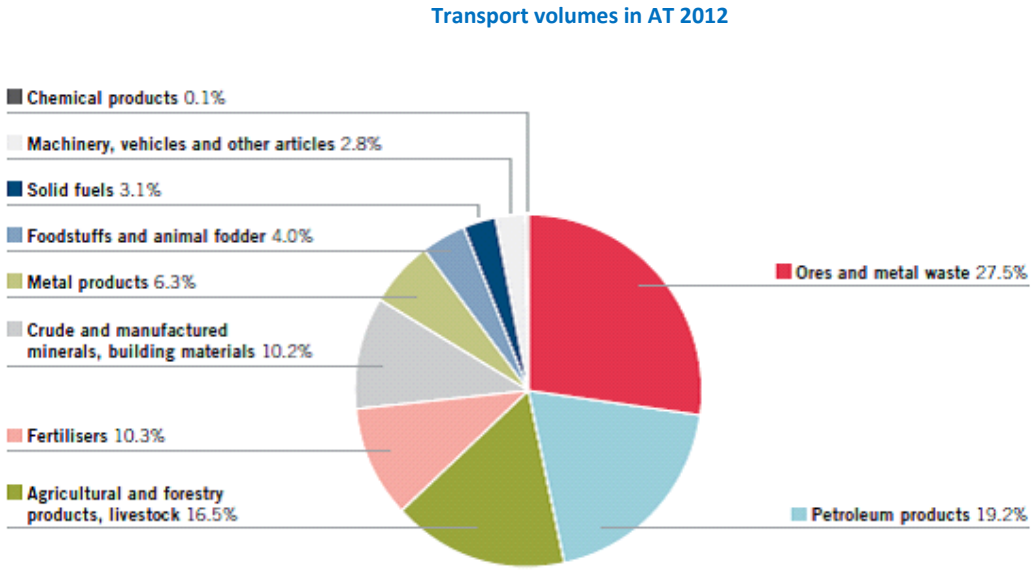


Figure 6: Transport volumes in AT 2012[13]

Petroleum products transport increased by 3.3% since 2011 and were the second largest product group in Austrian IWT with 3 mil tons.

The commodity group "Agricultural and product forestry products, livestock" rose by nearly 8% to 1.8 mil tons. The volumes of the product groups "fertilizers" and "crude and manufactured minerals", building material nearly equal each other and approx. 1.1 mil tons were transported via Danube in 2012, followed by metal products.

4.1.2. Transport volumes in Romania

The data of Eurostat for the country with the largest IWT volumes shows, that Romania had 29 mil tons[14] of inland waterway transports in 2012 which is 12 mil tons more than the calculation of viadonau, presented in chapter 2.2. Nevertheless, in this evaluation Eurostat will serve as the source of transported volumes on the Danube according to the goods groups (NSTR classification) due to lack of other data.

Figure 7 shows that IWT for metal ores accounted for more than 50% resp. 15 mil tons in 2012, which is an increase of more than 1 mil tons since 2011. Agricultural and forestry products amounted 6 mil

[13] viadonau (2013b), p.14
[14] Eurostat (2014a)

tons, which is an increase of 1 mil tons compared to the previous year. The third important product group is “Coal, lignite and natural gas” with 2.4 mil tons.

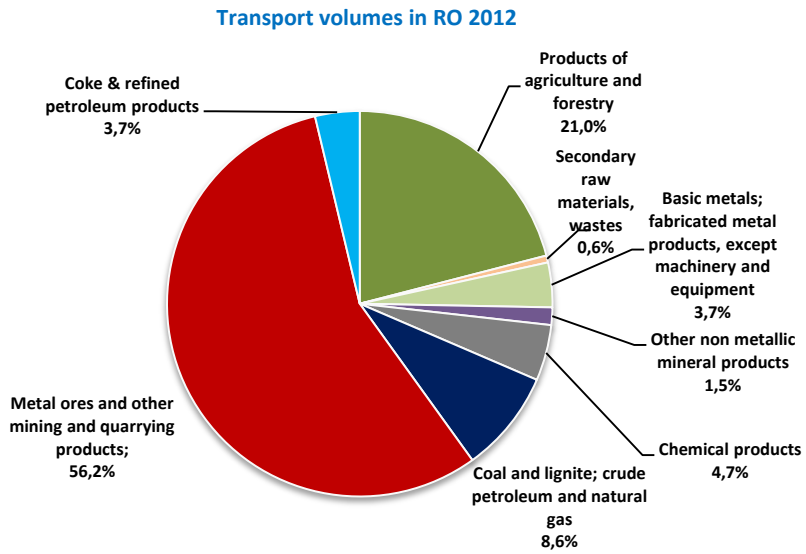


Figure 7: Transport volumes in RO 2012[15]

4.1.3. Transport volumes in the Ukraine

Due to Ukraine’s prevailing export orientation with 99%, it seems relevant to analyze the transported goods group on Ukraine’s rivers. According to the Ukrainian national statistical evaluation, 4.3 mil tons of freight were shipped on Ukrainian rivers (including all inland waterways) in 2012.

Transport of construction material accounted for 2.7 mil tons which was more than 60% of the total volume. However, this cargo group decreased since 2011 by almost 20%. Ores had a share of 12% which was equal to 514,000 tons, which is only 1/3 of the transported ores volumes in 2011. Grain is transported in large volumes, namely 426,000 tons in 2012 in comparison to 2011 when 290,000 tons of grain were transported. Other cargo groups achieved shares between 1% and 3%.

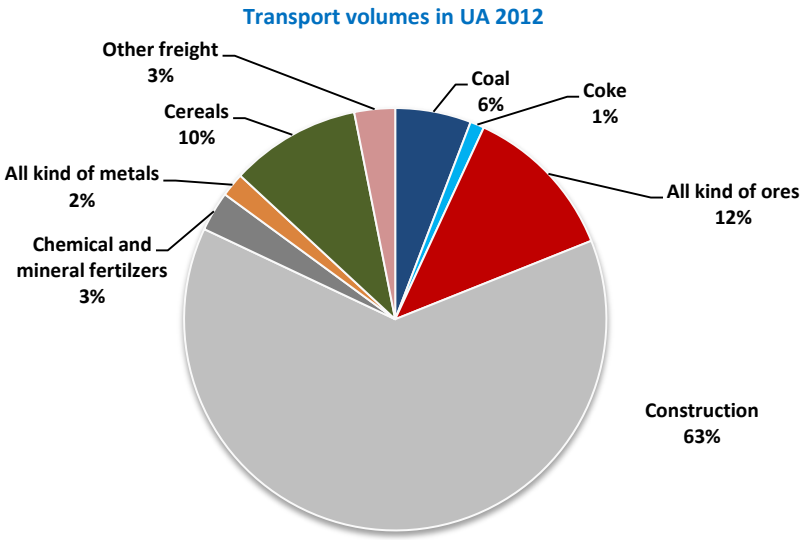


Figure 8: Transport volumes in UA 2012[16]

[15] Own chart based on Eurostat (2014a)

5. Renewable resources

By definition, renewable resources (RES) are agricultural and forestry products which are intended either for material and/or energetic use but not as food or feedstuffs. The availability of renewable resources is, in comparison to fossil raw materials, not limited but through secure and constant regrowth guaranteed.[17] In the course of this study, the use of RES for feedstuff will be taken into account due to the main purpose of this study: examination of the inland waterway transport potential of renewable resources and not the analysis of their intended use.

A small segment of the broad spectrum of RES use is illustrated in figure 9. 64 market segments, based on different renewable sources raw materials have been identified[18,] this market study, however, will focus on raw materials respectively cargo groups which are suitable for inland waterway transports, regarding their characteristics and their transport requirements. The cargo groups are wood, starch (plant with starch content), vegetable oils & fats and sugar beet.

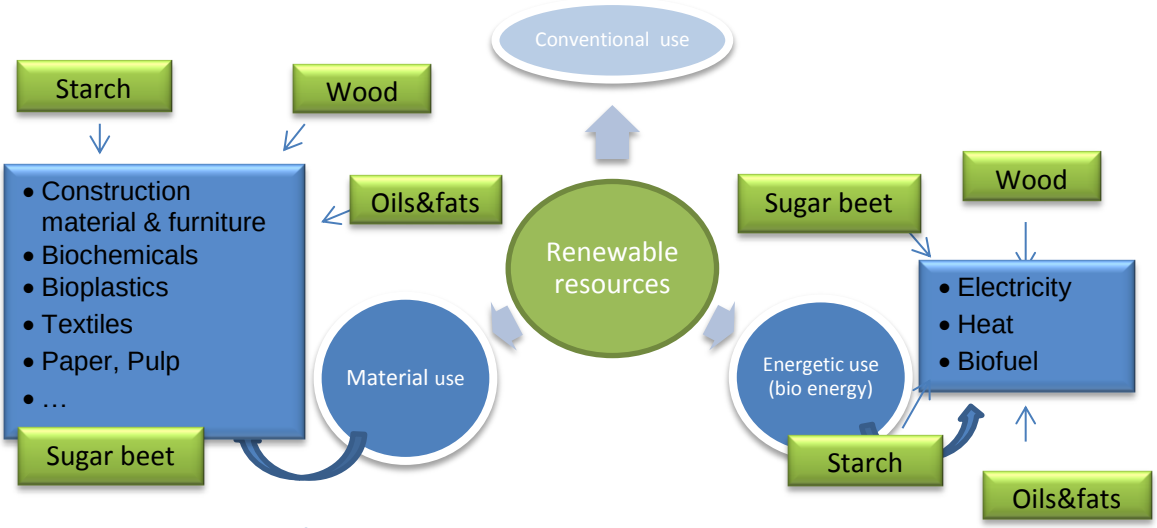


Figure 9: Overview use of RES[19]

The **EU "Directive on the promotion of the use of energy from renewable sources**", which came into force in 2009, established a European wide framework for production, use and promotion of renewable resources. The goal is to reach 20% share of energy from renewable sources and a 10 % share of energy from renewable resources in transport in community energy consumption by 2020.[20]

Moreover, national mandatory targets have been determined for EU member states as well as for SEE and Black See countries, which have signed the Energy Community Treaty.[21]

As stated in figure 10, several Danube riparian states achieved quite successful share rates by 2010 (2009), however the figures also show that especially Germany, Slovakia, Hungary, Croatia, Serbia and Ukraine have to catch up in order to achieve their national targets.

[16] State statistics of Ukraine (2012a), p.224
[17] BMLFUW
[18] Fachagentur Nachwachsende Rohstoffe (2012), p.14
[19] Own chart based on Fachagentur Nachwachsende Rohstoffe (2012), p.14 et seq.
[20] EUR Lex (2009)
[21] IRENA (2013), p.1

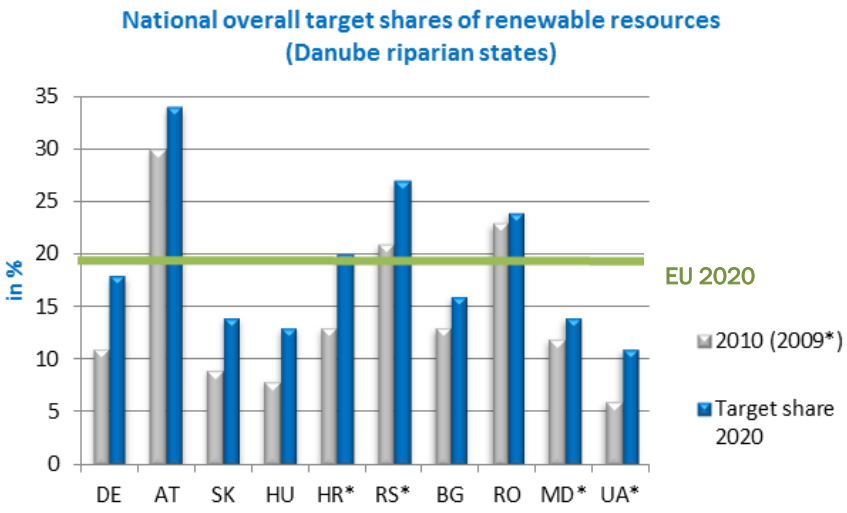


Figure 10: National overall target shares of renewable resources[22]

As mentioned, EU2020 targets aim at increasing the usage of renewable energies, resp. bioenergy which origins from biomass. The illustration below shows which products result from different raw materials and in what form of energy consumption they are used.

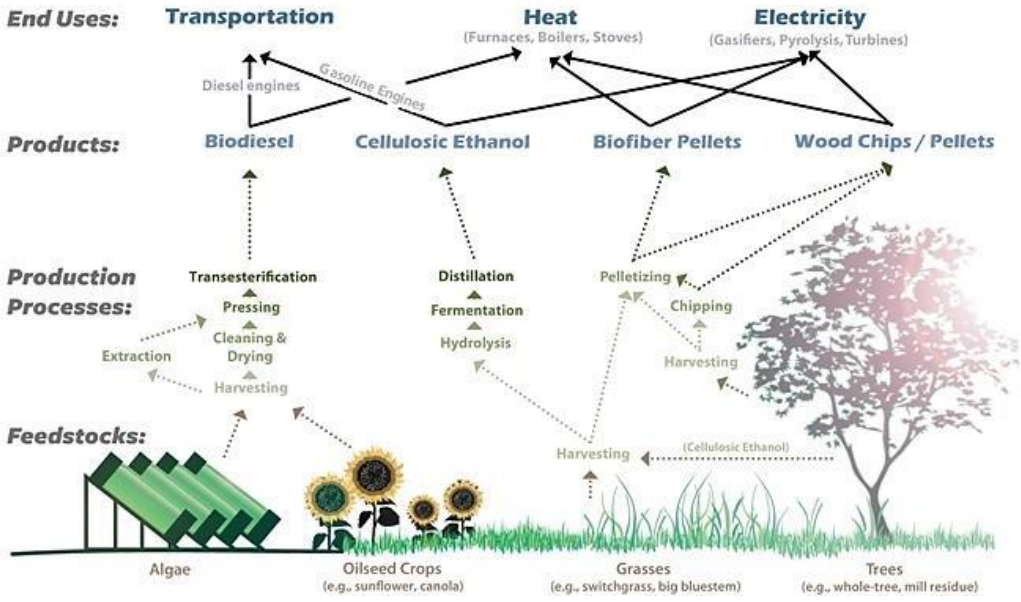


Figure 11: Biomass to bioenergy[23]

The focus of this chapter is on renewable resources for material and energetic use. Regarding the above mentioned the goal of 10% of RES in transport, two biofuels namely “Bioethanol” and “Biodiesel”, which are among others defined in the EU Directive (2009/28/EC) mentioned above[24] will be examined:

- ***Bioethanol*** is ethanol produced of biomass and contains at least 99% alcohol.
- Bio-ETBE is based on bioethanol and contains at least 37% renewable resources energy content
- Biomethanol is methanol produced from bioethanol, to be used as biofuel

[22] Own diagram based on European Commission (2014), Republic of Serbia (2013)
[23] Vermont Sustainable Jobs Fund (2014)
[24] European Commission (2014)

- Bio-MTBE is based on biomethanol and contains at least 22%% renewable resources energy content
- Bio-TAEE based in bioethanol with at least 29% renewable resources energy content
- Biobuthanol is produced from biomass, to be used as biofuel
- ***Biodiesel*** produced from vegetable or animal oil, of diesel quality, to be used as biofuel
- *Pure vegetable oil*

5.1. Transport and transshipment of renewable resources in the Danube region

From Kelheim to the Black Sea there is a minimum of 50 transshipment locations, either ports or sites, for agricultural and forestry products which ensure a dense network along the whole logistic axis, as illustrated below.

Figure 12: RES handling facilities[25]

Research showed that there is little data available in all Danube countries which examine the flows of renewable resources as a separated cargo group.

However, the Danube Commission states in its Danube Navigation statistics that in terms of transshipment volume in all Danube ports, agricultural and forestry products (NST-2007group 01) accounted for 6.8 mil tons resp. 17% of total handled cargo in 2012 which is a slight decrease of 0.2% compared to 2011.

Transshipment in Serbia, Croatia and Slovakia increased lightly while turnover in Romanian ports decreased relatively strong. Despite of the different national developments in terms of transshipment volumes agricultural products stayed a very important commodity group for the region as a whole.

[25] ©viadonau

CARGO TURNOVER OF ALL DANUBE PORTS in 2012 -2011 (statistical data form ST-12)

Thous.tonnes

Nomenclature NST-2007		UA [1]	MD [2] (2010)	RO	BG (2010)	RS	HR	HU (2011=2010)	SK	AT	DE[3] (2010)	Total	%
01	2012	378	*	953	317	1 860	33	2 622	148	507	*	6 818	16,9
	2011	*	*	1 455	317	1 345	13	2 921	114	652	*	6 817	17,1

* not available or magnitude "0".
[1] Data for 2011 submitted accordingly to NST/R.
[2] Data for 2010 from the website of port Giurgiulesti (http://www.gifp.md).
[3] Data on cargo turnover of Regensburg, Kelheim and Passau ports from *via donau* (see http://www.danubeports.info).
[4] Taking into account totals (NST/R) for 2011 from Germany, data for 2010 from the Republic of Moldova.
[5] Taking into account totals (NST/R) for 2011 from Ukraine and Germany, data for 2010 from the Republic of Moldova.

Table 3: Transshipment volume of agricultural goods in Danube port 2011-2012[26]

The following chapter contains information about three Danube countries which have strong cross border trade of renewable resources. A detailed look on the market situation as well as the involvement of inland waterway transports of these goods.

5.2. Market overview

5.2.1. Hungarian trade flows of RES

According to the Food and Agricultural Organization FAO, Hungary produced 16 mil tons of agricultural goods and 1.8 mil tons of forestry products in 2012.

Production agricultural and forestry goods in Hungary (in 1,000 tons)				
2008	**2009**	**2010**	**2011**	**2012**
Agricultural goods				
23,634	19,945	17,418	19,694	15,813
Forestry goods				
1,935	1,591	2,341	1,874	1,864

Table 4: Production of RES in HU[27]

The total exports of agricultural and forestry goods[28] accounted for 10 mil tons in 2012, which is 1 mil tons more than in 2011. The share of exports to all Danube countries amounted to 50% resp. 5.2 mil tons, as shown in table 5. Austria is the most important target market for this product group for Hungary with 1.7 mil tons of exported goods, followed by Germany and Romania.[29]

Exports of RES to Danube countries in 2012 (in 1,000 tons)									
DE	**AT**	**SK**	**HR**	**RS**	**BG**	**RO**	**UA**	**MD**	**Total**
1,185	1,690	830	154	20	67	1,229	25	3	**5,205**

Table 5: Export markets for RES in HU[30]

Out of the 5.2 mil tons exports to the Danube countries only 746,484 tons were transported on the Danube. The only target markets which were served on the waterway were Germany and Austria. Considering that the share of IWT for Hungarian exports of agricultural products amounted only 14%, it can be concluded that there is potential which is not used yet, especially regarding transports to Germany, Austria and Romania which are the most important trade partners for Hungary.

[26] Danube Commission p.16,17
[27] FAOStat (2014a)
[28] According to NACE Rev. 2 classification (please see http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-RA-07-015/EN/KS-RA-07-015-EN.PDF)
[29] Hungarian Central Statistical Office (2014)
[30] Hungarian Central Statistical Office (2014)

5.2.2. Austrian trade flows of RES

From 2008 to 2012 the overall Austrian imports of agricultural and forestry products stayed relatively unchanged and accounted for 10 mil tons per year in average.[31] This volume includes imports from all worldwide trade partners and transports with all means of transport. The table below also shows that imports of the particular product group origin with over 50% from one or more Danube riparian countries.

Austrian imports of agricultural and forestry products (in 1,000 tons)					
	2008	**2009**	**2010**	**2011**	**2012**
Austrian imports in total	9,337	10,228	10,706	10,675	10,307
Austrian imports from Danube countries	5,392	5,873	6,317	6,098	5,704
Share imports from Danube countries	**58%**	**57%**	**59%**	**57%**	**55%**

Table 6: Austrian imports of agricultural & forestry products total vs. Danube countries[32]

Austrian exports, similar to the imports did not experience major changes during the last years. The total volume exported amounted in average 2.8 mil tons, while exports to Danube countries increased from 2008 to 2009 by 164,000 tons and stayed since then quite stable with more or less 1 mil tons per year. As stated in the table, with shares of between 30% and 37% Danube countries are not the predominant countries of destination for agricultural and forestry products.

Austrian exports of agricultural and forestry products (in 1,000 tons)					
	2008	**2009**	**2010**	**2011**	**2012**
Austrian exports in total	2,526	2,881	2,788	2,855	2,812
Austrian exports to Danube countries	760	924	952	1,062	1,053
Share exports to Danube countries	**30%**	**32%**	**34%**	**37%**	**37%**

Table 7: Austrian exports of agricultural & forestry products total vs. Danube countries[33]

Austria's most intense import activities of agricultural products on the Danube arise from transports from Hungary which reached their record high in 2011 which almost 300,000 tons, however these transports declined by almost 50% until 2013. IWTs from Germany play the second strongest role for Austria in this commodity group. Strong annual fluctuations however do not allow to forecast a trend regarding import volumes on the Danube from Germany.

[31] Statistics Austria (2012): Classification: CPA 2008 Group A „Agricultural and forestry products"
[32] Own calculation based on Statistics Austria (2012)
[33] Own calculation based on Statistics Austria (2012)

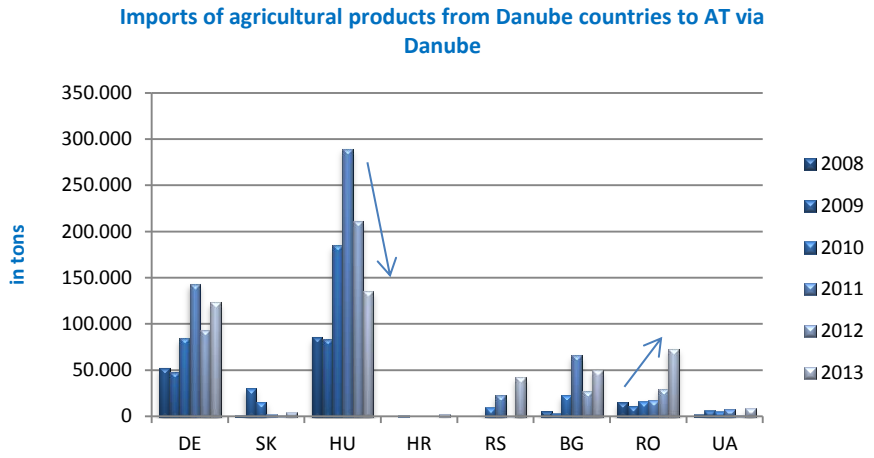


Figure 13: Imports of agricultural products to AT via Danube navigation[34]

Imports from Romania show a constant grow since 2008 and rose from 2012 to 2013 by almost 60% accounting for 73,000 tons lately. Imports from other Danube countries do not play an important role in comparison to the big players which does not mean that their role will not change in future. Having in mind imports of agricultural products from Ukraine, Serbia and Bulgaria in general increased in recent years, inland waterway transports should be seriously considered in future.

The export flows on waterways were predominantly concentrated on markets in Germany and Romania from 2008 - 2013. In 2013 there was a significant rise by almost 50% in export volumes to Germany, reaching 100,000 tons. At the same time, Romanian markets lost importance and exports dropped from 20,000 tons in 2012 to 6,000 tons in 2013. Looking at the two figures, it seems that Romania is a growing target market for IWT of agricultural goods rather than a source market for Austria, despite the large export volumes to Romania in general.

Other countries that were not involved in IWT but do have potential are besides Romania, Hungary and Slovakia.

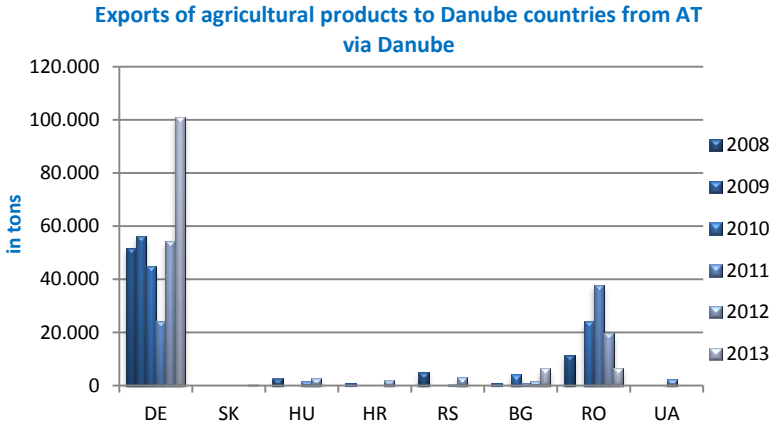


Figure 14: Exports of agricultural products from AT via Danube navigation[35]

[34] Own chart based on Statistics Austria (2014a)
[35] Own chart based on Statistics Austria (2012)

From the total Austrian IWT volume of nearly 11 mill tons in 2012, 16% resp. 1.8 mil tons were allocated to agricultural and forestry products according to the Standard Goods Classification NST/R Group 0. This cargo group rose by approx. 8% since 2011. Austria imported nearly 390,000 tons, exported 117,000 tons, while 1.2 mil tons were allocated to transit transports via waterways.[36] 93% resp. 364,000 tons of the imported goods originated from Danube riparian countries. Newest figures from 2013 show, that the transport volumes kept rising in 2013 and amounted lately 2.2 mil tons, while Austria's total imports of agricultural goods increased by 165,000 tons and accounted for 557,740 tons, of which 440,141 tons were imports from Danube countries.[37]

5.2.3. Serbian trade flows of RES

According to Mr. Sokovic, President of the Grain Association in Serbia, "Zita Srbija" approx. 75% of the exported agricultural goods namely wheat, maize, sunflower seeds are transported on the Danube River towards Black Sea. The target markets are countries in Asia like Korea and Vietnam as well as African countries. In the past years in average 850,000 tons of wheat, 90,000 tons sunflower seeds and small volumes of sugar beet were transported on the waterway. Soybean exports are mainly transported by railway. [38] Information received from Mr. Sokovic corresponds to the data available from the Austrian Statistical Office[39] which registered only 20,000 tons of agricultural goods exported via Danube from Serbia. Round 9,000 were transported to Germany and the remaining 11,000 tons the Netherlands.

5.3. Wood

As already illustrated in the introduction of this chapter, wood is used for materials as well as for energy production. Material use is reflected in the production of wood-based panels, plywood, construction material and furniture. Wood is even used in the chemical industry in the production of plastics. Additionally, paper and pulp as wood products are processed for paper, textiles and insulating material production.[40] In energy production wood pellets, fuel wood and chips are utilized.

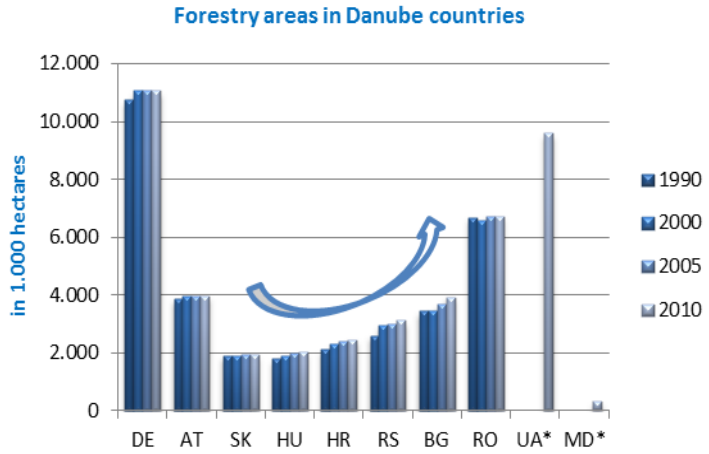


Figure 15: Forestry areas in Danube countries[42]

The availability of the raw material for material and energy use is naturally connected to forestry areas. As the figure shows, Germany, Austria and Romania did not change their forestry areas in remarkable extent whereas Hungary, Croatia, Serbia and Bulgaria enlarged the areas under forest between 13% (HU, BG) and even 20% (RS) since 1990.[41]

[36] viadonau (2013b), p. 14
[37] Own calculation based on Statistics Austria (2014a)
[38] Sakovic (2014)
[39] Statistics Austria (2013)
[40] Fachagentur Nachwachsende Rohstoffe (2012)p.56
[41] Own calculation based on UN Data (2014a)
[42] Own chart based on UN Data (2014a)

Forestry areas in the vicinity of the Danube River are identified in the figure below. From Regensburg-DE to Vienna-AT there are large broad-leaved, coniferous and mixed woodland areas. The important location is the border region between Serbia and Romania/Bulgaria with predominantly broad-leaved forests. Finally, forest areas lengthways Bulgaria are located near the Danube.

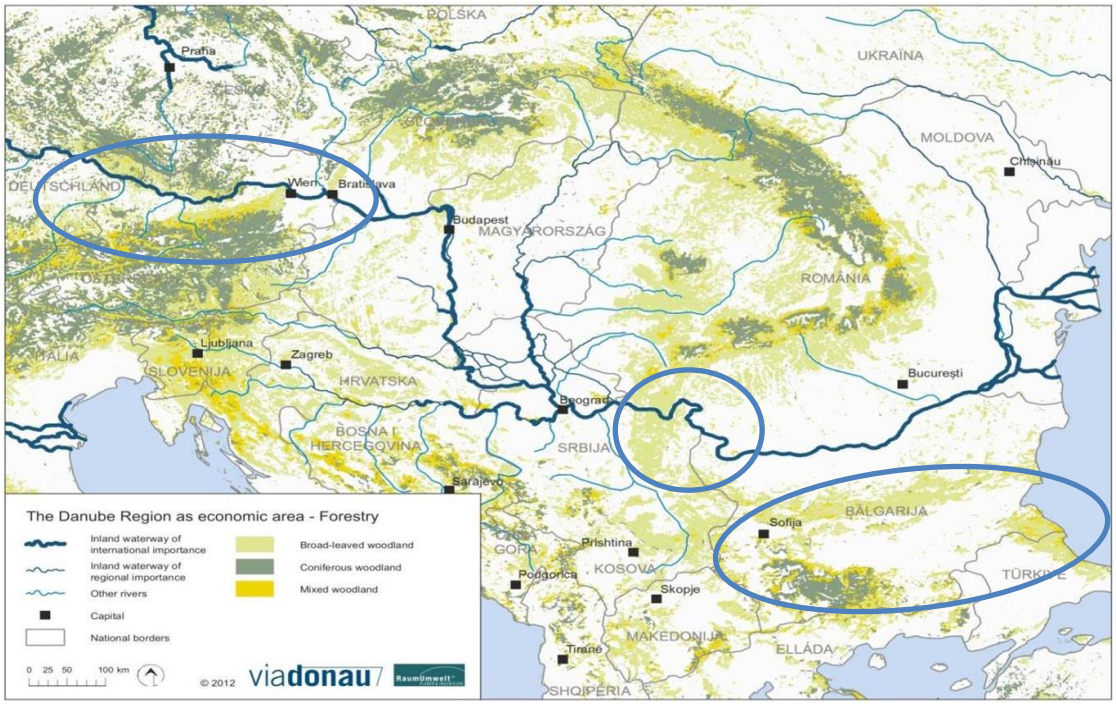


Figure 16: Forest areas in Danube region[43]

5.3.1. Material use

5.3.1.1. Round wood

Round wood resp. raw wood is lumbered and untreated wood which is used for further processing in the wood industry. The round wood production in the Danube countries did not experience dramatic changes since 2008 when 139 mil m3 were produced.
After a peak in 2011 with 141 mil m3, production slightly dropped in 2012 for 138 mil m3.

Figure 17: Round wood[44]

[43] viadonau (2013a), p.135
[44] ©viadonau

5.3.1.1.1. Market overview

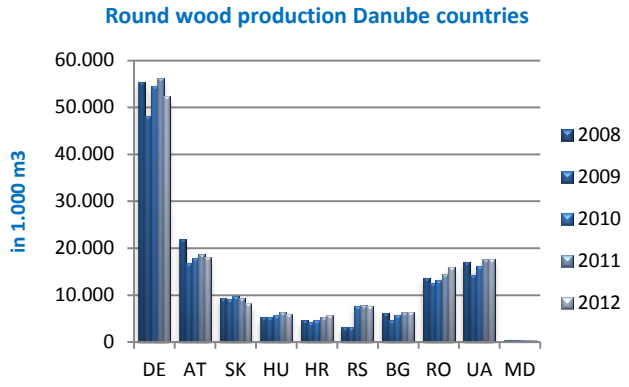


Figure 18: Round wood production in Danube countries[45]

The leading raw and accounted wood producer is Germany with nearly 38% (52 mil tons) of the total production in the Danube region in 2012, followed by Austria which had an output of 18 mil tons in the same year. Romania and Ukraine have comparable volumes amounting in average 16 mil tons. There is a remarkable increase in round wood output in Serbia in 2010 from 3 mil tons to 7.3 mil tons.

Round wood trade

In general round wood is an export driven cargo group, as table 8 shows. Germany, Austria, Slovakia and Ukraine are the largest exporters in the region. Largest import volumes are also realized by Germany and Austria. Despite of the large export volumes, Germany's exports declined since 2009 while the imports varied but kept a high level with approx. 7 mil tons in 2012.

Round wood trade flows in Danube countries (in 1,000 tons)						
		2008	2009	2010	2011	2012
DE	Export	7,181	4,009	3,858	3,774	3,461
	Import	6,231	4,904	8,071	7,482	6,861
AT	Export	1,013	805	1,030	1,081	884
	Import	7,817	8,599	8,651	8,252	8,041
SK	Export	2,289	2,685	2,563	2,683	2,395
	Import	807	550	650	676	874
HU	Export	827	912	1,119	1,160	1,197
	Import	290	284	509	328	276
HR	Export	728	752	825	1,080	972
	Import	20	11	13	15	12
RS	Export	48	29	42	43	56
	Import	96	82	105	74	95
BG	Export	413	278	679	919	1,031
	Import	205	44	28	54	59
RO	Export	257	224	429	831	623
	Import	214	397	611	686	943
UA	Export	3,396	3,396	3,670	4,151	4,139
	Import	133	133	19	22	18
MD	Export	2	2	2	0,1	0,1
	Import	41	41	41	47	50

Table 8: Round wood trade flows in Danube countries[46]

[45] Own chart based on FAOStat (2014a)
[46] FAOStat (2014b)

Germany

Germany's exports to Danube countries declined since 2008 from round 2 mil tons to 1 mil tons in 2013. Imports, on the other reached their maximum in 2010 with approx. 400,000 tons but decreased by 130,000 tons in 2013 and accounted lately round 264,000 tons.

Export and import round wood to and from Danube region (in 1,000 tons)						
	2008	**2009**	**2010**	**2011**	**2012**	**2013**
Export	2,186	1,668	1,356	1,327	1,284	1,194
Import	168	176	394	392	290	264

Table 9: Trade of round wood between DE and Danube region[47]

Exports and imports to and from Austria (in 1,000 tons)						
	2008	**2009**	**2010**	**2011**	**2012**	**2013**
Exports	2,180	1,666	1,356	1,326	1,283	1,193
Imports	160	166	344	366	260	225

Table 10: Trade of round wood between DE and AT[48]

Analysis showed that from all Danube countries Austria is the only trade partner for exports as well as for round wood imports. From 1,193,723 tons round wood exports to Danube countries less, than 1,000 tons reached other countries than Austria in 2012. In order to detect potential for inland navigation of round between these two countries a detailed analysis of the origin and destination of round wood has to be undertaken. Transport distances, costs of transshipment and other relevant factors determinate then the suitability for round wood IWT.

5.3.1.1.2. Transport requirements[49]

In dependence of the weight and length round wood is transported either individually or bundled. One single round wood can weigh 15 tons and more. During transshipment one has to bear in mind that single timber parts which fall into the water may sink due to their high density. The optimal transport temperate is lower than 10°C, higher temperatures might activate insects and mushrooms. Temperatures lower than 0°C might cause crack formation through frost. Furthermore, (round) wood should be protected from humidity in order to prevent quality loss and tonnage variations.
For transshipment of round wood grabbers are suitable, as illustrated in the picture below.

Stowage factor:

- very light species: < 2.43 m^3/t
- moderately light species: 2.43 - 2 m^3/t
- light species: 1.67 - 1.96 m^3/t
- moderately heavy species: 1.43 - 1.64 m^3/t
- heavy species: 1.25 - 1.43 m^3/t
- very heavy species: > 1.25 m^3/t

Figure 19: Transshipment round wood[50]

[47] Own calculation based Destatis-Federal Statistical Office Germany (2014)
[48] Own calculation based Destatis-Federal Statistical Office Germany (2014)
[49] TIS-Transport Information Service (2014a)

5.3.1.2. Sawn wood

According to FAO[51] "sawn wood includes planks, beams, boards, laths, sleepers, etc. with at least 5 mm in thickness. It includes sawn wood that is planed, unplaned, grooved, chamfered, beaded, etc., but it excludes wooden flooring".

5.3.1.2.1. Market overview

The total sawn wood production in all ten Danube countries accounted for 36 mil m3 in 2012, which is 2 mil m3 less than in the previous year.

Sawn wood production in Danube countries (in mil m3)				
2008	**2009**	**2010**	**2011**	**2012**
35	33	37	38	36

Figure 20: Sawn wood production in Danube region[52]

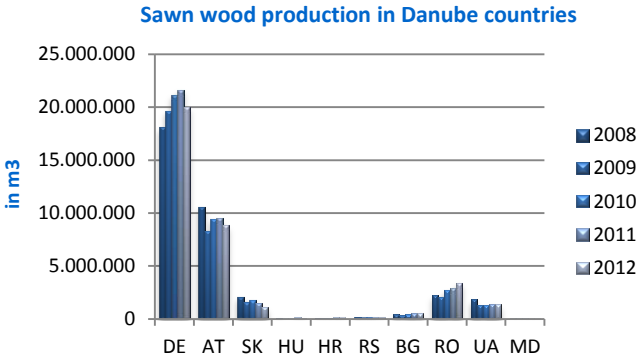


Figure 21: Sawn wood production in Danube countries[53]

The largest sawn wood producers were, as illustrated, Germany with round 20 mil m3 per year in average, while Austria's outputs accounted for almost 10 mil m3. With 3.4 mil m3 Romania is the leading producer in the eastern part of the region with increased output in the period between 2009 and 2012. Production in Slovakia experienced a decrease by 50% from 2 mil m3 to 1 mil tons.

Analysis showed that the demand and consequently the production output of EU27 saw mills is steadily increasing and will rise by 25% from 2010 to 2030 accounting for 250 mil m3 in 2030. This projection might raise the question of the *suitable and available means of transport* for the saw mills products across Europe.

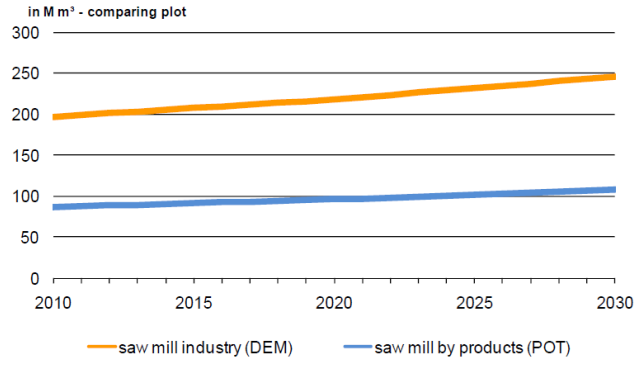


Figure 5-11: Projection of growth – sawmill industry demand and by-products

Source: Saal, U. Industrial residues and by-products, 2010 and Mantau, U.: Wood Resource Balance, 2010 based on Jonsson, R.: Econometric modelling, 2010

Figure 22: Projection of saw mills products demand increase[54]

[50] ©Port of Krems, G.Gussmag
[51] FAO (2011), p.4
[52] Own calculation based on FAOStat (2014a)
[53] FAOStat (2014a)

Sawn wood trade

The largest sawn wood producers are the largest exporters, as it is shown in the table below. Germany's exports declined from 2008 to 2012 and accounted for 6 mil m3 lately. Germany is also a great importer, however tending to decrease.
Austria's exports also had a negative development while imports increased in course of time. Romania seems to boost its sawn wood exports regarding the strong increase from 2008 to 2012.

Sawn wood trade (in 1,000 m3)						
		2008	2009	2010	2011	2012
DE	Export	8,100	6,261	6,648	6,793	6.177
	Import	5,549	3,434	3,912	4,089	3,866
AT ↓	Export	7,012	5,662	5,981	5,585	5,033
↑	Import	1,420	1,595	1,592	1,728	1,717
SK ↓	Export	391	354	537	1,012	486
	Import	131	54	235	143	149
HU	Export	21	26	31	30	22
	Import	318	481	402	372	322
HR	Export	10	13	28	53	68
	Import	284	226	186	187	135
RS	Export	2	1	1	2	2
↓	Import	419	316	304	287	281
BG	Export	61	82	159	301	262
	Import	3	11	6	7	16
RO ↑	Export	1,249	1,593	2,202	2,324	2,475
	Import	39	16	10	14	15
UA	Export	1,070	1,070	1,005	1,171	1,075
	Import	5,	5,500	2,598	12,121	5,769
MD	Export	0.6	0.6	0.6	0	0.3
	Import	140	140	140	133	112

Table 11: Sawn wood trade flows in Danube countries[55]

Germany

The wood industry is the second important form of land use in Germany, after agriculture. 31% of the countries area is forestry which equals 11 mil ha. The current annual turnover of the industry accounts for 170 bil €.[56]

98% of the processed wood originates from German forests. There are 2,000 sawmills which process 35 mil m3 of round wood annually. The core product of the sawmills is sawn wood (timber beans, boards) with an annual production of 21 mil m3 of which 20 mil originate from softwood and only 1 mil m3 from hard wood.

It is not surprising that softwood plays an important role in exports. According to the German cluster of the saw and wood industry 6.4 mil m3 softwood and 600,000 m3 hardwood was exported in 2012.

The target markets are *Austria* and France in Western Europe as well as overseas destinations. However, softwood exports decreased since 2007 for 3 mil m3, as figure 23 clearly illustrates. Sawn wood imports originate mainly from *Austria*, Sweden and Russia.[57]

[54] EUWood (2011), p.100
[55] FAOStat (2014b)
[56] BMELV-Bundesministerium für Ernährung und Landwirtschaft (2014a)
[57] DeSH-Deutsche Säge- und Holzindustrie (2014)

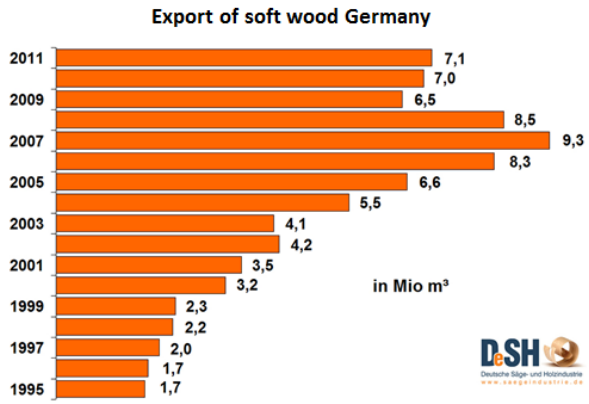


Figure 23: Export of sawn wood in DE[58]

Austria

The Austrian timber industry has over 1,400 companies. 1,000 saw mills and approx. 400 companies which operate in different areas like e.g. furniture production, ski production, etc. Most of them are small and middle sizes family businesses in economically weak areas.[59]

As illustrated below, the development of the sawn wood production values is characterized by fluctuations. After the low point in 2009, production increased in the following two years, dropping lightly in 2012 and 2013 and accounting for 9 mil m3. Nevertheless, this numbers stays far below the record production of more than 11 m3 in 2007.

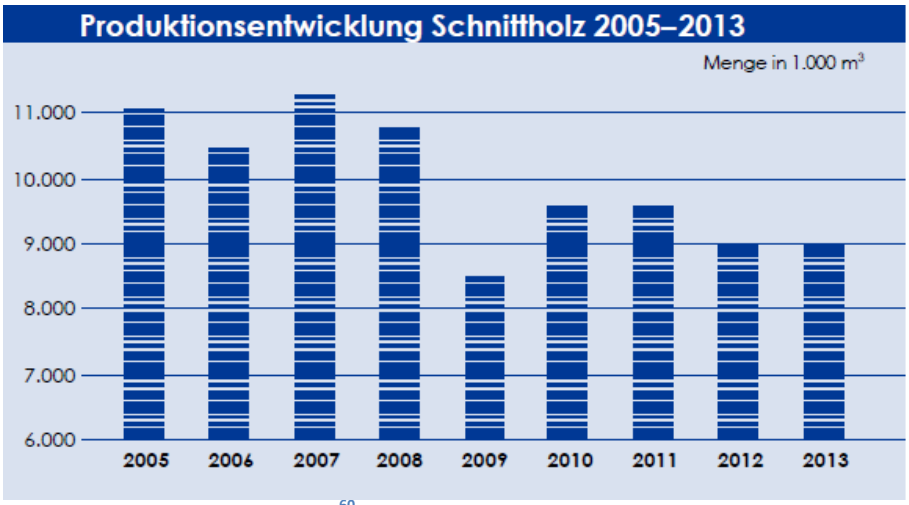


Figure 24: Wood production in AT[60]

5.3.1.2.2. Companies in the vicinity of the Danube River

The following table shows sawmills which are located within a 90 minutes truck drive from the Danube Rivers (in Germany Rhine and Danube). This list is non-exhaustive!

[58] DeSH-Deutsche Säge- und Holzindustrie (2014)
[59] WKO-Austrian Chamber of Commerce (2014a)
[60] WKO-Austrian Chamber of Commerce (2014b), p.31

	Company name and location	Truck travel time to the nearest port
DE[61]	Auernhommer Holz, Ellwangen	90min (Nuremberg)
	Augendecker, Morbach	70min (Mainz, Rhine)
	Lud.Kuntz GmbH	70min (Mainz, Rhine)
	Karl Decker GmbH, Hochscheid	70min (Mainz, Rhine)
	Gmach Holzwere, Pösing	60min (Regensburg)
	Hermes Holz, Stadtkyll	90min (Koblenz, Rhine)
	Van Roje, Oberhonnefeld-Gierend	40min (Koblenz, Rhine)
	Stora Enso Timber, Pfarrkirchen	50min (Passau)
AT	Stora Enso, Brand	45min (Krems)
	Stora Enso, Sollenau	50min (Vienna)
	StoraEnso, Ybbs an der Donau	3min (Ybbs-Schaufler)
	Brunner-Stern, Hohenberg	70min (Krems)
	Rumpelmayr, Altmünster	60min (Linz)
	Rumpelmayr, Enns	0min (directly located at port of Enns)
	Mayr-MelnhofHolz, Frankenmarkt	80min (Linz)
	Mosser Holzindustrie, Randegg	80min (Linz/Krems)
	Prehofer Sägewerk, Rutzmoss	55min (Linz)
	Holzhof Schmidt, Aspang	65min (Vienna)
	GebrüderSteininger, Rastenfeld	30min (Krems)
	UPM, Steyrermühl	40min (Linz)
	Kirnbauer, Prigglitz	80min (Vienna)
SK	Slovincom, Hurbanovo	15min (Komarno)
	Marpex Agro Eood, Tarnovo	90min (Svishtov)
	Gorainvest AD, Rousse	0km (directly located at port of Rousse)
	Agronim Eood, Pleven	70min (Belene)
	Montana	60min (Lom)
	Nsp-AT Eood, Shoumen	90min (Rousse)
	Dobrudjanska Gora AD, Dobrich	80min (Silistra)
	State Game Rezerve Dunav, Rousse	15min (Rousse)
	Izosoft Eood, Popovo	70min (Rousse)
RO[62]	SC Unicom Wood Production SA,	45min (Turnu Magurele)*
	SC Mitec Industrial SRL, Mihailești	65min (Giurgiu)
	Mary Jean Florin SRL, Calarasi	60min (Silistra)
	Fib Servcom SRL, Zimnicea	65min (Turnu Magurele)*
	Ganeti Silva SRL, Redea	60min (Bechet)
	Transelawood SRL, Medgidia	30min (Cernavoda)
	Uni-Rom-Exim SRL, Constanta	0min (directly located at port of Constanta)
	Silva Com Danubius SRL, Calarsi	60min (Silistra)
	SC Bio Serv SRL, Calarasi	60min (Silistra)
	Mapol Lemn For S.R.L. - D, Constanta	15min (Constanta)
	Pro Green Invest INVEST SRL, Constanta	10min (Constanta)

Figure 25: Saw mills in Danube region

5.3.1.2.3. Transport requirements[63]

Sawn wood is moisture sensitive and should be protected from moisture (rain, snow, etc.) during cargo handling in order to prevent mold and fungus growth.

[61] VDS-Association of German sawmill industry (2014)
[62] IHB-The timber network (2014)
[63] TIS-Transport Information Service (2014b)
*under the precondition that transshipment is possible

The cargo should be handled carefully due to its sensitivity to mechanical damage. It is essential to use suitable loading and unloading equipment and materials. Sawn wood is always bundled with steel strapping.

Stowage factor:

- very light species: < 2.43 m^3/t
- moderately light species: 2.43 - 2 m^3/t
- light species: 1.67 - 1.96 m^3/t
- moderately heavy species: 1.43 - 1.64 m^3/t
- heavy species: 1.25 - 1.43 m^3/t
- very heavy species: > 1.25 m^3/t

5.3.1.3. Wood-based panels

The cargo group of wood based panels includes, in this evaluation, hardboards, fiberboards and plywood.

Germany produced 12 mil m3 panels in 2012, which is the largest volume in the whole region, however, there is a declining trend since 2008. Austria kept a stable output with approx. 3.3 mil m3 annually. Romania doubled the production and as illustrated in figure 26 increased its exports as the only country in the Danube region.

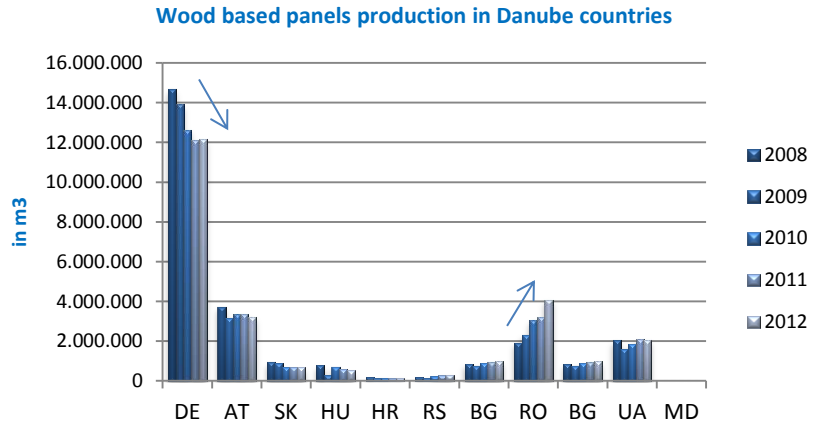


Figure 26: Wood based panels production in Danube countries[64]

Germany's exports decreased since 2009 for more than 2 mil m3 and accounted lately less than 6 mil m3 while imports increased since 2009 and equaled the imports of 5 mil tons in 2012. Austria's exports and imports stayed stable in the course of time. A significant rise in exports achieved Romania which exported more than 2 mil m3 in 2012 which more than a double of the volumes in 2008. Germany is clearly also the biggest importer of panels which rose since 2009 again.

[64] FAOStat (2014b)

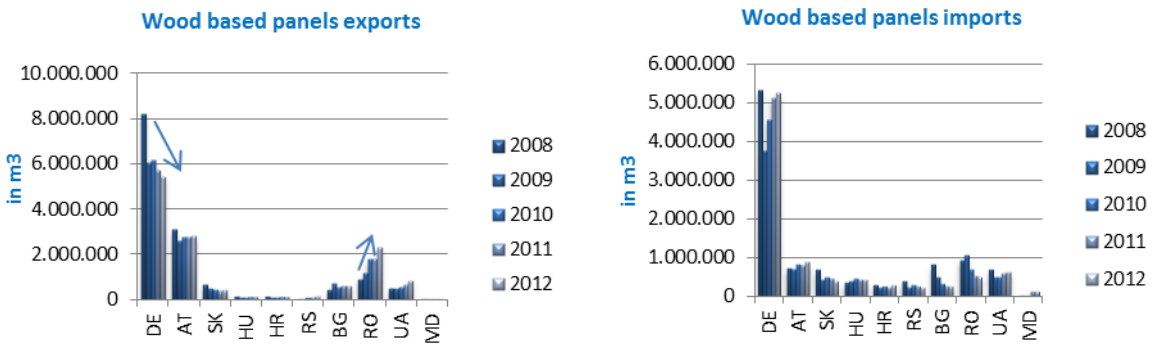


Figure 27: Wood based panels trade in Danube countries[65]

5.3.2. Energetic use

In the sense of energetic use, wood resp. woody biomass and numerous wood based products are suitable as raw material for heating and electricity production.

Pellets

Wood pellets as resources for energy have following advantages which are relevant in the sense of the EU2020 goals described in the introduction.[66]

- Pellets can save up to 50% of energy costs from fuel oil and natural gas
- Pellets are bundled energy: 1 kg pellets equal 4.9 kW → 2 tons pellets equal 1,000 liters fuel oil
- With efficient heating boilers 90% of the pellet energy be processed to heat
- CO2 emission during the burning process equal the absorption of CO2 during the wood growth period
- Pellets origin from renewable resources – wood

Pellets are made of wood chips which in the first step have to be dried. After the drying process chips are crushed and pressed through a die under high pressure. The end result are wood pellets. Excellent synergies can be achieved if pellet plants are located in the scope of sawmills which provide the raw material and the energy from renewable raw materials resp. wood residues such as bark which is used as biomass for the production. In that way transport and energy costs are reduced.[67]

Pellets are stored in silos until their distribution or packed in bags.

Figure 28: Pellets production and storage[68]

[65] FAOStat (2014b)
[66] ProPellets (2014a)
[67] ProPellets (2014b):
[68] ProPellets (2014b):

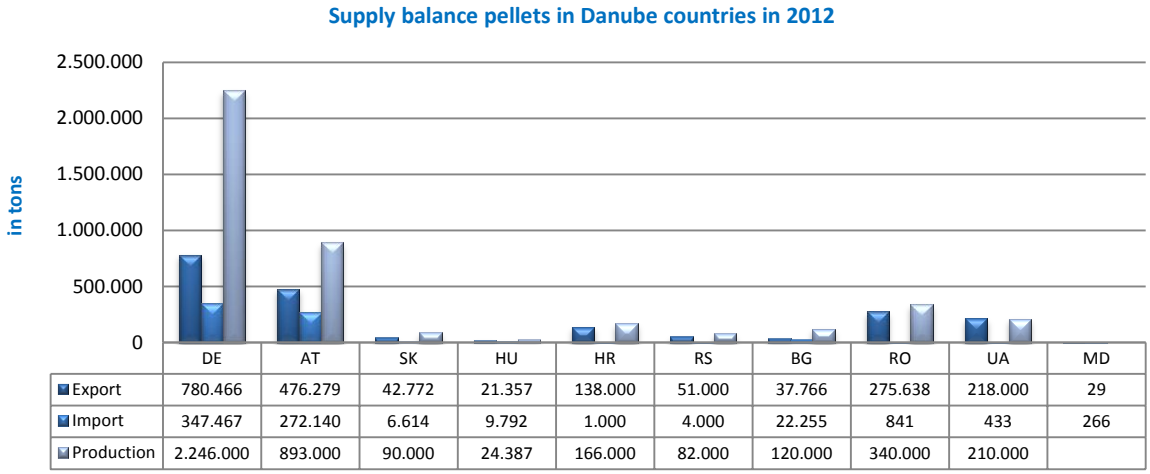
5.3.2.1. Market overview

In the ten Danube countries there are almost 300 pellet producers, most of them located in Germany. Austria, Bulgaria, Romania and Ukraine have between 30 and 40 production sites. The total production capacity of the Danube countries accounted for **8 mil tons in 2008/2009** (without HR, RS, UA, MD).

Number of pellet production plants in Danube region									
DE	**AT**	**SK**	**HU**	**HR**	**RS**	**BG**	**RO**	**UA**	**MD**
97	34	20	20	3	8	39	37	38	3

Table 12: Pellet production sites in Danube region[69]

The largest national production **capacity** have Germany and Romania with 2.6 mil tons, followed by Slovakia with 1.4 and Austria with 1.3 mil tons.[70]



	DE	AT	SK	HU	HR	RS	BG	RO	UA	MD
Export	780.466	476.279	42.772	21.357	138.000	51.000	37.766	275.638	218.000	29
Import	347.467	272.140	6.614	9.792	1.000	4.000	22.255	841	433	266
Production	2.246.000	893.000	90.000	24.387	166.000	82.000	120.000	340.000	210.000	

Figure 29: Supply balance pellets in Danube countries 2012[71]

The actual pellet production in the Danube region in 2012 accounted for 4 mil tons. 2.2 mil tons of pellets were produced in Germany, followed by Austria with 900,000 tons. Romania had the third largest output which amounted 340,000 tons. Hungary had the lowest production, while in Moldova pellets are not produced at all.

The dominating exporting activities were conducted by Germany with 800,000 tons and Austria with 480,000 tons in 2012. Other relatively large exporters were Romania and Ukraine. Remarkable imports are facilitated in Germany and Austria.

[69] Pelletsinfo (2014a)
[70] Own calculation based on Pelletsinfo (2014a), no data for HR, RS, UA, MD
[71] Own chart based on FAOStat (2014a), FAOStat (2014b)

Germany

As illustrated above, Germany was by far the largest pellet producer in the Danube region. Pellets production is mainly concentrated in the lower half of the country.* Furthermore, the importance of pellet heating in extremely high in the south of the country. From 180,000 pellets heating systems in the entire country, 38.2% are located in Bavaria.[72]

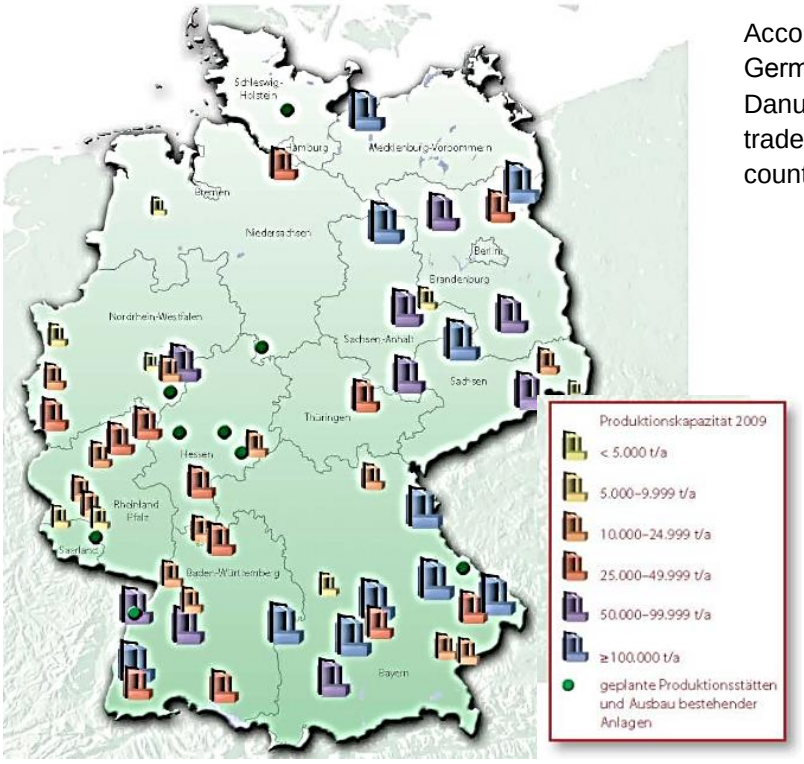


Figure 30: Pellets producers in DE[73]

According to statistical analysis, Germany's only trade partner in the Danube region was Austria. Pellets trade volume between the two countries is listed below.

Austria

In Austria there are 34 pellets production sites with an annual capacity of 1.3 mil tons. Pellets plants are mostly located in the scope of sawmills which has the advantage of prompt processing of the occurring wood chips. In that way transport and energy costs are reduced.[74]

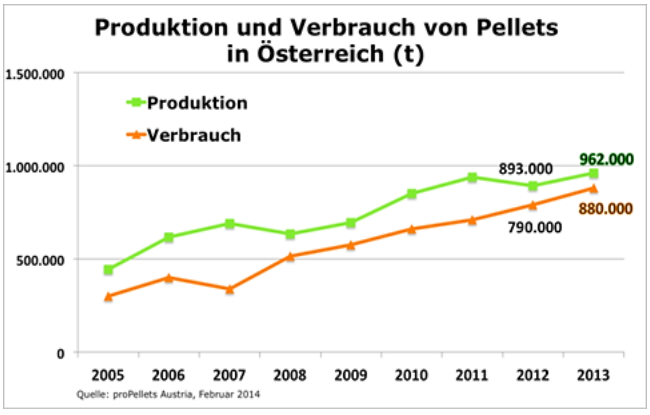


Figure 31: Production and use of pellets in AT[75]

Austrian pellets production (green line) steadily increased since 2005 as well as pellets consumption (orange line). In 2013 almost 1 mil tons of pellets was produced and 900,000 tons were used. The 360,000 tons of import came mainly from Romania with 185,000 tons, followed by Germany with 74,000 tons.

[72] Depv (2012)
[73] NWR (2014)
[74] ProPellets (2014c)
[75] ProPellets (2014c)

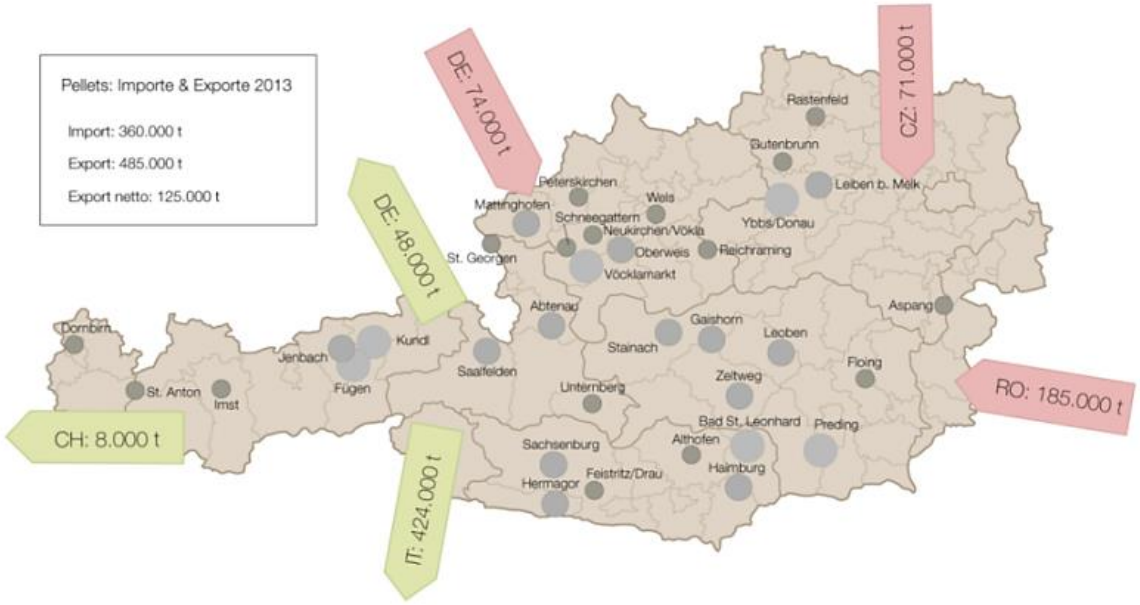


Figure 32: Pellets exports / imports in AT[76]

Pellets production is focused on the Austrian provinces Steiermark and Kärnten in the South and Upper Austria, Tirol in West. However, there are five plants which are located in the vicinity of the Danube River.

Pellet producers in Danube vicinity in AT	
Ybbs	2min (Ybbs-Schaufler)
Leiben bei Melk	30min (Ybbs)
Reichraming	80min (Linz)
Oberweis	60min (Linz)
Neukirchen/Völkla	90min (Linz)

Table 13: Pellets production plants in Danube vicinity AT[77]

Figure 33: Pellet production plants in AT[78]

*Company locations can be found in Pelletsinfo (2014a) under View Market Data

[76] ProPellets (2014c)

[77] Own calculation based on ProPellets (2014c)

[78] Adapted from ProPellets (2014c)

5.3.2.2. Transport requirements

Pellets are either transported as bulk cargo or in bags. Transshipment of pellets requires caution in order to prevent damages. This cargo can be handled with pneumatic pumps which is recommendable or with cranes and grabbers. Pumps have the advantage of optimal cargo transportation speed, elimination of dust formation and the general transportation speed with 500 tons per hour.[79]

Stowage factor:

- 1.5 m^3/t

5.4. Paper, paperboard and pulp

Paper industry plays an important role for the European economy with a 27% share in world paper and paperboard production approx. 100 mil tons of paper are produced and processed each year in Europe.[80]

The paper making process and is shown in the following figure and it seems clear that inland navigation can be included in two production phases. It starts with the delivery of raw material which includes wood as well as paper scrap (see chapter recycling products). Besides raw materials inland navigation can play an important role in the transport of finished products.

The necessity of a suitable mode of transport has also been identified by the Confederation of European Paper Industries (cepi), which stated that: "High quality and flexible, cost-efficient and sustainable transport solutions are essential for European pulp and paper industry's competitiveness. Many challenges, such as congestion, increasing emissions and rising costs have to be met. The European pulp and paper industry makes use of the three basic modes of transport – rail, road and water. As with many industry sectors, road transport is the main mode for European distribution. A vast majority of the yearly 300 million tons of the pulp and paper industry's raw materials and finished products are transported by road in Europe"[81]

[79] EUBIA (2009), p.10
[80] Wikipedia (2014b)
[81] Cepi-Confederation of European Paper Industries (2014a)

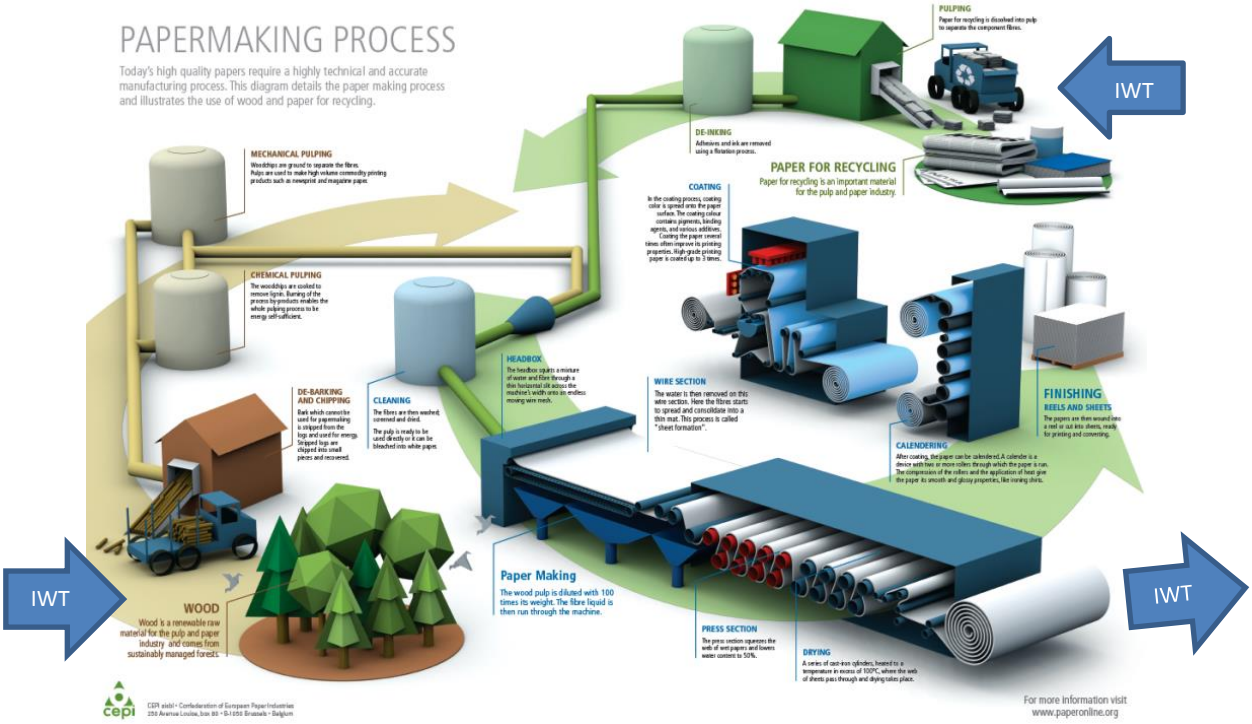


Figure 34: Paper production process[82]

5.4.1. Market overview

Paper, paperboard and pulp production in the Danube countries accounted for 37 mil tons in 2012 which is more or less equals the output since 2010. 2009 was a less successful year with a minimum output of 24 mil tons.

Production paper, paperboard and pulp in Danube countries (in mil 1,000 tons)				
2008	**2009**	**2010**	**2011**	**2012**
37,543	34,096	37,249	37,091	36,844

Table 14: Paper and pulp production in Danube countries[83]

The leading producer of this product group is Germany with more than 25 mil tons output per year in average while the second largest production is based in Austria with 7 mil tons annually. Slovakia has approx. 1.5 mil tons of output which twice as high as Croatia's output of 700,000 tons. Ukraine should also be mentioned producing 1 mil tons per year. Other countries produce between 100,000 tons (MD) and 400,000 tons (BG).

[82] Cepi-Confederation of European Paper Industries (2014b)
[83] FAOStat (2014a)

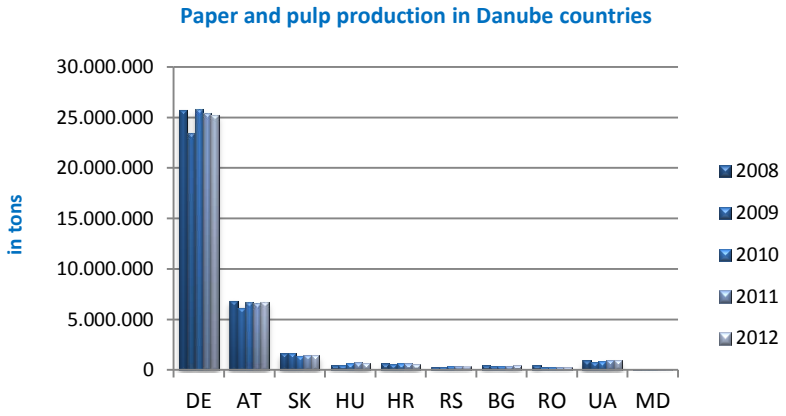


Figure 35: Paper and pulp production in Danube countries[84]

Germany and Austria are the largest exporters and importers of all Danube countries. In Germany remarkable 15 mil tons enter and leave the country per year, while Austrian imports amounted more than 4 mil tons per year. The imports of paper and pulp in Austria stayed stable in the course of time and accounted for round 2 mil tons per year. The imports of the remaining countries did not exceed 1 mil tons.

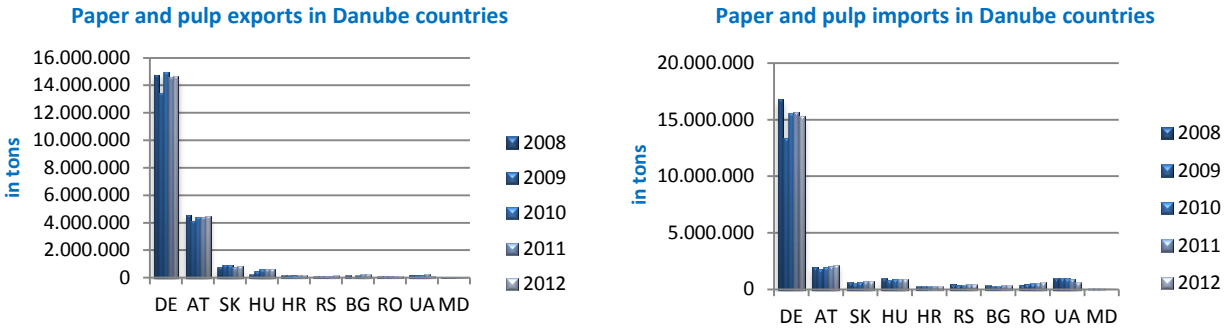


Figure 36: Paper and pulp exports and imports in Danube countries[85]

5.4.1.1. Germany

Germany is the 4th largest paper producer in the world following China, USA and Japan. There are 164 production plants (4 less than in 2012) which had a turnover of 14.3 bill € in 2013.

Germany's production volumes for paper and board in 2012 und 2013 accounted for 22.5 mil tons while 2.5 mil tons of pulp where produced. Germany exported almost equal volumes in 2012 and 2013 namely, 13 mil tons paper and board and 600,000 tons of pulp. Imports accounted for 14 mil tons per year, which is the second largest import volume worldwide, after USA.[86]

Company name and location	Truck travel distance to the nearest port
Hamburger Rieger GmbH & Co. KG Papierfabrik, Trostberg	90min (Passau)
Plattling Service GmbH, Platting	20min (Deggendorf)
Pfleiderer Teisnach GmbH & Co. KG, Treisnach	35 min (Deggendorf)

[84] FAOStat (2014a), Eurostat (2014b)
[85] Own calculation based on Eurostat (2014b), Stat RS (2014-07-06)
[86] BMWI-Federal Ministry for Economic Affairs (2014a)

Mondi Eschenbach GmbH, Eschenbach	80min (Nuremberg)
Gutta Rohplattenwerk GmbH, Riedenburg	40min (Regensburg)
LEIPA Georg Leinfelder GmbH, Schrobenhausen	80min (Regensburg)
Feinpappenwerk Gebr. Schuster GmbH & Co. KG, Hebertshausen	90min (Regenburg / Deggendorf)
UPM Unterschleißheim Myllykoski Corporation GmbH, Unterschleißheim	90min (Deggendorf)
SCA Hygiene Products S, Ismaning	90min (Deggendorf)

Table 15: Paper plants in DE and distance to the nearest port[87]

Germany - Pulp and Paper Industry			
(1,000 tonnes)	2012	2013	13:12
Production			
Mechanical Pulp (air dry 90 : 100)	1,043	1,013	-3
Chemical Pulp (air dry 90 : 100)	1,593	1,596	0
Total Paper and Board	**22,603**	**22,393**	**-1**
Graphic Paper	9,202	8,698	-5
Paper and Board for Packaging	10,644	10,903	2
Sanitary & Household (Parent Reels)	1,392	1,414	2
Other Paper and Board	1,365	1,378	1
Exports			
Mechanical Pulp (air dry 90:100)	75	68	-9
Chemical Pulp (air dry 90:100)	560	548	-2
Paper for Recycling	3,091	2,767	-10
Paper and Board	13,404	13,070	-2
Export share of Production (%)	59	58	
Imports			
Mechanical Pulp (air dry 90:100)	176	198	13
Chemical Pulp (air dry 90:100)	3,557	3,491	-2
Paper for Recycling	4,034	3,841	-5
Paper and Board	10,871	10,575	-3
Import share of Consumption (%)	54	53	
Consumption			
Mechanical Pulp (air dry 90:100)	1,218	1,188	-2
Chemical Pulp (air dry 90:100)	4,682	4,546	-3
Paper for Recycling	16,192	16,489	2
Mineral Fibers and Additives	4,044	3,810	-6
Paper and Board	20,070	19,898	-1
Paper and Board per capita (kg)	249	247	-1
Paper for Recycling Utilisation Rate[1)]	72	74	
Paper for Recycling Recycling Rate[2)]	76	78	
[1)] Paper for Recycling Consumption in % of Paper and Board Production			
[2)] Paper for Recycling Collection in % of Paper and Board Consumption			

Table 16: Paper and pulp industry in DE[88]

There are nine paper production plants in the vicinity of the Danube River, which are members of the Bavarian Paper Associations, as table 15 shows.

5.4.1.2. Austria

The Austrian paper, board and pulp production accounted for 5 mil tons in 2012, which is the second largest output in the Danube region, as the illustrated above. However, domestic use has additionally to be satisfied with imports.

Austria's most intense activities are realized with Germany with 2 mil tons of imports in 2012 which is however, the lowest point since 2008 when 3 mil tons of this product group were imported from Austria. Slovakia and Hungary should also be mentioned as important partners. Imports from SK varied in the observed period from 400,000 tons in 2008 to 1 mil tons in 2010. Hungary increased its exports to Germany steadily and they accounted lately 890,000 tons. Other Danube countries play a minor role for Austrian paper imports.

[87] Own calculation based on Baypapier (2014)
[88] VDP-Verband Deutscher Papierfabriken (2012)

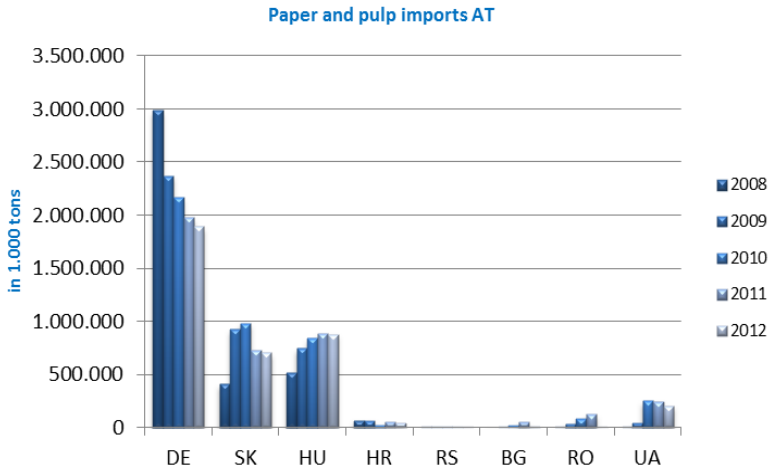


Figure 37: Paper and pulp imports in AT[89]

Considering the tight connection in paper, board and pulp trade between Austria and Germany in both ways, IWT on the Rhine-Main-Danube Axis has a great potential as a cost efficient and environmentally friendly means of transport.

"High quality and flexible, cost-efficient and sustainable transport solutions are essential for European pulp and paper industry's competitiveness."[90]

There are 25 production locations in Austria which employ round 8,000 persons. 14 of them are located within a 90 minutes truck drive from the Danube River, as table 17 shows.

Figure 38: Paper production plants in AT[91]

[89] Own chart based on Statistics Austria (2012)
[90] Cepi-Confederation of European Paper Industries (2014b)
[91] Austropapier (2013), p.88

No	Company name	Location	Distance to the nearest port
2	Dr. Franz Feuerstein GmbH	Traun	20min (Linz)
3a	W. Hamburger GmbH	Pitten	50min (Vienna)
4	Paul Hartmann GmbH	Grimmenstein	60min (Vienna)
6	Lenzing Papier GmbH	Lenzing	50min (Linz)
7b	Mayr-Melnhof Karton GmbH	Hirschwang	80min (Vienna)
8	Merckens Karton- und Pappenfabrik GmbH	Schwertberg	20min (Enns)
9b	Mondi AG	Hausmening	40min (Enns)
9c	Mondi AG	Kematen	40min (Ybbs)
10	Nettingsdorfer Papierfabrik AG & Co KG	Haid	30min (Linz)
13	Poneder GmbH	Hausmening	40min (Enns)
15	Salzer Papier GmbH	St.Pölten	30min (Krems)
17	SCA Graphic Laakirchen AG	Laakirchen	40min (Linz)
18	SCA Hygiene Products GmbH	Ortmann/Pernitz	50min (Vienna)
20	UPM Steyrermühl	Steyrermühl	40min (Linz)

Table 17: Production plants in AT in Danube vicinity[92]

5.4.2. Transport requirements

Paper:

Due to the large variety of paper types, only general information can be provided at this point:

During transshipment the cargo must be protected from moisture (rain, snow, etc.), due to the risk of losses caused by swelling and tearing of individual layers. Furthermore, incorrect handling may cause cracks while repeated transshipment naturally increases risks of damages.
Improper handling can lead to deformations in paper rolls. Very deformed roles can no longer be printed and have to be rewrapped.

For transshipment of paper roles should be conducted with special equipment as well as forklifts with paper roll clamps.

Figure 39: Forklift with paper roll clamps[93]

Pulp:[94]

Pulp is generally transported as bales (e.g. 120 x 80 cm) weighing approx. 200 or 250 kg and rolls weighing 250 - 400 kg. The cargo must be protected from moisture (rain, snow) during cargo handling, surfaces must be clean. In addition, forklift trucks should be checked for hydraulic fluid and oil leaks and squeeze clamps should be clean. Chemical pulp is highly flammable, so protect from sparks, cigarette ends, fire and naked lights.

The relative humidity during transport should account for 60-65% (dry pulp) and 85 - 90% (wet pulp) while water content varies in dependence to the pulp type.

[92] Own calculation
[93] ©Ennshafen
[94] TIS-transport Information Service (2014c)

Stowage factor:

- 1.50 m^3/t (bales in wooden frames)
- 1.25 - 1.39 m^3/t (loose bales)
- 1.25 - 1.39 m^3/t (unitized bales)
- 1.45 - 1.56 m^3/t (wet pulp)
- 1.65 - 1.90 m^3/t (bales)

Cardboard:

Cardboard goods are transported in packs (unpackaged, strapped with plastic strapping), bales, packets or paperboard cartons and in rolls. Goods must be protected from moisture (rain, snow) during cargo handling, as there is a risk of losses caused by swelling and tearing of individual layers.

Incorrect handling during loading and unloading and storage entails the risk of damage. As a consequence, in the case of rolls the layers become unusable over the depth of the snags. They are then fit merely to be torn off (stripped down) and used as waste paper. Packs and bales must not be lifted by the strapping, as this may break.

Cargo handling of paper rolls should be performed only with special cargo handling gear and forklift trucks with paper roll clamps.

Stowage factor:

- 8.60 m³/t (packs, unpackaged, strapped with plastic strapping)

5.5. Starch

Starch and starch related products are nowadays mostly used for the paper and pulp industry, chemical and textile industry as well as in the pharmaceutical industry. However, starch also plays an essential role in the **bioethanol production**. In Europe, wheat and maize are predominantly used for starch production, while in rest of the world other raw materials namely Tapioca and rice are processed to starch too.[95]

5.5.1. Market overview[96]

In **Germany** starch production is concentrated in the northern part of the country. There is one starch plant in the south, which processes potato starch.[97] Potato processing plants in the Danube region will not be examined in this study and will be not taken into account in the following chapter due to the regional supply with the raw material.

There are two starch plants in **Austria**, namely the *maize* processing plant in Aschach an der Donau and a *wheat* processing plant in Pischelsdorf, both operated by the Austrian company Agrana. The same company runs a maize starch plant in Szabadegyháza in Hungary.[98]

Agrana also runs a maize starch plant in Țăndărei **Romania**, halfway between Bucharest and Constanta. The production capacity accounts for 36,000 tons of maize.[99]

Cereals production including maize accounted in 2012 across all Danube countries 138 mil tons, which is the lowest volume in the analyzed period considering production of volumes of 169 mil tons in

[95] Fachagentur Nachwachsende Rohstoffe (2012), p.28
[96] Without rice
[97] Informationssystem Nachwachsende Stoffe (INARO)
[98] Agrana (2014a)
[99] Agrana (2014b)

2008. Nevertheless, seasonal fluctuations in production on national basis are common and visible in the graphic below.

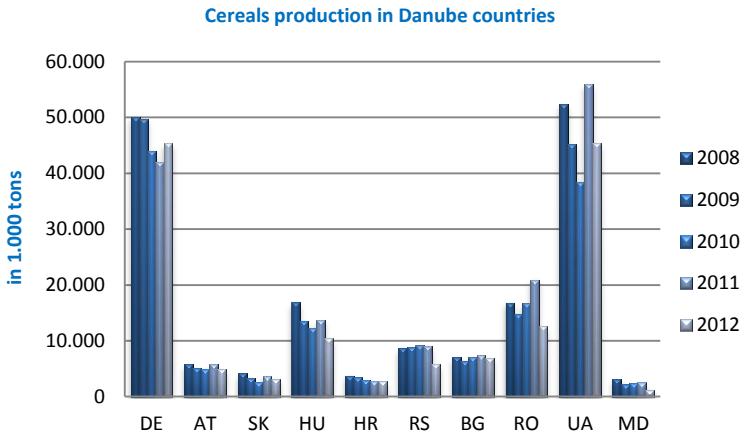


Figure 40: Cereals production in Danube countries[100]

The largest producers in Danube region are Germany and Ukraine with an average production of 47 mil tons during the observed period, followed by Romania, Hungary and Serbia.

Despite of comparable grain production volumes of Germany and Ukraine, trade flows of the two countries do not correspond to each other. The table below illustrates the strong export activities of the Ukraine in terms of quantity as well as in terms of proportion to total production volume. Ukraine exported 27 mil tons of cereals in 2012, which is best result in the examined period of time. Ukraine's imports are irrelevant and account for less than 1%.

Germany, on the other side, despite of the second largest exports, has a more equalized balance of trade, meaning that Germany also imports large quantities. The share of exports accounts for 30% of total production volumes per year in average, while imports account for 22%. Looking at Ukraine, 41% is allocated to exports and imports are nearly non-existent. Hungary has the largest share in exports from total production which accounted for up to 60% (in 2012). Grain from Romania, Bulgaria and Serbia is also exported in large quantities.

Cereals trade flows (in 1,000 tons)						
		2008	**2009**	**2010**	**2011**	**2012**
DE	Export	13,152	15,616	15,125	12,971	13,228
	Import	9,286	10,372	10,244	10,799	10,283
AT	Export	1,480	1,520	1,623	1,581	1,758
	Import	1,142	1,637	1,855	2,116	1,863
HU	Export	6,041	6,259	6,389	5,433	6,080
	Import	141	129	193	225	285
HR	Export	237	685	479	275	
	Import	171	25	54	94	
RS	Export	902	2,050	2,328	2,159	2,691
	Import	50	39	47	77	68
BG	Export	2,491	2,793	3,437	3,282	3,610
	Import	No relevance. Shares > 1%				

[100] FAOStat (2014a)

RO	Export	3,329	4,589	5,323	4,665	5,316
	Import	1,156	1,502	1,246	1,127	695
MD	Export	238	522	358	262	121
	Import	No relevance. Shares > 1%				
UA	Export	16,668	26,160	14,239	14,825	27,798
	Import	No relevance. Shares > 1%				

Table 18: Cereals trade flows in Danube countries[101]

5.5.2. Wheat

Wheat is a cereals grain which is classified according to the growing season in winter wheat and spring wheat. Moreover, there are numerous wheat species which have different intensities of use and cultivation. The most spread wheat types are hard wheat “durum” and common wheat.[102]

The total wheat production across all Danube countries accounted for 57 mil tons in 2012, which is the lowest volume since 2008 (e.g. in 2011 67 mil tons of wheat were produced). Germany is by far the largest wheat producer with approx. 25 mil tons per year, followed by Ukraine which has large output fluctuations from year to year. Romania, Hungary and Bulgaria produce between 4 mil and 7 mil tons year. Austria and Slovakia have comparable production volumes while Croatia and Moldova harvest the smallest wheat volumes in the region.

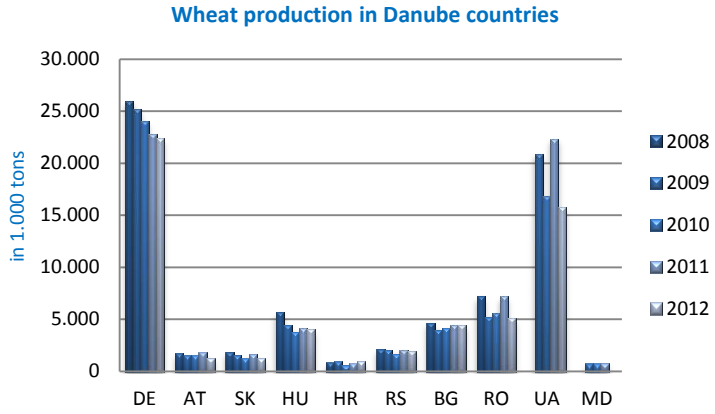


Figure 41: Wheat production in Danube countries 2008-2012[103]

5.5.2.1. Market overview

As assumed, the largest export volumes are realized in Germany and Ukraine. Germany’s wheat exports reached their maximum in 2009 when more than 10 mil tons were exported. However, exports from Germany are concentrated on Western Europe respectively the Netherlands, from where further transports to importing countries are realized.

Ukraine‘s exports vary heavily and achieved the largest volume in 2009 with over 12 mil tons. Romania, Bulgaria and Hungary exports comparable volumes of wheat which accounted for approx. 2.5 mil tons in 2012.

[101] UN Data (2014b),Own calculation State statistics of Ukraine (2012a), p. 159, RZS-Statistical Office of the Republic of Serbia (2014a)
[102] Wikipedia (2014c)
[103] Eurostat, RZS-Statistical Office of the Republic of Serbia (2014a), State statistics of Ukraine (2012a),p. 243, National Statistics Office of the Republic of Moldova (2014)

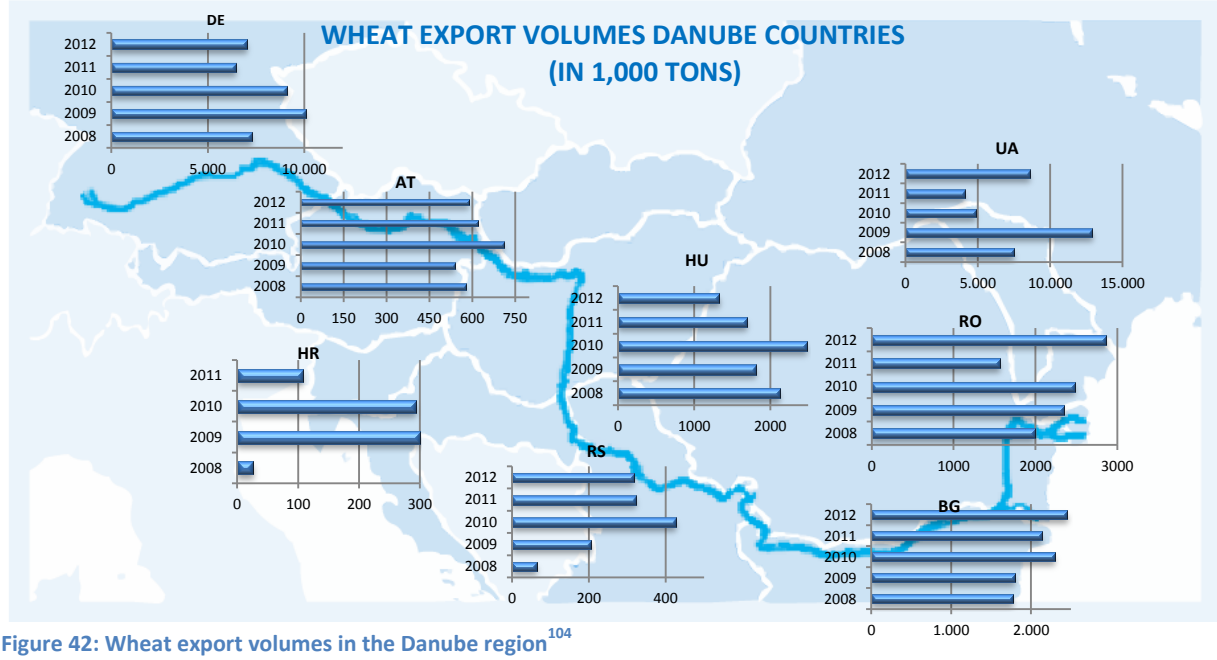


Figure 42: Wheat export volumes in the Danube region[104]

In comparison to other Danube countries, Austria's wheat trade of balance shows that in Austria imports and exports nearly equal each other. From the total wheat **exports** in 2012 which accounted for 580,000 tons, 25% in total were exported to Danube countries. Here, the most important export partner was Germany with 92,000 tons.

The Austrian wheat **imports** in 2012 amounted 512,000 tons. Danube countries play a more important role as procurement markets namely, 75% resp. 390,000 tons of the imported wheat originates from one of the Danube countries. Hungary and Slovakia were the predominant trade partners with nearly 300,000 tons in 2012. Austria is the only Danube country which imports mentionable wheat quantities from Germany namely in average 81,000 tons per year.[105]

Imports from Croatia, Bulgaria, Romania and Serbia increased in large extent in 2012 which could be interpreted as an Austrian expansion of procurement markets in SEE.[106]

Serbia's target export countries are for 50% beyond European borders namely on the African and Asian continent, while in Danube region Romania is by far the most important trade partner with over 1 mil tons of exported wheat per year.[107]

5.5.2.2. Transport requirements

Wheat which is dry for shipment is more than 12 months durable. The water content of wheat should not exceed 15% due to danger of mold, fermentation and germination. Optimal condition for wheat transport and storage are 70% humidity and 20°C. Sufficient ventilation if case of higher water content should be ensured in order to prevent self-heating. Wheat transport as bulk is more common than transport in bags.

Stowage factor:

- 1.31 - 1.36 m^3/t (bulk cargo)

[104] Own chart based on UN Data (2014b), Statistics Austria (2012), RZS-Statistical Office of the Republic of Serbia (2014a)
[105] Own calculation based on Destatis-Federal Statistical Office Germany (2014)
[106] Statistics Austria (2012)
[107] RZS-Statistical Office of the Republic of Serbia (2014a)

- 1.18 - 1.34 m^3/t (bulk cargo)
- 1.34 - 1.50 m^3/t (bags)
- 1.23 - 1.70 m^3/t (bulk cargo)
- 1.42 - 1.53 m^3/t (bags) [108]

If wheat is carried as bulk cargo, the stowage factor (specific weight) is crucial for the determination of the tonnage needed. Since the stowage factor of wheat can vary considerably, depending on the quality of the grain, it is of importance to determine the precise stowage factor before booking a barge.

As food product, special attention must be paid to the condition of the load compartment, which has to be clean and dry. Residues of previous non-compatible cargo, e.g. genetically modified products, or diverse pest, e.g. grain beetles, may contaminate the load compartment. Therefore, attention must be paid to the latest three previous cargoes and the method of cleaning after the last cargo. At least wet cleaning may be required.

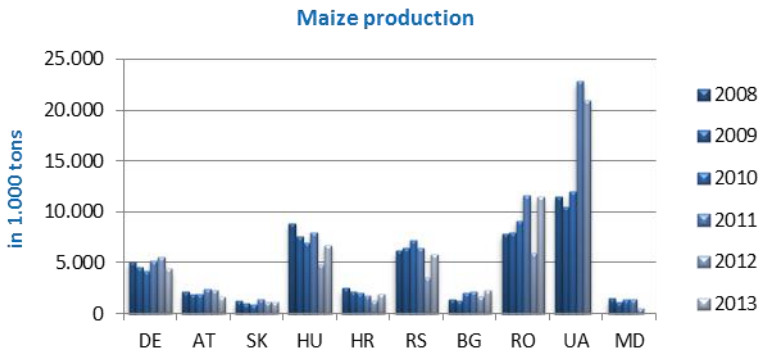
The condition and suitability of the load compartment should be checked by an inspector and confirmed on a LCI (Load Compartment Inspections) certificate immediately before the loading process starts. Also, it may happen that only barges with a steel floor are accepted, especially if bio-wheat is to be shipped.

If wheat is to be transported under GMP (Good Manufacturing Practice) regulation, all storage facilities, handling equipment as well as transport vehicles throughout the whole transport chain must be GMP certified.

5.5.3. Maize

Maize or corn, is a summer grain which is mainly grown in warmer climates. Beside the predominant use as fodder, maize has become an important energy supplier in the *biofuel industry*.[109]

5.5.3.1. Market overview



The total maize production in the Danube region accounted in average for 47 mil tons per year with the exception of 63 mil tons in 2012 which was obviously a favorable maize growing period of time.

Figure 43: Maize production in Danube countries[110]

Figure above shows that in 2011 Ukraine doubled the maize volumes from 11 mil tons to 23 mil tons and continued with this trend in 2012, while the maize production decreased in all countries from Hungary downstream. In 2013 Hungary, Serbia, Romania and Bulgaria had increased outputs again. Ukraine, Romania, Hungary and Serbia are the four largest maize producers.

[108] TIS-Transport Information Service (2014c)
[109] Anbau (2014)
[110] Own chart based on Eurostat, Statistics Austria (2012), RZS-Statistical Office of the Republic of Serbia (2014a) , Statistics RS, Statistics Moldova, State statistics of Ukraine (2012a), p. 934

From the following table it is evident that Germany is the greatest maize importer in the region with around 1.9 mil tons per year. The four biggest maize producers Hungary, Serbia, Romania and Ukraine are the largest exporters. Hungary and Serbia did not have large fluctuation however Romania and Ukraine increased their export activities steadily since 2008.

Maize trade flows (in 1,000)						
		2008	2009	2010	2011	2012
DE	Export	685	687	646	764	n.a.
	Import	1,892	1,963	1,880	1,901	n.a
AT	Export	428	445	306	341	515
	Import	203	411	608	795	613
SK	Export	201	343	259	320	n.a
	Import	208	95	200	211	n.a
HU	Export	3,371	4,176	3,910	3,643	n.a
	Import	43	36	96	101	n.a
HR	Export	209	381	179	165	n.a.
	Import	79	6	22	35	n.a.
RS	Export	551	1,602	1,662	1,630	2,118
	Import	No relevance. Shares > 1%				
BG	Export	212	572	650	938	n.a
	Import	221	110	116	87	n.a
RO	Export	694	1,686	2,054	2,310	n.a.
	Import	521	813	430	373	n.a
UA	Export	2,811	7,178	2,888	7,806	n.a
	Import	No relevance. Shares > 1%				

Table 19: Maize trade flows in Danube countries[111]

5.5.3.2. Transport requirements

Maize which is dry for shipment is more than 12 months durable. The water content of maize should not exceed 15.5% in overseas transports since humidity can lead to mold and loss of quality, especially in winter. The humidity protection should also be respected during transshipment and storage with a maximum of 75% as well as temperature with an optimum of 20°C. Higher temperatures cause mold growth and reinforce self-heating.

Stowage factor:

- 1.36 - 1.39 m^3/t[112]

If maize is carried as bulk cargo, the stowage factor is crucial for the determination of the tonnage needed.

As food product, special attention must be paid to the condition of the load compartment, which has to be clean and dry. Residues of previous non-compatible cargo, e.g. genetically modified products, or diverse pest, e.g. grain beetles, may contaminate the load compartment. Therefore, attention must be paid to the latest three previous cargoes and the method of cleaning after the last cargo. At least wet cleaning may be required.

[111] FAOStat (2014a), except values for AT; Source Statistics Austria (2012)
[112] TIS-Transport Information Service (2014d)

The condition and suitability of the load compartment should be checked by an inspector and confirmed on a LCI (Load Compartment Inspections) certificate immediately before the loading process starts. Also, it may happen that only barges with a steel floor are accepted, especially if bio-maize is to be shipped.

If maize is to be transported under GMP (Good Manufacturing Practice) regulation, all storage facilities, handling equipment as well as transport vehicles throughout the whole transport chain must be GMP certified.

5.5.4. Bioethanol

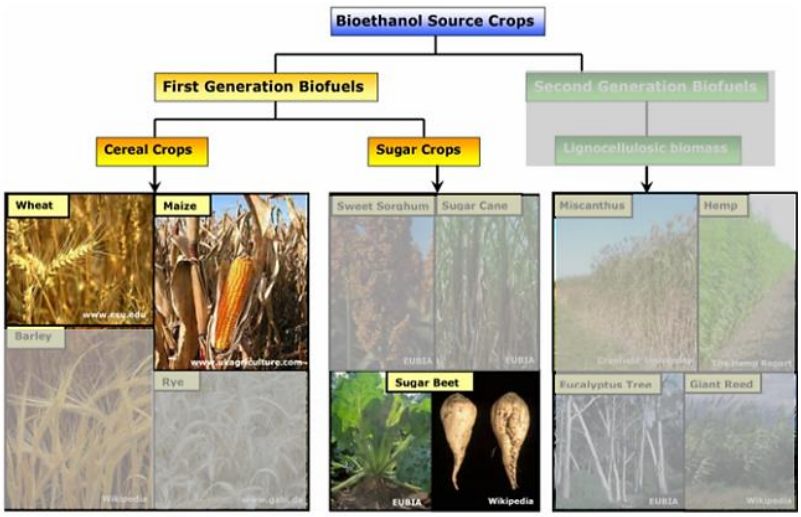


Figure 44: Bioethanol source crops[114]

Bioethanol from starch containing plants is produced through fermentation of the plant carbohydrates into alcohol. In Europe, starch plants resp. cereals such as wheat, maize and potatoes are usually used for bioethanol production. As ethanol is produced from processed crops and organic material, it is referred to as renewable ethanol.[113] Important by-products of the bioethanol production is fodder (D.D.G.S) which ensures high utilization of the raw material.

The bioethanol production process is illustrated below. After raw material is delivered, it is milled fermented and distilled. As mentioned, high in protein feedstuff is an important by-product of bioethanol production which is suitable for inland waterway transports due to its characteristics.

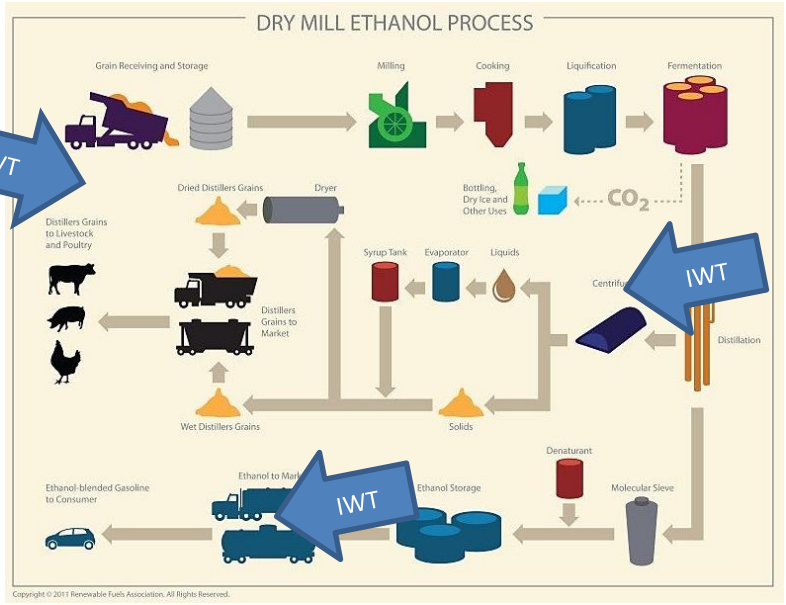


Figure 46: Bioethanol production from wheat[116]

Figure 45: Animal fodder[115]

[113] RESTMAC, p.5
[114] RESTMAC, p.5
[115] Agrana (2014c)

Besides the transportation of the by-products, IWT can also be used in the delivery of raw material. Bioethanol plants located near the Danube are examined later in the study.

Beside the use of bioethanol in the fuel sector, which accounted for 66% in the global usage, ethanol is also used the chemical and food sector.

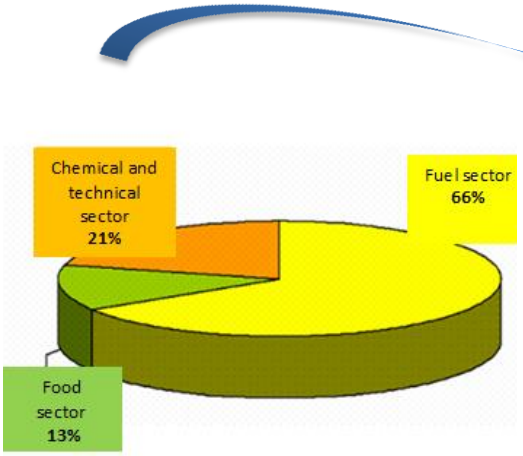


Figure 47: Global use of ethanol in sectors[117]

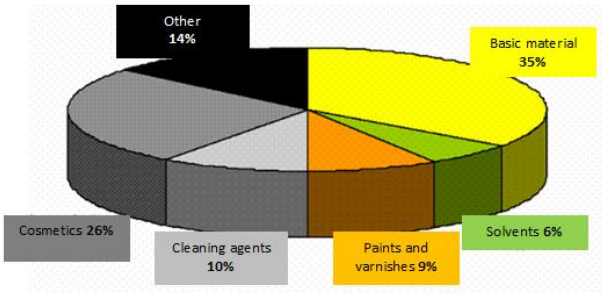


Figure 48: Ethanol use in chemical/technical sector[118]

20% of the ethanol use is allocated to the chemical and technical industry, which has a broad utilization of ethanol as stated above. Ethanol is used as an addictive for cleaning agents, paints and varnished as well as basis for solvents. The cosmetics industry also has a large share of bioethanol use. In this sector bioethanol is used as basis for perfumes and deodorants.

5.5.4.1. Market overview and bioethanol plants in the vicinity of the Danube River

Germany: See chapter Sugar beet/ Germany/Bioethanol.

The **Austrian** starch plant in Pischelsdorf additionally produces bioethanol from wheat, maize and sugar beet molasses. Currently, up to 190,000 tons of bioethanol from 620,000 tons of grain can be produced annually. Per year 190,000 tons of the grain based high- quality fodder *Actiprot* can be produced.

70km (90 minutes truck drive) from the port of Bratislava **Slovakia**, in Leopoldov, “Enviral” produces up to 120,000 m3 bioethanol and 90,000 tons D.D.G.S using approx. 300,000 tons of maize per year as raw material.

The starch plant in Szabadegyháza, **Hungary** with 50% share by the Austrian “Agrana” is also involved in bioethanol production based on maize exclusively. The production capacity accounts for 187,000 m3 per year. By-products used for feedstock are maize germ.[119] Since the plant processes

[116] RFA-Renewable Fuel Associations (2014)
[117] Adapted figure from Guide Bauer Sachs (2014)
[118] Adapted figure from Guide Bauer Sachs (2014)
[119] Agrana (2014e), p.10

maize of *Hungarian origin,* no imports of foreign resources and consequently no IWT potential can be identified for this plant.[120]

The second Hungarian bioethanol plant is located in Györ "Györ Distillery" right at the Danube River and has a production capacity of 40 mil liters per year. The plant uses cereals and maize as raw material.[121]

"Pannonia Ethanol" is also situated at the Danube River near the port, in Dunaföldvár with an annual utilization of 575,000 tons of maize with a production of 240 mil liters of ethanol and 175,000 tons of high protein fodder D.D.G.S.[122]

Croatia: There were several initiatives to start the bioethanol production in Croatia on a larger scale. The most serious one is from the company "Etanol Osijek", which planned to build the bioethanol factory in the free business zone of Osijek, which is just near the port area of Port Osijek. This project is still in the realization phase, and according to the plans, in cooperation with the Port authority Osijek and Port Osijek, the most of the bioethanol produced would be transported via IWT.

Serbia: See chapter Sugar beet/Serbia/Bioethanol

The **Bulgarian** company "Euro Ethyl", located in Silistra 20km away from the Danube port and 110km form the sea port in Varna, produces since 2004 bioethanol and bio fodder. The maximum capacity accounts 120,000 liters in 24 hours.[123]

"Chrystal chemicals" with headquarter in Velingrad, Bulgaria has biofuel, among various other products, in its portfolio.[124]

Romania: The company "Bio Fuel Energy" which was inaugurated in 2009, as the biggest bioethanol plant in South East Europe with capacities of 80,000 tons bioethanol per year. The plant uses mainly corn as raw material and besides bioethanol, D.D.G.S fodder and other by-products are marketed. It located in Zimnicea near the Danube River bank. The company promotes itself IWT as means of transport and its connection of the Port of Constanta.[125] The first neighboring port of the Port of Giurgiu, 50km (90 minutes truck drive) away.

Ukraine has no currently bioethanol production, however in 2015 in Eastern Ukraine a bioethanol and fodder plant will start operating, mainly using starch products as raw material. The plant has no favorable connection to waterways, for that reason no potential is given for IWT and trade flow.

[120] Hungara (2014)
[121] Györ Distillery (2014)
[122] Pannonia Ethanol (2014a)
[123] Euroetil (2014)
[124] Christal Chemicals (2014)
[125] Biofuelenergy (2014)

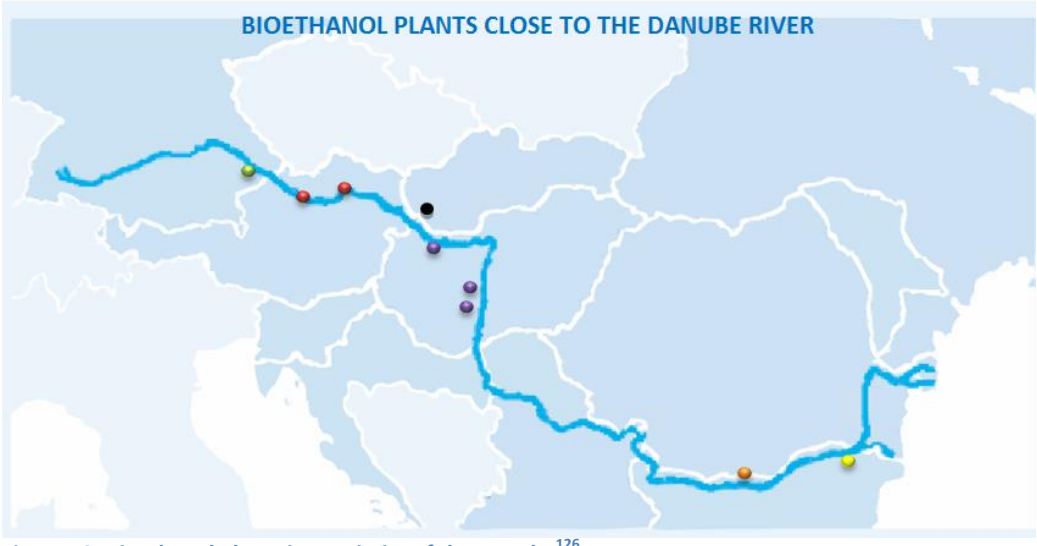


Figure 49: Bioethanol plants in proximity of the Danube[126]

5.5.5. Vegetable oils and fats (Oil seeds)

Vegetable oils and fats have a broad range in usage beside the food industry. Chemistry, bio-based synthetic materials, lubricants, pharmaceutical industry and biofuels are only some of the rages of application.[127] Raw materials for vegetable oil production can be soybean, rapeseed and sunflower but also palms, coconuts, olives, etc.[128] In this study only the first three mentioned oilseeds will be examined due to their cultivation in the Danube region.

The total production volume of oilseeds (soybean, rape and sunflower) accounted for 24 mil tons in the whole Danube region in 2012. The production volume stayed relatively stable since 2008 and 2012 which is illustrated in the table below.

Production of oil seeds in Danube region (in 1,000 tons)				
2008	**2009**	**2010**	**2011**	**2012**
23,994	24,290	24,648	26,113	24,234

Table 20: Production of oil seeds in Danube region[129]

The production process of vegetable oil is illustrated through the example of rape seed oil production. Important by-products in the oil production is cake meal which is high in protein and are suitable for adding into animal feedstuff. Based on their natural origin recommendations regarding storage are identified:

[126] Own chart
[127] Fachagentur Nachwachsende Rohstoffe (2012), p.6
[128] Wikipedia (2014d)
[129] Own calculation based on Eurostat (2014c), RZS-Statistical Office of the Republic of Serbia (2014a), National Statistics Office of the Republic of Moldova (2014)

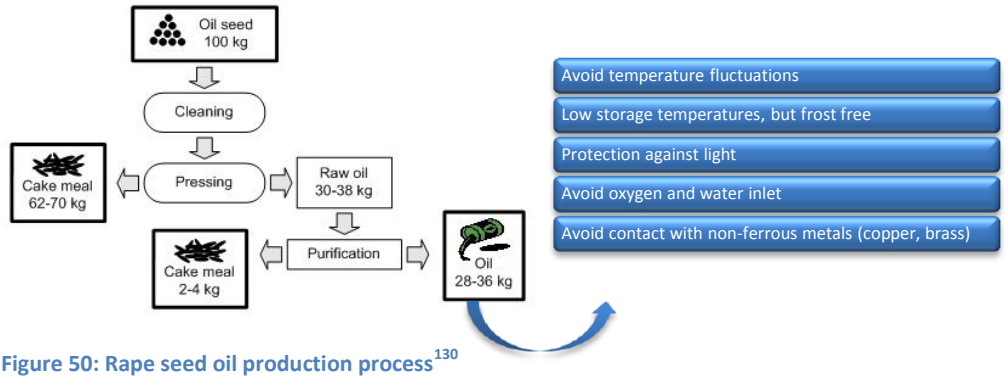


Figure 50: Rape seed oil production process[130]

5.5.6. Soybean

Soybean plants are annual plants which prefer warm and humid growing areas. Soybeans have high contents in protein (39%) and oil (17%). Consequently, soybeans are mainly used for oil production while production residues as soybean meal or soybean cake are processed to feedstuff or meat substitutes in the food industry.[131]

5.5.6.1. Market overview

The production volumes in the whole region experienced a constant growth, as the table shows. The output doubled from 2008 to 2012 and accounted lately more than 3 mil tons of soybean.

This development was mainly driven by the Ukraine's production increase from 813,000 tons to more than 1.8 mil tons 2008/2009. After a slight decrease in 2010, Ukraine again boosted production and reached the highest output in 2012 with almost 2.5 mil tons.

Production soybean in Danube region (in 1,000 tons)				
2008	**2009**	**2010**	**2011**	**2012**
1,559	2,630	2,836	3,329	3,151

Table 21: Soybean production in Danube region[132]

The second largest producer is Serbia with however, declining outputs since the record 2010 with more than 500,000 tons. Recently Serbia produced round 280,000 tons. The production volume of other Danube countries did not exceed 150,000 tons per year.

[130] INTECH (2014)
[131] Magazin Gesund (2014) Landwirtschaftskammer NÖ (2014)
[132] Own calculation based on Eurostat (2014c), RZS-Statistical Office of the Republic of Serbia (2014a), National Statistics Office of the Republic of Moldova (2014)

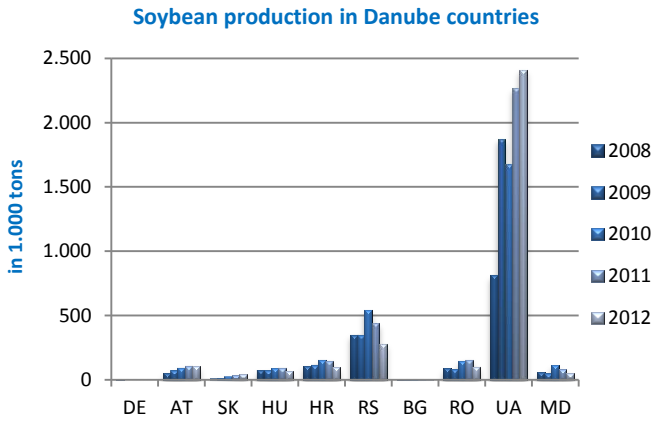


Figure 51: Soybean production in Danube countries[133]

The table below shows that Ukraine was the largest exporter of soybeans since 2008, however, from 2010 to 2011 Ukraine boosted its exports to a large extent which accounted for 1 mil tons lately. Other exporting countries are marked in green their volumes account between 50,000 and 80,000 tons per year. It can be concluded that soybean exports had increased in every Danube country in examined period of time.

Soybean imports are dominated by Germany with 3.2 mil tons in 2011, followed by Austria with round 90,000 tons in 2011 and even 100,000 tons in 2012. Austria and Moldova have recognizable imports with approx. 80,000 tons in 2011.

Soybean trade flows (in 1,000 tons) [134]						
		2008	**2009**	**2010**	**2011**	**2012***
DE	Export	46	35	39	45	
	Import	3,484	3,165	3,383	3,189	
AT	Export	32	44	39	53	
	Import	108	100	111	87	100
SK	Export	1	7	14	10	
	Import	18	7	7	12	
HU	Export	11	24	29	42	
	Import	13	14	13	26	
HR	Export	9	41	37	54	
	Import	17	0,4	31	3	
RS	Export	1	2	48	40	
	Import	2	41	41	4	
BG	Export	No relevance				
	Import	1	3	17	7	
RO	Export	38	10	36	72	
	Import	94	20	15	34	
MD	Export	20	11	35	53	
	Import	5	13	18	93	

[133] FAOStat (2014a), except fort AT: Statistics Austria (2012)
[134] FAOStat (2014a), except fort AT: Statistics Austria (2012)
*no data available except AT; Orange field underline large imports, green field large exports

UA	Export	201	263	195	1,096	
	Import	No relevance				

Table 22: Soybean trade in Danube countries[135]

5.5.6.1.1. Germany

Due to almost non existing domestic production Germany imports large volumes of this oil seeds. The total imports from the Danube countries increased from 2008 to 2011 10 times and reached their peak with 100,000 tons in 2011. Since then imports again declined and amounted in 2013 67,000 tons, which is marginal number compared to global imports of soybean to Germany. Soybean imports are dominated by overseas countries like USA with for e.g. 1.5 mil tons in 2013.[136]

Soybean imports from Danube countries DE (in tons)					
2008	**2009**	**2010**	**2011**	**2012**	**2013**
9,069	10,712	9,738	101,133	57,165	66,784

Table 23: Soybean imports from Danube countries DE[137]

Nevertheless, in the Danube region imports from Ukraine prevailed with 60% in 2013. The largest volumes were achieved in 2011 with 80,000 tons and dropped in the following year down to 30,000 tons. Imports from Austria varied from 7,000 and 21,000 tons while imports from Romania, Slovakia and Hungary stayed at a relatively low level. German exports to Danube countries were focused especially on Austria with round 3,000 tons per year and to a small extent on Slovakia with approx. 7,000 tons.

Due to the overall small and very instable trading volumes between Germany and remaining Danube countries, IWT seems not be have potential. In case Germany establishes regular trading cooperation with e.g. Ukraine and Serbia, as the two most important producers in the region, IWT should be considered as a suitable mode of transport of soybean to Germany.

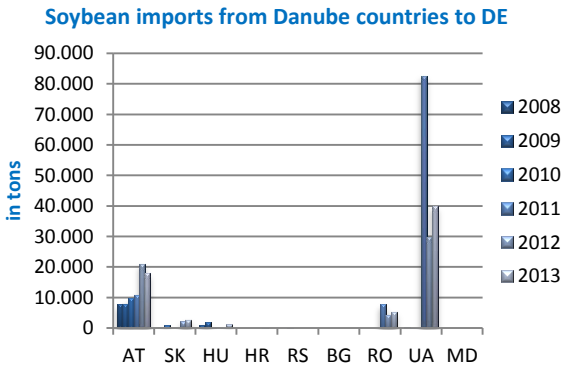


Figure 52: Soybean imports from Danube countries to DE[138]

[135] FAOStat (2014b)
[136] Destatis-Federal Statistical Office Germany (2014)
[137] Destatis-Federal Statistical Office Germany (2014)
[138] Destatis-Federal Statistical Office Germany (2014)

5.5.6.1.2. Austria

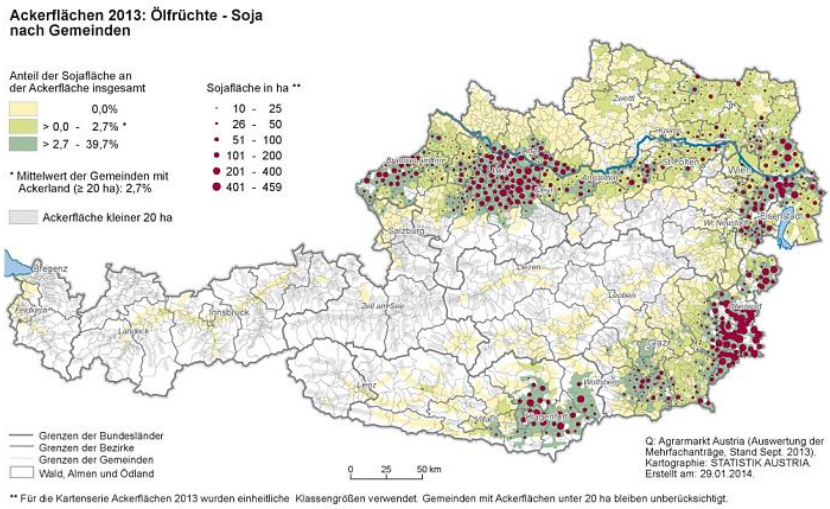
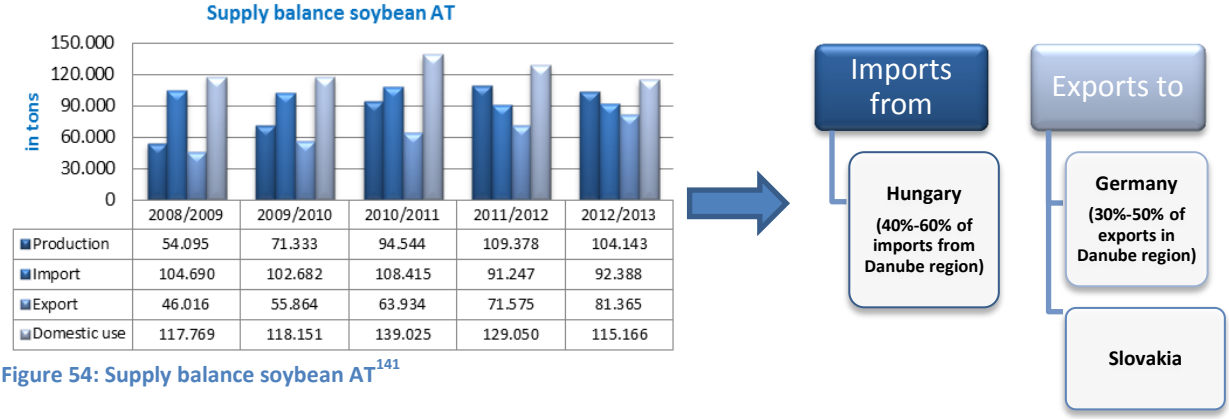


Figure 53: Soybean growing areas in AT[139]

The growing area of soybeans in Austria is located in the vicinity of the Danube River in Upper Austria in the west and in the border region with Slovakia and Hungary in the Eastern part of the country. The sown area accounted for 42,000 ha in 2012 which is an increase of 100% since 2008.

As figure below shows that Austrian soybean production cannot satisfy domestic use consequently, Austria imported in average 100,000 tons of soybean per year. Production increased since 2008 by 100%, exports also rose in the course of time while imports kept declining.

From the 100,000 tons imported soybean only from Hungarian soybean had mentionable quantities, namely 24,000 tons in 2012. Imports from Germany accounted for 8,000 tons and from Slovakia accounted for 5,000 in 2012, which is a rather low amount for recognizing IWT potential.[140]



	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013
Production	54.095	71.333	94.544	109.378	104.143
Import	104.690	102.682	108.415	91.247	92.388
Export	46.016	55.864	63.934	71.575	81.365
Domestic use	117.769	118.151	139.025	129.050	115.166

Figure 54: Supply balance soybean AT[141]

As already mentioned, Germany (and other western European countries) imports large volumes of soybean from the USA in order to satisfy domestic demand for soybean based products. Round 20 mil ha of soybean are cultivated in North and South America exclusively for European demand.

In order to counteract the dependency of American soybean, where the question of genetically manipulated soybean (GM) has always been a subject for discussion, the "**Danube Soya Initiative**" was established in Austria. It is an independent, international, non-profit, multi stakeholder association which aims at increasing GMO free soybean cultivation in the Danube region.

[139] Statistics Austria (2014b)
[140] Statistics Austria (2012)
[141] Own chart based on Statistics Austria (2014c)

According to the Austrian Chamber of Commerce, soybean production in the Danube region can be boosted up to 4 mil tons per year. The increased domestic soybean will not only lead to European soybean supply but also foster economy in the Danube region. First activities for the implementation of the project have already been realized in Serbia, Croatia, Hungary and Rumania.[142]

5.5.6.2. Transport requirements

Soybeans should be protected from moisture in order to prevent mold and activation of self-heating processes. Consequently, water content beyond 13% and humidity over 70% are critical. Soybeans require particular temperature 5-25°C and ventilation conditions also. Soybeans are generally transported as bulk cargo but occasionally also as break-bulk cargo in bags. The use of hooks should is not recommended in case of bagged cargo.

Stowage factor:

- 1.53 - 1.67 m³/t (flat bags of jute fabric)
- 1.39 - 1.48 m³/t (bags from Far East)
- 1.81 m³/t (bags from West Africa)
- 1.59 - 1.62 m³/t (bags, US gulf states)
- 1.23 - 1.28 m³/t (bulk)
- 1.35 - 1.39 m³/t (bulk, US gulf states)
- 1.33 - 1.61 m³/t (bulk) [143]

Figure 55: Soybean handling with pump[144]

If soybeans are carried as bulk cargo, the stowage factor (specific weight) is crucial for the determination of the tonnage needed. Since the stowage factor of soybeans can vary considerably, depending on the protein content of the grain, it is of importance to determine the precise stowage factor before booking a barge.

As food product, special attention must be paid to the condition of the load compartment, which has to be clean and dry. Residues of previous non-compatible cargo, e.g. genetically modified products, or diverse pest, e.g. grain beetles, may contaminate the load compartment. Therefore, attention must be paid to the latest three previous cargoes and the method of cleaning after the last cargo. At least wet cleaning may be required.

The condition and suitability of the load compartment should be checked by an inspector and confirmed on a LCI (Load Compartment Inspections) certificate immediately before the loading process starts. Also, it may happen that only barges with a steel floor are accepted, especially if bio-soybeans are to be shipped.

If soybeans are to be transported under GMP (Good Manufacturing Practice) regulation, all storage facilities, handling equipment as well as transport vehicles throughout the whole transport chain must be GMP certified.

5.5.7. Rape

In comparison to other oilseeds, rape is usually not used directly as food or fodder but has to be processed in large or small oil mills. There is no waste in the rape processing since the entire plant is used. Rape products are rape oil, rapeseed oil cake and extraction shreds. Crude rape oil is either used in the food industry (rape oil, margarine) or for biodiesel production.

[142] Donau Soja (2014)
[143] TIS-Transport Information Service (2014e)
[144] ©viadonau

5.5.7.1. Market overview

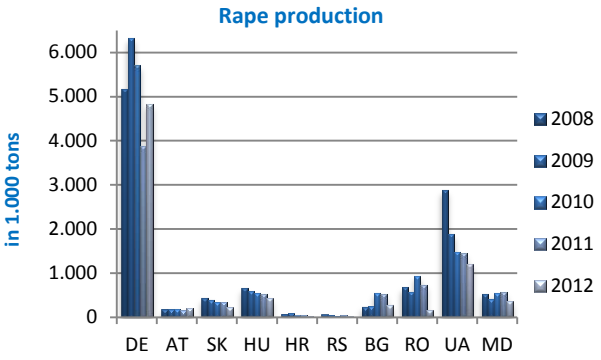


Figure 56: Rape and colza production in Danube countries[145]

Rape production has experienced a decline in every Danube riparian country since 2008. The total production accounted for 11 mil tons across all countries in 2008 while in 2012 only 7.5 mil tons of rape were harvested. The biggest rape producer is undoubtedly Germany with shares in total production between 47% in 2011 and even 63% in 2012. Ukraine, as the second important player cut the **production dramatically since 2008, from 2.9 mil to 1.2 mil tons in 2012.**

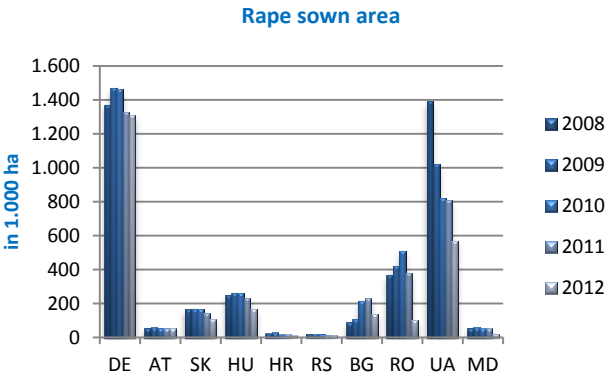


Figure 57: Rape sown area in Danube region[146]

The declining trend in rape production is also visible in the development of harvest areas in the Danube countries, especially in Ukraine where the rape areas account for 1/3 in 2012 compared to 2008. In Romania the rape areas dropped suddenly from 2011 to 2012 from 377,000 ha to 99,000 ha. In Austria production volume as well as harvest areas stayed stable in the observed period.

5.5.7.1.1. Germany

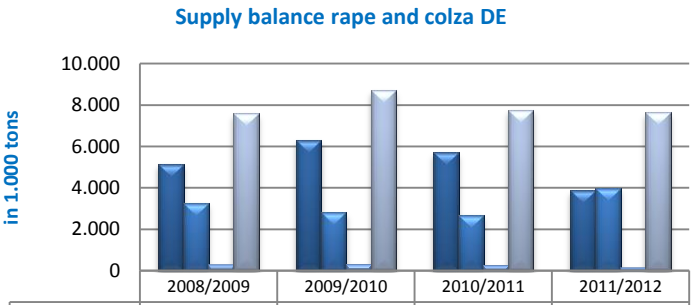
Despite of its leading rape production volumes in the Danube region, Germany cannot cover all domestic use by own production. Therefore, Germany imports large amounts of rape and rapeseed. From the overall rape imports, e.g. in 2012 which amounted 4 mil tons Germany imported 500,000 tons from countries of the Danube region. Here Hungary is the most important trade partner. 40% - 60% of the imports from Danube countries are allocated to Hungary.

Rapeseed and colza imports from Danube countries DE (in 1,000 tons)					
2008	**2009**	**2010**	**2011**	**2012**	**2013**
640	794	620	602	459	866

Table 24: Rapeseed and colza import to DE[147]

On the other side, the Austrian market is dominating target market for German rapeseed. The second important target market is Ukraine.

[145] Eurostat (2014c), RZS-Statistical Office of the Republic of Serbia (2014a), National Statistics Office of the Republic of Moldova (2014)
[146] Eurostat (2014c), RZS-Statistical Office of the Republic of Serbia (2014a), National Statistics Office of the Republic of Moldova (2014)
[147] Destatis-Federal Statistical Office Germany (2014)



	2008/2009	2009/2010	2010/2011	2011/2012
Production	5.155	6.307	5.698	3.870
Import	3.275	2.814	2.701	4.002
Export	286	306	260	158
Domestic use	7.585	8.702	7.767	7.646

Figure 58: Supply balance rape and colza in DE[148]

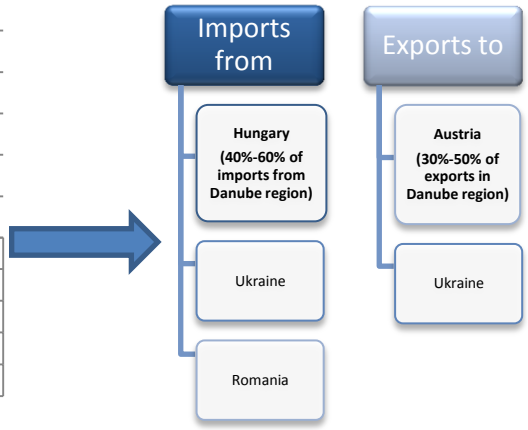


Figure 59: Trade partners rape and colza for DE[149]

5.5.7.1.2. Austria

As figure below shows, rape production areas concentrated along Austrian Danube namely in Upper Austria South of the Danube and in Lower Austria North of the Danube. Rapeseed areas are also located in the province of Burgenland in the Eastern part of the country. The sown area stayed nearly unchanged between 2008 and 2012 and accounted for approx. 55,000 ha per year.

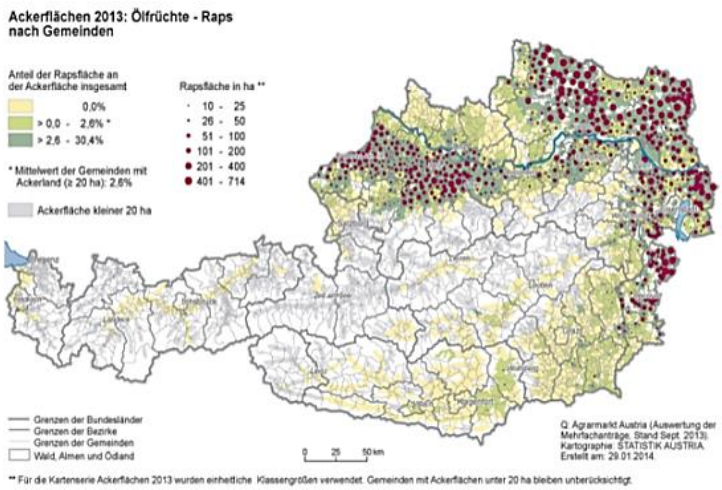


Figure 60: Rape growing areas AT[150]

The Austrian rape production experienced a steady increase from 2008 to 2012, when it reached an output of 180,000 tons. However, domestic production could not satisfy the domestic usage and resulted in large imports which amounted between 208,000 and 275,000 tons in the considered period of time. From the graphic below one can deduce that production, imports and domestic use have decreased in the season 2012/2013 after a period of increase, while exports increased slightly.

[148] BMELV (2014b)
[149] Own chart based on Destatis-Federal Statistical Office Germany (2014)
[150] Statistics Austria (2014b)

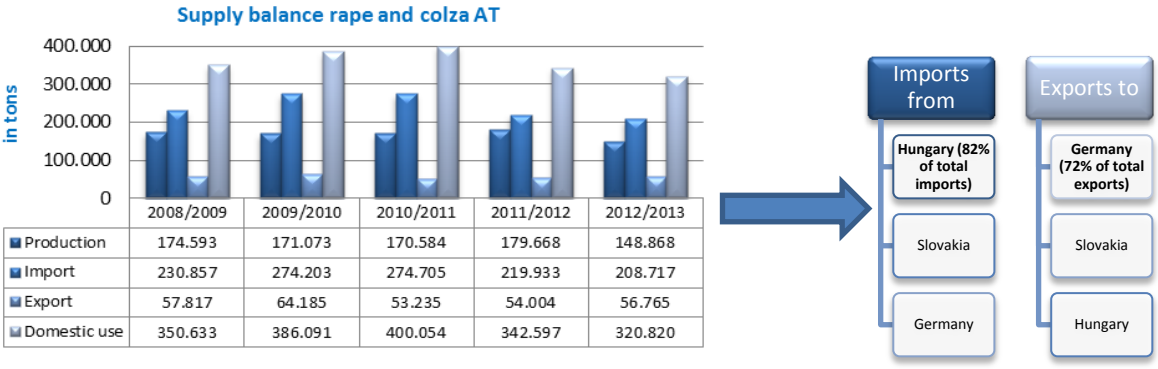


Figure 61: Supply balance rape and colza and trade partners AT [151]

From the total rape and colza imports, 82% originated from Hungary which is obviously the most important source market. On the other hand, the main target market for exports was Germany which absorbed 72% of total Austrian rapeseed exports. The third important trade partner was Slovakia.

5.5.8. Sunflower seeds

5.5.8.1. Market overview

In 2012 the ten Danube countries produced 13.5 mil tons of sunflower seeds in total, which is a 1 mil tons less than in 2011.

Production of sunflower seeds in Danube region (in 1,000 tons)				
2008	**2009**	**2010**	**2011**	**2012**
11,612	11,012	11,566	14,536	13,456

Table 25: Sunflower production Danube countries

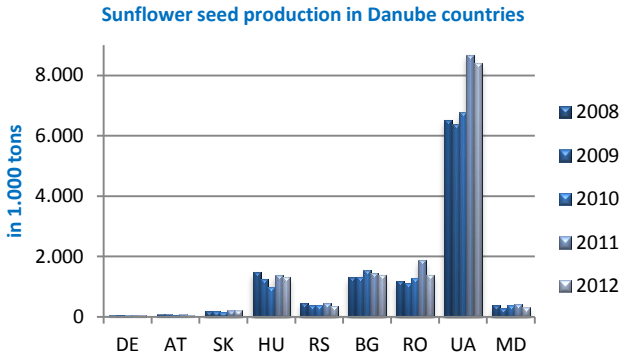


Figure 62: Sunflower production in Danube countries[152]

The biggest sunflower seeds producer in this part of Europe is Ukraine, with an output of 8.4 mil tons in 2012 which is 3 mil tons more than the total production of all other countries together in the same year (total production DE, AT, HU, SK, RS, BG, RO, MD → 5 mil tons). Ukraine's production results increased in 2011 strongly and stayed at a high level in 2012.

Strongly export oriented countries are Hungary, Bulgaria, Romania and Ukraine. Comparing the national production volumes and export quantities, it seems that Ukraine has large domestic usage due to relatively low export volumes compared to the production quantities. Bulgaria exported almost the total domestic production in 2009 and 2011 as well as Romania in 2011.

Due to almost non existing domestic sunflower seed production, Germany imported between 360,000 and 390,000 tons in the analyzed time period. Austria's imports were stable accounting for 100,000 per year while Romania increased sunflower seeds imports more than 200% since 2008.

[151] Statistics Austria (2014c), Own chart based on Statistics Austria (2012)
[152] Own chart based on Eurostat (2014c), RZS-Statistical Office of the Republic of Serbia (2014a), National Statistics Office of the Republic of Moldova (2014)

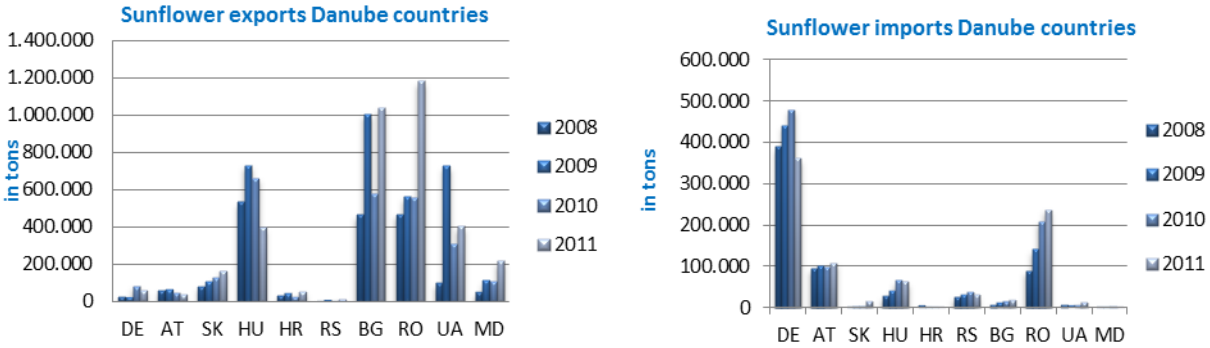


Figure 63: Sunflower trade flows in Danube countries[153]

5.5.8.1.1. Germany

Due to low domestic production and high demand, Germany is the largest importer of sunflower seeds in the region with volumes between 350,000 and 450,000 tons.

The Danube region is an important resource area for sunflower seeds, as table 23 illustrates. The total imports from Danube countries accounted for 280,000 tons in 2013 which is a stable value with the exception of 2012.

Imports of sunflower seeds from Danube region DE (in 1,000 tons)					
2008	**2009**	**2010**	**2011**	**2012**	**2013**
224	279	273	259	161	277

Table 26: Imports sunflower seeds from Danube region DE[154]

Hungary was the dominating source market from 2008 with volumes of 138,000 tons (2010/2011) and even 183,000 tons in 2009. However, in 2012 imports from Hungary dramatically decreased by 82,000 tons and amounted only 57,000 tons. In 2013 Hungary again increased its exports to Germany and they accounted lately 100,000 tons.

Bulgaria and Austria are also important trade partners for Germany with stable (Austria) and increased volumes (since 2010) going to Germany.

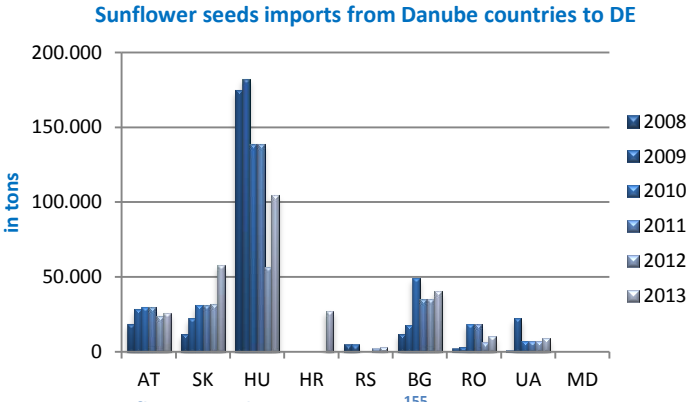


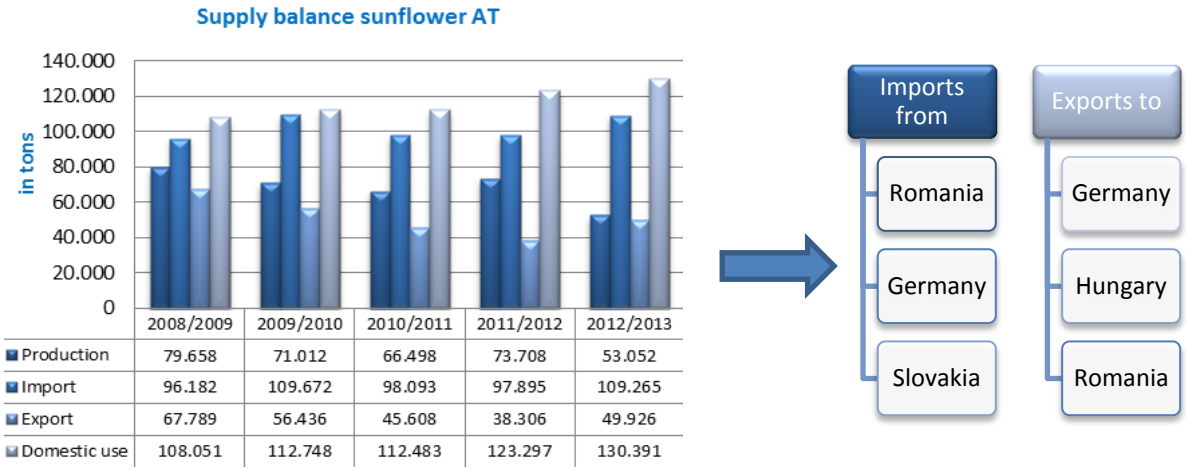
Figure 64: Sunflower seeds imports to DE[155]

[153] Own charts based on UN Data (2014b)
[154] Own calculation based on Destatis-Federal Statistical Office Germany (2014)
[155] Own chart based on Destatis-Federal Statistical Office Germany (2014)

5.5.8.1.2. Austria

Austria has been a stable sunflower seeds importer since 2008, for that reason Austrian sunflower seeds production and trade is shortly examined in the flowing text.

The sunflower seeds production in Austria reached its peak in the season 2008/2009 with 80,000 tons, followed by a decrease in the following two seasons and a slight increase in 2011/2012. Despite of the record domestic consumption of 130,000 tons in 2012/2013, the production level reached a low in the same period with only 53,000 tons. Consequently, imports increased steadily and exports reached almost the level of the country's production. The main trade partners are Romania, Germany and Slovakia as resource market, while Austria mainly exports to Germany and Hungary.[156]



	2008/2009	2009/2010	2010/2011	2011/2012	2012/2013
Production	79.658	71.012	66.498	73.708	53.052
Import	96.182	109.672	98.093	97.895	109.265
Export	67.789	56.436	45.608	38.306	49.926
Domestic use	108.051	112.748	112.483	123.297	130.391

Figure 65: Supply balance sunflower in AT[157]

5.5.8.1.3. Bulgaria

Bulgarian sunflower production accounted for 1.3 and 1.5 mil tons per year in the observed period, however, the strong export orientation of the country for this product deserves a quick analysis of the trade.

In 2011[158] the total exported volumes accounted for 1 mil tons of sunflower seeds which almost equaled the total domestic production of the same year and the output record since 2008. The exports to Danube countries had a share of 25% resp. 262,000 tons.

In 2013 Bulgaria's most important target markets in the Danube region were Romania with 193,000 tons, Germany with round 69,000 tons and Austria with approx. 30,000 tons. [159]

5.5.9. Biodiesel

The production of biodiesel is based on pressing out or extracting the oil out of the oil seeds and adding alcohol and a catalyzer. The by-products press cake or seed meal can be used as feed, the catalyzer as fertilizer and the glycerol can be used as an important substance in the pharmaceutical industry.[160] Biodiesel can be processed out of different oil plants in this study however, only oil plants which are grown in the Danube region will be examined namely soybean, rape and sunflower.

[156] Statistics Austria (2012)
[157] Own chart based on Statistics Austria (2014c)
[158] FAO, Due to lack of data for 2012, 2011 will be examined
[159] UN Data (2014b)
[160] WKO-Austrian Chamber of Commerce (2014c)

Calculation example:

3,000kg rape seed →

- 1,000 liters biodiesel
- 1,400 – 1,800 press cake

5.5.9.1. Market overview

Biodiesel production in 2012 accounted for 3 mil tons, which is a decrease of almost 300,000 tons since 2011, due to reduction of biodiesel outputs mainly in Germany and Austria, which also the largest producers in the Danube region.[161]

Production of biodiesel in Danube region (in 1,000 tons)				
2008	**2009**	**2010**	**2011**	**2012**
2,714	2,640	3,250	3,286	3,017

Table 27: Biodiesel production in Danube region[162]

Country	Biodiesel production 2012 (in 1,000 tons)
DE	2,492
AT	166
SK	99
HU	129
HR	35
RS	n.a.
BG	7
RO	89
UA	n.a.
MD	n.a.

Table 28: Biodiesel production in Danube region[163]

5.5.9.1.1. Germany

The annual production capacity of the 28 German biodiesel production plants accounted for 2.9 mil tons in 2013. The largest biodiesel plants are Cargill in Frankfurt am Main with 300,000, NEW Natural Energie West in Neuss with 260,000 and Verbio Diesel Schwedt with 250,000 tons.[164]

The locations of the plants are mainly concentrated on central and North-West of the country however, 6 plants are located with 90 minutes truck drive to the rivers Main, Rhine and naturally Danube.

Biodiesel companies and locations	Truck travel distance to the nearest port/site
ADM Mainz GmbH, Mainz	0min (located at the Rhine river bank)
Cargill GmbH, Frankfurt am Main	5min (Main)
MBF Mannheim Biofuel GmbH, Mannheim	(located at the Neckar river bank)
NEW Natural Energie West GmbH, Neuss	0min (located at the Rhine river bank)
Ullrich Biodiesel GmbH/IFBI, Kaufungen	90min (Nuremberg)

Table 29: Biodiesel production plants in the vicinity of Danube in DE[165]

[161] Not complete
[162] Own calculation based on Eurostat (2014c), data without RS, MD, UA,
[163] Eurostat (2014c)
[164] UFOP- Union zur Förderung von Oel- und Proteinpflanzen (2013), p.35
[165] UFOP- Union zur Förderung von Oel- und Proteinpflanzen (2013), p.35

Statistics data from 2013 shows that biodiesel exports achieved a record value of 1.6 mil tons which is an increase of almost 360,000 tons since 2012. At the same time, imports decreased and accounted in 2013 for 560,000 tons.

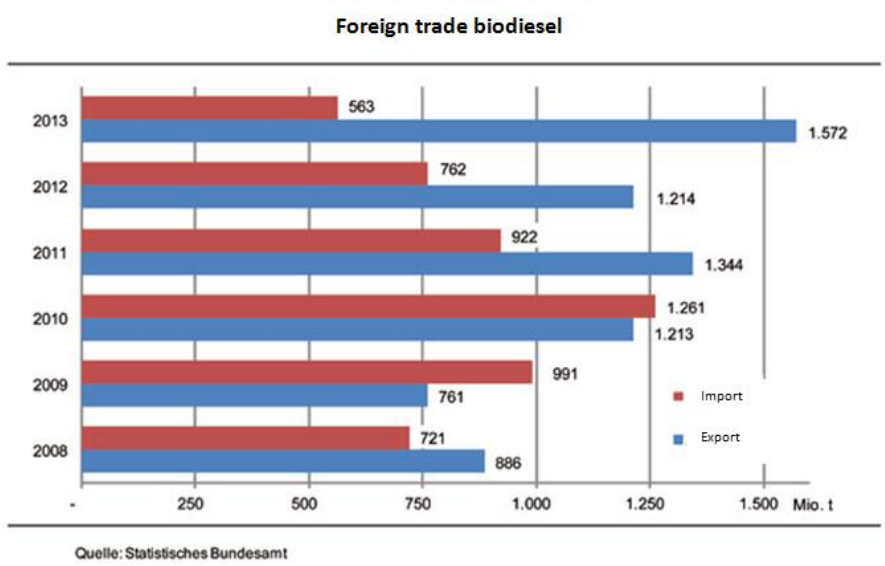


Figure 66: Biodiesel trade in DE[166]

Domestic use of biodiesel was experiencing a steady decrease since 2007. The total use of pure biodiesel and biodiesel blends accounted for 2 mil tons in 2013, while in 2007 3.2 mil tons were used. The share of pure biodiesel also in domestic use heavily declined from 1.8 mil tons in 2007 to almost non-existing 30,000 tons in 2013.

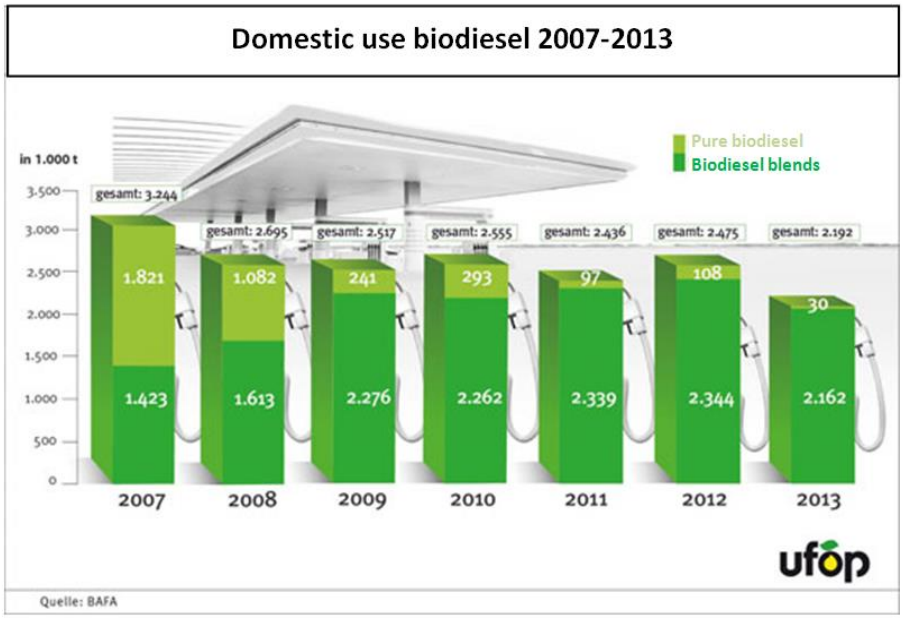


Figure 67: Domestic use biodiesel in DE[167]

[166] Adapted from UFOP-Union zur Förderung von Oel- und Proteinpflanzen (2014a)
[167] UFOP-Union zur Förderung von Oel- und Proteinpflanzen (2014b)

5.5.9.1.2. Austria

In 2012 12 biodiesel production plants with a total annual capacity of 645,000 tons operated in the **Austrian** market. The production volume of seven biodiesel producers in the same year accounted for 265,000 tons, of which 193,000 tons are allocated to domestic use and 73,000 tons were exported.

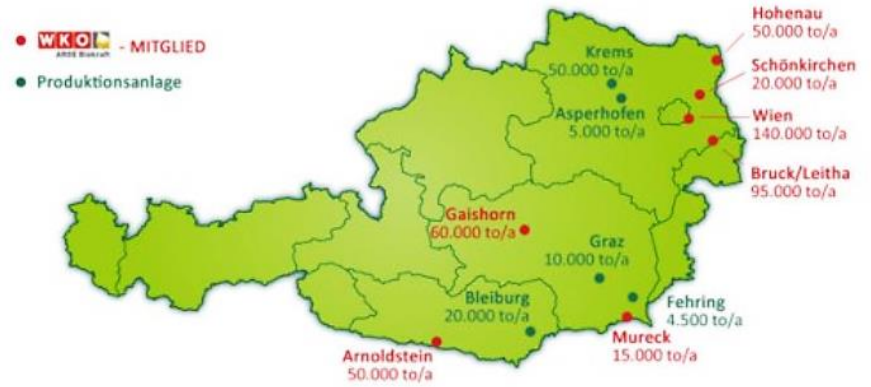


Figure 68: Biodiesel plants in AT[168]

From the 12 biodiesel plants illustrated in figure 53, 5 are located in the vicinity of the Danube, as the table below shows.

Location	Truck travel distance to the nearest port/site
Schönkirchen	45min (Vienna)
Vienna	0 min (located at river bank)
Bruck an der Leitha	45min (Vienna)
Asperhofen	45min (Krems)
Krems	0 min (located at river bank)

Table 30: Biodiesel production plants in the vicinity of Danube in AT[169]

Biodiesel production in Austria outweighs the output of bioethanol. However, production decreased since 2010 strongly by more than 100,000 tons. At the same time bioethanol kept rising.

[168] WKO-Austrian Chamber of Commerce (2014c)
[169] Own calculation based on WKO-Austrian Chamber of Commerce (2014c)

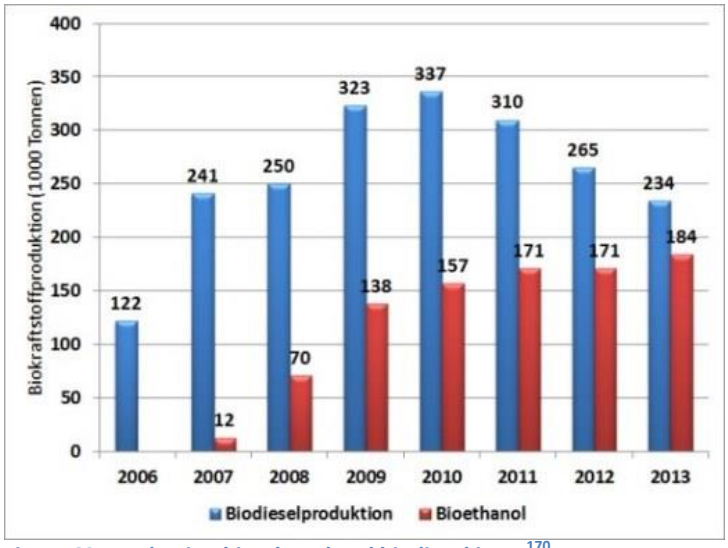
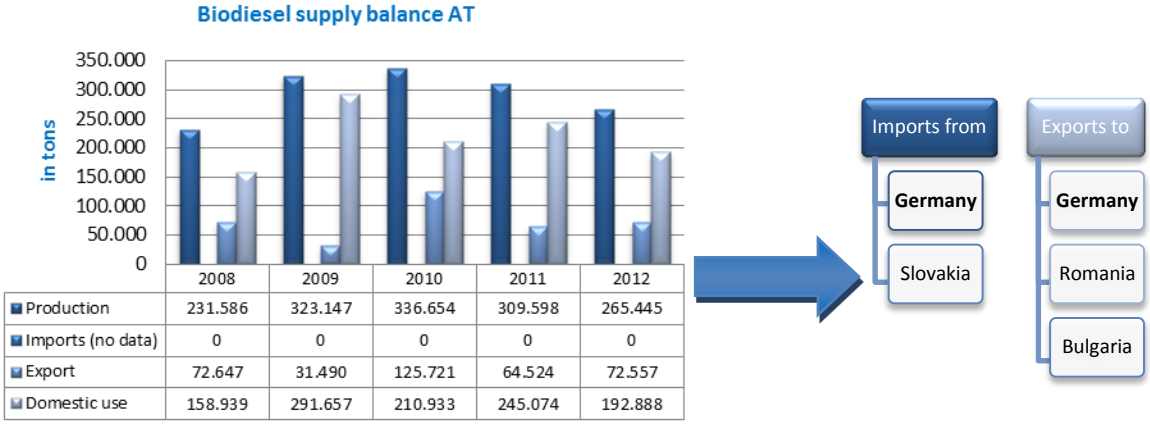


Figure 69: Production bioethanol and biodiesel in AT[170]

The Austrian production decreased from 2011 to 2012 by 14% while exports increased and domestic production declined. The main trade partner in the Danube region for export and imports activities was Germany, followed by Slovakia for imports and Romania for exports of biodiesel.



	2008	2009	2010	2011	2012
Production	231.586	323.147	336.654	309.598	265.445
Imports (no data)	0	0	0	0	0
Export	72.647	31.490	125.721	64.524	72.557
Domestic use	158.939	291.657	210.933	245.074	192.888

Figure 70: Biodiesel supply balance in AT[171]

5.5.9.1.3. Hungary

The annual production capacities of the four Hungarian biodiesel plants were almost 200,000 tons in total. Which was 70,000 tons more than the production volumes in 2012. Biodiesel production in general experienced an increase since 2008, as shown below.

Production of biodiesel in Hungary (in 1,000 tons)				
2008	2009	2010	2011	2012
122	112	126	127	129

Table 31: Biodiesel production in HU[172]

[170] WKO-Austrian Chamber of Commerce (2014d)
[171] WKO-Austrian Chamber of Commerce (2014e)
[172] Eurostat (2014c)

The largest biodiesel plant is located in the city of Komaron and is owned by the Slovak company Envien with 75% and MOL with 25%. The raw materials are sunflower and rapeseed oil as well as used fats. From the 150,000 tons, 120,000 tons were meant for sale to MOL while the remaining 30,000 tons were reserved for export. The plant is located within 30 minutes truck drive from the port of Györ. The second important plant is located in Bábolna and had a production capacity of at least 15,000 tons.

5.5.10. Sugar beet

5.5.10.1. Market overview

Sugar beet is grown in temperate climate zones and the production has experienced growth in the Danube riparian countries since 2008 by 20% amounting nearly 56 mil tons in 2012.
While in the Danube region Germany and Ukraine harvested the largest amounts of sugar beet of all considered countries with nearly 28 mil tons resp. 18 mil tons in 2012, Bulgaria hardly grows sugar beet at all.

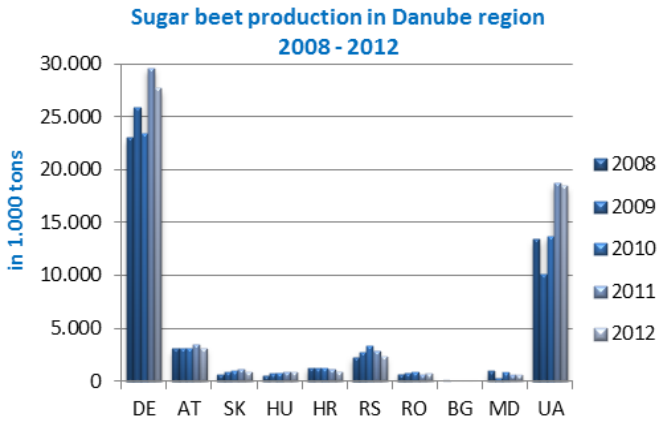


Figure 71: Sugar beet production in Danube countries[173]

Sugar beet production in Austria remained constant from 2008 to 2012 and accounted lately for 3.1 mil tons. Serbia's production experienced an increase from 2008 to 2010 reaching more than 3 mil tons output however, since then production again decreased. The growing areas of sugar beet are also identified along the Danube River or in relative proximity to it, as illustrated in the figure below with green plant symbols.

[173] Own diagram based on Eurostat (2014c), RZS-Statistical Office of the Republic of Serbia (2014a), National Statistics Office of the Republic of Moldova (2014)

Figure 72: Sugar beet growing areas in Danube region[174]

Sugar beet is mainly used for production of sugar and sugar related products. However, besides this primary use, sugar beet is also used in the chemical, pharmaceutical and cosmetics industry.[175] By-products of sugar production such as molasses and beet pulp are processed to fodder high in protein and fertilizers as well as to biofuel – bioethanol which originates from fermentation of biomass and contains at least 99% alcohol.[176]

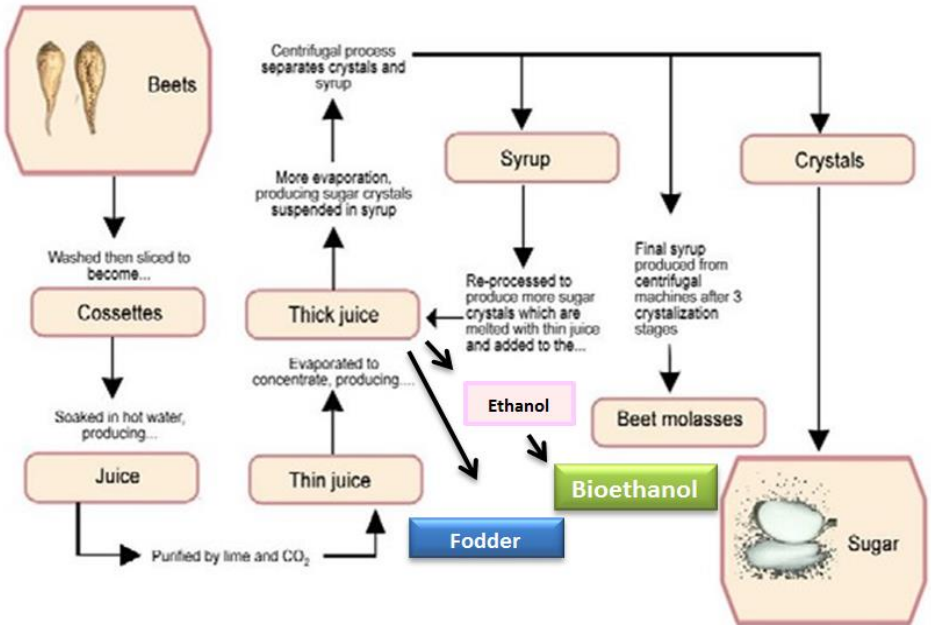


Figure 73: Bioethanol and fodder production from sugar beet[177]

[174] viadonau (2013a), p. 139
[175] Fachagentur Nachwachsende Rohstoffe (2012)p.16
[176] Agrana (2014c)
[177] Adapted figure from Statistics Canada (2014)

Sugar beet has a greater output in bioethanol as well as in fodder compared to other agricultural products which are used for biofuel production in larger extents such as corn, wheat or sugar cane. As showed in the chart, sugar beet yield per ha results in biofuel for over 80,000km while biofuel from wheat allows only 35,000km travel distance. For that reason, sugar beet should be considered as a product with high potential when considering attempts in lowering CO2 emission and reducing consumption of fossil fuels. In order to achieve the target of 10% of RES in **transport energy** by 2020 according to the EU Directive mentioned above member states are obliged to ensure a share of 5.75% biofuels to convenient fossil fuel.
Having in mind that fodder and bioethanol are by-products, it appears clear that sugar and bioethanol production should be located at one spot in order to achieve synergies and prevent additional transportation costs of material. For that reason production sites and their transport connection will be examined in the course of this study.

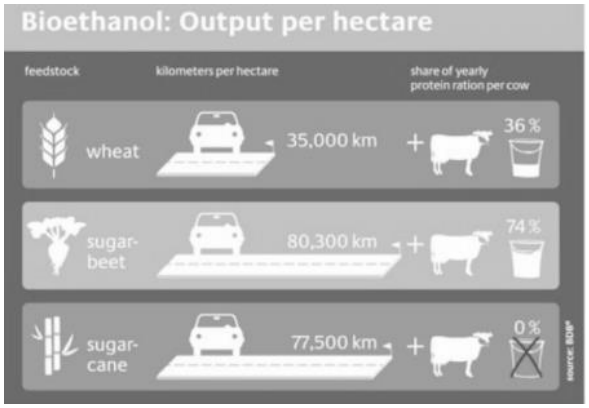


Figure 74: Bioethanol out per ha[178]

5.5.10.1.1. Germany

As stated above, Germany is by far the largest producer of sugar beet in the Danube region with 28 mil tons in 2012. Despite the leading position in production, Germany cannot cover its own needs for that reason Germany imported from 2008 – 2012 between 250,000 and 300,000 tons sugar beet per year.[179]

One of the most important areas under crops in South Germany is located along the Danube River (and Main). Sugar beet processing in South Germany is regulated by "Südzucker AG" with nine sugar production sites and eight incorporated feedstuff productions, while there are 20 sugar factories in Germany in total[180]. Looking at the sugar beet processing sites in Germany, it is clear that there are five plants which can be reached within 90 minutes truck travel time from the next port. Regarding that the Danube is not a standalone system, but a transnational corridor connected to other waterways, in this table rivers Main and Neckar which are directly or indirectly linked to the Danube are taken into account.

Figure 75: SÜDZUCKER plants in DE[181]

Sugar plants in Germany	Truck travel time to the nearest port/site
Plattling	20min (Deggendorf)
Offenau	30min (Heilbronn, Neckar)
Ochsenfurt	10min (Ochsenfurt - Main)
Offstein	20min (Worms, Rhine)

Table 32: SÜDZUCKER plants in vicinity of a river in DE

[178] Pannonia Ethanol (2014b)
[179] FAOStat (2014a)
[180] Verein der Zuckerindustrie (2014a)
[181] Adapted from Verein der Zuckerindustrie (2014b)

One of the largest sugar plants in Germany is situated in the small city of Plattling located 12km from the Danube River and the port of Deggendorf. It processes between 1 and 2 mil tons sugar beet and fabricates 160,000 to 320,000 tons of sugar per year. The plant is one of the largest producers in Germany and obtains sugar beet from over 3,000 farmers in the region.

"Südzucker AG" is not only operating in Germany has a very broad network in Europe. In the Danube region "Südzucker AG" operates in Austria, Slovakia, Hungary, Romania and Moldova either through subsidiaries or shares in eight beet sugar plants or raw sugar refineries.

Sugar beet is traditionally a question of increased regional than international supply for that reason, trade relations of the finished product "sugar" will be examined briefly.

Germany has a balanced ratio between the *sugar exports and imports* since 2009. Annually Germany exports and imports approx. 2 mil tons of sugar in total, while in average 170,000 tons are exported to all Danube countries. **Austria imports 70%** (115,000 tons) of the sugar imports of all Danube countries which makes Austria the number one sugar buyer from Germany in the respective region. Hungary is the second important target market with 20,000 tons per year in average. German sugar imports from Danube countries are concentrated on **Austria, Hungary and Slovakia** with 80% of the total German sugar imports from Danube countries.[182]

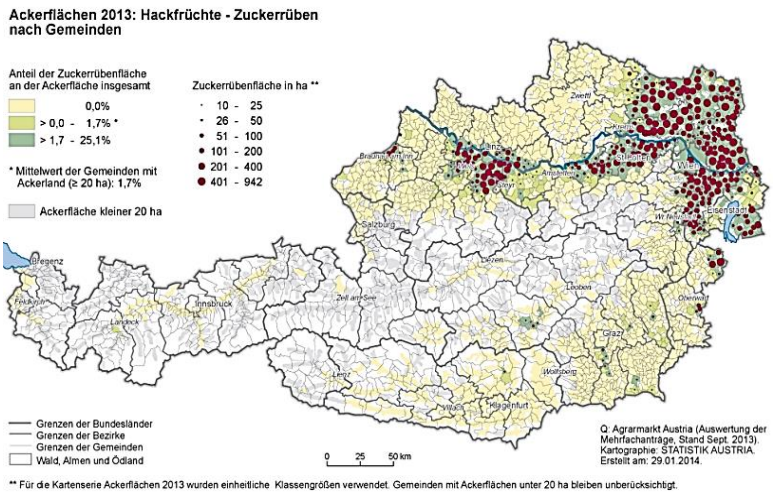
Bioethanol

One of the largest bioethanol plants in Europe is run by "Südzucker" in the city of Zeitz together with the sugar processing plant.[183] The plant has a production capacity of 360,000 m3 biofuel per year and can process molasses from 1 mil tons sugar beet annually.[184] The total bioethanol production in Germany from 2008 to 2012 amounted between 460 and 613 mil tons annually while 1/3 of the used raw material was sugar beet.[185]

Few kilometers upstream on the Danube River bank from the plant Plattling in Straubing one of the nine bioethanol production sites in Germany is located. The plant produced 1,000 tons bioethanol per year and is the biggest bioethanol demonstration plant in Germany.[186] Due to presence of several bio-based companies which operate not only with sugar beet but also with wood, starch and rapeseed oil in the vicinity of Straubing, the port of Straubing-Sand has doubled the share of RES in handled cargo since 2008 and amounted in 2012 75% of total handled cargo.[187]

[182] Destatis-Federal Statistical Office Germany (2014)
[183] Südzucker (2014)
[184] Crop Energies (2014)
[185] VDB (2014), p.1
[186] BDBe (2014)
[187] Löffert (2014)

5.5.10.1.2. Austria



The sugar beet production in Austria accounted for 3.1 mil tons in 2012 on a growing area of 49,300 ha, which has risen from 2008 to 2012 by approx. 1,500 ha per year. Sugar beet growing area makes in the Eastern part of Austria up to 25% of the total arable land, marked as dark green in the illustration to the left. Sugar beet growing areas are particularly concentrated nearby the Danube in Lower Austria, Upper Austria and Burgenland.

Figure 76: Sugar beet growing areas in AT[188]

There are two sugar production plants in Austria and namely in Leopoldsdorf and Tulln, both operated by “AGRANA Zucker GmbH”, which is structurally connected to “Südzucker AG” from Germany. Taking into account the seven AGRANA sugar plants and two raw sugar refineries in Austria, Hungary, Czech Republic, Slovakia and Romania, it can be stated that the approx. 6 mil tons of sugar beet have been processed during the season 2011/2012 and about 1 mil tons of sugar has been produced.

Figure 77: Agrana sugar plant network[189]

There are four Agrana sugar plants which are in the catchment of a 90min truck travel time from the Danube resp. Sava River in Bosnia.

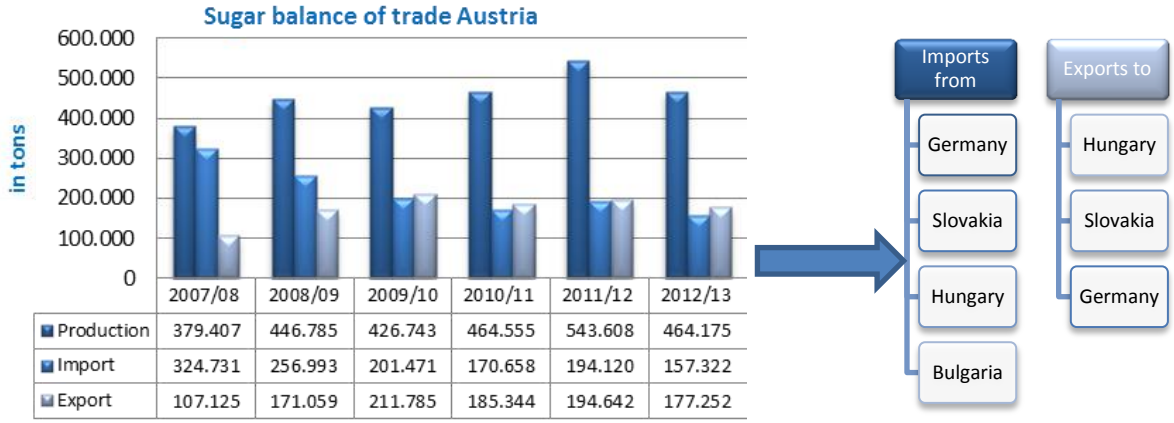
AGRANA sugar plant locations	Truck travel time to the nearest port/site
Tulln (AT)	20min (Pischelsdorf)
Leopoldsdorf (AT)	60min (Vienna)
Sered (SK)	50min (Bratislava)
Brčko (BiH)	Brčko (Sava River)

Table 33: Agrana plants in vicinity of the Danube[190]

[188] Statistics Austria (2014d)
[189] Agrana (2014g)
[190] Own calculation

As illustrated below, Austrian imports and exports of sugar have reached almost equal volumes during the observation period. At the same time, sugar imports decreased by 100% from 2007/08 to 2012/13 while exports stayed stable since 2009/10.

The main target markets in the Danube region are Hungary, Slovakia and Germany. The same countries are also the most important procurement markets including Bulgaria which has gained importance in the 2012. [191]



	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13
Production	379.407	446.785	426.743	464.555	543.608	464.175
Import	324.731	256.993	201.471	170.658	194.120	157.322
Export	107.125	171.059	211.785	185.344	194.642	177.252

Figure 78: Sugar balance of trade AT[192]

Bioethanol see chapter bioethanol

Since 2008 AGRANA is operating the only bioethanol plant in Austria. It located in Pischelsdorf, directly on the Danube and approx. 325,000 tons of renewable resources are delivered via Danube navigation per year.[193] Currently, mainly wheat and maize are used as raw material. To small extents molasses is processed too.

5.5.10.1.3. Serbia

In 2012 out of 2.5 mil ha arable land 69,000 ha were sugar beet growing areas while 95% of sugar beet production takes place in the northern province of Vojvodina, which surrounds the river Danube. In the same year 2.3 mil tons were harvested, 100,000 tons less than in 2010.[194] There are hardly any trade flows resp. exports to Danube riparian states or any other country, except Croatia.

As illustrated, *sugar beet* exports dropped dramatically in 2012 after reaching a peak in 2011 with over 430,000 tons of traded sugar beet. The reason for the decrease was that Croatia became an EU member state and could not offer attractive prices for sugar beet, as it had in the past years.[195]

[191] Statistics Austria (2012)
[192] Own chart based on Statistics Austria (2014c), (no data on domestic usage available)
[193] Kitzweger T. (2012)
[194] Chamber of Commerce Serbia (2014)
[195] Vecernji list (2013)

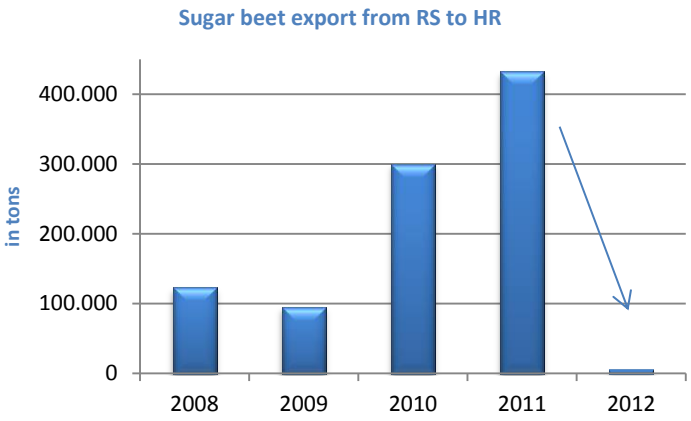


Figure 79: Sugar beet export from Serbia to Croatia[196]

Another reason for the sudden drop, or as a consequence of the EU member, Croatia's boosted sugar beet production from 2011 to 2012. In this short period of time domestic sugar beet production almost doubled. Sugar beet is grown on round 20,000 to 31,000 ha on a yearly basis and sold to one of the three big sugar beet processing companies: Viro from Virovitica, Kandit from Osijek and Sladorana from Županja. Out of these three, two are situated near the waterways. Kandit from Osijek is situated just few kilometers from Port Osijek and Sladorana from Županja is situated 60km from the Port Slavonski Brod. Both companies used IWT in the past, mainly in the period 2004-2006 and they were transporting through Port Vukovar. Since 2007 the IWT share of their transports was getting smaller and smaller and then completely stopped in 2011. The reason for this change is not known, but considering the quantities of sugar beet produced and the vicinity of inland waterways near the production sites, probably it would be possible to transfer at least of share of these quantities on the inland waterways.

Sugar

Serbian sugar plants had an output of 433,000 tons of sugar in the season 2010/2011 and increased it in the following season up to 492,000 tons. Serbia has become the leading sugar producer in South-East Europe due to the decrease or abandonment of sugar beet production in this part of Europe.[197]

Serbia's total exports of refined sugar and sugar beet molasses amounted in the considered time period 2008 and 2012 between 173,000 tons sugar (2012) and 282,000 tons (2010) while molasses exports accounted for 60,000 tons (2011) and even 120,000 in 2010. Trade flow with the riparian states, as stated in the figure, is recognizable with Hungary for refined sugar as well as for molasses. Romania's imports are focused on sugar, while sugar and molasses almost equal for the Bulgarian market.

[196] RZS-Statistical Office of the Republic of Serbia (2014a)
[197] FAO (2013a, p.27

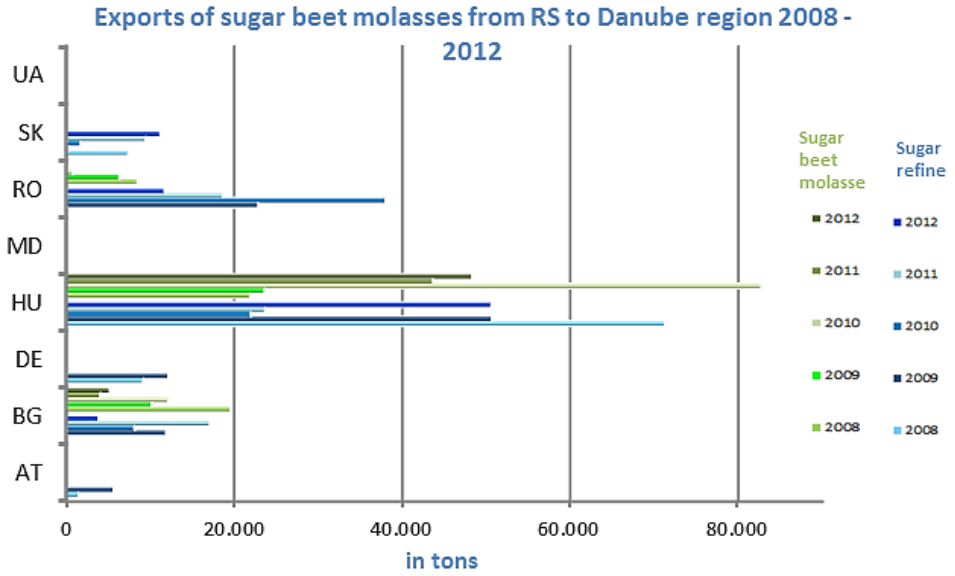


Figure 80: Exports sugar and molasses to Danube countries from Serbia[198]

According to the Food and Agricultural Organization - FAO there are 6 sugar production plants (and several previously state owned plants which are in the privatization or restructuring process). All of them are located in the Province of Vojvodina, in the growing area of sugar beet.

Sugar plants in Serbia	Truck travel time to the nearest port
Vrbas	80min (Novi Sad)
Pecinci	45min (Belgrade)
Kovacica	50min (Pancevo)
Crvenka	70min (Apatin)
Zabalj	40min (Novi Sad)

Table 34: Sugar plants in RS in the vicinity of the Danube[199]

As stated above, Serbia exports sugar beet molasses and refined sugar predominantly to Hungary. The molasses export volumes varied from 2008 to 2012 between 20,000 and 80,000 tons, while sugar exports amounted between 20,000 and 70,000 tons, in dependence to production volumes resp. the agricultural season. Despite of the geographical proximity to Hungary, IWT should be considered as an alternative to truck or train especially in seasons with large production volumes. Exports to Romania should also be taken into account for IWT of the product group.

Bioethanol

Serbian sugar factories are currently not engaged in biofuel production. However, there are seven plants (distilleries) which produce 96% vol. ethanol, based on molasses and cereals, aimed for alcoholic drinks, medical and pharmaceutical purposes. The total production capacity of the plants is 23,000 tons per year. In 2011 Serbian bioethanol production was 9 mil liters, which equals 30% of the

[198] Own chart based on RZS-Statistical Office of the Republic of Serbia (2014a
[199] Own calculation

actual production capacity and indicates a rather low utilization. 2007 bioethanol output accounted for 19 mil liters achieved its maximum in the observed period.[200]

The seven plants are located within a 90 minutes truck drive to a Danube port, which is an asset for potential future developments in the bioethanol industry. Currently, large investments are needed for modernization and upgrade of sugar and bioethanol plants and the obligatory admixture of biofuel is not a priority for the Serbian government. Consequently, it seems that the domestic use of molasses for bioethanol will not play an important role in future, despite of the availability of raw materials such as sugar beet, wheat and maize.[201]

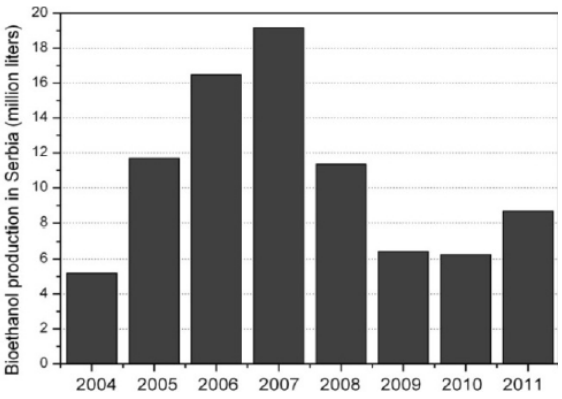


Figure 81: Bioethanol production RS 2004-2011[202]

Distillery name and location	Truck travel time to the nearest port
Alpis-SLC, Kovin	15min (Smederevo)
Vrenje, Belgrade	15min (Belgrade)
Lukas, Bajmok	70min (Bezdan)
Panon, Kadaks, Crvenka (3 plants)	70min (Apatin)
Reahem, Srbobran	50min (Novi Sad)

Figure 82: Bioethanol plants in RS, distance to Danube ports[203]

5.5.10.1.4. Ukraine

With 600,000 ha growing area, 2,000 agricultural producers and 18 mil tons sugar beet per year, the Ukraine has the second largest sugar beet production in the Danube region.[204] Sugar beet growing areas are extended between the borders with Poland in the West and Russia in the East throughout the central and northern part of the country.

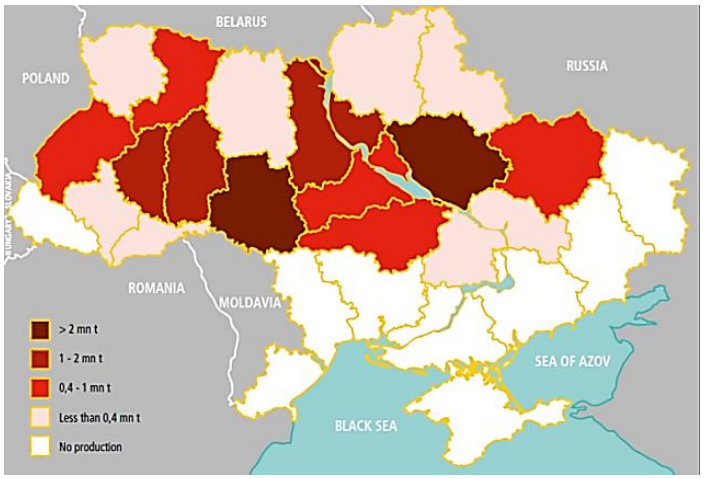


Figure 83: Sugar beet growing areas UA205

[200] Mojović L., et al. (2013), p.384
[201] FAO (2013a), p.60,61
[202] Mojović L., et al. (2013), p. 384
[203] Own calculation
[204] FAO (2013b, p.1
[205] FAO (2013b), p.10

Despite the large sugar beet production, Ukraine has no considerable trade flows with other countries. Nearly 100% of harvested sugar beet is used for sugar production and the satisfaction of the domestic market. Planted areas decreased in the last 20 years and, it is to be expected that this trend will be intensified in future, due to the lack of exports, unattractive domestic market prices for sugar, domestic oversupply and increasing fertilizer costs. Moreover, sugar production is regulated by government with minimum stated prices for sugar and sugar beet, since it is considered as a strategic food product.[206]

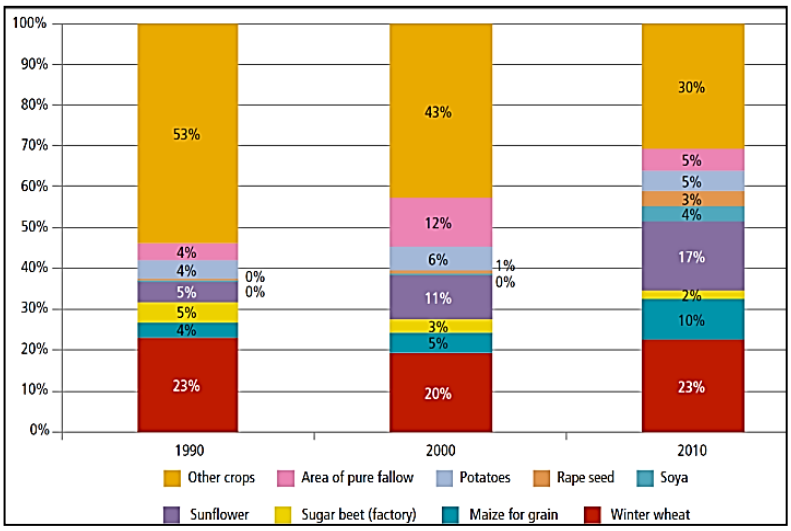


Figure 84: Shares in planted area by crop[207]

There are 150 sugar plants in the Ukraine of which 70-80 produce sugar every year from mostly locally grown sugar beet.[208] It does not surprise that all sugar plants are located in sugar beet growing areas so that short transportation ways are ensured and that waterway transport does not play an important role.

Sugar

Ukraine sugar trade is focused on GUS countries, meaning that refined sugar is mainly imported from Belarus and exported to Kyrgyzstan and Moldova.[209]

Bioethanol

Bioethanol in general, is a relatively new issue in Ukraine. Since 2014 a share of 5% is biofuel to fossil petrol is mandatory and in 2016 the share should increase and account for 7%. However, according to researches Ukraine faces, among other problems, low quality of produced bioethanol due to lack of national quality standards and testing methods. The Ukrainian government stated that domestic production and cooperation with foreign and experienced countries and companies should be fostered.[210] This determination is underpinned by the recent announcements for cooperation between Ukraine and Slovakia in terms of new technologies in bioethanol production.[211]

5.5.10.2. Transport requirements

Sugar beet is usually transported via rail and truck. Sugar beet is a quite sensitive plant which can easily be damaged during transshipment which has a decrease in quality as a consequence. If sugar beet is carried as bulk cargo, the stowage factor (specific weight) is crucial for the determination of the tonnage needed.

Besides the transport of sugar beet as a whole, sugar beet pulp is also transported as bulk cargo on the Danube on regular basis (feedstuff).

[206] USDA Foreign Agricultural Service (2013)
[207] FAO (2013b), p.2
[208] FAO (2013b), p.2
[209] FAO (2013b), p.52
[210] WKO-Austrian Chamber of Commerce (2013)
[211] Ukrainian National News (2013)

As food product, special attention must be paid to the condition of the load compartment, which has to be clean and dry. Residues of previous non-compatible cargo, e.g. genetically modified products, or diverse pest, e.g. grain beetles, may contaminate the load compartment. Therefore, attention must be paid to the latest three previous cargoes and the method of cleaning after the last cargo. At least wet cleaning may be required.

The condition and suitability of the load compartment should be checked by an inspector and confirmed on a LCI (Load Compartment Inspections) certificate immediately before the loading process starts. Also, it may happen that only barges with a steel floor are accepted, especially if bio-sugar beet is to be shipped.

If sugar beet is to be transported under GMP (Good Manufacturing Practice) regulation, all storage facilities, handling equipment as well as transport vehicles throughout the whole transport chain must be GMP certified.

As moisture sensitive cargo, sugar beet must be protected from moisture throughout the whole transport chain.

6. Vehicle components and cars

6.1. Market overview

The world car production accounted for 63 mil in 2012. 23% of the global passenger car output resp. 15 mil cars were allocated to European production, the second largest production after the BRIC countries[212] with 23 mil cars.[213] Since the year 2000 European car production has decreased from 39% to 23%, while the BRIC states increased their share more than 4 times in the same period of time, as illustrated in the figure below. Nevertheless, the automotive industry stays an important factor for the EU in the sense of economy, employment and research and development (R&D). The sector generated a turnover of 900 bil € in 2013 and employed almost 13mil people which equals 5.3% of the total EU employment. This industry is also the EU largest investor in R&D with 32 bill. € and nearly 10,000 patents per year.[214]

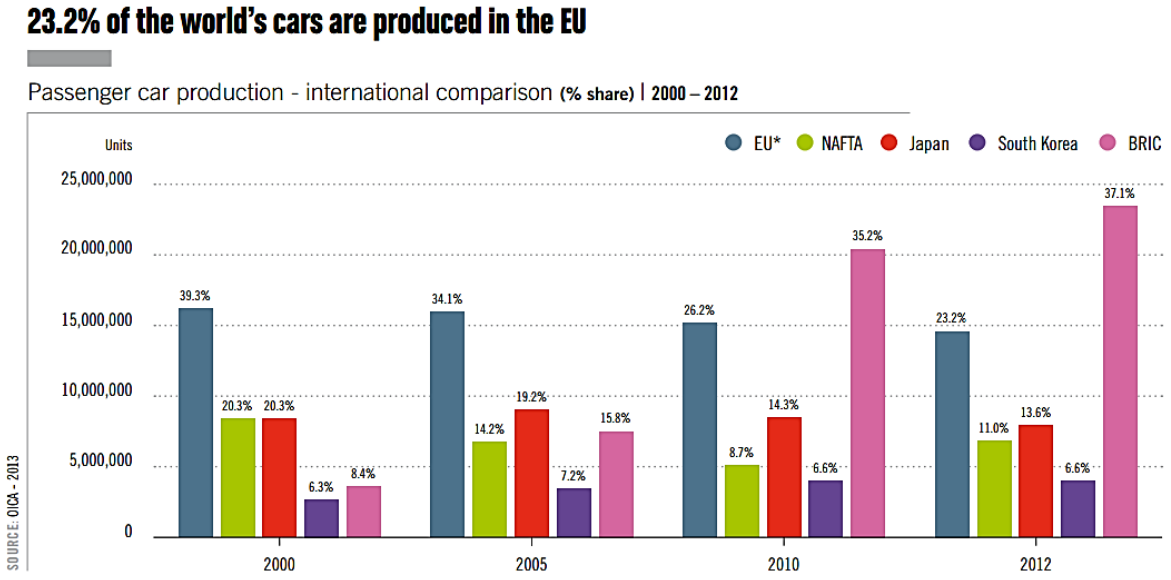


Figure 85: World car production[215]

[212] BRIC countries: Brazil, Russia, India, China,
[213] ACEA-European automobile manufacturers association (2013) p.37
[214] ACEA-European automobile manufacturers association (2013, p.21,22
[215] ACEA-European automobile manufacturers association (2013) p.37

The development of car production in the Danube region has also experienced mayor changes in the last years, not in total output but in the national production volumes. Approx. 7.8 mil motor vehicles were produced in 2008 in all ten Danube countries, while in 2013 the output accounted for about 7.6 mil. which does not represent a significant change.

However, there are countries that have increased or decreased their production to a large extent and influenced the total outcome strongly. Namely, Slovakia and Romania developed to important vehicle production countries with 1 mil resp. 400,000 vehicles per year due to the establishment of big international car producers in recent years.

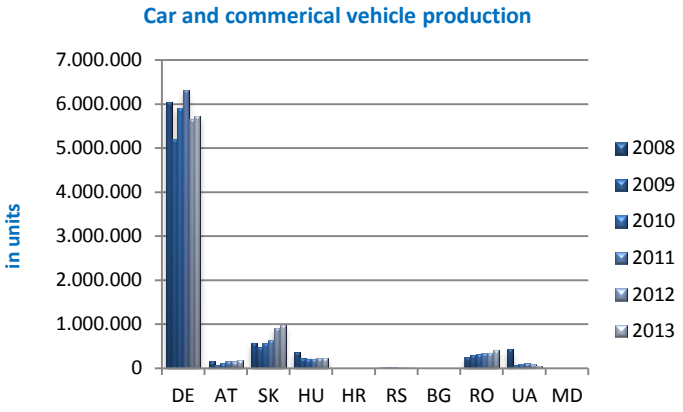


Figure 86: Motor vehicle production in Danube region[216]

After heavy production cuts in 2009, Austria and Hungary boosted the sector again with steady annual growth rates. On the other hand, Ukraine reduced the production to nearly 1/10 in 2013 compared to 2008 due to the financial crisis in 2009 and the resulting loss of income and devaluation of the local currency against the Euro and US Dollar.

Germany has a historically grown strong automotive industry in Europe and the world with stable outputs between 5 mil and 6.3 mil vehicles per year since 2008. The share of German outputs in the total production of all Danube countries accounted up to 80% which underlines Germany's dominant position in this sector.

Motor vehicle production in Danube countries

	2008		2009		2010		2011		2012		2013	
	Cars + commercial vehicles	Cars	Cars + commercial vehicles	Cars	Cars + commercial vehicles	Cars	Cars + commercial vehicles	Cars	Cars + commercial vehicles	Cars	Cars + commercial vehicles	Cars
DE	6,045,730	5,532,030	5,209,857	4,964,523	5,905,985	5,552,409	6,311,103	5,871,918	5,649,269	5,388,456	5,718,222	5,439,904
AT	151,277	125,836	72,334	56,620	107,997	86,183	152,505	130,343	142,662	123,602	171,220	148,320
SK	575,776	575,776	461,340	461,340	561,933	561,933	639,793	639,763	900,000	900,000	975,000	975,000
HU	346,055	342,359	214,534	212,773	211,461	208,571	213,531	211,218	217,840	215,440	222,400	220,000
HR												
RS	11,628	9,818	16,738	16,337	15,200	14,551	11,203	10,227	11,032	10,227	10,905	10,100
BG*												
RO	245,308	231,056	296,498	279,320	350,912	323,587	335,232	310,243	337,765	326,556	410,997	410,959
UA	423,127	400,799	69,295	65,646	83,133	75,261	104,654	97,585	76,281	69,687	50,449	45,758
MD												
Total	**7,798,901**	**7,217,674**	**6,340,596**	**5,641,353**	**7,191,621**	**6,822,495**	**7,768,021**	**7,271,297**	**7,334,849**	**7,033,968**	**7,559,193**	**7,250,041**

Table 35: Motor vehicle production Danube region[217]

[216] OICA-The International Organization of Motor Vehicle Manufacturers (2013)
[217] OICA-The International Organization of Motor Vehicle Manufacturers (2013) , partly own calculation

The vehicle production sector is highly complex concerning that the industry is globally acting and that vehicles consist of up to 12,000 single parts, which are not produced internally but purchased from numerous suppliers.

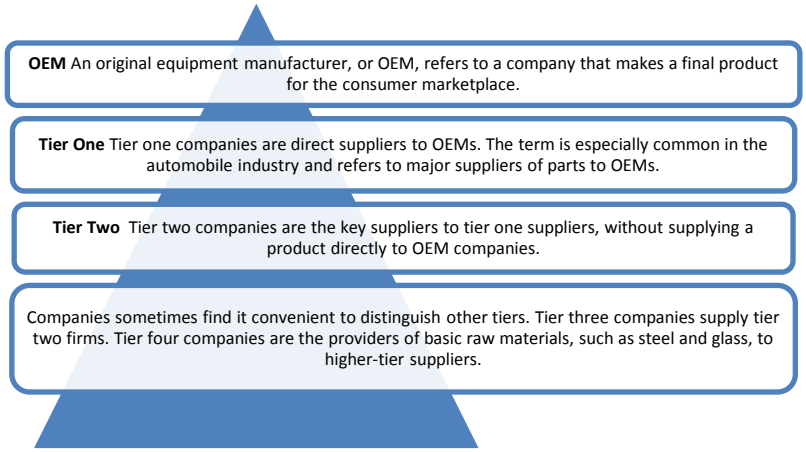


Figure 87: Supply pyramid in automotive industry

The connection between the actors is often illustrated as a pyramid with car manufacturers at the top, followed by the system and component suppliers, the suppliers of other parts as and the raw material manufacturer. Logistics, distribution, purchase financing and further areas are covered by various service companies.

Through the tight connection between the actors in automotive production and the global sphere of action of the whole industry, efficient transport of the final products resp. cars and components is essential.

6.1.1. Germany

The German vehicle industry is the largest in Europe and the fourth largest in the world with more than 750,000 employees in 2013 and an annual turnover of 360 bil € (+1% compared to 2012) in the same year. The industry is focused on car production with a share of approx. 90% of the total production while the remaining 10% are allocated to commercial vehicles.[218] Car production experienced slight fluctuations between 2008 and 2013 and accounted lately 5.7 mil car, as shown in the introduction of the this chapter.

As illustrated in the following figure, German car producers are mainly located in the states Baden-Württemberg and Bavaria in the South of the country.

* Great Wall Litex car production in Lovech, BG started in 2012. No data available

[218] BMWI-Federal Ministry for Economic Affairs (2014b)

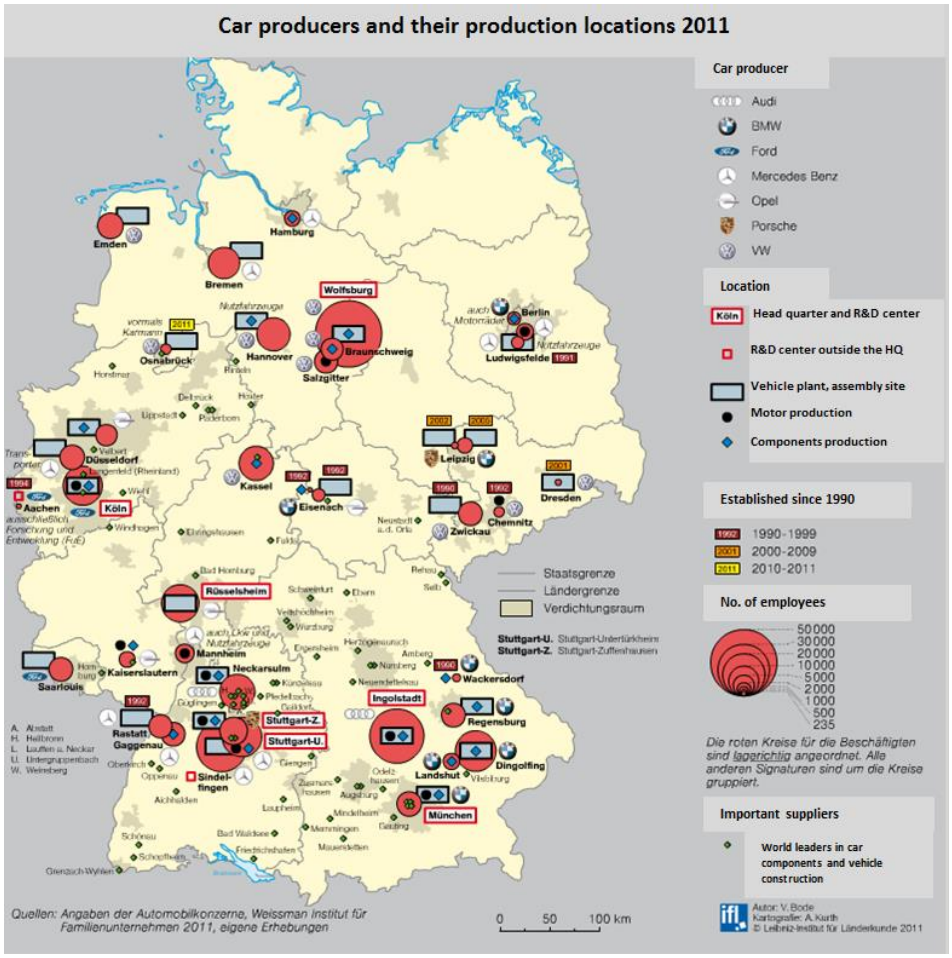


Figure 88: Car producers in DE[219]

Germany's vehicles industry is export oriented with quite stable export activities from 2008 to 2013, except the crisis-ridden year of 2009, when Germany's global exports dropped from 7 mil tons down to 5.8 mil tons. From 2011 to 2013 German car exports accounted for approx. 8 mil tons per year.

Car exports from Germany in total (in 1,000 tons)					
2008	**2009**	**2010**	**2011**	**2012**	**2013**
7,272	5,776	7,160	7,850	7,815	7,797

Table 36: Car exports from Germany in total[220]

The Danube region as a target market for German cars does not play a particularly important role and has even lost importance since 2008. In 2008 7% resp. 500,000 tons of the global car exports were intended for Danube countries, in 2013 only 360,000 (4.6%) of exported German cars had a Danube country as target market.

Car exports from Germany to Danube countries (in 1,000 tons)					
2008	**2009**	**2010**	**2011**	**2012**	**2013**
505	321	372	378	393	361

Table 37: Car exports from DE to Danube countries in total[221]

[219] Nationalatlas (2011)
[220] Destatis-Federal Statistical Office Germany (2014)
[221] Own calculation based on Destatis-Federal Statistical Office Germany (2014)

Austria is the most important trade partner in the Danube region. Since 2009 annual exports to Austria almost equaled the exports to all the remaining Danube countries in total. E.g. in 2013 190,000 tons were exported to Austria and 170,000 tons to all remaining Danube countries in total. It is obvious that the trade relations to Austria did not experience major clashes in the year of crisis 2009, as it happened in other countries. Especially exports to Hungary, Croatia, Romania and Ukraine decreased to a large extent. Although no country has achieved the values from 2008 yet, all countries seem to catch up Ukraine in particular. In Ukraine car imports from Germany increased five times in the period between 2009 and 2013. Slovakia had a declining development which might be caused by its own strong domestic car production.

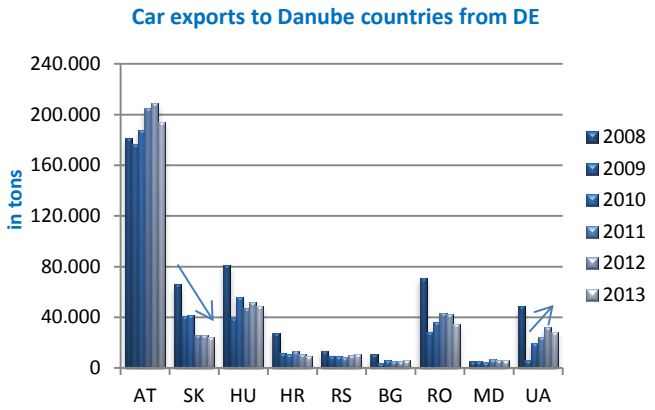


Figure 89: Car exports from DE to Danube countries[222]

Germany's global imports accounted for 3 mil tons per year and did not experience strong fluctuations from 2008 to 2013.[223] Surprisingly, Germany's car imports reached its peak in the crisis year 2009 with more than 3.1 mil tons of car imports.

Car imports to Germany in total (in tons 1,000)					
2008	**2009**	**2010**	**2011**	**2012**	**2013**
2,758	3,151	2,687	3,077	3,074	2,894

Table 38: Car imports to DE in total[224]

The Danube region is not an important source market of cars for Germany. Similar to its status as a target market. In 2013, car imports from the Danube region accounted for round 360,000 tons which was approx. 12% of Germany's total car imports.

Car imports to Germany from Danube countries (in 1,000 tons)					
2008	**2009**	**2010**	**2011**	**2012**	**2013**
240	351	303	288	339	357

Table 39: Car imports to DE from Danube countries in total[225]

Four of the nine Danube countries are worth mentioning for car imports to Germany. The trade relations with Austria showed a declining development since 2008 due to the reduction of 30,000 tons until 2013. On the other hand, imports of Slovak cars nearly tripled from 2008 to 2012 from 50,000 tons to 140,000 tons, but then slightly decreased in 2013.

[222] Own chart based on Destatis-Federal Statistical Office Germany (2014)
[223] Destatis-Federal Statistical Office Germany (2014)
[224] Destatis-Federal Statistical Office Germany (2014)
[225] Destatis-Federal Statistical Office Germany (2014)

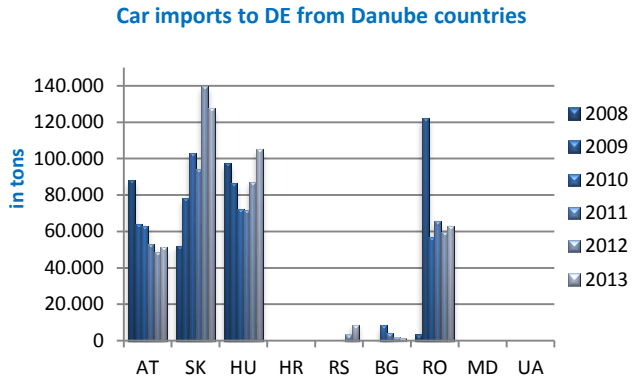


Table 40: Car imports to DE from Danube countries[226]

Car imports from Hungary varied to a large extent in the course of time, but rose since 2011 and accounted lately for approx. 100,000 tons. In 2008 Germany imported 120,000 tons of cars, however, the imports turned down to 57,000 in 2009 and stayed unchanged until 2013. Imports from Serbia and Bulgaria did not exceed 8,000 tons in the observed period, and for that reason they are not relevant at this point.

6.1.2. Slovakia

Slovak car production achieved exceptional growth rates from 2008 to 2013, almost doubling the production from 575,000 cars to 975,000 cars which makes Slovakia the second largest car producer in the Danube region.

Three large car producers namely Volkswagen, Peugeot-Citroen and Kia Motors established their production sites in Slovakia since 1992.

Volkswagen is based in Bratislava in the vicinity of the port of Bratislava, in Martin and in Kosice. The total production capacity amounts 400,000 cars per year. The assembly plant is located in Bratislava, car components are produced in Martin while in Kosice VW vehicles are prepared for the Russian market.

The Peugeot-Citroen (PSA) plant in Trnava was established in 2003. The annual production capacity accounts for 300,000 vehicles, and the company achieved sales worth almost 2 bil € in 2012. PSA Slovakia is like VW strongly export oriented (99% of the produced cars.

Kia Motors settled in 2004 in Žilina, and it is the first KIA vehicle production plant in Europe. With approx. 4 bil € sales in 2012 and a production capacity of 300,000 vehicles per year, Kia is the second largest car producer in Slovakia. 99% of the produced models Kia Sportage, Kia Venga and Kia cee´dare were foreseen for export. The KIA motor production plant is also located in Žilina in the scope of the vehicle plant.[227]

Figure 90: Car producers in SK[228]

[226] Own chart based on Destatis-Federal Statistical Office Germany (2014)
[227] Slovak Investment and Trade Development Agency, p.4
[228] Slovak Investment and Trade Development Agency, p. 5

The vast majority namely 202 of the 274 Slovak automotive supplier plants are located in the western part of the country in the vicinity of the production plants and motor highways, as figure below shows. The high-quality supply chain company does not only ensure an efficient supply of the domestic plants but also the supply of plants beyond the Slovakian country borders.[229]

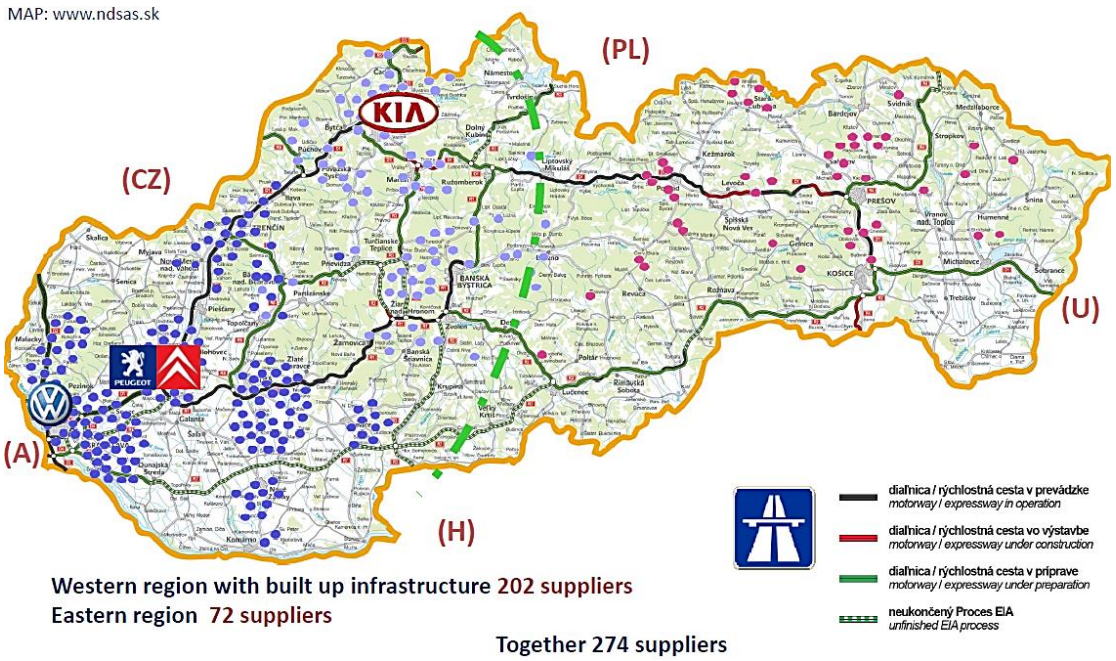


Figure 91: Automotive suppliers in SK[230]

In 2012 Slovakia exported approx. 218,000 tons of cars to the Danube region. Germany is the most important target market with 171,000 tons resp. 80% of the total Slovak exports to this part of Europe. Austria is ranked second with 20,205 tons, followed by Hungary with 10,000 tons.

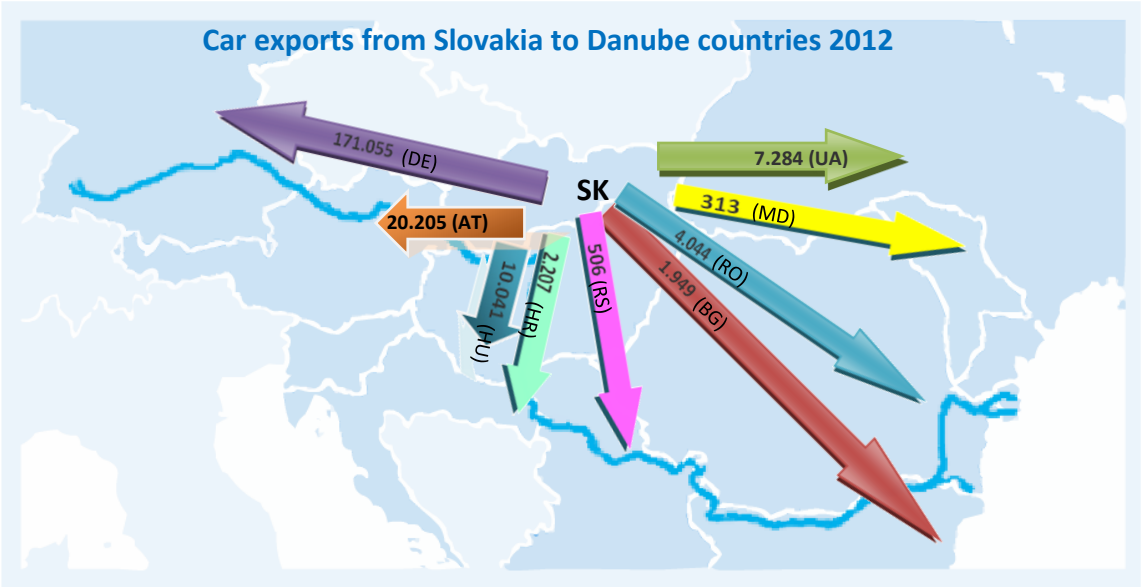


Figure 92: Car export from SK to Danube countries[231]

[229] Slovak Investment and Trade Development Agency, p.5
[230] Holecek J., p.4
[231] Comtrade database

Slovakia's imports accounted for 23,000 tons in 2013, which underlines Slovakia's strong domestic automobile industry. More than 70% of the total imports were allocated to Germany (16,767 tons), followed by Hungary with 3,200 tons and Romania with 2,000 tons.[232]

6.1.3. Romania

The automotive industry plays an important role in the Romanian economy having in mind, that approx. 10% (9 bil €) of the national GDP is allocated to automotive.

Car production experienced a steady increase since 2008 with annual growth rates of between 1% in 2009/2010 and even 22% from 2012/2013 accounting for over 410,000 produced cars in 2013.

Car production in Romania (in units)					
2008	2009	2010	2011	2012	2013
245,308	296,498	305,912	335,232	337,765	410,997

Table 41: Car production in RO[233]

Romania has the third largest production output in the Danube region, with 16 produced vehicles per 1,000 inhabitants. Nevertheless, Romania has the lowest production rate per capita in the entire European Union. Furthermore, the motorization degree with 227 cars per 1,000 inhabitants in 2011 stays far below the European average with 447 cars, although the Romanian motorization has increased since 2007.

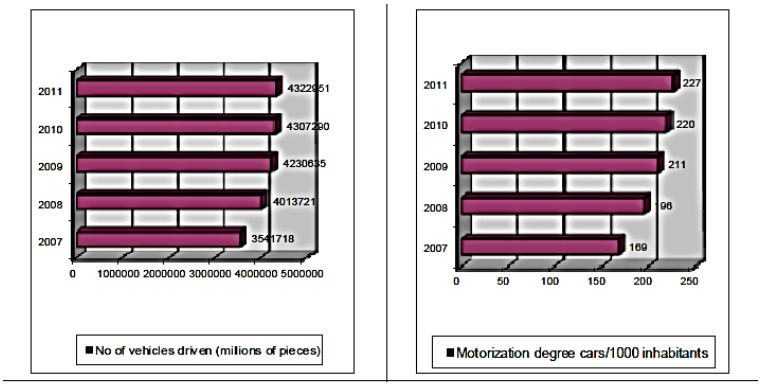


Figure 2. The evolution of the number of vehicles in use and of the monitoring degree

Figure 93: No. of vehicles and motorization in RO[234]

Romanian total car sales accounted for 52,000 in 2000 rising six times within 11 years and amounting to 343,000 in 2011. This sales increase resulted from a sharp rise in exports while domestic sales decreased since 2007 from 100,000 to 31,000 cars in 2011, as showed in the figure below.

Table 2. The evolution of the automobile sales during the period 2000-2011

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Internal sales	50133	52013	52742	57874	80013	113276	107777	102000	84708	41862	36719	30872
Export	2270	2355	4939	11292	18895	50623	79438	128000	172886	269420	312010	312361
Total sales	52403	54368	57681	69166	98908	163899	187215	230000	257594	311282	348729	343233

Source: adapted from http://www.apia.ro/buletin-statistic/

Figure 94: Automobile sales in RO internal vs. exports[235]

[232] Comtrade database
[233] OICA-The International Organization of Motor Vehicle Manufacturers (2013)
[234] Mihai D. (2012), p.170
[235] Mihai D. (2012), p 168

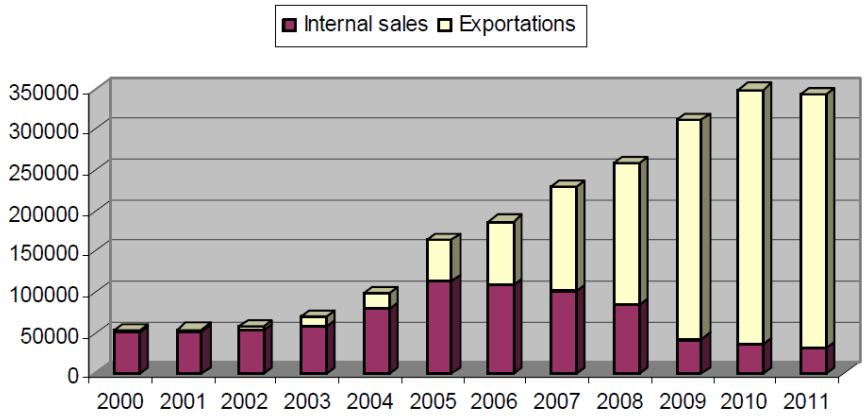


Figure 1. Automobile sales during the period 2000 – 2011

Figure 95: Car sales in RO internals vs. exports[236]

In 2011 car and components exports accounted for 18% of the total Romanian exports and a total turnover of 11 bil € (+ 8% compared to 2010) in companies involved in the automotive industry.

With 72% resp. 7.6 bil € exports of car components are predominant, while vehicle exports (Dacia Renault and Ford) achieved 3.5 bil € (28%).[237]

There are two large car producers in Romania, Ford and Renault Dacia both located in the Southern part of the country (see figure below).

Figure 96: Car producers and suppliers in RO[238]

In 1999 the French car producer Renault purchased 51% shares of the Romanian car producer **Dacia** and currently owns even nearly 100% of the capital. The capacity accounts for 350,000 cars per year,

[236] Mihai D. (2012), p 169
[237] Mihai D. (2012), p. 168
[238] Gheorghisor C. (2011), p.6

and the production site is located in Pitesti, 130km northwest of Bucharest and 220km from the nearest Danube port with a RoRo ramp (Calafat).

Dacia is export-oriented with 31,000 sold cars on the domestic market and 312,000 exported cars. France is the main market for Dacia cars with 94,000 sold cars in 2011. Regarding the sales in the Danube region, Germany is the target market no. 1 with 43,000, followed by Austria with 5,700 cars in the same year. At is should be mentioned that important other non-European countries for Dacia cars are Turkey, Morocco and Algeria[239].

In 2008 the Daewoo plant in Craiova was taken over by the **Ford** Motor Company. The annual capacity of the three Ford models B-Max and the light commercial vehicles Transit and Transit Connect accounted for 300,000 vehicles in 2011, and there are announcements that Ford Germany will relocate further production to Craiova due to difficult economic conditions in Germany. This news leads to the conclusion that the Romanian car production will increase in future and that efficient and reasonable transportation modes will be an important issue for the producer. With the takeover of the plant, Ford has also gained land in the port of Constanta[240] which offers ideal conditions for IWT.

Looking at Romanian trade flows with Danube countries, it is obvious that Germany is essential for the automotive industry. 63% resp. 48,268 tons were exported to Germany in 2012 while imports of German cars accounted for nearly 28,000 tons. Other important target markets are Ukraine and Austria. Beside Germany, Romania imports vehicles from Hungary, Austria and Slovakia.

Romanian car trade flows in Danube region (in tons)		
	Export	**Import**
DE	48,268	27,890
AT	7,637	5,106
SK	2,027	2,829
HU	3.372	7,668
HR	862	n.a.
RS	1,442	4
BG	2,900	1,501
MD	2,013	6
UA	8,502	n.a.
	77,023	**45,004**

Table 42: Exports & imports of cars RO with Danube countries[241]

6.2. Companies in the vicinity of the Danube River

In the following table, all car production plants in the Danube region have been evaluated regarding their distance to a river port on the Rhine-Main-Danube axis. There are 20 car producers within a 90 minutes truck drive from a port. In total 12 are located in Germany with the remaining plants in Slovakia, Hungary, Serbia, Bulgaria and Romania.

The car components sector is, as already mentioned, comprehensive and includes large international companies as well as local small and medium-sized companies. For that reason, it is not possible to evaluate the available number. However, motor production location were examined and listed in the following table.

[239] Dacia Group (2012)
[240] Ford (2008), p.10
[241] Comtrade database

Country	Car plant	Location	Truck travel time to the nearest port
DE	VW (Porsche)	Stuttgart-Zuffenhausen	30min (Stuttgart, Neckar)
	Daimler AG (Mercedes Benz)	Sindelfingen	30min (Stuttgart, Neckar)
	VW (Audi)	Ingolstadt	80min (Regensburg)
	General Motors Europe (Opel, Vauxhall)	Rüsselsheim	35min (Frankfurt, Main)
	BMW	Dingolfing	40min (Deggendorf)
	BMW	Regensburg	20min (Regensburg)
	General Motors Europe (Opel, Vauxhall)	Bochum	50min (Duisburg, Rhine)
	Daimler AG (Mercedes Benz)	Rastatt	30min (Karlsruhe, Main)
	VW (Audi)	Neckarsulm	65min (Mannheim, Rhine)
	BMW	Munich	90min (Deggendorf)
	Binz GmbH	Lorch	55min (Wiesbaden, Rhine)
	Ford	Cologne	20min (Cologne, Rhine)
SK	VW (VW, Porsche, Audi, Skoda, Seat)	Bratislava	20min (Bratislava)
	PSA (Peugeot, Citroen)	Trnava	60min (Bratislava)
HU	Suzuki	Esztergom	80min (Budapest)
	VW	Györ	20min Győr-Gőnyű)
	Daimler (Mercedes)	Kecskemet	60min (Dunaföldvár)
RS	Fiat	Kragujevac	90min (Smederevo)
BG	Litex Motors (Great Wall Motors)	Lovech	90min (Somovit)
RO	Ford	Craiova	90min (Calafat)
Country	**Motor production plant**	**Location**	**Truck travel time to a port**
AT	General Motors Europe (Opel, Vauxhall)	Aspern	20min (Vienna)
	BMW	Steyr	30min Enns
DE	Daimler	Affalterbach	40min (Stuttgart, Neckar)
	General Motors Europe (Opel, Vauxhall)	Kaiserslautern	60min (Mannheim)
	Daimler	Mannheim	15min (Mannheim)
	BMW	Munich	90min (Deggendorf)
	VW	Nuremberg	15min (Nuremberg)
	VW (Porsche)	Stuttgart-Zuffenhausen	30min (Stuttgart, Neckar)
HU	VW (Audi)	Györ	20min (Győr-Gőnyű)

Table 43: Car and motor plants in Danube vicinity

There are 20 (+ 1 under construction in Giurgiulesti) Roll-on Roll-off (RoRo) ports in the Danube region, which offer the suitable infrastructure for transshipment of vehicles.

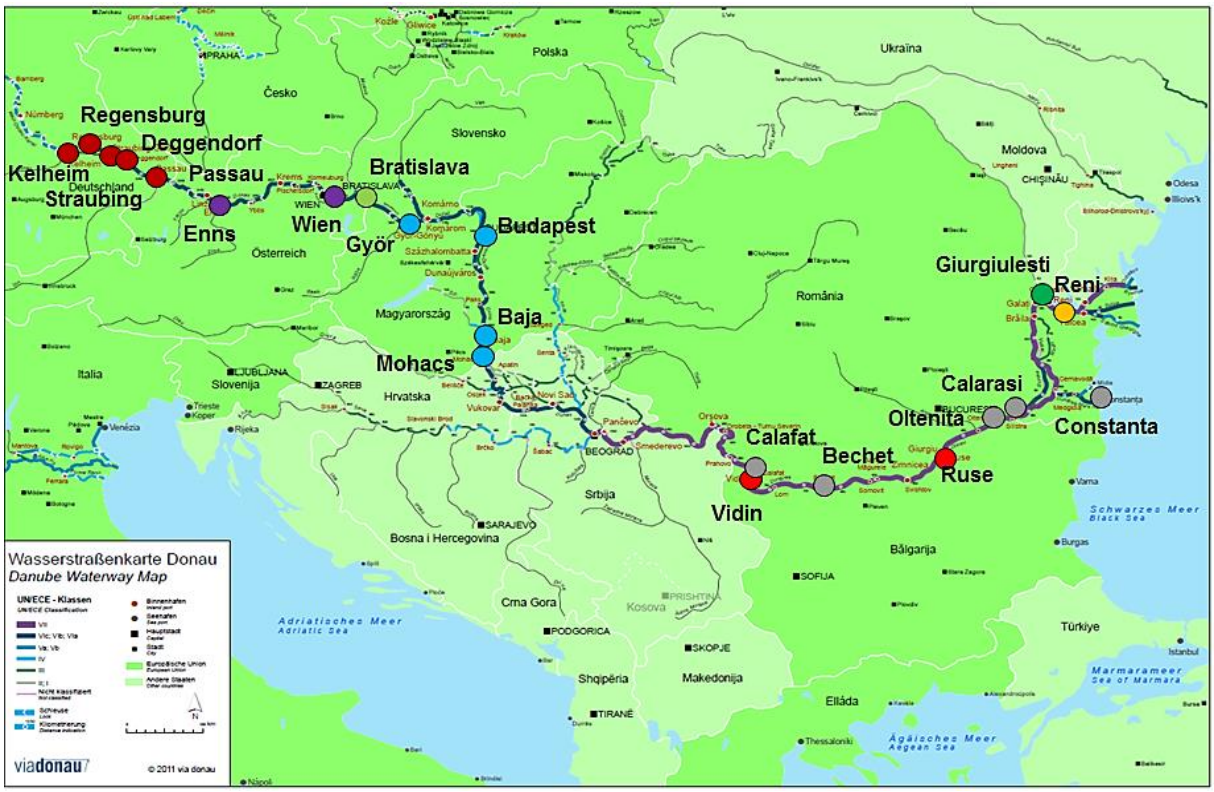


Figure 97: Roll-on Roll-off ports in Danube region[242]

6.3. Transport requirements[243]

Vehicles must be checked in order to ensure a safe transport e.g. ensure that doors, windows and tank fillers are securely closed, the tires are pumped up to a sufficient air pressure, etc.)

Automobiles are primarily transferred onto the means of transport on their own wheels via ramps (Ro-Ro ships, ferries and combined container/Ro-Ro ships, car carriers, auto freight cars).

Conventional loading (lift-on/lift-off (Lo-Lo)) is rare today or is used only for used vehicles, while ramps are more convenient for new cars. The advantage of ramps is the lower risk of damage in comparison to Lo-Lo loading.

During IWT of cars should be specially secured with e.g. lashing belts in to avoid slipping and damage of the cargo.

[242] © viadonau
[243] TIS-Transport Information Service (2014f)

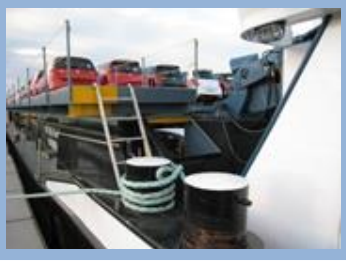
Example of good practice:[244]

Regular service for vehicle transport on the Danube

One of the largest providers of automotive logistics is the German company BLG LOGISTICS. Currently BLG runs the only regular service for the transport of new cars in the whole Danube region from Kelheim, Germany to Budapest, Hungary, and vice versa. Two departures of two motor cargo vessels per week ensure a transport according to schedule. Changes are possible and accepted in case of demand fluctuations.

Mitsubishi, Ford and Renault vehicles are transported from Germany to Hungary while upstream BLG transports Suzuki cars from Budapest to Kelheim. In that way, empty runs are avoided and maximum cost-efficiency is achieved.

The cargo vessels have three decks and a loading capacity of 200 to 260 cars. For transshipment, bow ramps of the vessel and RoRo ramps of the port are used.



7. Chemical products

The European chemical industry is one of the largest industries in global scale and ensures the supply of chemical products for various economic sectors. The chemical industry plays an essential role in providing all manufacturing sectors, as well as construction, health and agricultural sectors, with essential products and services. The chemical industry in Europe is a 673 bil € worth industry and the world's largest exporter and importer of chemicals, with a record 49.1 bil € trade surplus in 2012.[245]

Chemical products can be classified in *basic chemicals*, *specialty chemicals* and *consumer chemicals* while basic chemicals are further divided into petrochemicals, polymers and basic inorganics.

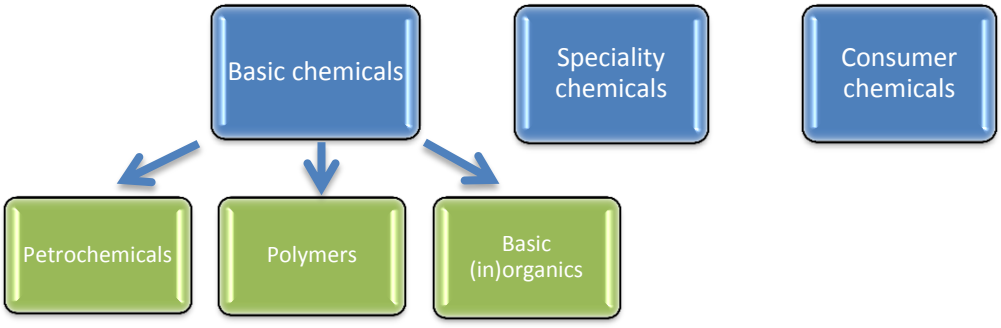


Figure 98: Classification of chemicals[246]

Petro chemistry subsumes all chemical products which are fabricated from petroleum but increasingly also from coal and biomass, especially in Asian countries e.g. China. Petrochemicals are

[244] viadonau (2013a), p. 166
[245] Cefic-The European Chemical Industry Council (2014a)
[246] Owm chart based on The essential chemical industry (2013a)

mainly traded within the chemical industry for further processing into a wide range of chemical products which are either useful instantly like e.g. ethanol or ready for converted into final products ready for use e.g. ammonia to fertilizers. However, petrochemicals are mainly used for the production of various polymers.[247]

Polymers are conjoint of simple molecules which are defined as plastics, in case of synthetic production resp. polymerization. The field of polymers usage is very broad, within this study a short and non-exhaustive overview of chemicals which are suitable for IWT and / or used in sectors which are also reviewed in this study is shown below:

1. *Methanal plastics (Formaldehyde plastics)*[248]*are basis for the production of the three most important resins*
    a. Phenol-methanal (phenol-formaldehyde) plastics are used as electrical insulator and for the manufacture of brake and clutch linings for vehicles in the **automotive industry**. By adding wood flour these plastics are used of the production of worktops and printed circuit board insulation. They are also widely used as adhesives e.g. in **plywood and hardboard production**.
    b. Carbamide (urea)-methanal (formaldehyde) plastics result from heating ammonia and carbon dioxide under pressure. The plastic is produced either as a powder or as granules, which makes it very suitable for waterway transport in large quantities. Mostly they are used as wood adhesives particularly as a binder in the **production of chipboard**. The resin powder or granules are molded into electrical plugs and sockets, toilet seats and some table wear. Furthermore, this product is utilized in various paper production processes and in the textile industry.
    c. Melamine-methanal (melamine-formaldehyde) plastics are stable to heat, light and moisture and is also produced IWT friendly namely as powder. Melamine is mostly used to make laminates for surfaces, light-weight picnic ware and tableware (e.g. Melaware). **Textile, paper industry** and the **automotive industry** for the production of **car lacquers** uses these plastics too.
2. Polyamides (nylons) have a broad usage in the **clothing industry** but they are also used in engineering plastic (e.g. car industry) and in films production for food packaging. Compact polyamides are often granulated which again is a suitable condition for waterway transport.
3. Polycarbonates are also used in various sectors like **construction** (stadium roofs, signs), automotive industry (interior lighting and headlamps, sunroofs, side windows) and packaging (PET bottles). Again the granules can be easily transported on vessels.

Basic organics and inorganics are mostly used for plastics, pharmaceuticals, **fertilizers**, soaps, surfactants and building materials. The chemicals which are allocated to this group are comprehensive and not examined in this study, for that reason only chemicals which are the basis for fertilizers will be examined.

[247] The essential chemical industry (2013a)
[248] The essential chemical industry (2013b)

7.1. Market overview

7.1.1. Germany

The strongest chemical industry in Europe is allocated to Germany with an annual turnover of 190 bil € and almost 438,000 employees in 2013. The German chemical industry plays an important role in the worldwide and European perspective. Germany has the leading chemical industry in Europe and the fourth largest industry in the world, producing over 30,000 different chemical products. 90% of the outputs are used as primary products in other industry for further processing.

There are 2,121 chemical companies in Germany of which 93% fall into the category of small and medium sized enterprises SMEs. Consequently, an evaluation of their location in regard to the Danube or Rhine and Main appears difficult.

The figure below shows the dense network of basic chemicals producers. The plants are often located in the vicinity of refineries (market in brown rhomboid symbols) and chemical parks (marked with bigger round symbols), which host companies, R&D institutions and associations.

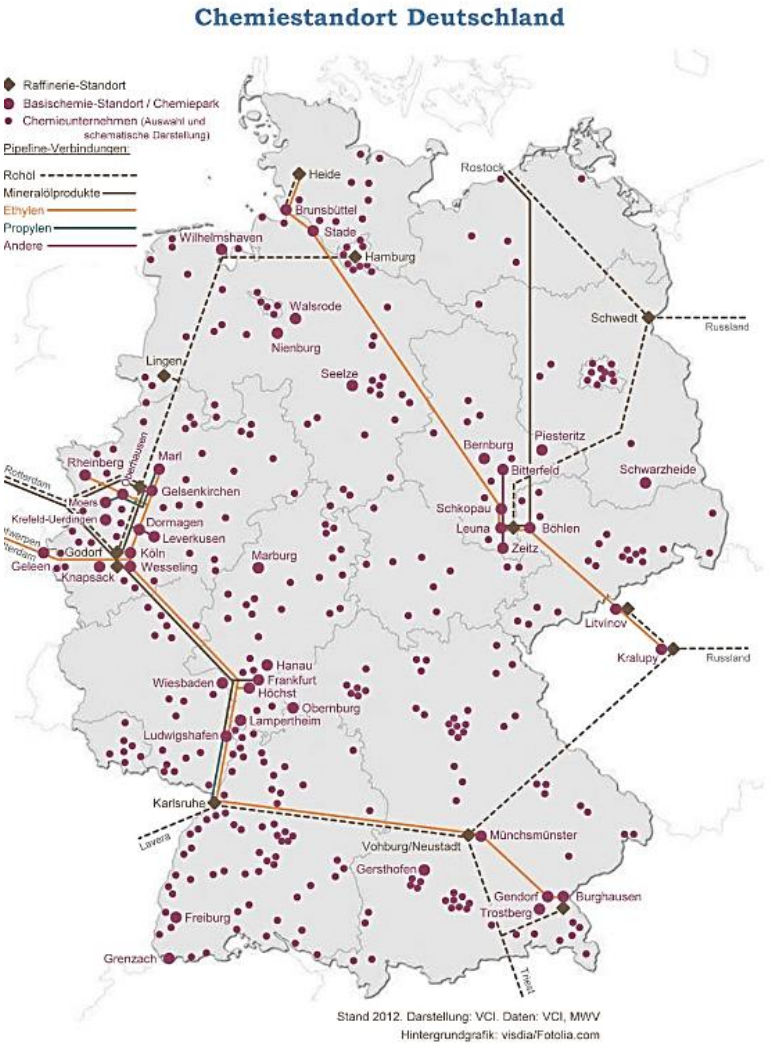


Figure 99: Location of basic chemical producers in DE[249]

[249] VCI-Verband der chemischen Industrie (2012)

German trade with chemicals is an essential factor for the industry. Germany exported chemicals worth 162 bil € in 2012 and imported products worth more than 100 bil € in the same year.[250] As far as the Danube region is concerned exports worth 12.5 mil € and imports amounting 4 mil € were realized in 2012, in 2013 even 13 mil € were gained through exports and imports rose to 5 mil €.

The exported volumes to the Danube region increased from 2008 to 2013, as Germany's global exports increased too. Germany's global imports in 2013 equaled the imports from 2008, while imports from the Danube region increased for more than 300,000 tons.

2008	2009	2010	2011	2012	2013
Exports of chemical products in total (in 1,000 tons)					
61,168	55,511	63,136	63,575	64,193	65,128
Exports of chemical products to Danube region (in 1,000 tons)					
4,981	4,465	4,933	5,032	5,413	5,502
Imports of chemical products in total (in 1,000 tons)					
43,840	39,185	45,121	45,022	43,601	43,914
Imports of chemical products from Danube region (in 1,000 tons)					
2,721	2,398	2,888	3,107	3,041	3,043

Table 45: Trade flows of chem. products between DE and Danube region[251]

From the graphics below appears clear that Germany's most important target and resource market for chemical products* is Austria. Germany exported more than 3 mil tons of chemicals to its neighboring country since 2010. On the other hand, Austria exported between 1.5 and 2 mil tons of various chemicals to Germany.

The Hungarian chemical sector is the second most relevant trade partner for Germany. Germany exported and imported around 500,000 tons to and from Hungary. Exports to Slovakia, the third largest market account, less than imports from this country for about 50,000 tons per year in average.

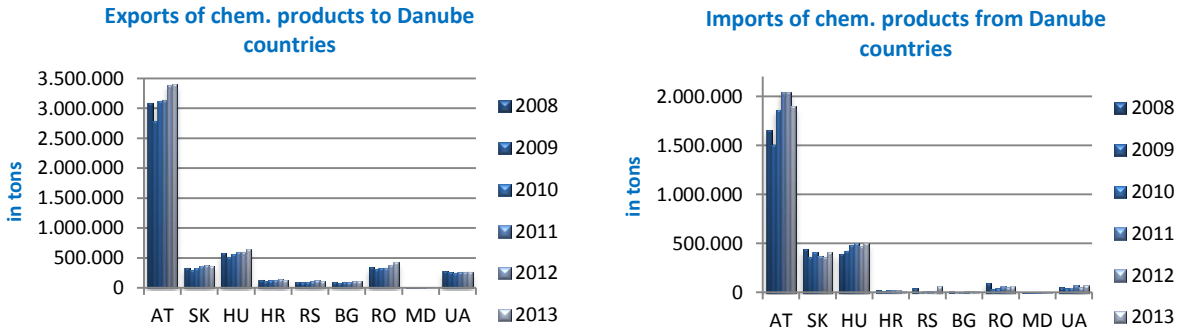


Figure 100: Trade flows with Danube countries of chem. products DE[252]

Fertilizers

As mentioned in the introduction of the chapter, chemical products include a very broad range of products. For that reason, in the following evaluation the focus will be set on fertilizers which are one of the most important chemical products which are suitable for transport by inland navigation in the Danube region.

The Danube region in total does have a significant impact on Germany's exports of nitrogenous fertilizers, however, Austria has become an important target market in the course of time. Exports to

[250] VCI- Verband der chemischen Industrie(2013)
*Classification according to SITC REV.5 Group 5 "Chemical products"
[251] Destatis-Federal Statistical Office Germany (2014)
[252] Destatis-Federal Statistical Office Germany (2014)

Austria increased threefold from 37,000 tons in 2008 to 92,000 tons 2013. Slovakia's imports of German fertilizers sharply increased in 2009 and kept the level of around 16,000 tons per year. However in 2013 only 6,000 tons of the product were imported from Germany.

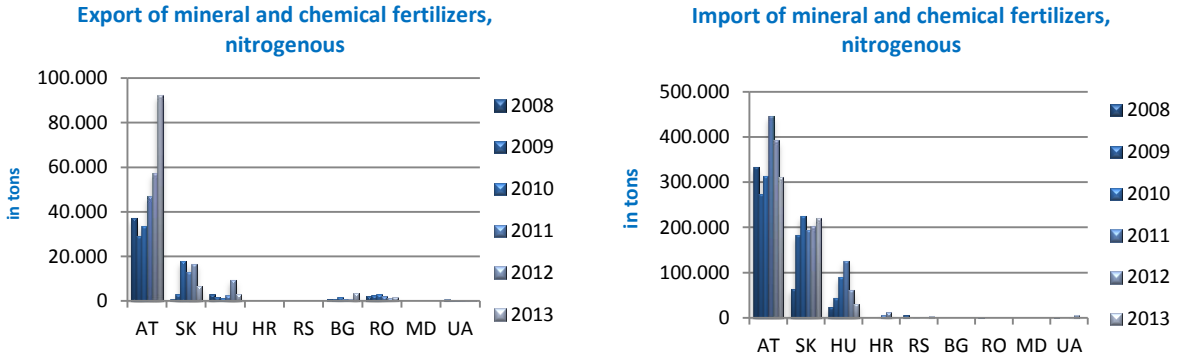


Figure 101: Trade flows of fertilizers DE and Danube countries[253]

Fertilizers originating from the Danube countries played a more important role. Austria was the dominant source market for Germany. The imports from Austria reached the peak in 2011 when the volume of 450,000 tons was realized. In 2013 imports decreased and equaled the volume achieved in 2010 namely approx. 310,000 tons. Since 2009 Slovakia became a relevant market for fertilizers when imports from Germany increased from 64,000 tons in 2008 to 181,000 tons in the following year.

7.1.2. Austria

The chemical industry is one of the most important industrial sectors in Austria, holding almost 10.2% resp. 14.95 bil € production value relating to the total industrial production in 2013. The chemical sector is characterized by a large number of small and middle sized companies which has decreased since 2000 and it currently (2013) amounts 257 with approx. 43,000 employees.

The strong connectivity with foreign countries is underlined through intense trade relations namely, nearly 2/3 of the domestic output is exported. However, exports are compensated by nearly equal import values as shown in the following table.

	Imports in mil €	Exports in mil €
2005	13,442	12,715
2006	14,647	14,444
2007	15,524	15,975
2008	16,229	16,795
2009	14,574	15,085
2010	17,174	17,584
2011	18,917	18,881
2012	17,685	17,567
2013	**17,999**	**17,683**

Table 46: Trade balance chem. products AT[254]

Austria's total exports of chemical products* measured in tons increased since 2007 by approx. 655,000 tons and achieved a record high in 2013 with round 7.2 mil tons. The importance of Danube riparian countries for Austria as a target market is shown in the following table. Since 2007 the share of exports to this region has not changed significantly accounting between 44.46% in the worst case (2009) and 48.12% in 2011 when the largest share in export was realized.

[253] Destatis-Federal Statistical Office Germany (2014)
[254] FCOI-Fachverbandes der Chemischen Industrie (2014)
*according to SITC REV.5 Group 5 "Chemical products"

Exports of Austrian chemical products					
2007	**2008**	**2009**	**2010**	**2011**	**2012**
Exports of chemical products in total (in 1,000 tons)					
6,504	6,677	6,027	6,710	7,008	7,159
Exports of chemical products to Danube countries in total (in 1,000 tons)					
2,929	3,066	2,680	3,063	3,376	3,408

Table 47: Exports of chem. production from AT to Danube countries[255]

A closer look at the bilateral export activities between Austria and the Danube countries shows, that Germany is an essential trade partner importing more than 60% of total imports to all Danube states. Hungary is an important target market, too, with approx. 400,000 tons of chemical products per year. Exports to Slovakia varied between 188,000 tons in 2009 and 325,000 in 2012, while Romania fluctuated between 144,000 and 234,000 tons annually.

Exports to Serbia doubled since 2007 and amounted 135,000 tons in 2012. The second rising market was Bulgaria, where imports of Austrian chemical also steadily increased and achieved a twice fold rise from 50,000 tons in 2007 to 100,000 tons in 2012.

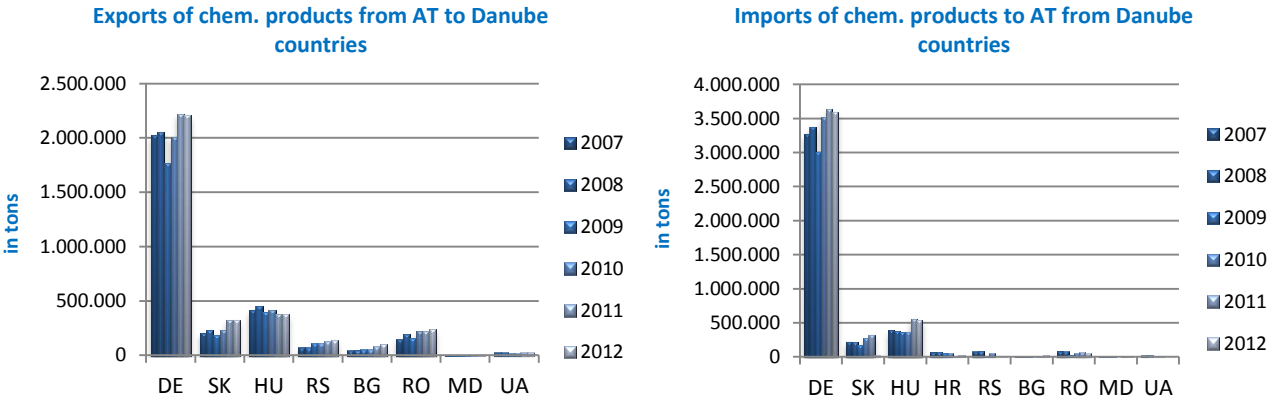


Figure 102: Trade flows of chemicals to and from AT[256]

Imports of chemical products to Austria					
2007	**2008**	**2009**	**2010**	**2011**	**2012**
Imports of chemical products in total (in 1,000 tons)					
6,762	6,866	6,066	7,061	7,409	7,360
Imports of chemical products from Danube countries in total (in 1,000 tons)					
4,110	4,201	3,623	4,314	4,602	4,273

Table 48: Imports of chem. production from Danube countries to AT[257]

Austrian imports, as already illustrated in the trade balance, are almost equal to the exports. However, imports from the Danube region have a larger share namely 60% in average.

Germany's role as a resource market is in this case even more obvious with quotas between 79% and 84% in the observed period of time. Imports from Hungary increased since 2010 and exceeded the 500,000 tons level in 2011 and 2012. The third important resource market was Slovakia, where quantities varied and lately (2012) amounted 220,000 tons.

[255] Own calculation based on Statistics Austria (2012)
[256] Own chart based on Statistics Austria (2012)
[257] Own calculation based on Statistics Austria (2012)

Fertilizers

- Ammonium nitrate

The total Austrian imports of ammonium nitrate decreased almost three fold since 2007, especially from 2008 to 2009 and 2009 to 2010. The absolute minimum was reached in 2011 with only 5,347 tons while in the following year imports increased again by almost 100%.

The Danube region as a resource market plays a quite important role although there are differences in the intensity of the trade form year to year. In 2012 e.g. 92% of Austrian ammonium nitrate imports originated from one of the Danube countries while in 2009 this percentage amounted 56%.

Imports of ammonium nitrate to Austria					
2007	**2008**	**2009**	**2010**	**2011**	**2012**
Imports of ammonium nitrate in total (in 1,000 tons)					
26	21	10	6	5	10
Imports of ammonium nitrate from Danube countries in total (in 1,000 tons)					
25	18	6	4	2	9

Table 49: Imports of ammonium nitrate AT[258]

The figure below shows that the Austrian imports of this chemical product did not show a coherent trend. Germany was the only country which exported regularly ammonium nitrate to Austria. Imports from the remaining countries were volatile in time and quantity therefore, there is no trend that can be evaluated. It seems plausible that the Austrian imports of ammonium nitrate vary in dependence to domestic agricultural seasons and conditions which determine the demand of the ammonium nitrate fertilizer and consequently define the necessity for imports.

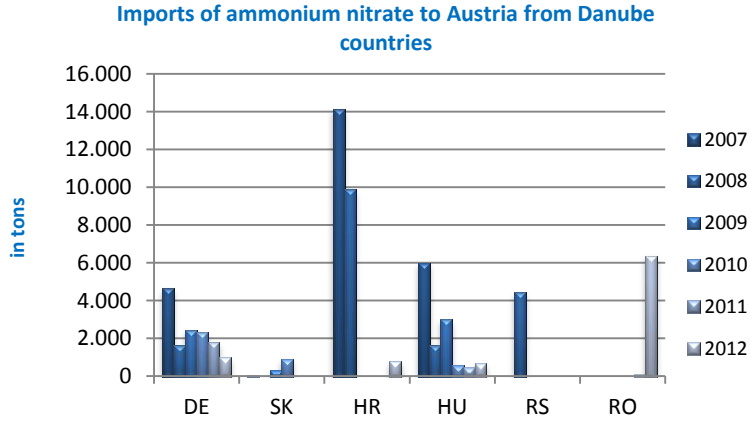


Figure 103: Imports of ammonium nitrate from Danube countries to AT[259]

As a consequence of the illustrated Austrian ammonium nitrate trade flows, it seems that there is not mayor potential for IWT regarding these products. The imports fluctuated strongly and there is no sign that this status will change in the future. Furthermore, exports are almost non-existent.

- Urea

The fertilizer urea plays a more important role in terms of imported volumes. The imports had declined from 2007 to 2009 but then again increased and amounted approx. 171,000 tons in 2012.

The share of imports from the Danube region varied between 59% in 2009 and 76% in 2007. In 2012 63% of the imported urea came from the Danube region.

[258] Own calculation based on Statistics Austria (2012)
[259] Own chart based on Statistics Austria (2012)

Imports of urea to Austria					
2007	**2008**	**2009**	**2010**	**2011**	**2012**
Imports of urea in total (in 1,000 tons)					
184	142	148	148	172	172
Imports of urea from Danube countries in total (in tons)					
141	91	87	101	120	108

Table 50: Imports of urea AT[260]

The involvement of the single countries is illustrated below. It appears that Austria has five almost "equal" resource markets: Germany, Slovakia, Hungary and Romania while imports from Croatia decreased steadily since 2007. Although imports from these countries varied heavily from year to year, it can be stated that these countries do realize regular trade with Austria. No trend can be concluded from the figure due to the fluctuations. It seems plausible that Austrian imports of urea and the choice of the trade partner depend on the annual demand and possibly of the actual price of the fertilizer.

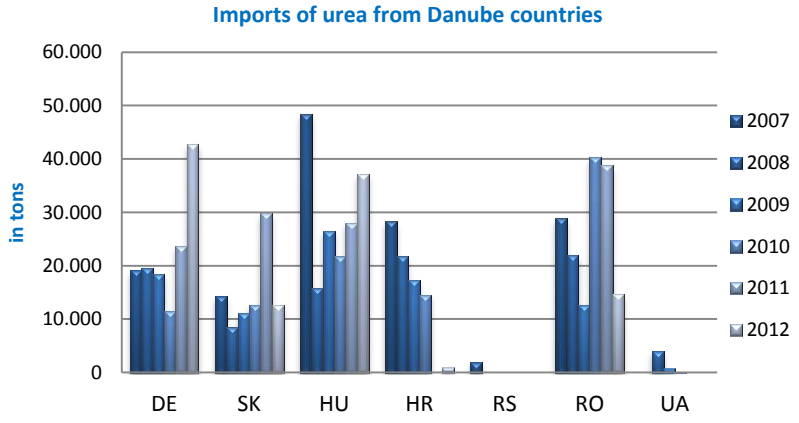


Figure 104: Imports of urea from Danube countries to AT[261]

7.1.3. Hungary

Hungary is the country with the third largest chemical industry in the Danube region with 17% shares of all industrial exports. The output of the total Hungarian chemical industry accounted for 17 bil € in 2012. The successful privatization, the following investments and modernization of companies made Hungary one of the most important players in Central Europe.

There are three significant chemical clusters in Northern Hungary, Central Hungary (Budapest and the surrounding area) and Central Transdanubia. Central Hungary and parts of Central Transdanubia are located in the vicinity of the Danube.

- Northern Hungary: 15% of sales; focus on petrochemical and polymer production, two large companies with < 1 bil € turnover.
- **Central Hungary** (Budapest and surrounding area): 50% of sales; focus on oil refining, petrochemicals and polymers; specialty and fine chemicals; pharmaceuticals. Large presence of SMEs.
- **Central Transdanubia**: 8% of sales; focus on fertilizers, carbon fibres and agrochemicals. Significant number of SMEs. [262]

[260] Own calculation based on Statistics Austria (2012)
[261] Own calculation based on Statistics Austria (2012)

In 2012 almost 4 mil tons of chemical products were exported. The Danube region is an important partner for this sector regarding that more than 50% of the exports are going to Danube countries (except in 2009).

Exports of chemical products from Hungary to Danube region (in 1,000 tons)				
2008	**2009**	**2010**	**2011**	**2012**
2,079	1,884	2,077	2,297	2,218

Table 51: Exports chemical products from HU to Danube region[263]

Four out of the remaining nine Danube countries imported large volumes from Hungary every year namely Germany, Austria, Slovakia and Romania.

Exports to Germany accounted for more than 500,000 tons per year since 2009, reaching even 600,000 tons in 2011. The Austrian market decreased in 2009 by 100,000 tons but rose again in 2010 to 2012 accounting lately 400,000 tons. With 500,000 tons the Slovak market plays the second important role after Germany while exports to Romania stayed stable with values round 400,000 tons.

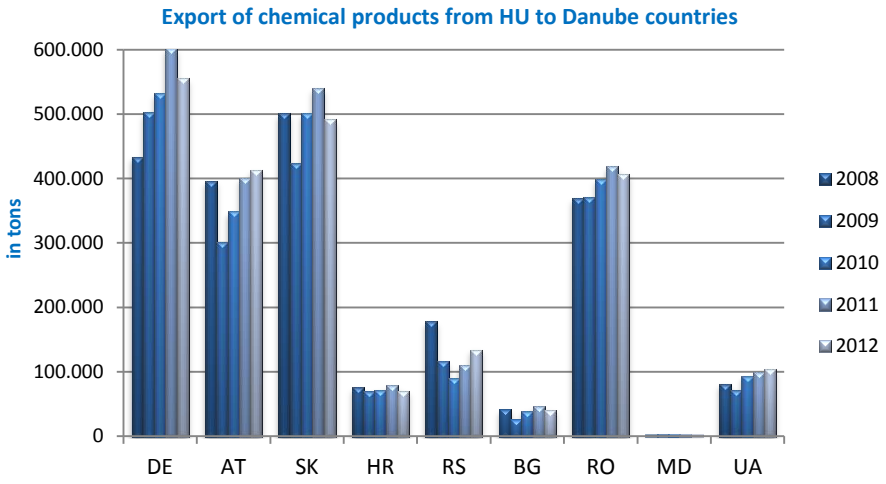


Figure 105: Export of chemicals products from HU to Danube countries[264]

The most important target market for Hungarian products was Germany with volumes accounting from 500,000 to 600,000 tons between 2009 and 2012 followed by Slovakia which imported 500,000 tons of Hungarian chemicals in 2012. The Romania market was stable from 2010 to 2012 with volumes around 400,000 tons. Austria was also an important trade partner with an increase in imports by 100,000 tons from 2009 to 2012. With the exception of Moldova all other Danube riparian countries imported, more or less, large volumes of Hungarian chemicals.

In terms of imports, again the four largest target countries for Hungarian chemicals are also the four largest resource markets. Slovakia became increasingly important as a chemicals supplier for Hungary since 2008. The volumes increased by 200,000 tons in the observed period of time.

[262] Mavez-Hungarian Chemical Industry Association (2014)
[263] Own calculation based on Hungarian Central Statistical Office (2014)
[264] Own chart based on Hungarian Central Statistical Office (2014)

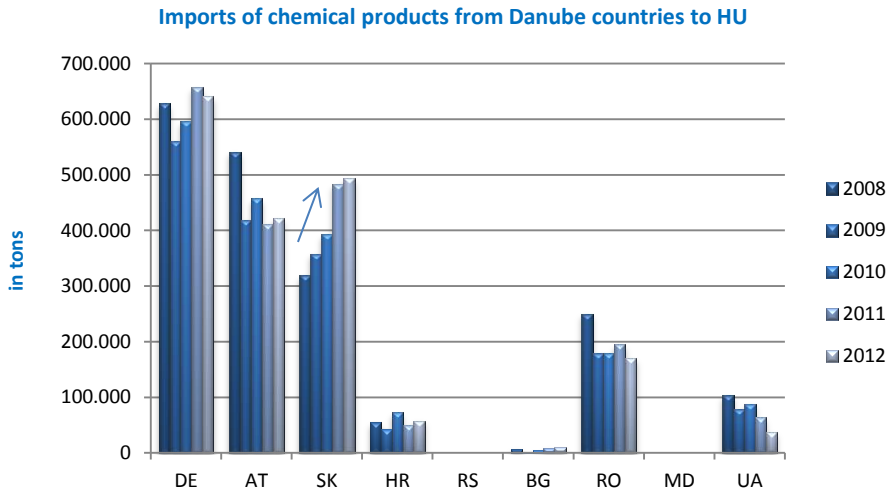


Figure 106: Imports of chem. products from Danube countries to HU[265]

Fertilizers

The database Statinfo of the Hungarian Central Statistical office does not allow evaluation of trade flows of product subgroups for e.g. urea. For that reason a closer look at trade flows of fertilizers and nitrogenous compounds in general was taken.

Hungarian total imports of fertilizers and nitrogen compounds ranged between approx. 600,000 and 740,000 tons in the observed period of time. In 2012, over 684,000 tons of these goods crossed Hungary's border.

The share of imports from the Danube region accounted for 62% in 2012, in 2009 even, 71% of Hungarian imports originated from Danube riparian countries, as shown in the table below.

Imports of fertilizers and nitrogen compounds to HU				
2008	**2009**	**2010**	**2011**	**2012**
Imports of fertilizers and nitrogen compounds in total (in 1,000 tons)				
1,201	856	1,138	1,149	1,109
Imports of fertilizers and nitrogen compounds from Danube countries in total (in 1,000 tons)				
721	604	737	742	684

Table 52: Import of fertilizers to HU[266]

The most relevant source markets were Austria and Slovakia. Austria's volumes had two peak points reaching 290,000 tons in 2008 and 275,000 tons in 2010, while in the remaining years imports from Austria accounted for round 200,000 tons per year.

Slovakia grew to a very important trade partner for Hungary in the course of time. The imports from Slovakia doubled from 2008 to 2012 from 138,000 tons to 280,000 tons.

Nevertheless, it is clear that almost all Danube countries provide Hungary with fertilizers. Romanian fertilizers had remarkable volumes from 2008 to 2011, however, a sharp decline occurred in 2012. Germany, Croatia and Serbia accounted for approx. 30,000 to 60,000 tons in 2012 while imports from Ukraine dropped from 60,000 tons in 2008, 2009 and 2010 down to 26,000 tons in 2012.

[265] Own diagramme based on Hungarian Central Statistical Office (2014)
[266] Hungarian Central Statistical Office (2014)

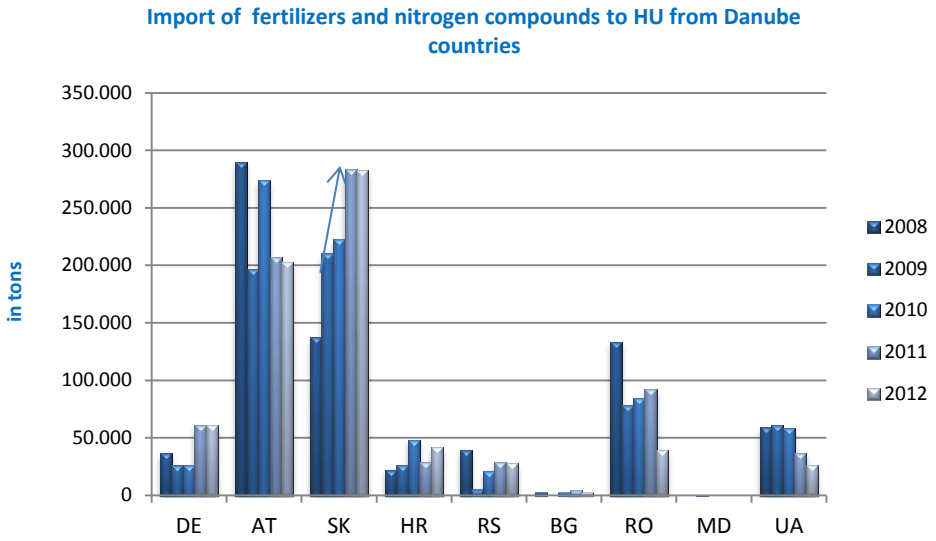


Figure 107: Import of fertilizers to HU from Danube countries[267]

Hungary exported approx. 558,000 tons fertilizers and nitrogen compounds in total in 2012, which is 138,000 less than the recorded high in 2011 of 696,000 tons.

The importance of the Danube countries as target markets increased since 2008 when 57% of the exports found their way to the Danube region while in 2012 this share accounted for 73% as shown in the table below.

Exports of fertilizers and nitrogen compounds from HU				
2008	**2009**	**2010**	**2011**	**2012**
Exports of fertilizers and nitrogen compounds in total (in 1,000 tons)				
436	495	625	696	557
Imports of fertilizers and nitrogen compounds from HU to Danube countries in total (in 1,000 tons)				
250	225	332	441	404

Table 53: Exports of fertilizers from HU[268]

Hungary had four major trade partners in the region, Germany, Austria, Slovakia and Romania. Germany experienced a significant development since 2008 as the fastest growing market for Hungarian fertilizers. Furthermore, no country imported more than Germany in 2012. Romania grew steadily as a target market, similar to Germany, only to a smaller intensity. Austria and Slovakia both had comparable market developments importing 84,000 tons in 2008 from Hungary, in 2009, imports in these countries dropped and increased again in 2009.

[267] Own chart based on Hungarian Central Statistical Office (2014)
[268] Hungarian Central Statistical Office (2014)

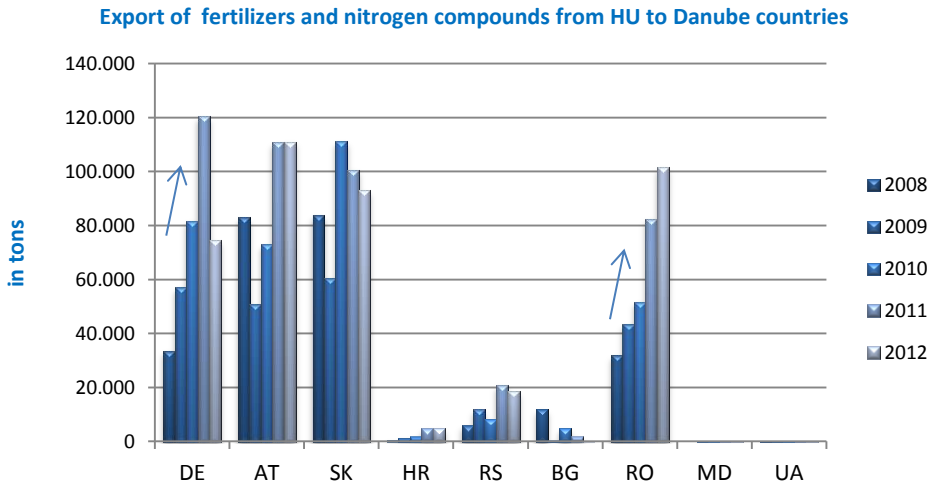


Figure 108: Exports of fertilizers from HU from to Danube countries[269]

7.2. Transport requirements

Ammonia[270] is a toxic gas, which is essential for fertilizer production namely urea or ammonium salt. 85% of processed ammonia is used in the scope of fertilizer production while the rest is accounted to e.g. chemicals and wood pulp production. Usually ammonia is either stored as a liquid cargo on site and pumped to another part of the plant for fertilizer production or it is transported, again liquefied to other plants using also vessels.

As stated, ammonia is a toxic gas which is furthermore classified as dangerous for the environment. The gas is flammable and can form explosive mixtures with air. Copper- and zinc-containing alloys and brass fittings should not be used for handling the due to corrosion through ammonia. Liquid ammonia can also attack rubber and certain plastics. [271]

Example of Ammonia (anhydrous)	
Facts	
Origin	-
Stowage factor (in m^3/t)	▪ 0.86 kg/m^3 (1.013 bar at boiling point) ▪ 0.73 kg/m^3 (1.013 bar at 15°C) ▪ 681.9 kg/m^3 at −33.3°C (liquid) ▪ 817 kg/m^3 at −80°C (transparent solid)

Figure 109: Ammonia factsheet[272]

Ammonium nitrate[273] is an important fertilizer which is solid at room temperature and standard pressure. This fertilizer is less concentrated than urea which leads to a slight transportation disadvantage of ammonium nitrate. However, it is more stable than urea and does not loose nitrogen to the atmosphere. During warm weather urea should only be applied before imminent rain in order to minimize nitrogen loss.

[269] Own chart based on Hungarian Central Statistical Office (2014)
[270] The essential chemical industry (2013c)
[271] Cargohandbook (2014a)
[272] Cargohandbook (2014a)
[273] Cargohandbook (2014b)

Explosion may be caused by ignition or heating and it should not be stored inflammable substances or certain fertilizers, especially urea. Heating or any ignition source may cause violent combustion or explosion. Ammonium nitrate has a critical relative humidity of 59.4%, above which it will absorb moisture from the atmosphere. Product is acceptable only in dry containers, NOT in operating or non-operating reefers because it is liable to evolve corrosive vapors, which could result in heavy damage to the reefers.

In Danube navigation this fertilizer is also transported as bulk.

Example of Ammonium Nitrate	
Facts	
Origin	-
Stowage factor (in m^3/t)	1 m^3/t (bulk)
Humidity / moisture	See text
Ventilation	Ventilate well

Figure 110: Ammonium nitrate factsheet[274]

Urea[275] is produced out of ammonia and carbon-dioxide and is the most used nitrogen fertilizer in the world. Urea is also the most concentrated fertilizer which is usually available as granulated form and therefore suitable for IWT transport.

Figure 111: Urea[276]

Urea can be shipped in bags or bulk. Contact with alkaline materials such as basic slag or lime must be avoided. Cool storage should be ensured in order to prevent emission of toxic gases die to heating.[277]

If urea is carried as bulk cargo, the stowage factor (specific weight) is crucial for the determination of the tonnage needed. Since the stowage factor of urea can vary considerably, depending on the producer, it is of importance to determine the precise stowage factor before booking a barge.

As moisture sensitive cargo, Urea tends to lose its pourability upon the absorption of water. Therefore, urea must be protected from moisture throughout the whole transport chain. A specific danger is condensation if freshly produced urea is loaded in a still warm condition.

Example of Urea	
Facts	
Origin	-
Stowage factor (in m^3/t)	1,17 - 1,56 m^3/t (bulk)
Humidity / moisture	<1%

Figure 112: Urea factsheet[278]

[274] Cargohandbook (2014b)
[275] Cargohandbook (2014c)
[276] Cargohandbook (2014c)
[277] Cargohandbook (2014c)

The European Chemical Industry Council (CEFIC)[279] conducted a survey among 13 large chemical companies and 15 logistics service providers in order to identify main chemical transport corridors and volumes, as well as bottlenecks and barriers in terms of ***intermodal transport.***

The results of the survey show that the most used intermodal transport combination is "road-rail" (72 %). Short-sea-shipping represents 27%, mainly related to transport from/to the clusters in Great Britain and Iberia. **Intermodal inland waterway transport is currently used to a very limited extent namely 1%.**

The participants of the survey identified new potential corridors for intermodal transports that are not in use today but may be interesting for intermodal shifts in the future. The chemical industry sees potential for volumes to be shifted to and from France and to and from the **CEE countries**, especially Russia and the **South-East of Europe** since there are no intermodal concepts that are currently offered on the market for these connection and can only be performed by road.

According to the survey about 1.4 million tons may be shifted towards intermodal transport solutions, if the requirements would be met.

In terms of Danube navigation the identified intermodal flows of more than 200,000 tons per year towards Turkey and Russia are relevant and should be considered as a great opportunity for all parties included in this industry but also the European Union which aims at shifting 30% of road freight over 300km to other modes such as rail or waterborne transport by 2030, and more than 50% by 2050.

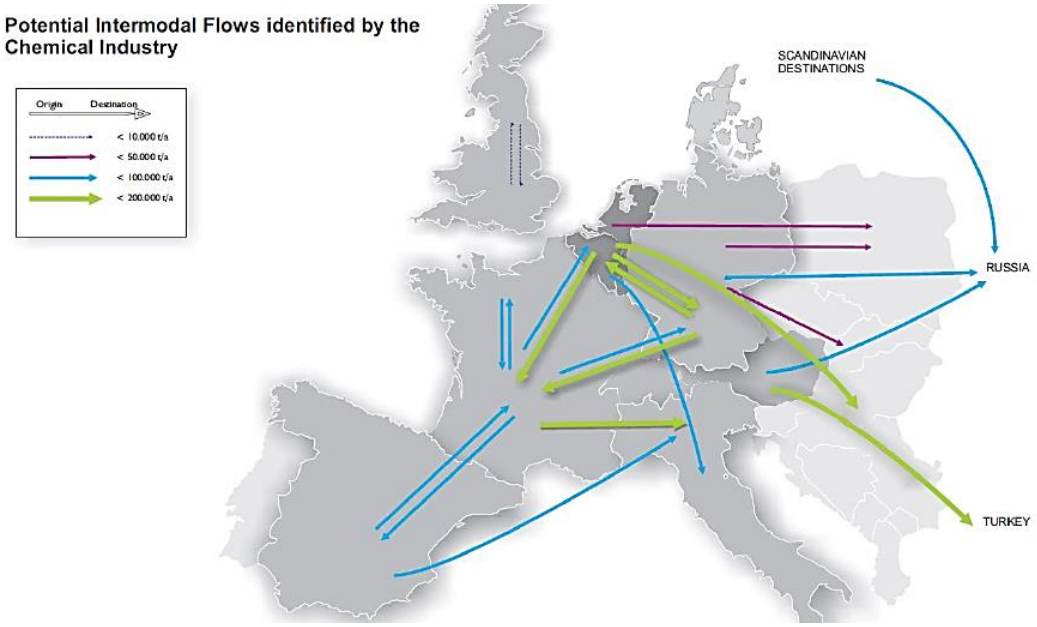


Figure 113: Potential for intermodal flows of chemical products in Europe

The interviewed companies' representatives also determined important topics that should be discussed in order to enable a reliable and more competitive intermodal market:

[278] Cargohandbook (2014c)
[279] Cefic-The European Chemical Industry Council (2014b)

- Harmonized dangerous goods regulations: Regulations for the handling and storage of dangerous goods need to be harmonized throughout Europe (e.g. a standardized minimum storage time allowance of at least 48 hours). Also, dangerous goods regulations for short sea transports need to be further harmonized with ADR.

- Harmonized customs regulations: The documentation procedures and main regulations for transporting goods need to be further harmonized, so that a more reliable planning of the logistics supply chain is possible. This especially applies to non-EU neighbors. Today, short sea transports are in many cases still handled the same way as deep sea shipments. Introduction of paperless systems should be supported.

- Better connection of ports: Sea ports are the backbone of international transport and especially suitable for intermodal hinterland transport strategies.

8. Mineral resources and mineral oil products

8.1. Non-metallic raw materials

8.1.1. Aggregates

Primary aggregates are sand and gravel, crushed rock such as limestone, sandstone, igneous rock which are mainly used for production of building material e.g. concrete, building sand and road stone but they are also used directly for drainage of buildings, houses, etc. or fill purposes.[280]

"Sources for these basic materials can be grouped into three main areas: Mining of mineral aggregate deposits, including sand, gravel, and stone; use of waste slag from the manufacture of iron and steel; and recycling of concrete, which is itself chiefly manufactured from mineral aggregates."[281]

8.1.1.1. Market overview

The total production of primary aggregates in the Danube region accounted for 726 mil tons in 2012, 104 mil tons less than in 2008. The largest production is allocated to Germany with an average of 450 mil tons per year. Consequently, almost 50% of the total production in the region of primary aggregates takes place in Germany. The second important producer is Ukraine reaching 100 mil tons in 2011 and 2012. Austria's stable outputs accounted for 54 mil tons (2010) and 66 mil tons (2008) which gives Austria the position of the third important producer of aggregates in the region.

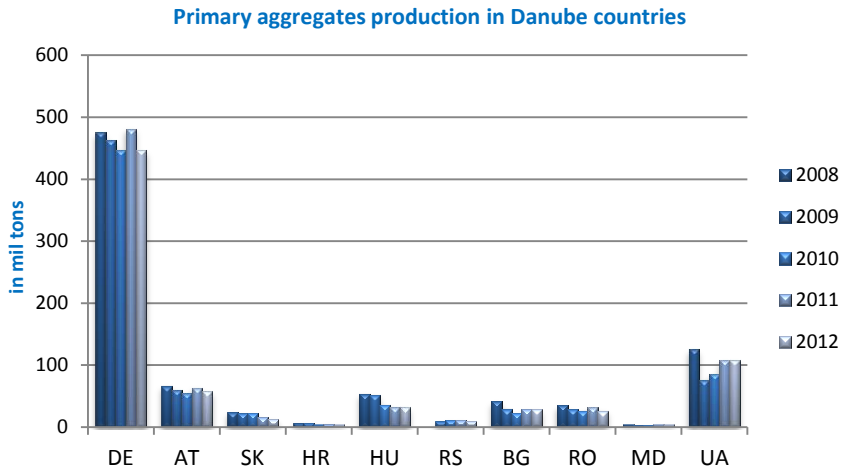


Figure 114: Primary aggregates production in Danube countries[282]

[280] British Geological Survey (2014), p. 144
[281] Cargohandbook (2014k)
[282] Own chart based on British Geological Survey (2014)

Looking at the export activities, as illustrated below, it is clear that Germany exported by far the largest volumes which amounted between 25 and 29 mil tons resp. 6% of its total production on average from 2008 to 2012. Ukraine on the other hand, achieved export shares of 15% in 2012 and even 20% in 2011, which underlines Ukraine's stronger export orientation.

After four years of constant export volumes of about 3 mil ton annually, a decrease by 1 mil tons was registered in 2012 in Austria. Croatia, which had comparable export volumes like Austria in 2008 and 2009, strongly reduced exports in 2011 and 2012, and exports lately accounted for 600,000 tons.

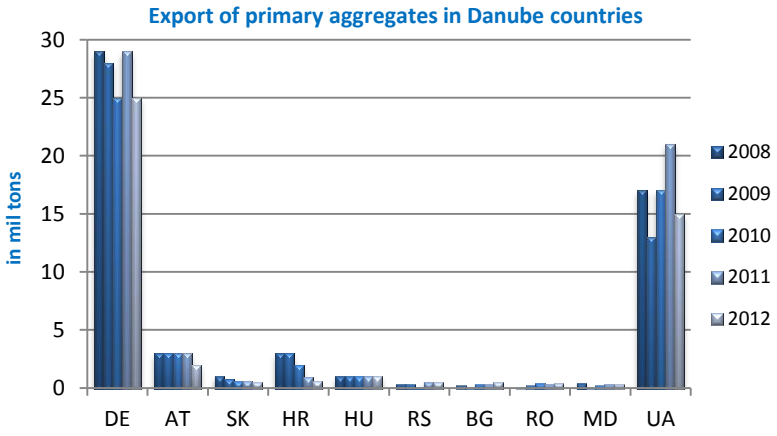


Figure 115: Exports of primary aggregates in Danube countries[283]

Primary aggregates imports are again dominated by Germany with volumes between 12 mil tons and 14 mil tons per year. Austria imported 3 mil tons per year in 2008, 2009 and 2012 while in the remaining two years, imports dropped by 1 mil tons and amounted 2 mil tons annually.

Croatia experienced the greatest fluctuations in imports of all countries especially from 2008 to 2009, when imports dropped significantly from 5 mil tons down to 2 mil tons and in 2010 even to 900,000 tons. In 2012 Croatia reached again 2 mil tons like in 2009.

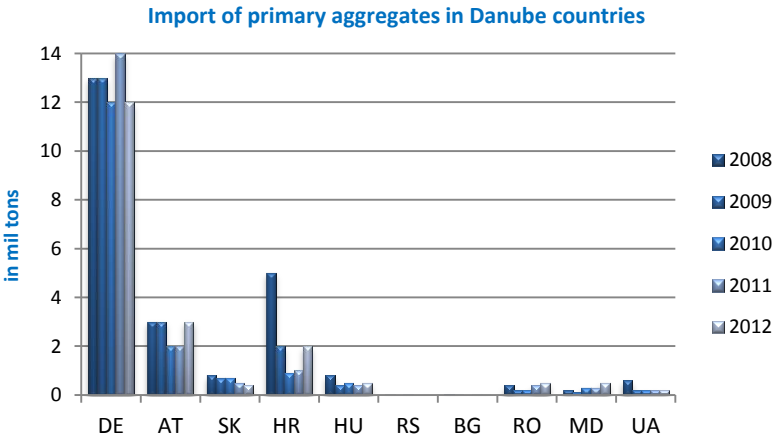


Figure 116: Imports of primary aggregates in Danube countries[284]

The trade relation analysis among the countries showed that Germany, as the primary aggregates leading producer, exporter and importer, did have two main trade partners in the region, Austria and

[283] Own chart based on British Geological Survey (2014), National Statistics Office of the Republic of Moldova (2014), Comtrade database SITC Rev.2 (273)
[284] Own chart based on British Geological Survey (2014), National Statistics Office of the Republic of Moldova (2014), Comtrade database SITC Rev.2 (273)

Hungary. The remaining Danube riparian countries played a minor role as resource and target markets[285]. For that reason, volumes of these countries will be excluded in the following table.

Germany imported around 1.5 mil tons primary aggregates from Austria per year. On the other side, Austria was also an important target market for the raw material. In 2008, 1 mil tons were destined for Austria, however, the volumes dropped since then and accounted lately 700,000 tons. As already mentioned, Hungary is the second important trade partner in the Danube region mainly, as a target market. Exports to Hungary remained stable with 300,000 tons annually.

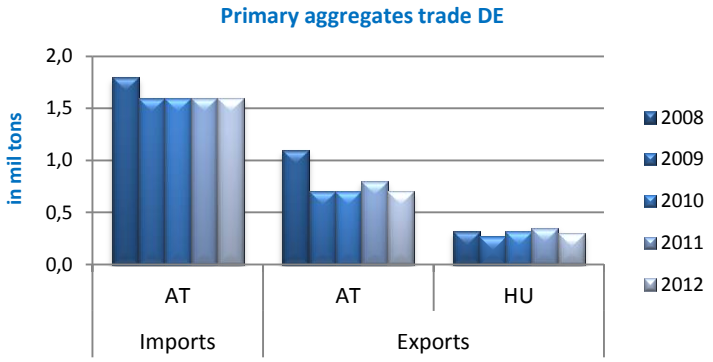


Figure 117: Primary aggregates exports and imports in DE[286]

As far as Ukraine is concerned, the only mentionable trade was realized with Moldova. Ukraine exported approx. 200,000 tons sands and gravel from 2008 to 2011 to Moldova. In 2012, the export volume increased and accounted for 400,000 tons.[287]

8.1.1.2. Cement

A general definition understands cement as a binder, which sets and hardens independently and can bind other materials together. Cement is made by heating limestone with small quantities of other materials e.g. clay. The resulting product is the so-called 'cement clinker' which is the basis for the most commonly used powder cement known as 'Ordinary Portland Cement' (often referred to as OPC). Cement is used in construction mostly in the production of mortar and concrete.

8.1.1.2.1. Market overview

The total production of cement, clinker as well as finished cement, accounted for 91 mil tons in 2012 which is 22 mil tons less than in 2008. As shown in the illustration, national cement outputs sharply decreased in the year of crises 2009, in Bulgaria for example production was cut into half from 9 mil tons in 2008 to 4 mil tons in the following year. With the exception of Germany, no country managed to reach volumes of 2012 but they kept the outputs more or less stable from 2009 to 2012. Germany's cement production accounted for 57 mil ton resp. 60% of the total output of the region in 2012 followed by Ukraine with approx. 10 mil tons per year since 2009. The third largest producer, Romania, produced around 7 mil tons of cement annually from 2009 to 2012.

[285] Comtrade database
[286] Own chart based on Comtrade database
[287] Comtrade database

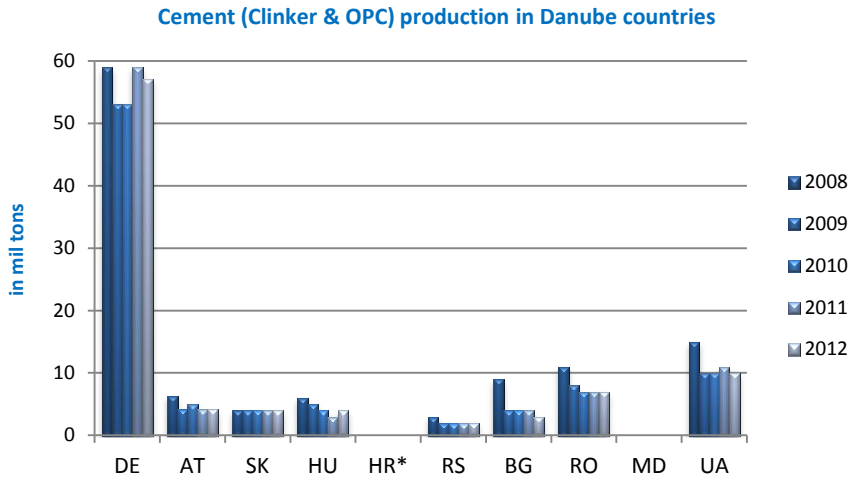


Figure 118: Cement production in Danube countries[288]

The most important exporter of cement is Germany reaching lately, in 2012, 7 mil tons. Surprisingly, Slovakia plays the second important role with an export rate of almost 50% of total annual production. Croatia exported between 900,000 tons and 1.3 mil tons in the observed period of time.

Cements imports show a more diversified picture in the Danube region. Ukraine's import volumes are characterized by strong fluctuations from 200,000 tons in 2008 up to nearly 2 mil tons in 2009, accounting for 1.5 mil tons in the recent year 2012. Germany and Austria imported comparable volumes of around 1 mil ton annually.

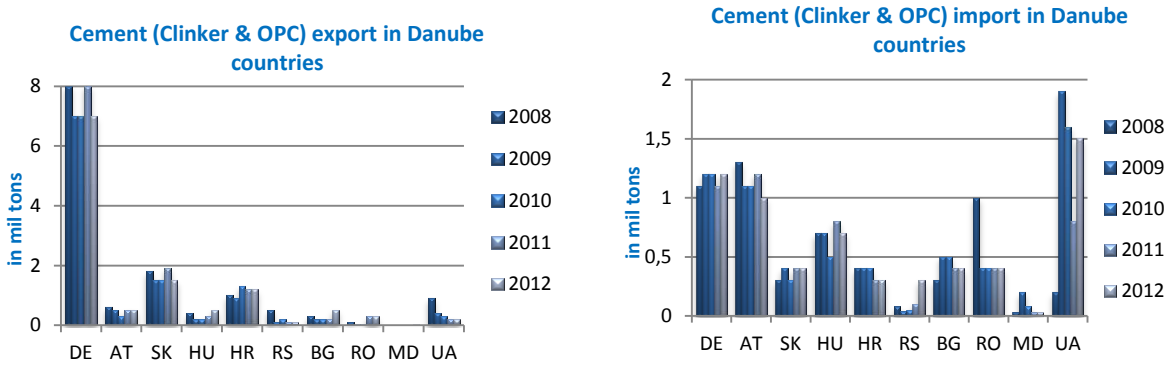


Figure 119: Cement trade flows in Danube countries[289]

The total imports of all Danube riparian countries amounted 6.2 mil tons in 2012 while in the previous years between 5.4 mil tons (2008) and 6.8 mil tons (2009) of cement were imported per year.

Germany is the important player in the cement market in the Danube region, a closer look at its trade partners and cement production locations seems to be promising.

8.1.1.2.1.1. Germany

Germany's trade activities were mainly conducted with Austria. Austria is almost an exclusive target market for German cement with volumes between 400,000 and 550,000 tons per year. Germany also exports to Romania, in much smaller volumes which amounted for approx. 20,000 tons annually.

[288] Own chart based on British Geological Survey (2014)
[289] British Geological Survey (2014), p.181,182, Comtrade

The most important Danube resource market for Germany is, as mentioned, Austria, however, Germany also imports cement from Slovakia and from Croatia. Imports from Austria rose from 32,000 tons in 2009 to remarkable 72,000 within 3 years and dropped again in 2013 accounting for approx. 60,000 tons. In 2010 Slovakia's exports to Germany reduced by 50% compared to 2009 accounting for less than 10,000 tons. In 2013, the volumes achieved the value from 2011 namely 13,000 tons.

Although Croatia exported approx. 1.2 mil tons in 2012 to the Danube countries, Germany does not seem to be an essential trade partner.

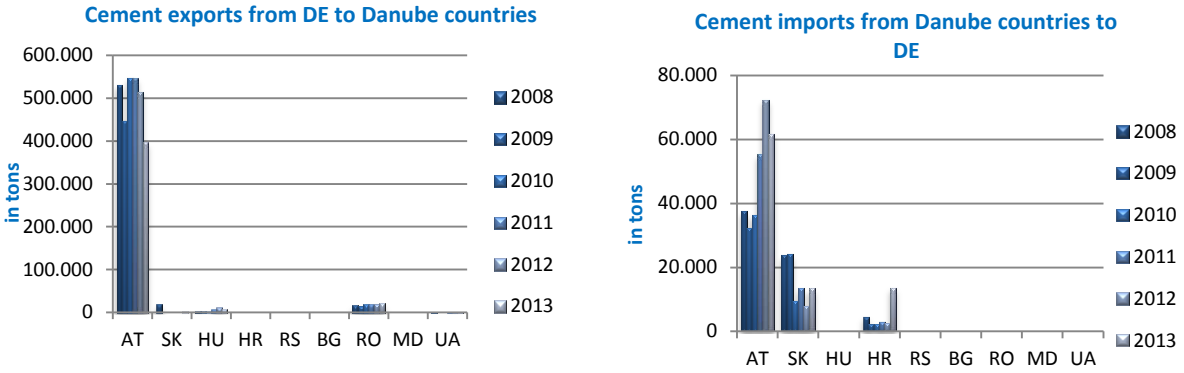


Figure 120: Cement exports and imports DE and Danube countries[290]

The cement production plants are located mainly in the South and the West of Germany. The following figure shows cement production plants with and without clinker production. There are three plants in the vicinity of the Danube River namely in Hartmannsdorf, Burglengenfeld and Solnhofen. The product portfolios of these plants are wide: besides cements they manufacture dry sands, gravel, mortar and various binding material.

[290] Destatis-Federal Statistical Office Germany (2014

Figure 121: Cement plants in DE[291]

8.1.1.2.1.2. Ukraine

Ukraine is the second largest cement producer but also the country which achieved the highest import volumes in single years.

There are 20 cement production plants in Ukraine with a total annual capacity of 20 mil tons per year (15 out of 20 plants). Most of the Ukrainian plants are located in the interior of the country at great distance to the Danube River, however, two cement processing plants have access to other waterways.

The Yugcement (Dyckerhoff) plant in south Ukraine near the city of Odessa is located 65km from the Black Sea along the estuary of the Southern Bug river (where it meets the Inhul River). The second plant is also part of the Dyckerhoff company and is situated on the peninsula for Crimea in Sevastopol.

[291] Adapted from VDZ-Verein Deutscher Zementwerke (2014)

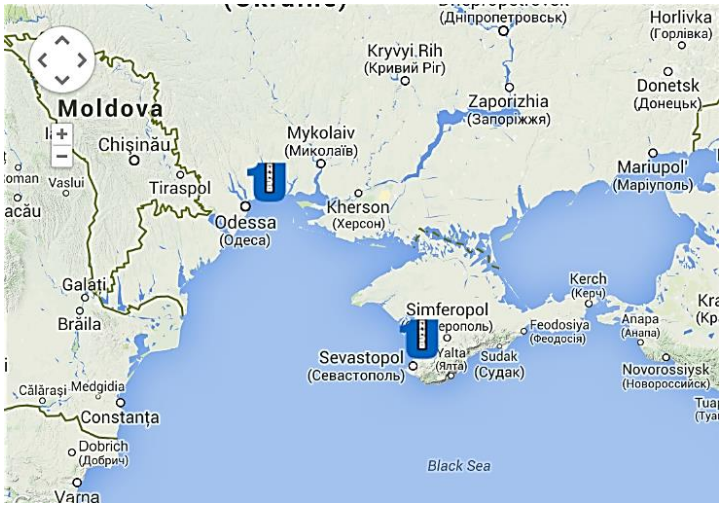


Figure 122: Dyckerhoff cement plants in UA[292]

As already mentioned Ukraine is the largest importer but also an important cement producer in the region. Due to lack of data, Ukraine's main trade partners cannot be evaluated.

8.1.1.2.1.3. Slovakia

There are four cement production sites in Slovakia with a total annual capacity of 4.5 mil ton per year. In the vicinity of the river Danube there is only one plant namely Holcim (Slovensko) in the town of Rohoznik with production capacities of 1.5 mil tons.

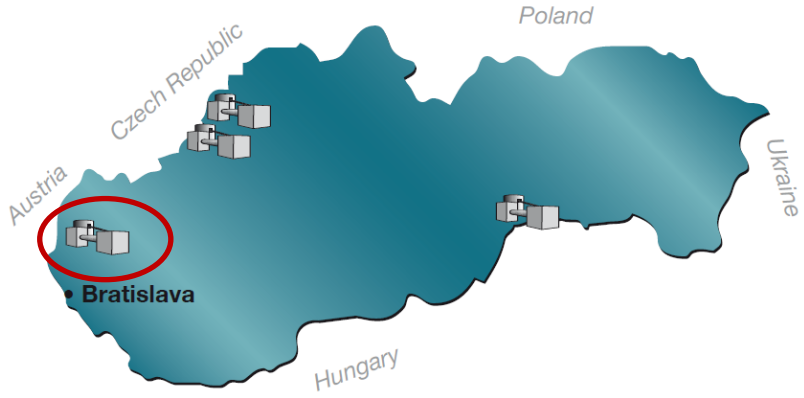


Figure 123: Cement production sites in SK[293]

Slovakia exported 1.2 mil tons of clinker and OPC to Danube countries in 2013. Due to data incompleteness values for Hungary in 2011 and 2012 are missing but from the following graphic it is clear that Hungary is the largest buyer of Slovak cement products with more than 800,000 tons in 2013 and 2008. Austria's imports reached half the Hungarian values resp. between round 350,000 in 2013 and 470,000 tons in 2011. Having in mind that Hungary as well as Austria are neighboring countries and that the distance to these countries is not large the suitability of IWT from Slovakia to the mentioned neighbors has to be evaluated on a case-to-case basis.

[292] Dyckerhoff Ukraine
[293] International Cement Review

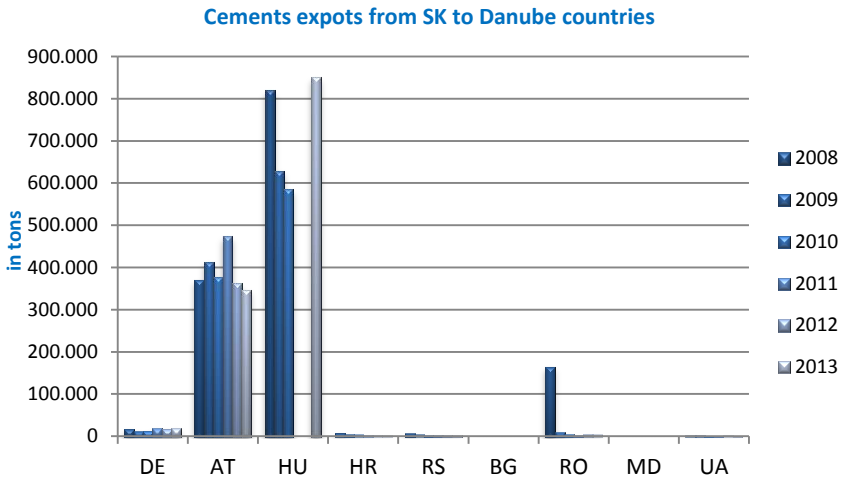


Figure 124: Cement exports from SK to Danube countries[294]

8.1.1.2.2. Transport requirements

Cement is a grey dusty cargo which absorbs moisture and/or carbon dioxide from the air which leads to loss of cement quality and reduction of the product's performance. Consequently, damp-proof or water-proof material should be used for packaging.

Contamination through sugar affects the setting and hardening performance of cement. Should sugar have been recently carried in a compartment into which cement is to be loaded, the cleaning of floors, brackets, stringers, etc., should be thorough, and an officer should inspect every part of the compartment before loading commences.

Cement is shipped either as bulk, in 50 kg paper sacks or one to two ton polypropylene bags. Bulk cement should be transported in specially designed vessels, which are dry and properly closed and condensation does not occur. Contact with moisture results in a hard crust or a lump which has to be removed. "Fresh made" cement loaded directly from the production plant reaches temperatures around 160°C, and it should be avoided to stow other cargo in the same compartment.[295]

Example of Cement	
Facts	
Origin	-
Stowage factor (in m^3/t)	▸ 0,82 m^3/t (bulk) ▸ 0,85 m^3/t (bagged)

Figure 125: Cement factsheet[296]

[294] Own chart based on Comtrade databse , Data for HU 2011/2012 missing
[295] Cargohandbook (2014d)
[296] Cargohandbook (2014d)

8.1.1.3. Salt

Salt [sodium chloride (NaCl)] is a crystalline mineral which is first and foremost, a major industrial chemical. Only 17.5% of the salt produced worldwide is used for human consumption while the remaining 82.5% are processed in production of soda, chlorine, pulp and paper, in setting dyes in textiles and fabrics, and the making of soaps and detergents.
Salt is produced through vaporization of seawater or brine from other sources, such as brine wells and salt lakes, and by mining rock salt. Apart from its use in table salt in the diet, sodium chloride is a major industrial chemical. [297]

8.1.1.3.1. Market overview

The largest salt producer in the Danube region is Germany which increased its production for 6 mil tons from 2008 to 2012 accounting 19 mil tons in 2012, followed by Ukraine which lately reached the salt output of 6 mil tons (2012).
Ukraine increased production by 20% since 2008 and recently produced 6 mil tons of salt. Romania had unchanged outputs from 2008 to 2012 with approx. 2 mil tons annually.

A remarkable increase in salt production occurred in Austria from 2011 to 2012 when salt output rose from 1.1 mil tons to 3.1 mil tons.

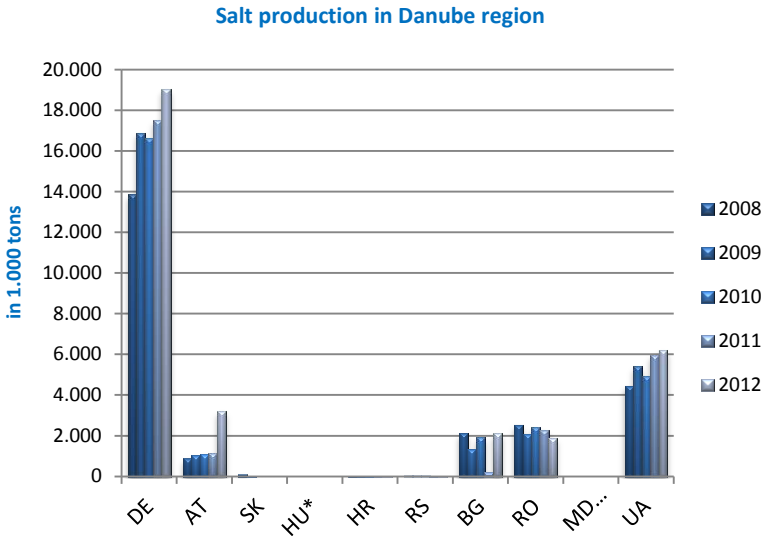


Figure 126: Salt production in Danube region[298]

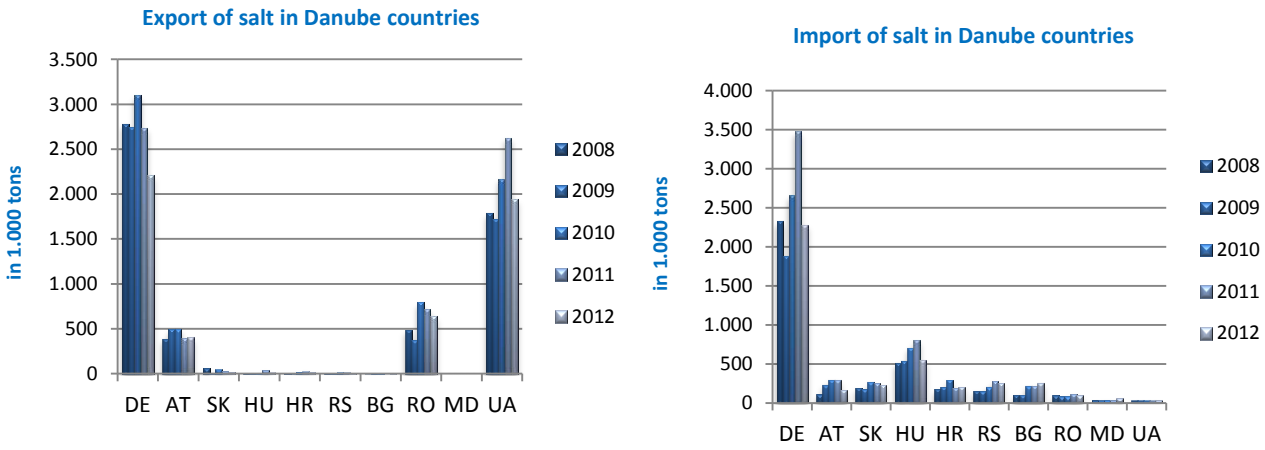


Figure 127: Salt trade flows in Danube countries[299]

[297] Cargohandbook (2014e)
[298] British Geological Survey (2014)
[299] Own chart based on British Geological Survey (2014)
*potash is salt that contains potassium

There are two big players in the salt exporting business in the Danube region, Germany and Ukraine. Germany's highest exports were realized in 2010 when more than 3 mil ton left the country. Recently, in 2012 exports accounted for 2.2 mil tons. Ukraine's export peak was reached in 2011 with more than 2.5 mil tons while in 2012 exports almost approached the 2 mil mark. Romania exported more than 500,000 tons per year since 2010 while Austria's exports did not exceed 500,000 tons but amounted between 400,000 and 490,000 tons in the period between 2008 and 2012.

Germany is also the largest salt importer of all Danube riparian countries. Record volumes of 3.5 mil tons were realized in 2011 but they declined since then, and amounted 2.3 mil in 2012. Hungary is the second important importer of salt with 500,000 tons in 2012. Austria, Slovakia, Croatia, Serbia and Bulgaria imported approx. 200,000 tons of salt annually.

8.1.1.3.1.1. Germany

In 2011 10,300 employees worked in the salt (and potash) industry which realized a turnover of 2.9 bil € in 2011. Besides salt production, Germany is producing potash to a very strong extent namely 35 mil tons in comparison to 16 mil tons of salt (NaCl) in 2011.[300] Potash is mainly used as a fertilizer and it is the third important plant nutrient after nitrogen and phosphorus. For that reason a closer look on German potash will be given in this chapter.

There are eight salt mines, potash mines and five salt works in Germany, four of them are located in the vicinity of a river port as illustrated in the table below.

Salt mines and location	Truck travel time to a port
Salt mine, Heilbronn	2min (Heilbronn, Neckar)
Salt work, Bad Friedrichshall	20min (Heilbronn, Neckar)
Salt mine, Bad Friedrichshall-Kochendorf	20min (Heilbronn, Neckar)
Salt mine and work, Borth	30min (Rheinberg, Rhine)

Table 54: Salt mines and works in the vicinity of a river port in DE[301]

[300] VKS: Verband der Kali- und Salzindustrie (2012), p. 25
[301] Own calculation

Figure 128: Salt mines and salt works in DE[302]

Germany's salt exports did not experience significant fluctuations from 2008 to 2013. The exports peak was achieved in in 2011 when more than 3 mil tons were exported. In 2013 2.7 mil tons of German salt found their way to other importing countries worldwide.

Looking at the exports to Danube countries it is clear that the market strongly increased in the observed period. From 2008 to 2013 German exports doubled and reached 185,000 tons in 2013 which is also the highest recorded volume in the six years.

Salt exports from DE					
2008	**2009**	**2010**	**2011**	**2012**	**2013**
Salt exports in total (in 1,000 tons)					
2,799	2,756	3,113	2,737	2,207	2,685
Salt exports to Danube countries in total (in 1,000 tons)					
81	137	153	152	131	185

Table 55: Salt exports from Germany[303]

[302] VKS: Verband der Kali- und Salzindustrie (2012), p.20,21
[303] Partly own calculation based on Destatis-Federal Statistical Office Germany (2014)

Germany has one mayor trade partner in the region, Austria. Exports to Austria sharply rose in 2009 for the first time, when volumes twice as large as in 2008 were exported. Between 2009 and 2012 German salt for Austria stayed stable at round 100,000 tons per year and again strongly increased in 2013 reaching 133,000 tons.

The Slovak market for German salt grew from year to year, and rose 10 times since 2008 achieving volumes of almost 30,000 tons in 2013. Hungary is the third important target market for Germany which stayed balanced in the previous years. Germany exported approx. 20,000 tons to Hungary each year.

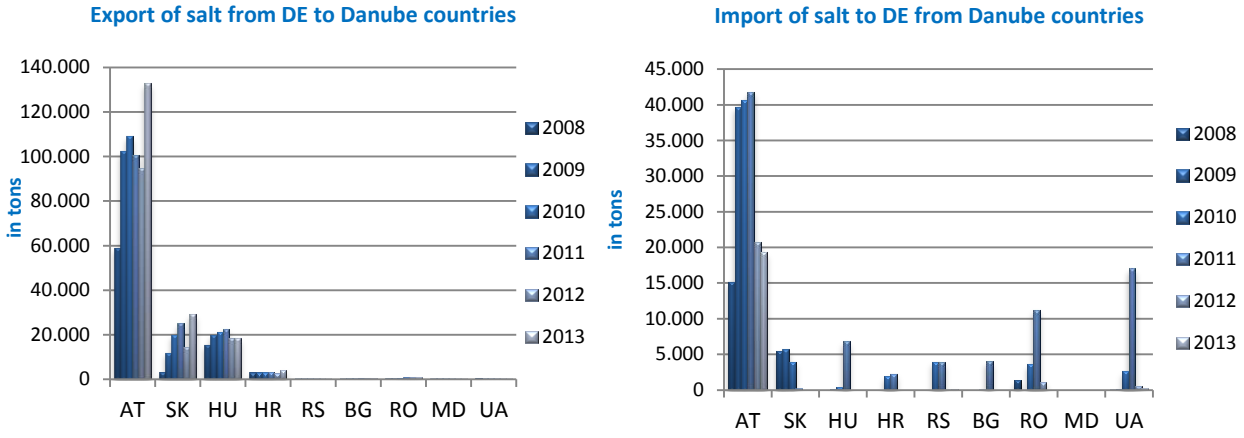


Figure 129: Salt trade flows DE and Danube countries[304]

Austria is also a significant salt source market for Germany. From 2009 to 2011, Germany's imports from Austria accounted for approx. 40,000 tons per year. In 2012 imports were cut into half and stayed at the same level in 2013. As shown in the figure above to the right, in 2010 and 2011 unusual upward swings occurred in all Danube countries except Moldova. Germany had almost nonexistent imports from Ukraine, however, in 2011 17,000 tons of salt were imported to Germany. In the same year 11,000 tons of salt were imported from Romania.

8.1.1.3.1.2. Ukraine

The Donetsk region, in the eastern part of the country, is the center of the salt production in the Ukraine, however, research showed that one large salt production company PJSC "Crimean Soda Plant" is located on the peninsula of Crimea and connected via waterways.

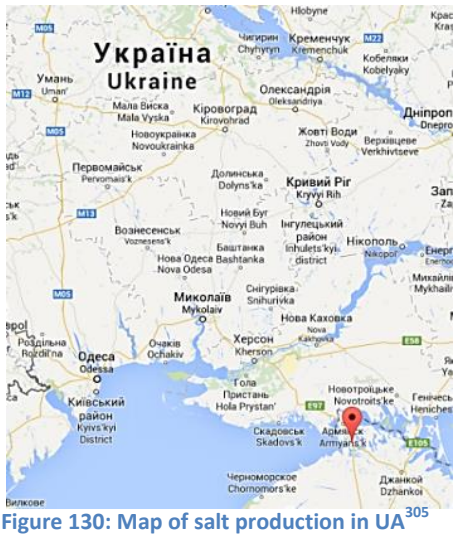


Figure 130: Map of salt production in UA[305]

[304] Own chart based on Destatis-Federal Statistical Office Germany (2014)
[305] Google maps (2014-08-20)

As already illustrated, Ukraine is the second largest exporter of salt in the Danube region with volumes between 1.7 mil tons in 2009 and 2.6 mil tons in 2011. The recent exported quantities in 2013 nearly equal the record values of 2011.

Salt exports from UA					
2008	**2009**	**2010**	**2011**	**2012**	**2013**
Salt exports in total (in 1,000 tons)					
1,783	1,714	2,172	2,629	1,943	2,619
Salt exports to Danube countries in total (in 1,000 tons)					
365	362	434	572	198	318

Table 56: Salt exports from UA[306]

In 2011 nearly 600,000 tons of Ukrainian salt was exported to Danube countries which is the absolute peak volume and the highest share in total exports namely 26% in the observed period of time. In 2013, more than 318,000 tons of salt found their way from Ukraine to Danube countries.

As stated in the figure below, salt trade experienced significant changes in volume especially in Slovakia and Hungary from 2008 to 2013. The highest bilateral trade was achieved in 2011 with Hungary accounting for 250,000 tons which equals 44% of the total export volume in the whole Danube region in the same year. Surprisingly, exports to Hungary dropped ten times down to 25,000 tons in 2012, rising again in 2013 and amounting 150,000 tons. The Slovak market absorbed relatively high volumes of salt from 2008 until 2011 however after the sharp decrease from 134,000 tons in 2011 to 27,000 in 2012 no further increase was realized in 2013.

The Romanian market was balanced in the previous years. Ukraine exported between 81,000 tons (2011) and 50,000 tons (2012, 2013). Serbia experienced a decline in the previous years, accounting lately 24,000 tons per year. Moldova, on the other hand doubled salt imports from Ukraine since 2011 which accounted for approx. 60,000 tons in 2012 and 2013.

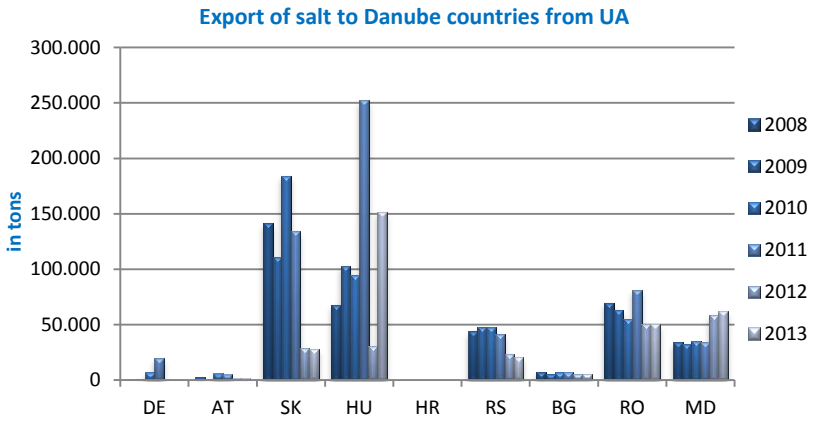


Figure 131: Salt exports to Danube countries from UA[307]

[306] Comtrade database
[307] Own chart based on Comtrade databse

8.1.1.3.1.3. Romania

There are seven active salt mines in Romania which are scattered throughout the country and organizationally connected to the “National Salt Company” (Societatea Nationala a Sarii S.A.- SNS SA). With approx. 2 mil tons production output Romania is the third largest producer and exporter of salt in the region. In 2012 Romania exported 636,000 tons, while 80% of trade relations are realized with neighboring countries, according to SNS SA[308]. Besides the production of salt for human consumption and food industry, rock salt for industrial usage is an important trade product for SNS salt mines. Industrial salt is available in various packaging units which include 20, 25, 50 and 1,000 kg (big) bags or even as bulk.

No mine is located in close proximity of the Danube River, the nearest one is Slanic Prahova 180 minutes truck travel time to the port of Braila. Upon request, SNS stated that that Slanic Salt Mine does not have any technical capacity of delivering salt on railway and for that reason cannot carry out transports on the Danube River.

Having in mind that the vast majority of the trade is conducted with bordering countries and the distance of the mines to waterways, IWT of salt does not seem to have large potential in Romania. Assuming Romania extends its trade partnerships with countries, which are at a greater distance such as Turkey, Netherlands, etc. IWT should be considered as suitable means of transport where pre-haulage can be also realized through truck transports.

Figure 132: Salt mines in RO[309]

[308] Mail from General Director Mr. Aurel Bucur
[309] Adapted map from Wikipedia (2014e)

8.1.1.3.2. Transport requirements[310]

Salt is a moisture sensitive cargo, therefore protection from moisture throughout the whole transport chain is essential.

Salt in inland navigation is mainly transported as bulk and in (big) bags. If salt is carried as bulk cargo, the stowage factor (specific weight) is crucial for the determination of the tonnage needed.

Stowage factor:

- 1.25 m^3/t (paper bags, 5-ply with plastic lining, 50 kg)
- 1.06 - 1.11 m^3/t (bags)
- 0.98 - 1.11 m^3/t (bulk)

In case of bagged salt for transport, it is important **not to** use hooks for transshipment in order to avoid bag damages.

Bulk salt can be handled with grabbers and it can be stored for several years, if it is stored in dry conditions.

Figure 133: Transshipment of salt in port of Vienna[311]

Figure 134: Bulk and packed salt[312]

8.2. Metallic raw materials

8.2.1. Iron ore

Rocks and minerals from which metallic iron can be economically extracted are iron ores. Iron ore predominantly used for steel production (98% of the mined iron ore), however, it is also used in the construction and transport industry (automobiles, trucks, train). Raw iron is not strong and hard as required from the field of purposes, for that reason iron is alloyed with other elements for strengthening and hardening.[313]

8.2.1.1. Market overview

Analysis showed that **Ukraine** is the dominating iron ore producer in the Danube region with significant outputs, not only on European but also on a global scale. Since 2009 production increased steadily and accounted for 84 mil tons in 2013.[314]

[310] TIS-Transport Information Service (2014g)
[311] ©viadonau
*protected data by Hungarian Central Statistical Office, ** no data available
[312] Artymsol
[313] Cargohandbook (2014f
[314] Worldsteel Association (2013), p.98

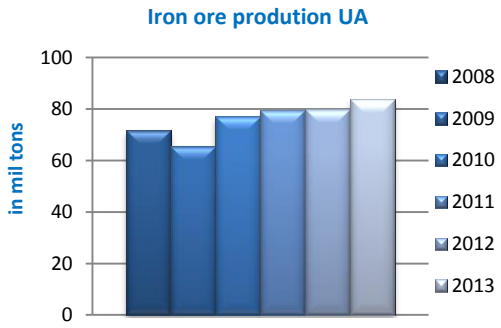


Figure 135: Iron ore production in UA[315]

Ukraine holds 4% in the total world production and is the sixth largest iron ore conveyer. Currently, Ukraine has about 30 billion tons of iron ore deposits which represent the largest extraction potential worldwide.

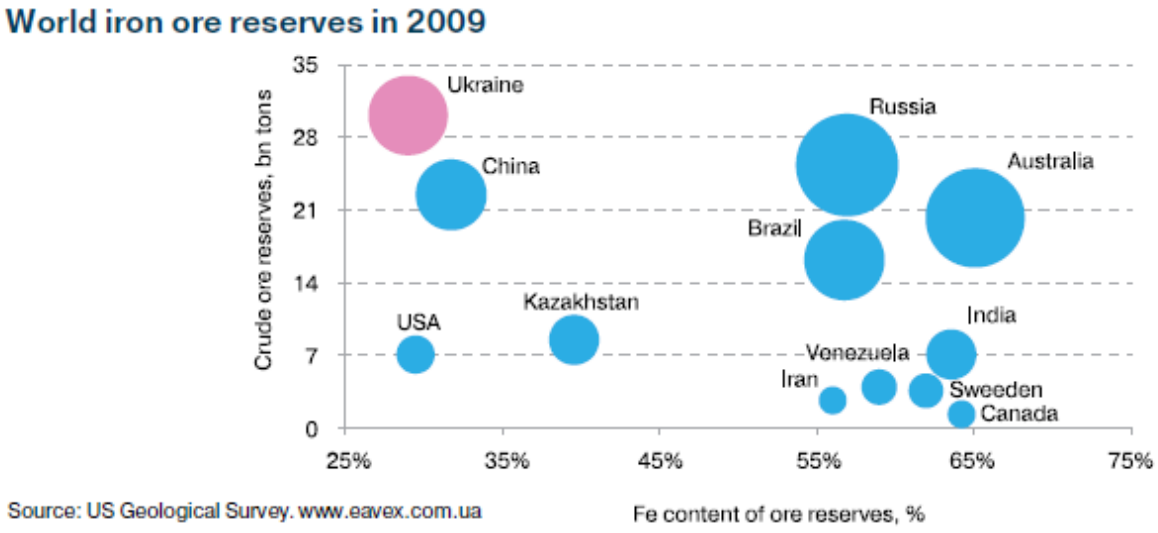


Figure 136: Ore reserves in UA[316]

Ukraine is not only the largest iron ore producer but also the largest resp. the only exporter of significance. Ukraine‘s exports increased steadily since 2008 and rose from 23 mil tons to 35 mil tons in 2012 in total. In With the exception of the year of crisis, 2009, Ukraine exported between 8.5 and 10 mil tons to Danube riparian countries which equals shares in total exports between 25% in 2012 and even 39% in 2008.

Iron ore exports from UA				
2008	**2009**	**2010**	**2011**	**2012**
Iron ore exports in total (in mil tons)				
23	28	33	34	35
Iron ore exports to Danube region in total (in mil tons)				
8,5	5,9	10	9,6	8,8

Table 57: Iron ore exports UA[317]

More than 70% of Ukraine’s exports to the Danube region in 2012 targeted Austria and Slovakia, which were also the main markets in the previous years. In 2010 exports to these countries rose

[315] Own chart based Worldsteel Association (2013), p.98
[316] Invest Ukraine p.8
[317] Worldsteel Association (2013), p.99; Partly own calculation based on Comtrade databse

strongly and while the Austrian market since then steadily decreased, exports to Slovakia kept rising and accounted in 2012 3.4 mil tons. In has to be mentioned, that the largest Austrian steel producer "voestalpine" receives iron ore from Ukraine, which is transported to Bratislava, SK via train and there transshipment on inland waterway vessels in order to reach the voestalpine plant, in the city of Linz (AT), for that reason volumes indicated below might be double counted.

Serbia was the third important market for Ukraine until 2011, however, in 2012 iron ore exports sharply declined due to operation difficulties of the largest steel producer in Serbia "Zelezara Smederevo", in the city of Smederevo, which is located at the Danube.

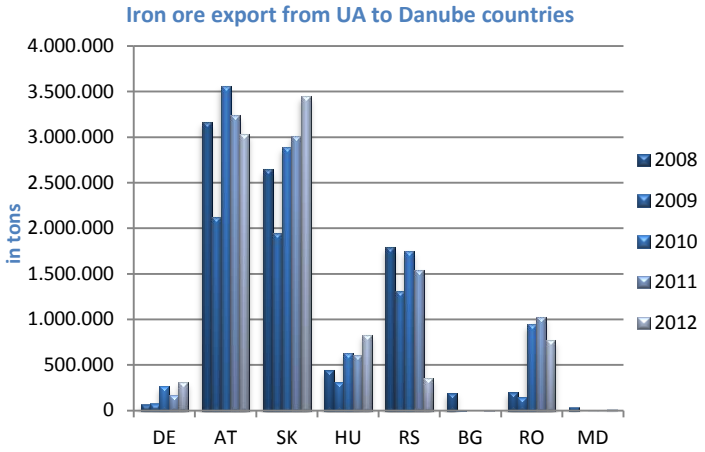


Figure 137: Iron ore export to Danube countries from UA[318]

Ore deposits are located in the regions of Kryvbas, Dnipropetrovsk and Zaporizhia in the central and south-eastern part of the country. Despite of the fact that mining companies which produce iron ore pellets, concentrate and sinter, are not located in the proximity of the Danube River a huge potential is given for Ukraine exporters resp. importers from the Danube region to use waterway transport of iron ore.

[318] Own chart based on Comtrade databse

Figure 138: Iron ore deposits and mining companies in UA[319]

The reason is the good rail connectivity to important ports as shown above and connectivity to the **Dnieper River** which flows into the Black Sea. Transshipment from sea vessels to river vessel can be conducted at so-called maritime Danube ports. The most important ports are:

Maritime Danube ports	Country
Braila	Romania
Galati	Romania
Giurgiulesti	Moldova
Reni	Ukraine
Tulcea	Romania
Izmail	Ukraine
Sulina	Romania
Constanta	Romania

Figure 139: Maritime Danube ports[320]

8.2.1.2. Transport requirements

Iron ore can be shipped as:

- Pellets (round 10mm diameter)
- Fines (1mm < 10mm diameter)
- Lump (max. 30mm diameter)

[319] Map adapted from Wikipedia Wikipedia (2014f), Break bulk (2013)
[320] ©viadonau, Port of Constanta, PBV

The most common category which is transported via inland navigation is “pellets” with a share of more than 60%, followed by iron ore fines with round 30% (Austrian example).

Stowage factor[321]:

- 0.29 – 0.8 m^3/t (lump)
- 0.45 - 0.5 m^3/t (pellets)
- 0.7 – 0.8 m^3/t (fines)

The cargo is not sensitive to moisture and temperature and can be handled with grabbers (all iron ore categories).

Example of good practice:

Iron ore from Ukraine to Austria – on a daily basis

“On average, two Danube ships a day arrive at the river terminal in Linz bearing iron ore from Ukraine. The Danube is in this way a major artery for delivering raw materials to the blast furnaces in Linz.

The iron ore is sourced from the Poltava region at the heart of Ukraine. It is some of the world’s richest ore, containing 65% iron. voestalpine uses iron ore in the form of pellets which are produced in the pelleting plant in Komsomolsk. From here the valuable cargo travels via the deep sea port of Juschni to Constanta in Romania where it is loaded onto barges. Around 50% of the 2.4 million tons of Ukrainian iron ore transported annually is brought to Linz by ship. The raw materials undertake a journey of up to four weeks from the mine to the plant. The rest arrives by train. In this way, an average of two fully loaded ships reaches the river terminal in Linz each day. Up to a third of all the iron ore needed for the blast furnaces in Linz and Donawitz originates from Europe’s largest country. However, this environmentally-friendly method of transport on the river is a two-way street; voestalpine is striving to increase the share of return freight in order to improve the ecological balance further and make transport even more cost-efficient.”

Figure 140: Good practice iron ore IWT; Figure iron ore[322]

8.3. Steel

An alloy of iron, carbon and other elements with at least 2.14% carbon content is defined as steel. Steel products play an essential role in various business sectors due to their high strength, extraordinary formability and corrosion resistance. A further advantage is that steel structures are fully recyclable.

[321] IMSBC-Code p. 159-160
[322] voestalpine Klangwolke (2014)

A distinction between hot-rolled and cold-rolled steel is made while both steel types are based on steel plates that have been previously produced from the mentioned raw materials.

Cold-rolled steel products have a more qualitative material surface and are therefore, mainly used in the automotive and electrical industries. Hot-rolled steel, on the other hand, can be welded easily and is consequently, particularly intended for usage in engineering, construction and energy industries.

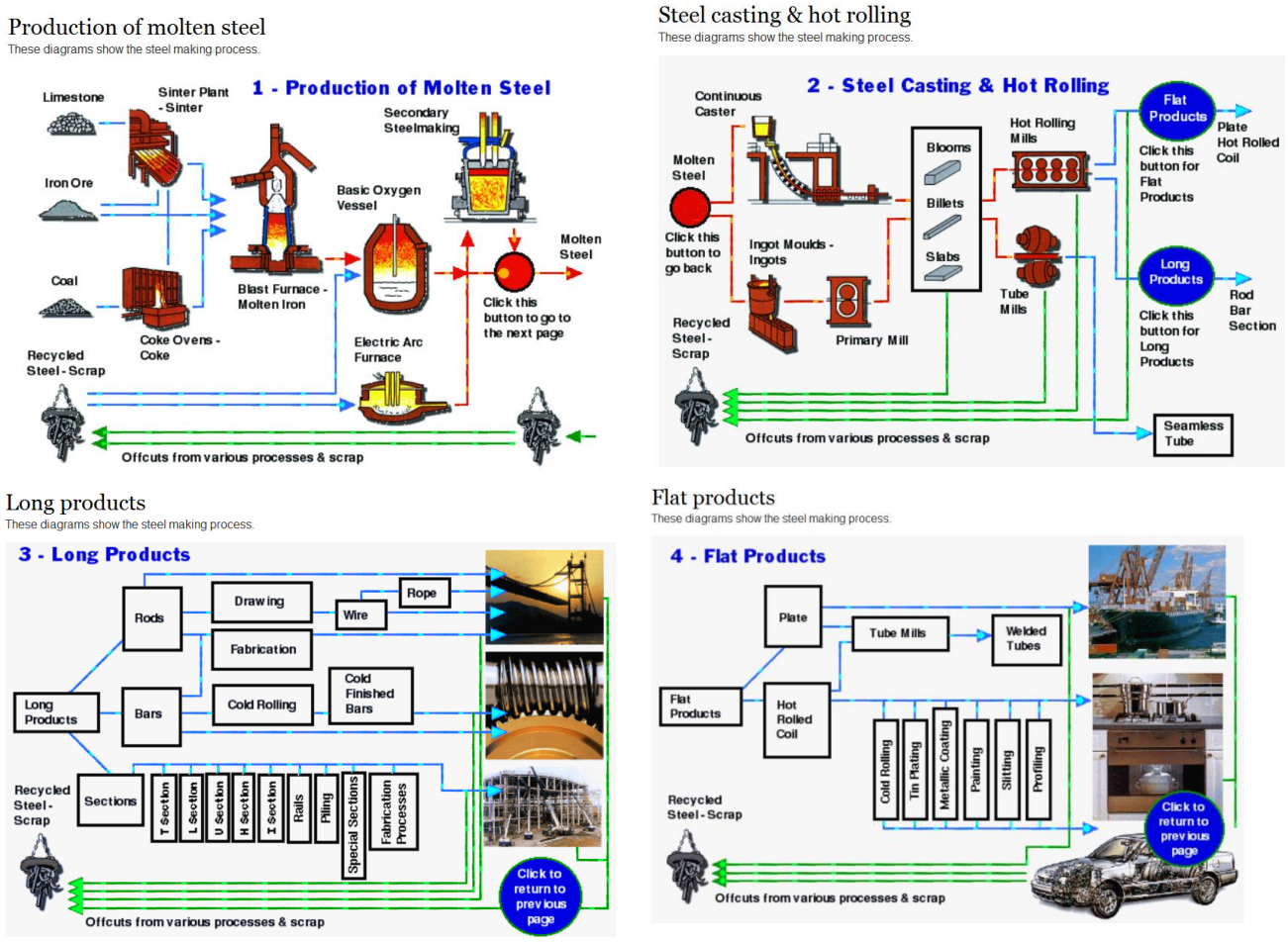


Figure 141: Steel production process[323]

8.3.1. Market overview

The world's steel production experienced high growth since 2002, as illustrated in the following table. The output increased by 71% from 2002 to 2012 and accounted lately 1.5 bill tons.

[323] UK steel: Steel production process

Years	World
2002	904
2003	970
2004	1,061
2005	1,147
2006	1,249
2007	1,347
2008	1,341
2009	1,236
2010	1,432
2011	1,536
2012	1,547

Figure 142: World steel production in mil tons[324]

million tonnes crude steel production

Country	2012		2011	
	Rank	Tonnage	Rank	Tonnage
China	1	716.5	1	702.0
Japan	2	107.2	2	107.6
United States	3	88.7	3	86.4
India	4	77.6	4	73.5
Russia	5	70.4	5	68.9
South Korea	6	69.1	6	68.5
Germany	7	42.7	7	44.3
Turkey	8	35.9	10	34.1
Brazil	9	34.5	9	35.2
Ukraine	10	33.0	8	35.3
Italy	11	27.3	11	28.7
Taiwan, China	12	20.7	12	20.2
Mexico	13	18.1	13	18.1
France	14	15.6	14	15.8
Iran	15	14.5	16	13.2
Spain	16	13.6	15	15.5
Canada	17	13.5	17	12.9
United Kingdom	18	9.6	18	9.5
Poland	19	8.4	19	8.8
Austria	20	7.4	22	7.5
Belgium	21	7.3	20	8.0
South Africa	22	6.9	21	7.5
Netherlands	23	6.9	23	6.9
Egypt	24	6.6	24	6.5
Malaysia (e)	25	6.0	26	5.9
Saudi Arabia	26	5.2	29	5.3
Czech Republic	27	5.1	28	5.6
Argentina	28	5.0	27	5.6
Vietnam (e)	29	4.9	30	4.9
Australia	30	4.9	25	6.4
Slovak Republic	31	4.4	34	4.2
Sweden	32	4.3	31	4.9
Thailand (e)	33	4.3	33	4.2
Finland	34	3.8	35	4.0
Kazakhstan	35	3.7	32	4.7
Indonesia (e)	36	3.7	37	3.6
Romania	37	3.3	36	3.8
United Arab Emirates (e)	38	2.8	42	2.0
Byelorussia	39	2.7	39	2.6
Venezuela	40	2.4	38	3.1
Luxembourg	41	2.2	40	2.5
Qatar	42	2.1	41	2.0
Portugal (e)	43	1.9	44	1.9
Chile	44	1.7	46	1.6
Hungary	45	1.5	45	1.7
Switzerland (e)	46	1.5	47	1.4
Colombia	47	1.3	49	1.3
Greece	48	1.2	43	1.9
Philippines (e)	49	1.2	50	1.2
Peru	50	1.0	51	0.9
Other		13.0		13.9
World		1,546.8		1,536.2

Figure 143: Leading crude steel producing countries[325]

With more than 42 mil tons crude steel output, Germany positioned itself as Europe's (with the exception of Russia) largest and seventh largest producer in the world. Besides Germany, five other Danube countries are amongst the crude steel manufacturers.

In 2012 the total crude steel production in the Danube region amounted more than 94 mil tons, which is approx. 12 mil tons less than in 2008.

Crude steel production in Danube region (in mil tons)				
2008	**2009**	**2010**	**2011**	**2012**
106	79	97	99	94

Table 59: Crude steel production in Danube region[326]

[324] Worldsteel Association (2013), p.4
[325] Worldsteel Association (2013), p.9
[326] Own calculation

As illustrated below, Germany had the leading position in the steel industry with stable outputs of round 44 mil tons since 2010. Even though all countries were hit by the year of crisis 2009, Germany's steel industry suffered the most when production decreased by 13 mil tons from 2008 to 2009.

Ukraine's outputs varied since 2008 and amounted for 33 mil tons in 2012. It is not surprising that outputs of the two mentioned countries made 80% of the total production in the whole region in 2012.

Austrian steel production was ranked third with approx. 7.5 mil tons output per year, followed by Slovakia and Romania with outputs less than 5 mil tons annually.

Figure 144: Sampling in steel production[327]

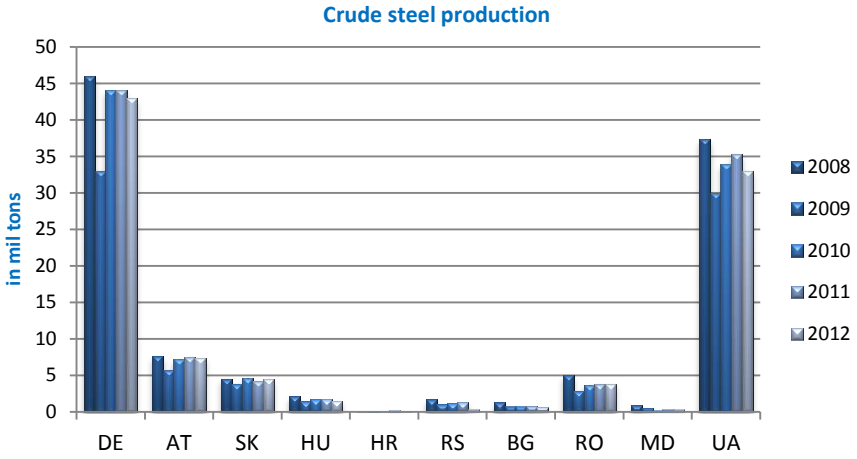


Figure 145: Crude steel production in Danube countries[328]

As already described above, there are various semi-finished steel products like ingots, coils, plates, etc. The national statistics of the Danube countries do not allow a detailed look at production and trade of steel products, for that reason, the categorization used in the European Mineral Report[329] 2009-2012, is used in the chapter too.

Exports of semi-finished steel products ingots, blooms and billets decreased since 2008 by more than 3 mil tons in the Danube region. In 2012 12.7 mil tons of these products were exported by Danube riparian countries. Import activities fluctuated from year to year. The import peak was reached in 2008 when 5.4 mil semi-finished steel products entered Danube countries followed by a heavy drop in 2009. After the registered increase in 2010 and 2011, imports again declined and amounted lately 3.7 mil tons.

2008	2009	2010	2011	2012
Exports of ingots, blooms and billets in Danube region in total (in mil tons)				
15,9	14,4	14,2	14,1	12,7
Imports of ingots, blooms and billets in Danube region in total (in mil tons)				
5,4	2,3	3,4	4,5	3,7

Table 60: Trade of semi-finished trade products in Danube region

[327] Wirtschaftsvereinigung Stahl
[328] Own calculation based on British Geological Survey (2014), p.241
[329] British Geological Survey (2014)

The steel semi-products export activity in the Danube region, is extremely limited to one dominating exporter and few small players. Ukraine's share in the region's total exports made up 79% (10 mil tons) in 2012, in 2009 even 84% (12 mil tons) of the total exports. Nevertheless, Ukraine's exports decreased since 2008 by 3 mil tons.

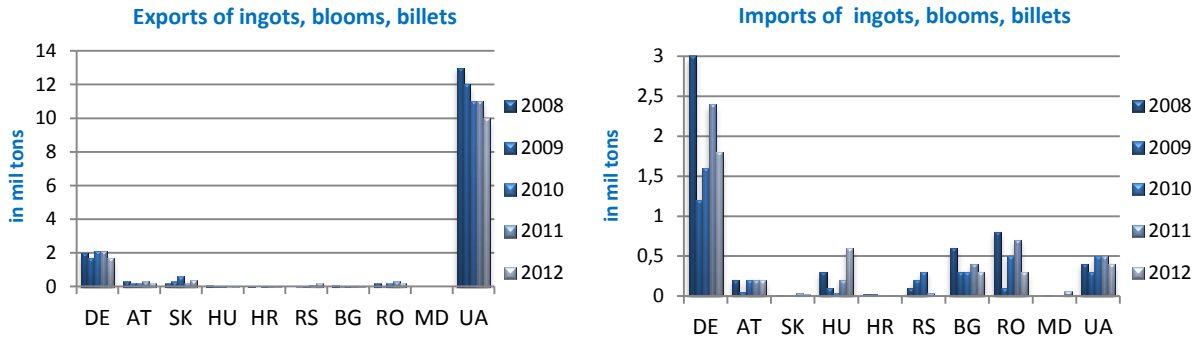


Figure 146: Trade of ingots, blooms, billets in Danube countries[330]

Concerning imports, a more differentiated picture is given. Germany is the country with the largest imports which varied in the observed period of time quite heavily. In 2008 Germany imported 3 mil tons of semi-finished steel products. In the following year, imports dropped down to 1.2 mil tons and increased again in 2010 and 2011 accounting then 2.4 mil tons. In 2012 Germany imported 1.8 mil tons. Other countries had varying import volumes in the observed period of time, as illustrated above.

Germany

Germany is the leading crude steel producer in the European Union and the seventh largest producer on global scale with a share of 3% in world production. 30% resp. 17.2 bil € of the German added value are allocated to the steel industry. Approx. 67% of the steel is manufactured in smelting plants while the remaining portion is produced in electric arc furnaces (EAF) which process metal scrap to new steel.

The province of North Rhine Westphalia which is located in the west of the country is the predominant steel production area with a share of 40% in total steel production in Germany[331] .

Figure 147: Steel production plant in DE map[332]

[330] British Geological Survey (2014), p.242,43
[331] Wirtschaftsvereinigung Stahl
*Due to lack of data no detailed list of steel producing and steel processing companies can be provided
[332] Wirtschaftsvereinigung Stahl

There are 12 ports in the mentioned province which are situated at the Rhine River:

Ports at Rhine River in Rhine-Westphalia	
• Bonn	• Krefeld
• Cologne	• Duisburg-Ruhrort
• Leverkusen	• Duisburg-Walsum
• Dormagen	• Rheinberg
• Neuss	• Wesel
• Düsseldorf	• Emmerich am Rhein

Table 61: Rhine ports in Rhine-Westphalia[333]

Germany's steel industry used more than 85 mil tons of raw materials in 2012 of which 38.9 mil tons iron ores, 20 mil tons steel scrap and the remaining 11.2 mil tons consist of various other materials, as illustrated in the figure below. The most important energy raw material for steel production is coking coal with an annual usage of more than 9 mil tons.

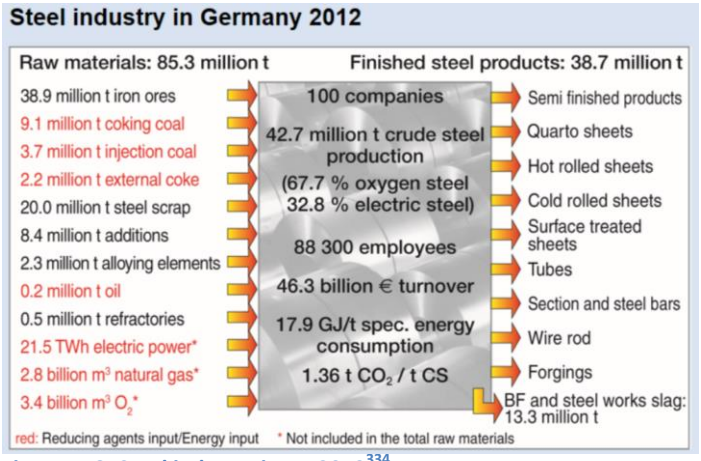


Figure 148: Steel industry in DE 2012[334]

As elaborated in the chapter "iron ore", Germany does not have significant iron ore production as a result iron ore imports are essential for German steel production. The dependence on imports of iron ore, coking coal and steel scrap, shown in the graphic, clearly underlines the necessity for reliable and large domestic and foreign raw material providers.

[333] Own research
[334] Wirtschaftsvereinigung Stahl

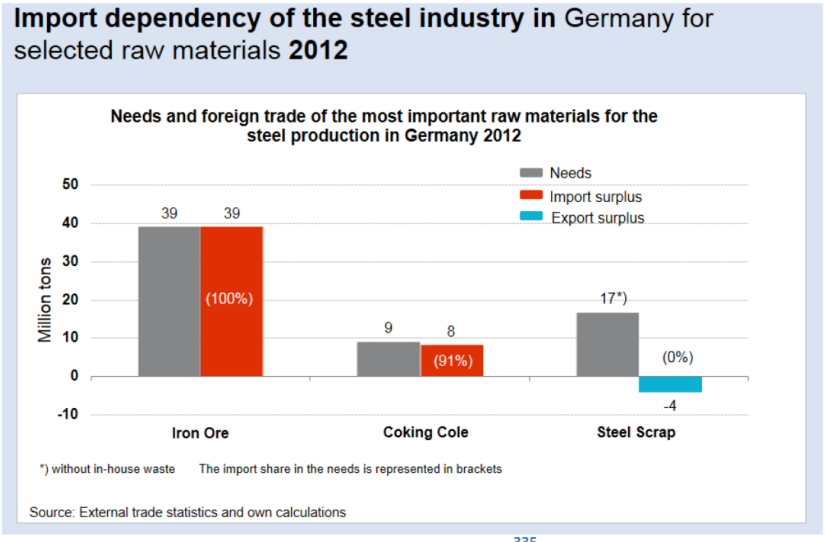


Figure 149: Import dependency of steel industry DE[335]

According to the "Steel-Center" in Düsseldorf, Germany[336] round 50% of the transports in the steel industry are conducted via rail, 30% via inland navigation and the remaining 20% via road haulage. As IWT is especially important for raw material delivery and Germany **is** truly depended on imports, waterway transport might play an even more significant role in future.

The following table shows Germany's trade flows of iron and steel* with countries of the Danube region. German exports achieved in 2013 the second largest volume since 2008 with approx. 2.42 mil tons of iron and steel semi-finished products were exported to Danube countries.

Danube countries, as source markets, for Germany accounted lately 3.91 mil tons in 2013 which was 360,000 tons less than the record high in 2008 which amounted almost 4.3 mil tons.

Iron and steel trade DE (in mil tons)					
2008	**2009**	**2010**	**2011**	**2012**	**2013**
Export of iron and steel products from DE to Danube countries					
2.74	1.85	2.38	2.37	2.36	2.42
Imports of iron and steel products to DE from Danube countries					
4.27	3.05	4.07	4.13	3.85	3.91

Figure 150: Iron and steel trade DE[337]

From the following figures it is clear, that Germany has one significant partner as target and resource market of steel in the Danube region. Exports to Austria stayed unchanged from 2010 to 2013 with round 1.5 mil tons per year which was more than 800,000 tons less than the volume in 2008 with the record high of 1.84 mil tons. The Slovak market steadily increased since 2009 with annual growth rates which resulted in exports of around 500,000 tons in 2013, whereas only 184,000 tons of the steel and iron products were exported to Slovakia in 2009. Hungary's market size which amounted in average 300,000 tons per year, did not vary substantially since 2010.

A similar picture can be identified when looking at imports of steel products from Danube countries to Germany. Round 2.8 mil tons of Austrian iron and steel products were imported to Germany 2011-2013. With the exception of 2009, imports from Austrian never dropped lower than 2.5 mil per year.

[335] Wirtschaftsvereinigung Stahl (2014-09-01)
[336] Wirtschaftsvereinigung Stahl
*in the German Commodity Classification for Foreign Trade Statistics (Warenverzeichnis für die Außenhandelsstatistik) group no. 72 (WA72) consists of iron and steel semi- finished products in all available forms (incl. coils)
[337] Destatis-Federal Statistical Office Germany (2014)

Slovakia was a stable source market with volumes between 400,000 and 500,000 tons. Hungary's supply amounted since 2010 approx. 280,000 tons annually.

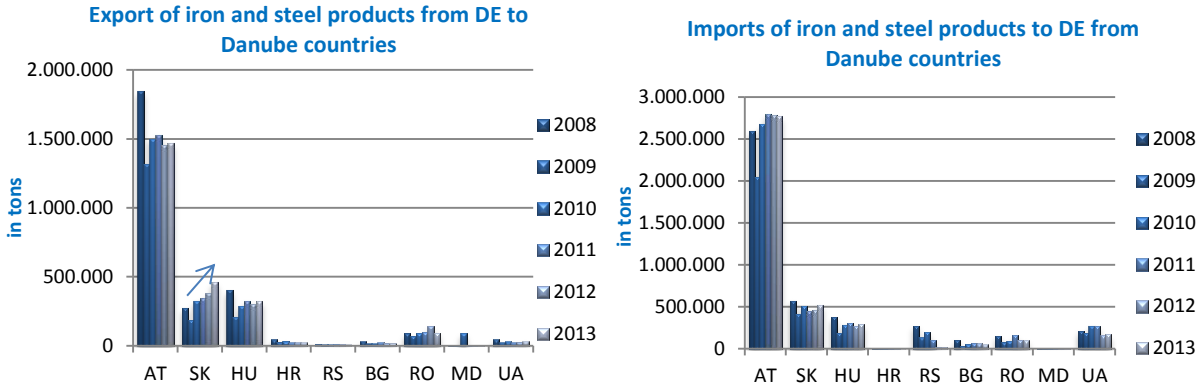


Figure 151: Trade of iron and steel products DE and Danube countries[338]

8.3.2. Transport requirements

Risk factors during transport and transshipment for all mentioned steel products are corrosion resulting from moisture, mechanical damage and contamination/defilement.

In general three types of steel are transported via waterways in large quantities: sheets, roiled sections and small section material, rods and wire.
Steel sheet is mainly carried in the form of coils, but smaller quantities are frequently carried in packs.

Cargo handling should be carried out in dry weather or under cover, due to moisture sensibility of the products.

Steel coils are especially sensitive to mechanical damages. Consequently, special equipment should be used such as C hooks, coil lifters, vertical coil lifters, coil mandrels, webbing slings, chain slings.[339]

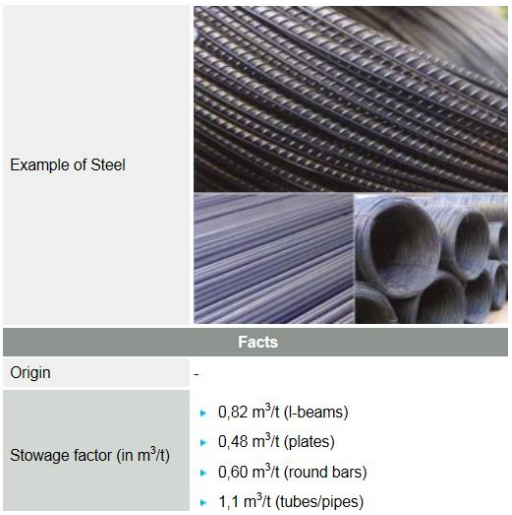


Figure 152: Steel factsheet[340]

[338] Destatis-Federal Statistical Office Germany (2014)
[339] Cargohandbook (2014g), TIS-Transport Information Service (2014h)
[340] Cargohandbook (2014g)

9. Energy raw materials

9.1. Crude oil

Crude oil or petroleum is a fossil fuel which is brought to surface through drilling. It is a flammable liquid with moderate fire risk. Crude oil has a wide range of application. After refining, crude oil is separated to petrol / gasoline / kerosene, asphalt and chemical components for plastics and pharmaceuticals production with a ratio of 6:1 in favor of petroleum-based products.[341]

9.1.1. Market overview

Crude oil is produced in all Danube riparian countries, however, Slovakia, Bulgaria and Moldova produce relatively small outputs accounting not more than 25,000 tons. The crude oil production leader was Romania with round 4 mil tons in 2012 which is 600,000 tons less than in 2008. Germany's output slightly varied in the observed period reaching in 2012 the same volume as in 2011, namely 2.6 mil tons. No data was available for 2012 regarding Ukrainian production volumes, but in the graphic below the declining trend is evident. The only Danube countries which recorded in increase is Serbia which doubled the production from 2008 to 2012 amounting lately 1.2 mil tons.

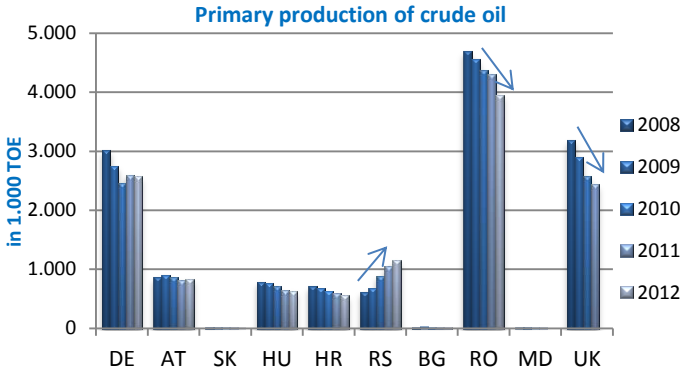


Figure 153: Crude oil production in Danube countries[342]

Analysis showed that there are no crude oil trade flows among the Danube countries. Furthermore, all countries have a negative trade balance importing crude oil mainly from Russia and (North) African countries outside Europe and The Netherlands, Great Britain and Poland.

In general, imports of crude oil decreased steadily from 2008 to 2011 for approx. 20 mil tons. The table below also shows that imports underwent a decline in almost every single Danube country. Especially in the case of Germany, the largest importer, decrease is visible. The reasons for the decrease might be the obligatory reduction of CO2 emission for EU member states. Having in mind that crude oil processing in refineries has great polluting effects on environment, the reduction in oil production and imports might continue in the future.

Imports of crude oil in Danube region (in 1,000 tons)			
2008	**2009**	**2010**	**2011**
154,060	143,142	135,699	130,068

Table 62: Crude oil imports in Danube region[343]

[341] Cargohandbook (2014h)
[342] IEA-International Energy Agency: Statistics
[343] IEA-International Energy Agency: Statistics

Imports of crude oil (in 1,000 tons)				
	2008	**2009**	**2010**	**2011**
DE	105,365	98,028	93,268	90,519
AT	7,864	7,424	6,795	7,293
SK	5,902	5,704	5,465	6,022
HU	6,665	5,425	5,731	5,887
HR	3,473	4,048	3,536	2,838
RS	2,585	2,279	1,883	1,389
BG	7,219	6,158	5,434	4,989
RO	8,419	6,894	5,822	5,452
MD	0	0	0	0
UK	6,568	7,182	7,765	5,679

Table 63: Crude oil in imports in Danube countries[344]

The current distribution of crude oil in Europe is facilitated through a wide network of pipelines and through tankers which transport crude oil over long distances across water way. The figure below shows existing pipelines* in and through Europe which seem to be connect all refineries.

Despite of the fact that crude oil imports are declining in the Danube region and Germany is the only country which exports crude oil, however, mainly to UK and Norway[345], inland waterway transport should be considered as a suitable alternative means of transport for crude oil. Especially for upstream routes from the Black Sea towards Germany it is worth to take a closer look at inland waterway transport opportunities.

The refineries in the Danube countries are marked in the following map. With the exception of Romania, all refineries in the Danube countries are located in the close vicinity of the Danube River.

[344] IEA-International Energy Agency: Statistics
[345] Destatis-Federal Statistical Office Germany (2014)
*the planned pipelines through Romania already exist (see: http://www.rafo.ro/en/index.php/activity/refinery/crude-oil-logistics.html)

Figure 154: Crude oil pipelines in EU[346]

9.1.2. Transport requirements

Crude oil can be contaminated through remains of previous cargo or by cleaning substances, as a result of improperly cleaned tank. Contact with coatings on tank walls may also cause damage through chemical changes in the product itself. Incomplete emptying of the tank may lead to loss in volumes however the loss depends on the properties of the product, the dimensions and design of the cargo tanks, and the efficiency of the ship's discharge system as well as the temperature of the discharge time. [347]

According to the UNECE "European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways" (ADN), crude oil as well as diesel, fuel oil and gasoline are is classified as dangerous.[348] Consequently, special transport conditions are required for this product. Furthermore, ADN requires double hull transport vessels, which should prevent leakage of petroleum products into the water in case of ship damages.

Example of Petroleum and Petroleum Products	
Facts	
Origin	See text
Stowage factor (in m^3/t)	Petr. oil 1,34 m^3/t (bulk) Petr. oil 1.4 m^3/t (drum)

Figure 155: Crude oil factsheet[349]

[346] Wikipedia (2014g)
[347] Cargohandbook (2014h)
*no data available
[348] United Nations Economic Commission for Europe, p.370 et al.
[349] Cargohandbook (2014h)

9.2. Diesel fuel & gas oil

Diesel is derived from crude oil during the fractionation processes, where heavier oils are separated from lighter oils. Diesel belongs to the group of middle distillates due to its middle boiling range (150°C to 390°C), as illustrated in the figure to the right.

Diesel is well known as fuel for motor vehicles but it can also be used for heating.

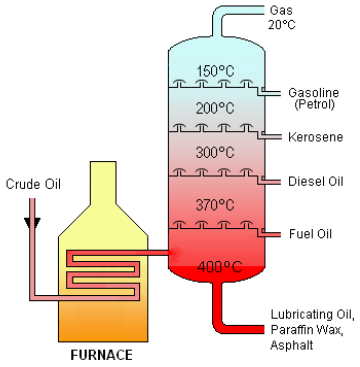


Figure 156: Crude oil fractionation[350]

Gas oil is an intermediate product of diesel. After the removal of sulphur (desulphurisation) from gas oil, it can be used as fuel for robust motors. Nowadays, the majority of inland waterway vessels uses gas oil as fuel for environmental reasons. The EU Directive 2009/30/EG dictates a maximum sulphur content of 10mg/kg fuel (=10 ppm) for inland vessels as from 2011 with the aim of reducing environmental pollution and achieving the goal of a 30% reduction in greenhouse gas emissions by 2020.

9.2.1. Market overview

The production of diesel and gas oil in the entire Danube region has experienced a decrease of 10 mil tons from 2007 to 2012 accounting lately round 63 mil tons.

Production of diesel & gas oil in the Danube region (in 1,000 tons)					
2007	**2008**	**2009**	**2010**	**2011**	**2012**
73,491	72,421	68,568	64,961	63,439	63,037

Table 64: Production of diesel & gas oil in Danube region[351]

The decrease in diesel and gas oil production mainly resulted from the production decline in Germany, which held 70% (round 44 mil tons) of the region's production in 2012. German output of these petroleum products accounted in 2012 almost 6 mil tons less compared to 2007 when more than 49 mil tons were produced.

Other Danube countries had more or less stable production volumes which did not exceed 5 mil tons per year. Austria, Hungary and Romania had comparable volumes of round 3.4 – 3.8 mil tons annually. In Croatia, Serbia and production declined slightly while in the Ukraine the volume dropped massively in 2012.

[350] Wikipedia (2014h)
[351] IEA-International Energy Agency

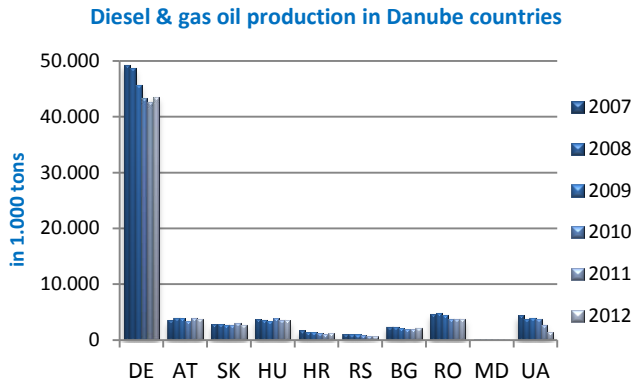


Figure 157: Production of diesel & gas oil in Danube countries[352]

Despite of the declining production in the Danube region, domestic consumption on the other hand increased since 2007 but fluctuated slightly from year to year. In 2012 approx. 76 mil tons of diesel and gas oil were consumed which is 1.4 mil tons less than in the previous year and even 3.5 mil less than in 2008 when the record high of almost 80 mil tons was achieved.

Domestic supply of diesel & gas oil in the Danube region (in 1,000 tons)					
2007	**2008**	**2009**	**2010**	**2011**	**2012**
71,525	79,856	75,190	77,197	74,875	76,327

Table 65: Domestic consumption of diesel & gas oil in Danube countries[353]

Germany had the leading position in domestic supply of diesel and gas oil with volumes of round 50 mil tons per year since 2009, Austria took the second place with 7.5 mil tons in average per year. With 5.5 mil tons per year, Ukraine plays the third important role in this resp. Supply in the remaining Danube countries varied from 1.4 (SK) to 4.3 (RO) mil tons per year.

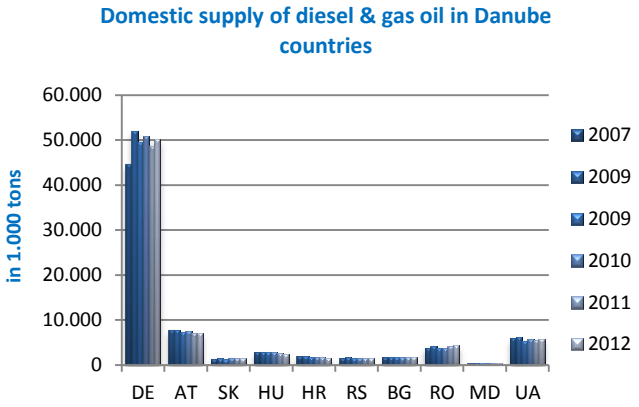


Figure 158: Domestic consumption of diesel & gas oil in Danube countries[354]

Concerning the increased domestic supply and decreasing national production it is not surprising that exports sharply declined resp. almost halved since 2007.

[352] IEA-International Energy Agency
[353] IEA-International Energy Agency
[354] IEA-International Energy Agency

Export of diesel & gas oil in the Danube region (in 1,000 tons)					
2007	2008	2009	2010	2011	2012
20,097	18,035	15,634	13,179	13,221	12,993

Table 66: Export of diesel & gas oil in Danube region[355]

At the same time, imports of diesel and gas oil increased by round 8 mil tons in order to satisfy the rising demand. Nevertheless, as illustrated in table 54 import volumes were not subject to continuous increase but one strong upward movement in 2008 and slight fluctuations until 2012.

Import of diesel & gas oil in the Danube region (in 1,000 tons)					
2007	2008	2009	2010	2011	2012
20,751	29,255	25,380	28,795	27,357	28,205

Table 67: Import of diesel & gas oil in the Danube region[356]

The developments of exports on national level did not vary significantly in the Danube countries with one exception, Germany. Due to Germany's leading position in this segment, it is obvious that Germany's massive exports cuts affected the entire Danube region. Germany reduced its imports by 50% within five years and they lately accounted for 6 mil tons while in 2007 even 12 mil tons of diesel and gas oil entered the country. Other Danube countries kept their export volumes relatively stable.

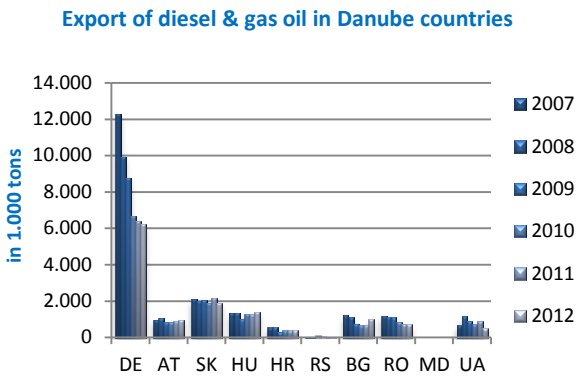


Figure 159: Export of diesel & gas oil in Danube countries[357]

As already mentioned the strong increase in imports occurred in 2008, driven by Germany which increased imports from 9 mil tons in 2007 to nearly 16 mil ton in the following year. The high import level in Germany varied slightly until 2012 and amounted 13.5 mil ton the in last year of observation.
Other countries which also increased imports were Ukraine and Romania.

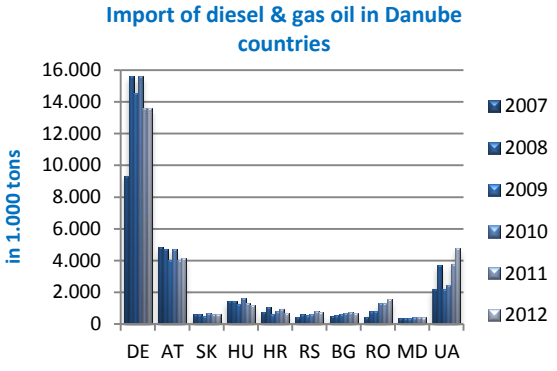


Figure 160: Import of diesel & gas oil in Danube region[358]

[355] IEA-International Energy Agency
[356] IEA-International Energy Agency 014-09-24)
[357] Own chart based IEA-International Energy Agency
[358] Own chart based on IEA-International Energy Agency

9.2.1.1. Germany

Germany is as stated the largest producer, consumer, exporter and importer of diesel and gas oil in the Danube corridor. Diesel which is intended for export or imported to Germany is mostly stored for some time after being distributed via pipeline or trucks to gas stations or industrial plants. According to the Independent Association of Tank Farms[359] there are 16 independent tank farm companies with round 70 tank farm locations spread throughout the entire country. The total capacity of the 70 tank farms amounts 11 mil m3[360].

Company, location	Capacity	Truck travel time to the nearest Danube /Rhine/Main port	If reachable via ship on rivers other than Danube/Rhine/Main max. dimensions of ship, max. tonnage
Petrotank, Regensburg	77,500 m³	0min (located at Danube river bank)	
Petrotank, Bamberg	3,500 m³	0min (located at Main-Danube-Canal bank)	
Petrotank, Erlangen	2,280 m³	35min (Nuremberg/Bamberg)	
Petrotank, Bullay	5,000 m³	70min (Koblenz)	90m length
Petrotank, Dortmund	70,200 m³	60min (Duisburg, Rhine)	110m length, 2.8m draught
Petrotank, Duisburg	106,600 m³	0min (located at Rhine river bank)	
Petrotank, Düsseldorf	60,500 m³	0min (located at Rhine river bank)	
Petrotank, Frankfurt am Main	34,340 m³	0min (located at Main river bank)	
Petrotank, Hamm-Uentrop	13,500 m³	80min (Duisburg, Rhine)	
Petrotank, Hanau	9,700 m³	0min (located at Main river bank)	
Petrotank, Cologne	100,000 m³	0min (located at Rhine river bank)	
Petrotank, Lünen	150,000 m³	50min (Duisburg, Rhine)	86m length, 2.7m draught
Petrotank, Marktredwitz	8,000 m³	85min (Bamberg, Main-Danube-Canal)	
Petrotank, Trier	32,500 m³	75min (Koblenz)	135m length
Petrotank, Würzburg	20,000 m³	0min (located at Main river bank)	115m length, 2.5m draught
UTG, Essen 1	106,000 m³	35min (Duisburg, Rhine)	
UTG, Essen 2	143,070 m³	35min (Duisburg, Rhine)	
ED Mineralölhandels KG	30,300 m³	20min (Koblenz, Rhine)	
Oiltanking, Bendorf	145,000 m³	0min (located at Rhine river bank)	
Oiltanking, Deggendorf	25,789 m³	0min (located at Danube river bank)	
Oiltanking, Duisburg	35,000 m³	0min (located at Rhine river bank)	
Oiltanking, Frankfurt	48,000 m³	0min (located at Main river bank)	
Oiltanking, Hamm	109,000 m³	75min (Duisburg, Rhine)	Two barges max 2,000 tons

[359] UTV-Verband gewerblicher Tanklagerbetriebe (2014)
[360] These tank farms are also used for chemical products

Oiltanking, Hanau	63,000 m³	35min (Frankfurt am Main, Main)	two Rhine barges max 3,300 tons each
Oiltankin, Rheinau-Honau	245,409 m³	0min (located at Rhine river bank)	
Oiltanking, Karlsruhe	261,000 m³	0min (located at Rhine river bank)	
Simon Tanklager-Gesellschaft mbH	304,000 m³	0min (located at Rhine river bank)	
TanQuid, Oberhausen	104,000 m³	90min (Regensburg)	
TanQuid, Duisburg	226,000 m³	0min (located at Rhine river bank)	
TanQuid, Hünxe	878,000m³	0min (located at Rhine river bank)	
TanQuid, Koblenz	34,000 m³	0min (located at Rhine river bank)	
TanQuid, Neuss I	56,500 m³	0min (located at Rhine river bank)	
TanQuid, Neuss II	24,500 m³	0min (located at Rhine river bank)	
TanQuid, Speyer	786,500 m³	0min (located at Rhine river bank)	
Unitank, Fürth	70,000 m³	0min (located at Main-Danube-Canal)	
Unitank, Emleben	330,000 m³	40min (Schweinfurt, Main)	
Valentin, Mainz	20.000 m³	0min (located at Rhine river bank)	

Table 68: Tank farms in DE and distance to the nearest port[361]

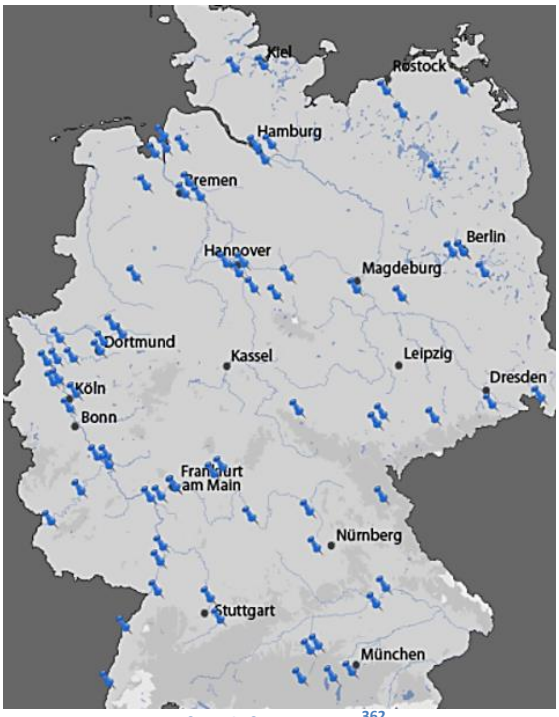


Figure 161: Map of tank farms in DE[362]

Besides tank farms, mineral oil refineries play also an important role for distribution and further processing of mineral oil products. There are 19 refineries in Germany, which are located mostly in the western and eastern part of the country esp. crude oil refineries, as illustrated. The green lines symbolize crude oil pipelines while the green lines show product pipelines. The capacity of the refineries is marked with grey symbols with one grey box equaling one mil tons flow rate capacity.

[361] Own research; data: company UTV-Verband gewerblicher Tanklagerbetriebe (2014)
[362] Stepmap (2009)

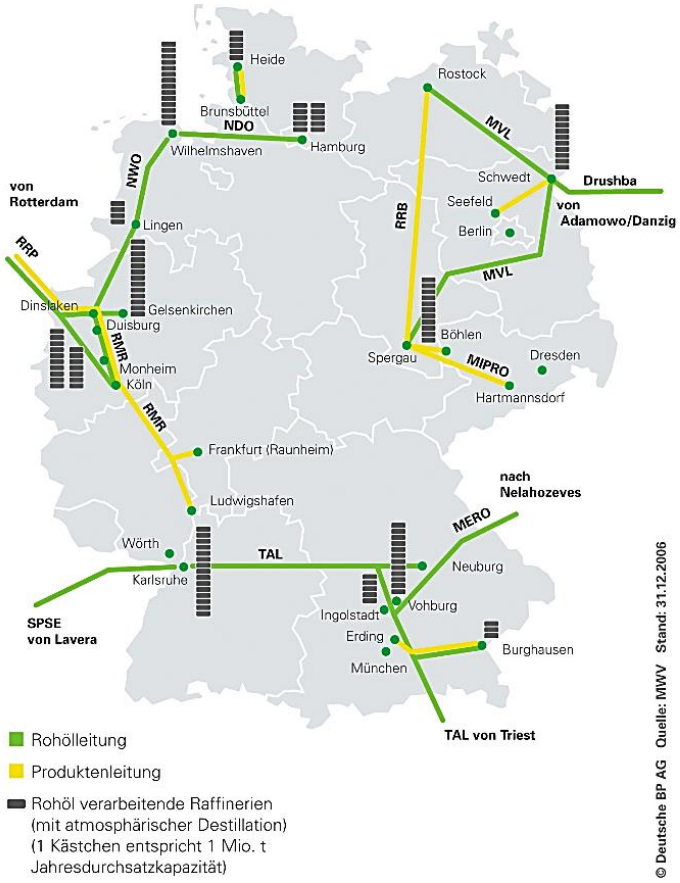


Figure 162: Refineries in DE[363]

Analysis showed that diesel trade is realized with a small number of partners from the Danube region. Concerning target market the table below clearly shows that Austria was by far the country with the largest volumes. In the observed time period exports to Austria did not vary considerably and accounted in 2011, which is the last available data, round 2.8 mil tons.

Export of diesel to Danube countries from DE (in 1,000 tons)					
	2007	**2008**	**2009**	**2010**	**2011**
AT	2,966	2,703	2,757	3,105	2,808
SK				12	21
HU	45	55	63	30	24

Table 69: Export of diesel to Danube countries from DE[364]

The important source markets for Germany are Hungary and Slovakia. Imports from Slovakia reached the peak in 2010 with round 100,000 tons and could almost keep this volume in 2011. Imports from Hungary strongly increased from 2009 to 2010 accounting for more than 200,000 tons followed by a decline of more than 50% down to 88,000 tons in 2011. Austria diesel fuel was only imported in 2011 with volume amounting 36,000 tons. The remaining Danube countries contributed no significant quantities.

[363] BP
[364] Destatis-Federal Statistical Office Germany (2014)

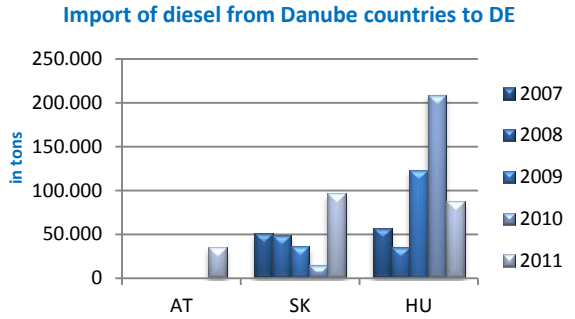


Figure 163: Import of diesel from Danube countries to DE[365]

The role of inland waterway transports for diesel transports to/from Germany cannot be conducted in depth due to lack of data, however the IWT share in transport of the product group "mineral oil products" which includes diesel shows that inland navigation does not play mayor role in overall modal shift.

The evaluation of realized inland waterway transports in 2010 until 2012 (2013) of mineral oil products from and to Germany resp. to and from the above mentioned trade partners, shows that IWT has a lot of unused potential.

In 2010 Germany exported round 31,000 tons via Danube navigation to Austria and Slovakia in total of which 25,000 tons were allocated to Austria. In 2011 Danube transports dramatically dropped down to approx. 7,000 tons where Austria again played a more important role in comparison to Hungary. In 2013 no Danube transports of German exported mineral oil products were conducted.

The right figure below shows that imports of mineral oil products to Germany from trade partners from the Danube region were increasingly realized through Danube navigation. While IWT from Hungary decreased, transport of mineral oil products from Austria increased. The total volume of imports via inland navigation grew since 2011 (200,000 tons) up to 320,000 tons in 2013.

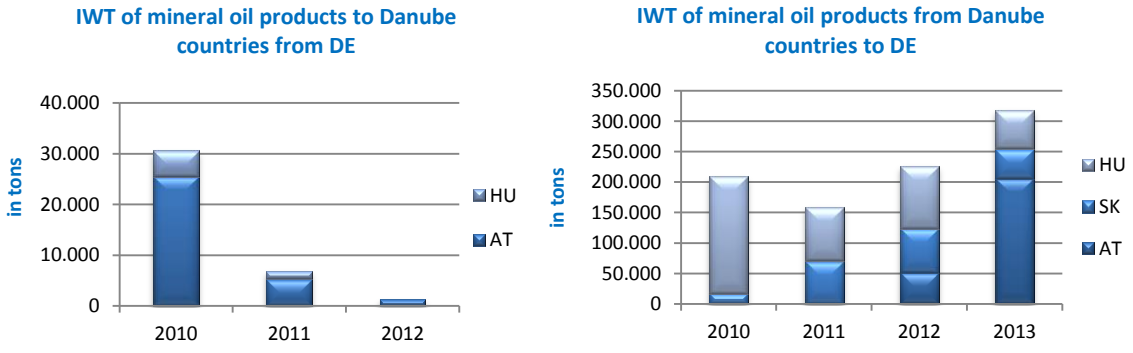


Figure 164: IWT transports of mineral oil products DE[366]

The development in inland waterway transport of mineral oil products in Germany, corresponds to the described market situation in the introduction of the chapter, namely, decreasing exports and increasing imports.

9.2.1.2. Hungary

As the second largest diesel and fuel oil exporter in the Danube region with round 2 mil tons per year, Hungary has three refineries of which one, namely the refinery of Duna in Százhalombatta, is located

[365] Destatis-Federal Statistical Office Germany (2014) KN: 2710 19 41

[366] Statistics Austria (2013)

in the vicinity of the Danube River. The Duna and the remaining two refineries are owned by the Hungarian MOL mineral oil company. The raw material, crude oil, is mainly imported from Russia through the Druzhba pipeline which is processed in all three refineries however the Duna site is the most complex one with motor fuel production capacities (included desulphurization components).

The annual production capacity of Duna is 8.1 mil tons per year with products such as LPG, gasoline, diesel (Euro V motor compliant), etc. [367]

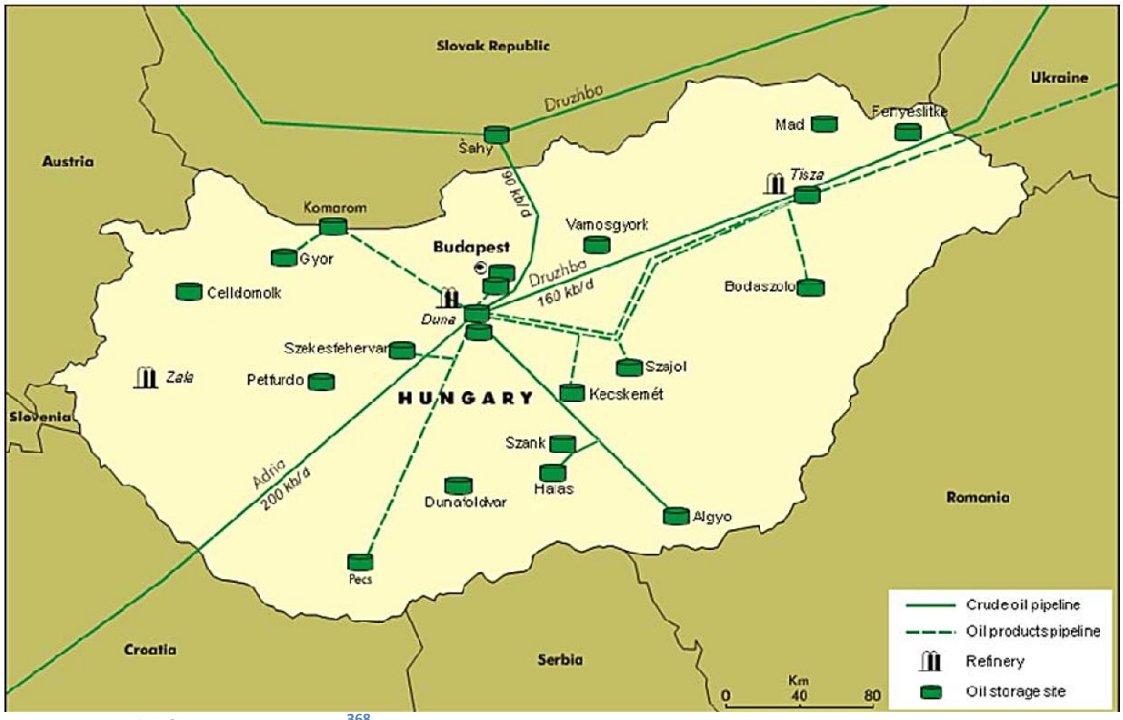


Figure 165: Oil infrastructure in HU[368]

There are 10 storage sites with a total capacity of 1.7 million tons for crude oil and mineral oil products in total. Eight MOL storage warehouses are public and are situated in Algyő, Csepel, Komárom, Pécs, Szajol, Székesfehérvár, Százhalombatta and Tiszaújváros. Other companies than MOL also operate tank farms like for e.g. in Százhalombatta, Tiszaújváros and Fényeslitke.

Besides the oil port in Budapest, import and export of mineral oil products can be facilitated in Komárom and Százhalombatta.

As shown in the figures, Hungary' diesel exports to the Danube region experienced a remarkable increase since 2008 of 410,000 tons in 2011 which is the latest available data.

Exports of diesel to Danube countries from HU (in 1,000 tons)			
2008	**2009**	**2010**	**2011**
735	742	1,147	1,145

Table 70: Exports of diesel to Danube countries from HU[369]

[367] IEA-International Energy Agency (2012), p.9
[368] IEA-International Energy Agency (2012), p.8
[369] Hungarian Central Statistical Office (2014)

Hungary had five target markets with strongly varying volumes in the Danube region as shown below. Nevertheless Austria was the most important market with a record export of 480,000 tons in 2010 which decreased by 80,000 tons in the following year.

The Romanian diesel market absorbed 370,000 tons of Hungarian diesel in 2011 which is 7 time more than 3 years ago in 2008 which represents an extraordinary development.

Serbia is also an important target market with annual volumes of round 200,000 tons per year (except 2009).

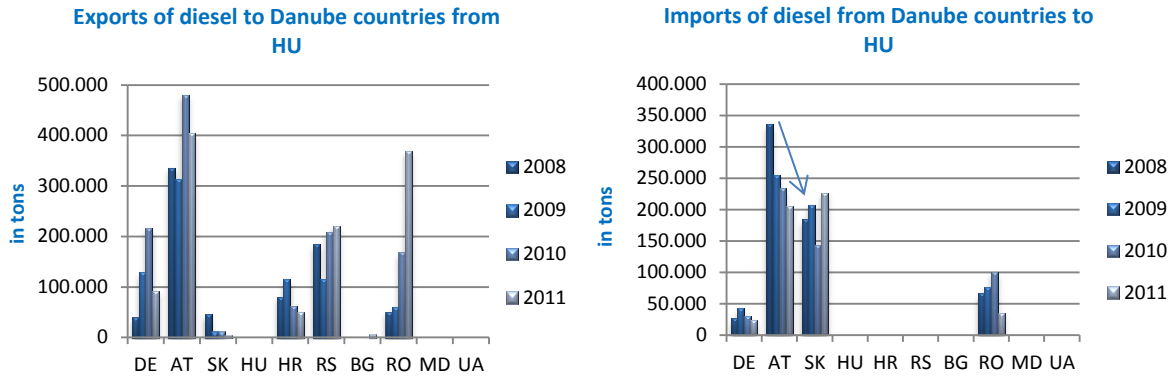


Figure 166: Trade flows of diesel HU[370]

Hungary does not only export diesel but also imports large quantities. The main source markets are Austria and Slovakia. Regarding imports from Austrian a declining trend can be observed due to the steady decrease of 131,000 tons from 2008 to 2011. On the other hand the Slovak market stayed stable (except in 2009) with round 200,000 tons annually.

Analysis of the mineral oil products transport to the three main target countries Austria, Serbia and Romania showed that Danube navigation is only conducted for transports to Austria. In 2012 the record high of 390,000 tons of mineral oil products was transported on the Danube from Hungary to Austria but volumes decreased by more than 120,000 tons in the following year.

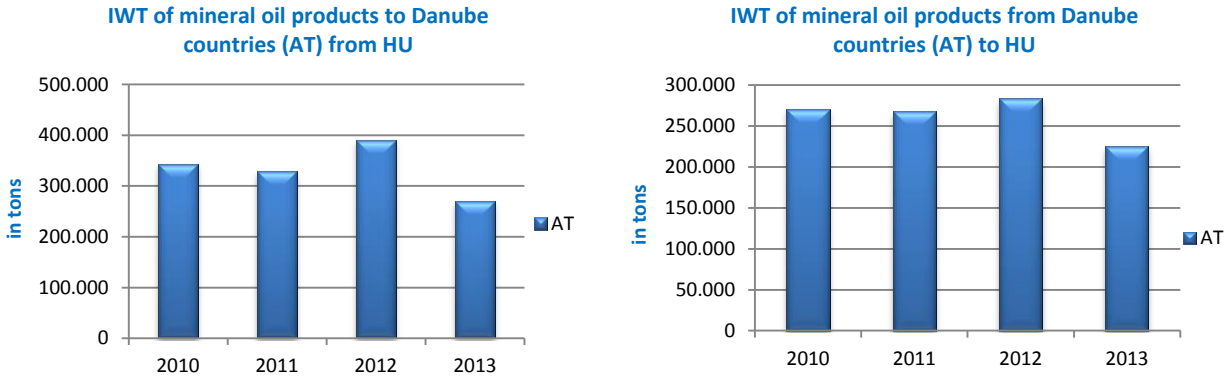


Figure 167: IWT transports of mineral oil products in HU[371]

[370] Hungarian Central Statistical Office (2014)
[371] Statistics Austria (2013)

Currently no inland waterway transport of mineral oil products takes place between Hungary and Serbia, despite of the large volumes exported to Serbia from Hungary.

Assuming that volumes between Hungary and Serbia will not change resp. not decline in future, inland navigation should be considered as a suitable alternative for mineral oil transports to Serbia.

Concerning inland navigation for imported mineral oil products, analysis showed that Austrian outputs are transported on the Danube to a large extent.

9.2.1.3. Austria

Austria has one large refinery OMV with an annual capacity of 9.6 mil tons which is located in the city of Schwechat in the vicinity of the Danube River. Apart from the refinery there are three tank farms namely in Lobau (Vienna), Korneuburg (Lower Austria) and Linz (Upper Austria).

During a two months observation period (Jan/Feb 2013) of the Austrian Danube section, transport notifications of hazardous cargo were evaluated. Based on the results, transport volumes of mineral oil products were identified. The total volume of the product group accounted for more than 300,000 tons in two months.

More than 55% (167,930 tons) were diesel transports, followed by gasoline with 13%. The remaining transports were allocated to fuel oil, biodiesel and crude oil distillates.

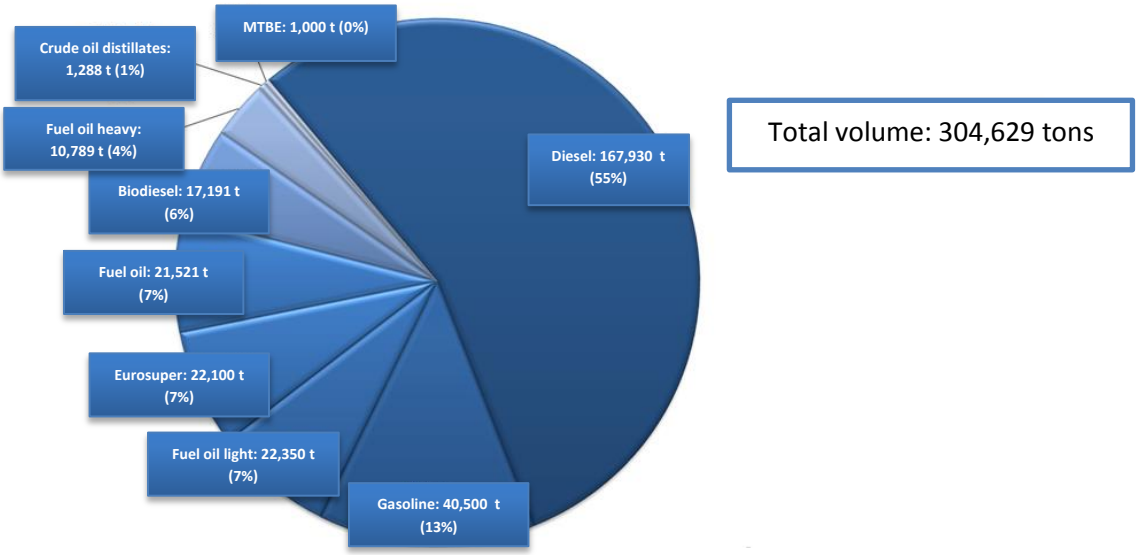


Figure 168: IWT of mineral oil products per category in AT[372]

Austria imported large volumes of diesel (round 4 mil ton per year). The most important trade partner is this respect is Germany with a 70% share in Austrian imports, followed by Slovakia and Hungary. Data analysis showed that Austria does not facilitate imports of this mineral oil product from other Danube countries.

[372] Research : viadonau

Looking at Austrian exports, besides the dominating target markets of Hungary and Slovakia with average volumes between 200,000 tons per year in Slovakia and 300,000 tons in Hungary, Romania, Germany and Bulgaria, were provided with OMV diesel, with declining volumes however.

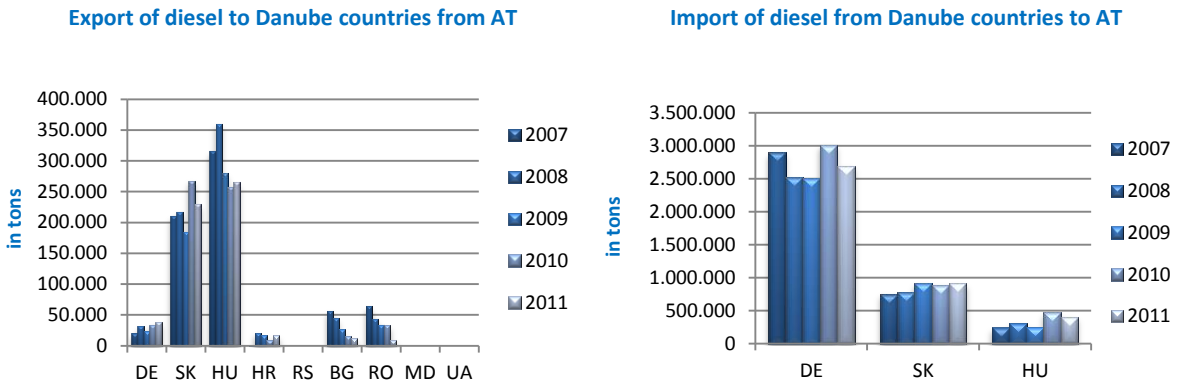


Figure 169: Trade flows of diesel in AT[373]

The comparison of total exports volume with the exported volume via inland navigation showed that IWT of mineral oil products to Hungary achieved a remarkable value. Between 226,000 tons (2013) and 284,000 tons (2012) were shipped on the Danube from Austria to Hungary. IWT of this product group to Slovakia however, declined steadily from 2010 to 2012 and in 2013 they were even nonexistent with less than 2,900 tons.

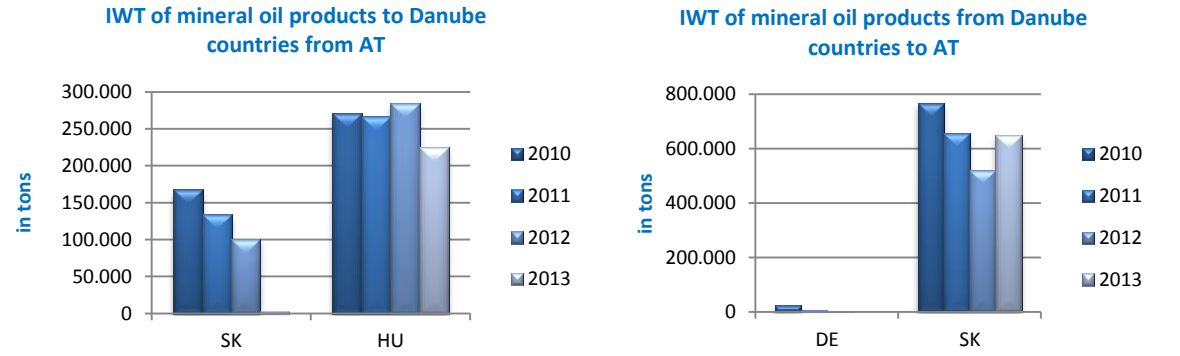


Figure 170: IWT transports of mineral oil products in AT[374]

In Austrian import activities IWT is relevant only in transports from Slovakia. In this case, volumes which amounted at least 500,000 tons in 2012 and even 770,000 tons in 2010, do show an intense usage of inland navigation.

Imports from Germany on the other hand, despite of its role as the leading source diesel market, are realized in a very small extent, as illustrated above. Use of Inland navigation might be raised between the two countries, due to the large volumes which are exported from Germany to Austria and the almost nonexistent IWT for mineral oil products.

Transport requirements: see crude oil

[373] Statistics Austria (2012)
[374] Statistics Austria (2013)

9.3. Gasoline

Gasoline is produced from crude oil (see diesel/gas oil chapter) and is mainly used as fuel in gasoline based vehicles.

9.3.1. Market overview

Gasoline production in the Danube region experienced a decrease by 10 mil tons since 2007. As illustrated below, the largest gasoline producers, Germany, Romania and Ukraine decreased their production continuously, which naturally influenced the overall output. Countries such as Austria, Slovakia and Bulgaria which had comparable output volumes kept the production level stable in the course of time.

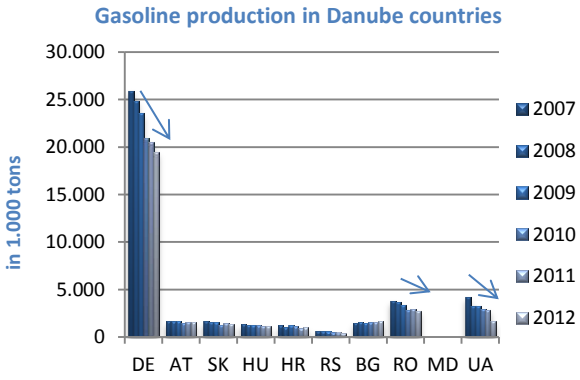


Figure 171: Gasoline production in Danube countries[375]

Compared to significant and steady production decline, imports of gasoline in the region did not correspond to the production development. As shown, Germany's imports decreased from 2007 to 2009. In 2010 imports again increased by round 500,000 tons and then again declined in the following two years.

Ukraine, on the other hand, sharply boosted imports in 2008 from 1.2 mil tons to almost 2.4 mil tons in 2008. After the decline in 2009, import volumes stayed almost unchanged between 2010 and 2012.

Other Danube countries, such as Austria, which was the third largest importer, did not fluctuate in import volume in the course of time.

Concerning exports, Germany was again the leading country with volume amounting 5 mil tons to 5.7 mil tons from 2007 to 2012, followed by Romania with record exports achieved in 2007 and 2008 (2.2 mil tons). The third largest gasoline exporter was Romania which nearly exported the volume of its domestic production (1.5 mil tons production and 1.1 mil tons exports).

[375] IEA-International Energy Agency

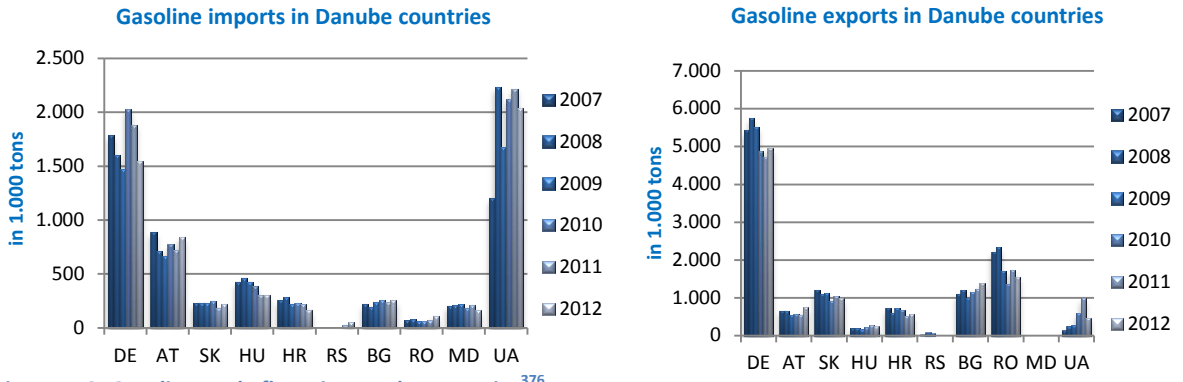


Figure 172: Gasoline trade flows in Danube countries[376]

As a result of the production and trade volumes, domestic supply in these countries was similar to the developments of national production volumes, as illustrated below. Germany and Ukraine showed clear declining trends, while domestic supply stayed unchanged in the remaining countries.

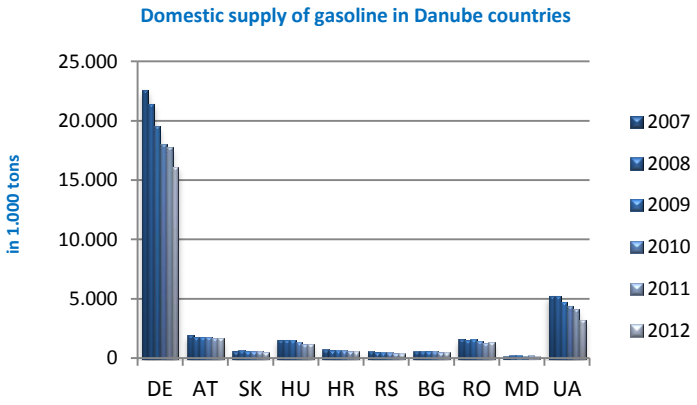


Figure 173: Gasoline domestic supply in Danube countries[377]

9.3.1.1. Germany

Analysis showed that for Germany, as the dominant player in the gasoline sector, the Danube region does not play an important role; neither for exports nor for imports of gasoline.

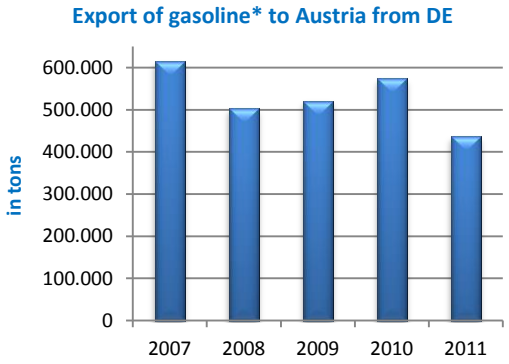


Figure 174: Gasoline export to Austria from DE[378]

In terms of exports Germany realized trade only with Austria since 2007. The record high with more than 600,000 tons was reached in 2007, while the minimum trade volume occurred in 2011 (436,000 tons) which was the lowest value in the observed period of time.

Imports of gasoline from Danube countries are nearly non-existent with the exception of Slovakia, which provided round 56,000 tons of the product in 2011 (in 2007 more than 126,000 tons were imported from SK).

[376] IEA-International Energy Agency
[377] IEA-International Energy Agency
*CN: 2710 11 41, 2710 11 45, 2710 11 49

The locations of the refineries and tank farms were already examined in the chapter “Diesel and fuel oil”.

Due to high annual export volumes of gasoline from Germany to Austria and the current low usage level of IWT (in 2012: round 2,000 tons from Germany to Austria), potential for a modal shift should be examined in future.

9.3.1.1.1. Ukraine

Ukraine, the second important gasoline importer, did not conduct trade with any of the Danube countries since 2007.

9.3.1.1.2. Austria

The third largest imports were realized by Austria (841,000 tons in 2012). It is not surprising that the Austria’s main partners for gasoline supply are the same as for diesel supply, Germany and Slovakia. Austria imported varying gasoline volumes, between 540,000 tons and 655,000 tons from Germany, while Slovak fuel increased in course of the time from 188,000 tons in 2007 to 253,000 tons in 2011.

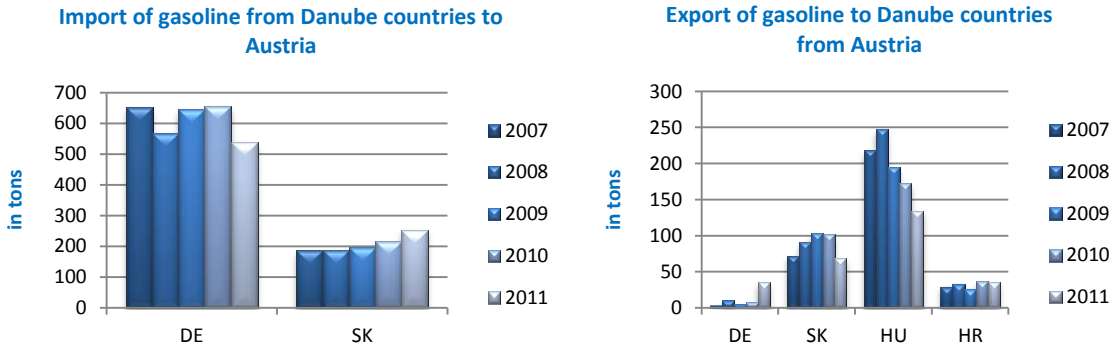


Figure 175: Gasoline trade flows in AT[379]

The main target market for Austrian gasoline exports was Hungary with the highest volumes of 247,000 tons in 2008. Since then exports to Hungary steadily declined and amounted in 2011 134,000 tons. The Slovak decreased in 2011 and reached the volume of 2007 (round 70,000 tons) after a period of increase from 2008 to 2010.

Transport requirements: Gasoline is classified as dangerous cargo, for that reason, IWT must be conducted under the ADN regulation (see chapter crude oil).

9.4. Liquefied natural gas (LNG)

Liquefied natural gas (LNG) is natural gas which is liquefied through cooling to −162 °C. This has the effect of volume shrinking (600 times less than in gaseous state) which makes the storage and transport of gas easier.[380]

After crude oil and coal, natural gas is the third important primary energy resource for the world achieving 24% share. It is mainly used in industry for electricity and heating production however usage in mobility is becoming more important.

Despite of the growing demand, natural gas is not likely to be limited like oil on the contrary the global supply will be improved though developments of non-conventional gas deposits – primarily in the United States.

[378] Destatis-Federal Statistical Office Germany (2014)
[379] Statistics Austria (2012
[380] LNG Masterplan (2014)

In 2012 the LNG market experienced for the first time a decrease which resulted from slow expansion of LNG capacities and bad capacity utilization of the existing facilities. The subsequent shortage in supply let the LNG prices rise significantly. However, the European gas market enjoys a relatively good position due to its connection to a large proportion of the global gas reserves via pipelines and LNG terminals. The mentioned connection to LNG terminals is unfortunately not given in the Danube region, which is the reason for the initiation of a large LNG project in this part of Europe.

By default, LNG terminals which either liquefy (liquefaction terminal) for export or regasify (regasification terminal) the gas for import, are connected to gas pipelines. After the liquefaction, LNG is pumped on special ships which transport the gas to another LNG terminal where LNG is unloaded with special pumps. After regasification gas is transported via pipelines to the desired destination.

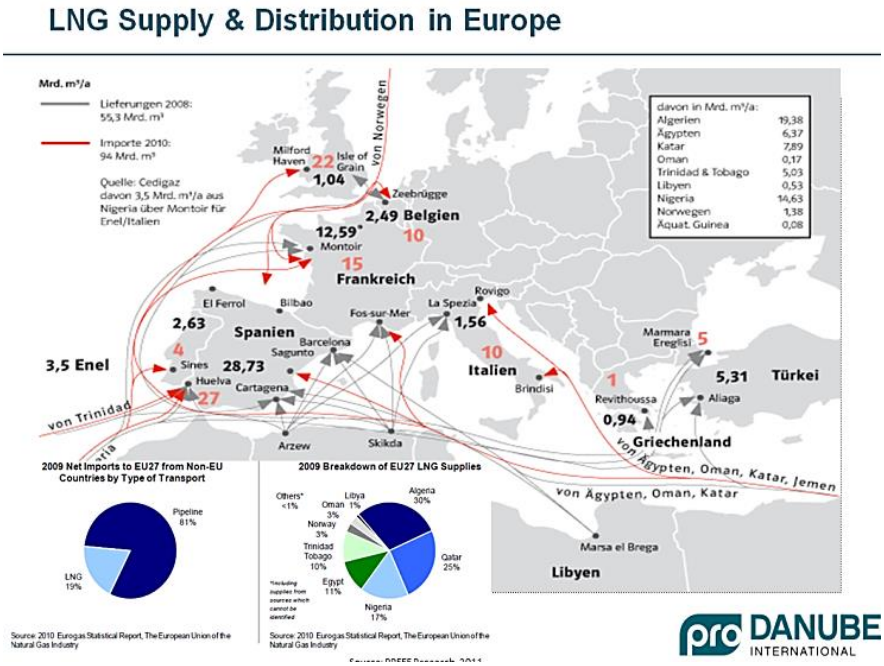
9.4.1. LNG in inland navigation

The LNG Masterplan - Liquified Natural Gas Fuel and Cargo for Inland Navigation 2013-2015 is one of the largest TEN-T projects with a budget of 80.5 mil € which aims at developing the infrastructure for LNG as **cargo** for inland navigation as well as **fuel** for inland navigation vessels.

LNG as cargo

"One of the visions of the LNG Masterplan is that the inland ports on the Rhine-Main-Danube axis will become key distribution centers for LNG. Inland terminals will function as satellites to the hinterland, enabling LNG to reach other pioneer markets like the public (transport) sector and the heavy duty transport industry (buses, garbage collection trucks, city logistics) and the energy industry."[381]

Currently, the European LNG supply is ensured through a dense network of pipelines.
Since the gas mainly originates from Russia and Norway, extended gas supply possibilities via inland navigation would reduce the dependence of gas from these countries and partly liberate the gas market.[382] As illustrated, in 2009 81% of EU's gas imports came through pipelines while the remaining 19% where in form of LNG transported in the waterways from North Africa and countries in the Near East to European *seaports* with LNG terminals.



[381] LNG Masterplan (2014)
[382] Fliesser L. (2014)

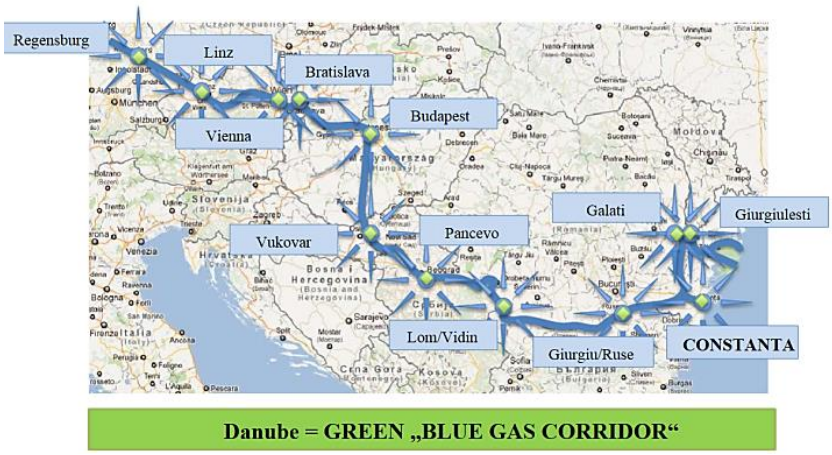


Figure 176: Possible LNG distribution from Danube ports and LNG distribution[383]

One of the objectives of the Masterplan will be the evaluation of LNG distribution potential of selected Danube ports as basis for further development of this segment in the Danube region (see figure 85). Furthermore, a pilot LNG terminal in Rousse is foreseen with waterfront storage unit of minimum 1,000 m3 including fuelling for vessels and trucks with calculated hinterland demand/base load in the first year approx. 40,000 m3. The second pilot will be a bunker station in Antwerp, NL as the other end of the axis.[384]

LNG as fuel

The second goal of the Masterplan is fostering LNG as **fuel** for inland navigation vessels. Compared to diesel which is nowadays used as fuel, LNG has a better environmental performance:[385]

- Nitrogen oxides (NOx) emissions reduced by 80%
- Particulate emissions reduced by 75%
- LNG spills do not require any remediation of soil, groundwater waters or surface due to immediate vaporization (unlike crude oil and crude-derived liquid fuels)

Besides environmental aspects, economic advantages should also be mentioned. Currently, fuel costs make up to 50% of the total transport costs, which is an important factor in relation to competitiveness of IWT. With the introduction of LNG as fuel, total transport costs can be reduced up to 15% due to fuel cost saving.[386]

In the scope of the Masterplan five LNG propelled vessels, new constructions and refitted vessels will be covered in pilot deployments.[387]

[383] Seitz M. (2012)
[384] LNG Masterplan (2014)
[385] LNG Masterplan (2014)
[386] Seitz M. (2012)
[387] LNG Masterplan (2014)

9.4.2. Market overview

Surprisingly, most of the Danube countries have domestic gas production which satisfies domestic demand only to a limited extent. The output for 2012 accounted for 39 mil tons of oil equivalent (1 TOE = 1,270 m3 LNG) while the biggest producers are Ukraine with 15 mil TOE, Germany and Romania. While Ukraine and Romania had stable production volumes, Germany decreased the output from 13 to 10 mil TOE from 2008 to 2012.

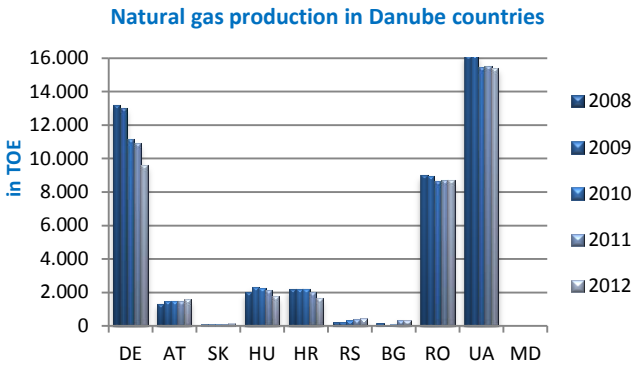


Figure 177: Natural gas production in Danube countries[388]

In Danube countries natural gas is mainly used in industry and for electricity/heat production. With the exception of Hungary and Moldova, industry and electricity/heat production are relatively balanced. Other fields of utilization are residential use, service and other, not further defined sectors.

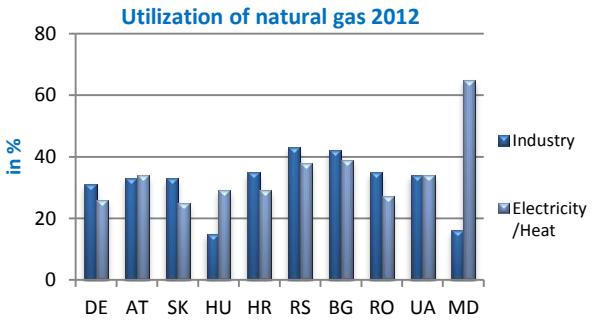


Figure 178: Natural gas utilization Danube countries[389]

The imports of natural gas accounted for 128 mil TOEs in 2012, which is a record low since 2008, when 147 mil TOE were imported from all Danube countries in total.

Natural gas imports Danube Countries in total (in 1,000 TOE)				
2008	**2009**	**2010**	**2011**	**2012**
147,143	130,028	138,906	138,009	128,107

Table 71: Gas imports in Danube region[390]

[388] Own chart
[389] Own calculation
[390] IEA-International Energy Agency

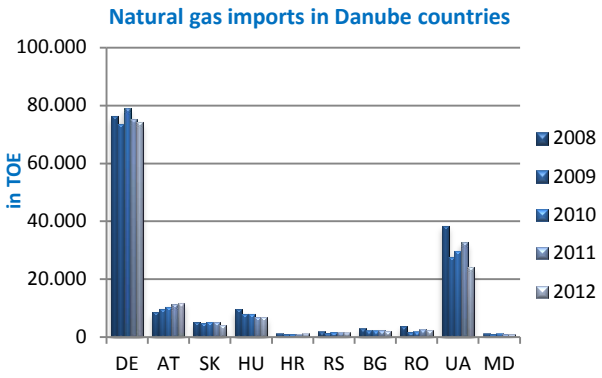


Figure 179: Natural gas imports Danube countries[391]

As illustrated, Germany is the most important gas importer in the region, which had no great fluctuations in imports compared to Ukraine. Austria is the only country in the region which increased the imports since 2008 steadily.

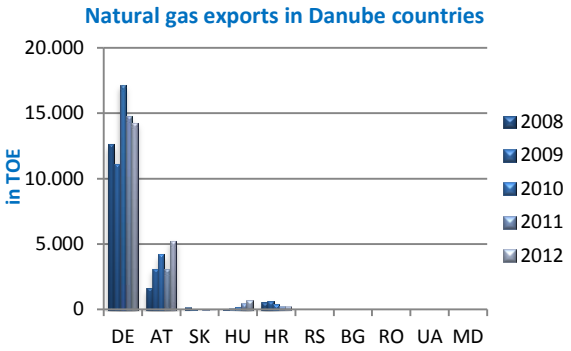


Figure 180: Natural gas exports Danube countries[392]

Looking at gas exports, there are only two countries which have exports worth mentioning – Germany and Austria. Germany's and Austria's exports account more than domestic production which leads to conclusion of increased gas trade.

The analysis of resource and targets markets of gas for Danube countries is at this point not relevant due to non-existent LNG trade flows which result from missing LNG infrastructure in this part of Europe. The expectation is that the market will experience a major change after the introduction of new markets and new means of transport resp. IWT.

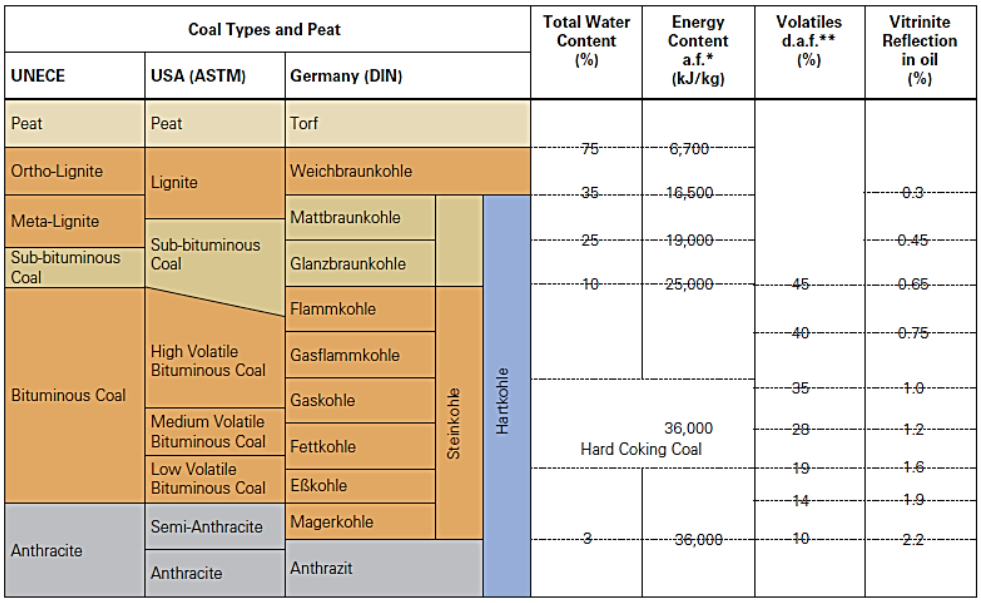
9.5. Coal

Coal is a fossil fuel which is extracted from the ground. It is the most important source for electricity production on a global scale.[393]

There are various classifications of coal type which are differently classified by organization and countries, as figure 111 shows. For the purpose of this study and for the simplification of the evaluation the division in hard coal ("Hartkohle" in the figure) and lignite will be used.

[391] Own chart
[392] Own chart
[393] Cargohandbook (2014i)

Coal classification



** a.f. = ash-free*
*** d.a.f. = dry, ash-free*

UNECE: Ortho-Lignite up to 15,000 kJ/kg
Meta-Lignite up to 20,000 kJ/kg
Sub-bituminous Coal up to 24,000 kJ/kg
Bituminous Coal up to 2 % average Vitrinite Reflection
USA: Lignite up to 19,300 kJ/kg
Source: BGR

Figure 181: Classification of coal[394]

9.5.1. Market overview

In average 30% of the EU28 electricity production is based on coal, however, the importance of coal on national level varies from country to county. In the Danube riparian countries, Austria had the lowest coal-based power production with 6% in 2012, while in countries such as Germany and Bulgaria, over 40% of the electricity production was depended on coal.

In 2013 the total output in EU28 accounted for 114 mil tons of coal and 407 mil tons of lignite, which is 14 mil tons resp. 26 mil tons less than in the previous year of 2012.[395]

The outputs of coal and lignite in the ten Danube countries accounted for 75.4 mil tons and 260.4 mil tons in 2013 which is a decrease of almost 13% compared to 2012, when a record output of almost 300 mil tons was realized.

Coal and lignite production in the Danube region (in mil tons)						
	2008	**2009**	**2010**	**2011**	**2012**	**2013**
Coal	87.5	74.2	72.8	76.7	85.9	75.4
Lignite	282.2	234.0	273.0	292.1	295.9	260.4

Table 72: Coal and lignite production in Danube region[396]

Looking at the Danube countries separately, it is obvious that there are great differences in production quantities and imports throughout the region.

[394] EURACOAL-The European Association for Coal and Lignite (2014)
[395] EURACOAL-The European Association for Coal and Lignite (2014)
[396] Own calculation based on market reports 2008-2013 of EURACOAL-The European Association for Coal and Lignite (2014)

From the graphic below, it can be concluded that hard coal production is limited to a small number of countries with Ukraine as the absolute top producer in the Danube region with stable outputs accounting for approx. 60 mil tons per year. Germany's hard coal production is second ranked but decreased in the course of time.

The lignite production sector is more diversified and has more players in the Danube region. With outputs between 170 mil tons and 182 mil tons of lignite Germany is the largest producer by far. Other lignite producers worth mentioning are Serbia as second ranked followed by Romania and Bulgaria with almost identical outputs per year.

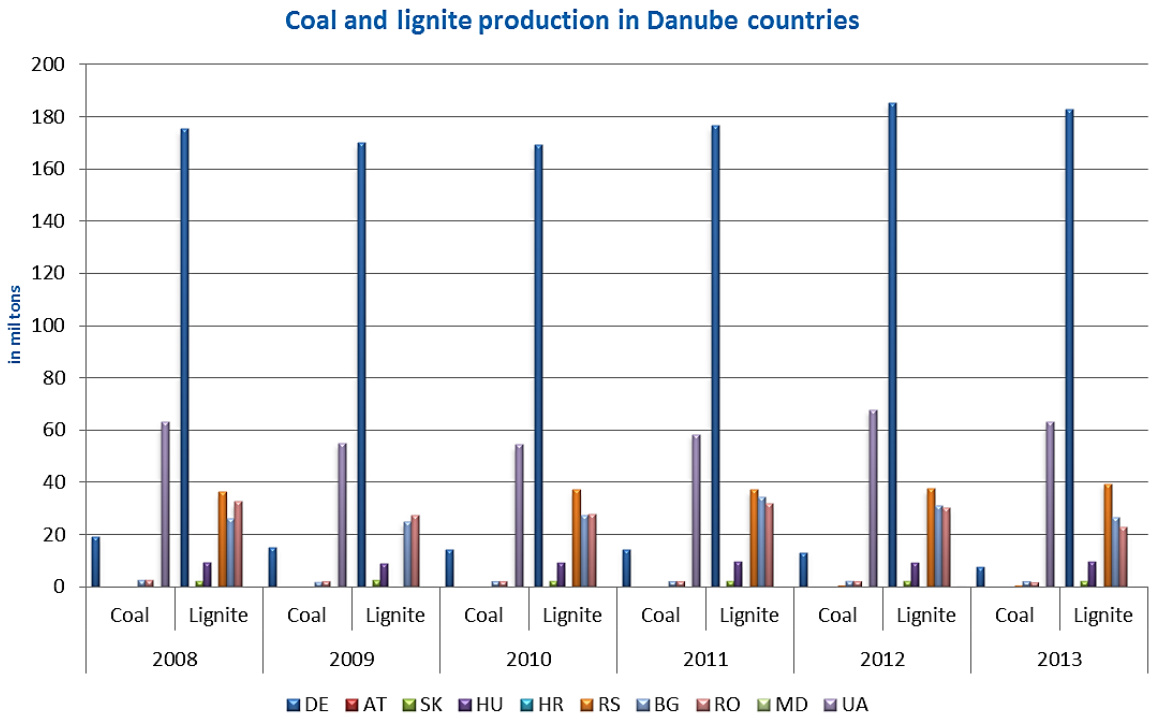


Figure 182: Coal and lignite production in Danube countries 2008-2013[397]

[397] Own chart calculation based on market reports 2008-2013 of EURACOAL-The European Association for Coal and Lignite (2014)

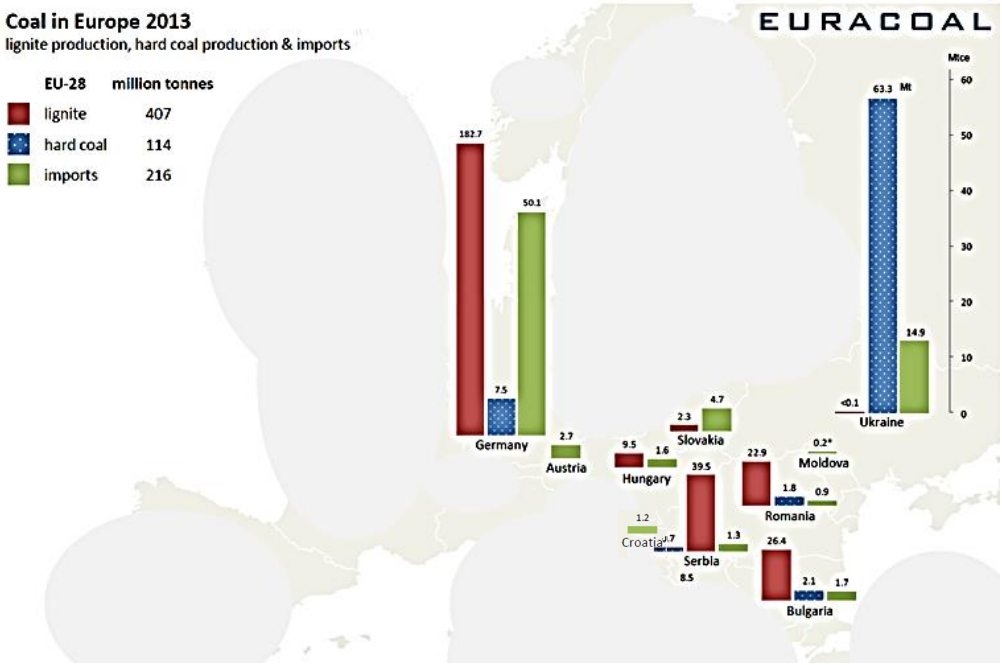


Figure 183: Map coal and lignite in Danube countries[398]

9.5.1.1. Germany

Germany's hard coal production has experienced a steady decline since 2008 when 19 mil tons were produced. In 2013 the German output accounted for only 7.5 mil tons. However, Germany is the largest hard coal importer not only in Danube Region but in the entire EU. The imports increased since 2008 constantly and reached more than 50 mil tons in 2013.

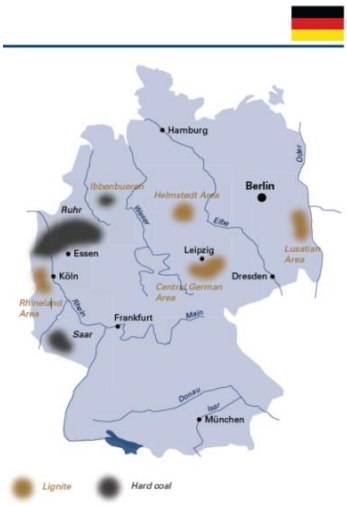


Figure 184: Hard coal and lignite in DE[399]

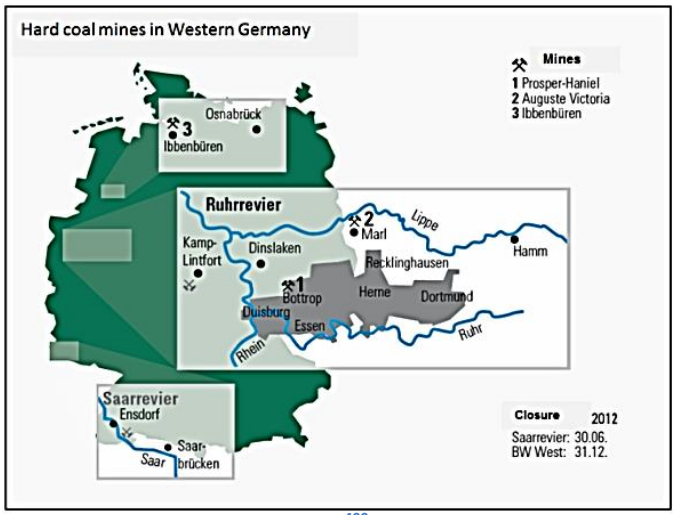


Figure 185: Hard coal mines in DE[400]

[398] Adapted map from EURACOAL-The European Association for Coal and Lignite (2014)
[399] EURACOAL-The European Association for Coal and Lignite (2014)
[400] Gesamtverband Steinkohle (2014), p.19

On the other hand, Germany is the largest lignite producer in the respected region. The recent output from 2013 accounted for 183 mil tons which is 70% of the total Danube region volume. As shown in the map below on the right lignite mines are not located in the vicinity or the Danube River however, an important lignite area is situated in the vicinity of the Rhine River near Cologne. Furthermore, five lignite based power plants are based within a 90 minutes truck drive from the port of Cologne as illustrated below.

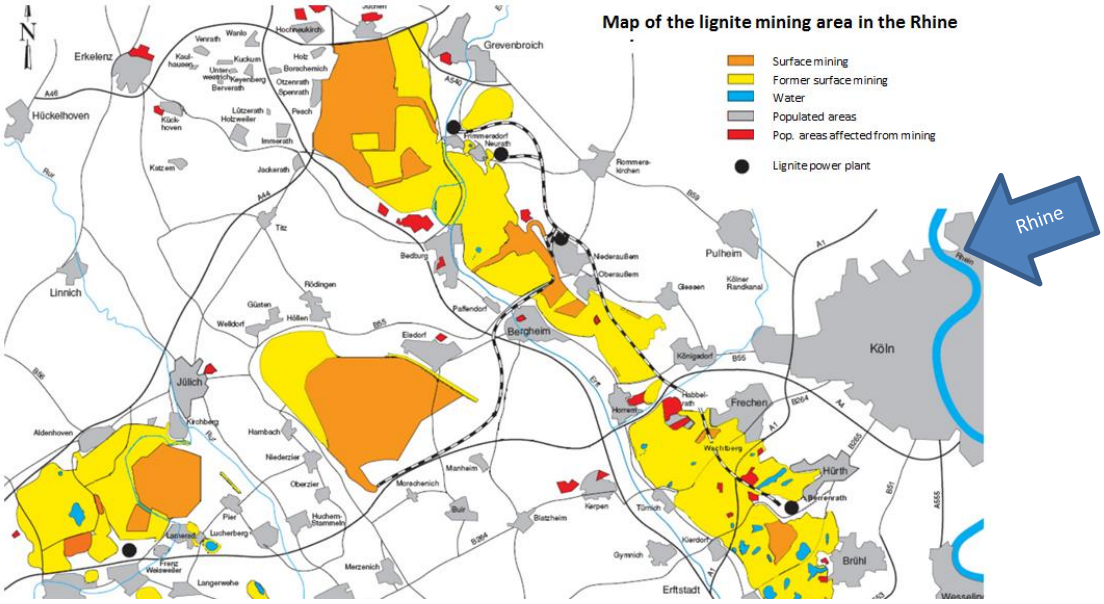


Figure 186: Lignite mines and power plants in the vicinity of Cologne and Rhine River[401]

The German government adopted an "energy concept" which aims at fostering environmentally friendly energy concepts such as nuclear power. "Scenario calculations underlying the energy concept foresee a drastic decrease of overall coal use in Germany. The market for hard coal halves by 2020 and then halves again by 2050." Subsidized hard coal production will be gradually phased out by 2018 according to the German energy concept.[402]

Germany's most important target market for coal and coke* in the Danube region is Austria. Austria has no own coal production but a large steel processing plant in the city of Linz near the Danube River with coal and coke as an essential raw material which has to be imported. Since 2008 Germany's exports to Austria volumes were stable and accounted for 235,000 tons per year in average. The Hungarian market is the second largest regarding exports of coal and coke with annual volumes between 26,000 tons and 46,000 tons. Lately, in 2013 almost 36,000 tons were exported. Slovakia and Croatia are also German target markets worth mentioning. While Slovak volumes fluctuated strongly in the past years Croatian market stayed pretty stable since 2009 absorbing approx. 13,000 per year.

As already mentioned above, Germany is the largest importer of coal with 50 mil tons in 2013. The Danube Region as a whole, does not play a crucial role as an important resource market, however, imports from Ukraine should be mentioned. As stated, Germany imported variable volumes from Ukraine since 2008. The record volume was achieved in 2013 with more than 1 mil tons of coal and coke imports.

[401] Bodenschätze
[402] EURACOAL-The European Association for Coal and Lignite (2014)
*coke is converted coking coal and it is used in steel production

Coal and coke trade Germany and Danube countries (in tons)										
		AT	HU	SK	HR	RS	BG	RO	MD	UA
2008	Export	235,806	35,202	52,732	19,194	8,801	417	2,754		1,036
	Import	5,889		174						66,073
2009	Export	227,291	26,344	22,532	12,835	2,521	493	2,946		237
	Import	3,303			1,891					86,683
2010	Export	218,735	46,427	11,241	13,522	4,366	555	2,733		
	Import	2,454	685	408						49,342
2011	Export	232,012	42,885	7,446	14,276	4,366	636	2,862		241
	Import	7,065	13,845							71,962
2012	Export	242,525	36,664	33,675	13, 265	4,517	639	2,039		348
	Import	5,356	9,041							71,737
2013	Export	227,830	35,983	19,752	12,952	3,093	650	2,545		453
	Import	5,492	15,322							1,137,950

Table 73: Coal trade DE and Danube countries[403]

9.5.1.2. Serbia

From 2008 to 2011 *Serbia's* total imports of coal and coke accounted between approx. 1 and 1.5 mil tons per year on a global scale while these imports decreased down to 800,000 tons resp. 440,000 in 2012 and 2013.[404] It is probable that the decline resulted from the return to state administration of the only steel producing plant "Zelezara Smederevo" by the previous owner "US Steel". The plant is located in the city of Smederevo at the Danube River bank.

The statistical evaluation showed that Serbia had changing trade developments with Danube riparian countries from year to year. Imports of coal and coke from Ukraine experienced a sharp decline from 2008 to 2013, as stated in the table below, accounting recently only 41,000 tons, compared to 360,000 tons 2008. Hungary and Slovakia were also important resource markets till 2011/2012 but in 2013 no imports from these two countries was realized. There is no import from Austria, Croatia and Moldova worth mentioning.

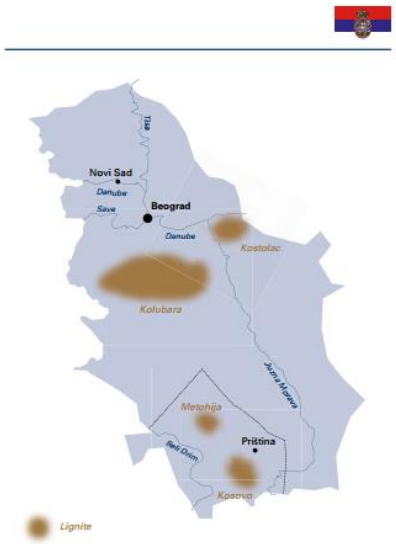


Figure 187: Lignite in Serbia[405]

On the other hand, Serbia had only one target market in the region, namely, Romania. From 2008 to 2010 exports between 110,000 and 157,000 tons were made however since 2010 this market is non-existent.

Coal and coke trade Serbia and Danube countries (in tons)										
		DE	AT	HU	SK	HR	BG	RO	MD	UA
2008	Export						3,988	157,242		
	Import	5,651		100,288	93,080					359,694
2009	Export							113,153		
	Import	3,247		63,040	75,083		5,029			87,006
2010	Export			4,957	9,795			109,324		

[403] Adapted based on Destatis-Federal Statistical Office Germany (2014)
[404] RZS-Statistical Office of the Republic of Serbia (2014b)
[405] EURACOAL-The European Association for Coal and Lignite (2014)

	Import	4,201	93,045	132,424	4,708	55,352
2011	Export					
	Import	5,505	100,197	120,300	2,744	89,264
2012	Export				2,250	
	Import	5,656	51,652	21,249	5,110	50,107
2013	Export					
	Import	4,860			7,990	41,173

Table 74: Coal and lignite trade RS[406]

9.5.1.3. Ukraine

The center of hard coal production in the Danube region is based in *Ukraine* which produced 84% resp. 63.3 mil tons of the total hard coal production in the region in 2013. The deposits are located in the Donetsk region at the border with Russia in the east as well as in the border region with Poland in the west.

Despite of the large hard coal production, Ukraine also imported large volumes of the fossil fuel. The "Energy Strategy of Ukraine" states that the domestic coal extraction will increase in future, in order to secure the country's energy supply and minimize the current dependence on gas imports. This goal shall be achieved through privatization of state owned mines and /or restructuring, modernization which will finally secure stable growth. The hard coal out shall remain unchanged in the foreseen implementation period 2011-2030.[407]

Figure 188: Hard coal in UA[408]

9.5.2. Transport requirements [409]

Coal, transported as bulk, is generally prone to spontaneous combustion consequentely, sufficient ventilation should be ensured in order to prevent damages. Decrease in calorific value and a significant change in the suitability of the coal/coke for its original purpose, may result from spontaneous combustion, heating or water damage. Coal or coke shipped in a wet condition may be subject to loss of weight due to drainage during the voyage or by evaporation, up to 3%, depending on the quantity shipped.

However, loading and discharging of these materials in heavy rain could result in an increase in discharged weight over shipped weight.

The loading, transportation and discharge of coke results in some degree of breakage, leading to a smaller average size of lumps and a greater content of fine material, breeze and dust. Careful sampling and testing according to standardized procedure are necessary to determine the extent of

[406] Own calculation based on RZS-Statistical Office of the Republic of Serbia (2014b)
[407] EURACOAL
[408] EURACOAL
[409] Cargohandbook (2014i)

these changes. Total quantities can be checked accurately only if the moisture content is known while the size analysis affects the value of coke for all saleable purposes.

When transported as bulk, coal and coke are classified as dangerous cargo, except if:[410]

- cargo hold temperature is lower than 60°C during loading and right after unloading
- transport duration is less than 20 days
- temperature observation is assured for transports of more than 20 days duration
- the boat master receives verifiably instructions during loading, how to proceed in case of significant temp. rise

The cargo loader has to ensure and record that max. allowed temperature was not exceed before, during and right after loading and that he/she gave instructions to the boat master.

Infobox on Coal and Coke	
Example of Coal and Coke	
Facts	
Origin	-
Stowage factor (in m^3/t)	▪ Coal 1,1/1,3 m^3/t (bulk) ▪ Coke (foundry) 2,1/2,4 m^3/t (bulk)

Figure 189: Coal fact sheet[411]

10. Recycling products

10.1. Metal scrap

Metal scrap is an essential element of the steelmaking industry which does not only have a positive effect on environmental protection in terms of CO2 emissions, but also on economic figures due to the decreased need for iron ore extraction.

Consequently, the importance of metal scrap, especially iron and steel (ferrous metal), as raw material increased and became a globally traded commodity. The use of metal scrap on global scale accounted for between 106 mil tons and 570 mil tons usage in 2011, depending on the data source[412]. Structures containing ferrous metals have a live cycle of 60 years which leads to the conclusion that "steel products can be seen as scrap-in-inventory". [413]

Recycling facts metal scrap

- Approx. 40% of the world's steel production is made from scrap.
- One ton recycled steel saves 1.100 kg iron ore, 630 kg coal and 55 kg limestone.
- CO2 emissions are reduced by 58% through the use of ferrous scrap.
- Recycling steel uses 75% less energy compared to creating steel from raw materials.

Recycled steel has a wide range of application fields which include construction materials for roads, railways, infrastructure and buildings, electrical devices, cans and containers, automobiles and other vehicles, etc. [414]

[410] ADN
[411] Cargohandbook (2014i)
[412] Comtrade database: 106 mil tons; Bureau of International Recycling: 570 mil tons
[413] Worldsteel Association (2013)
[414] Bureau of International Recycling (2014)

The steel recycling process starts with the collection and sorting of material. After the slugging and grinding process, scrap is heated in the furnace and formed to various semi-finished products which are again processed to end products.

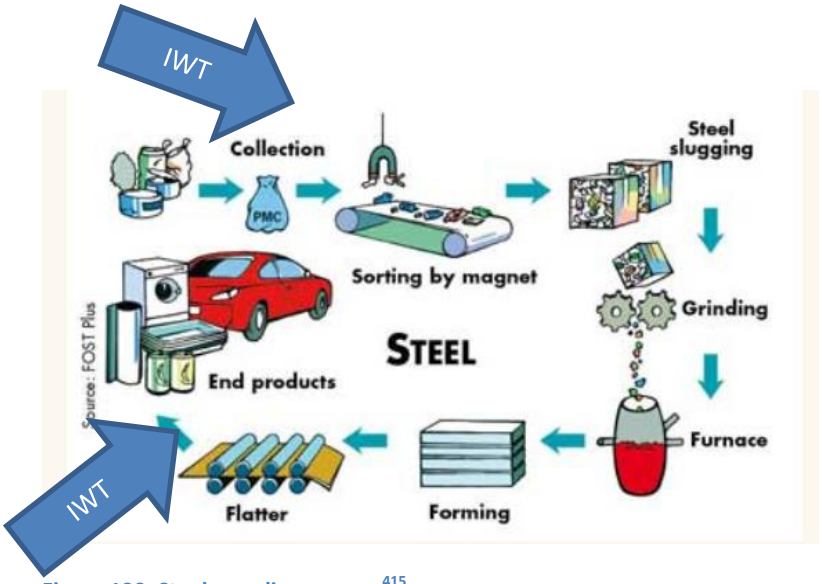


Figure 190: Steel recycling process[415]

10.1.1. Market overview

The Danube region is a net exporter of metal scrap whereas the relation between exports and imports accounted for 2:1 in 2012 as illustrated below. Approx. 15 mil tons of scrap were exported from Danube countries in total in 2012 which is round 1.6 mil tons less than the record high in 2010. In contrast, imports reached the peak in 2008 with more than 9 mil tons while the recent imports amounted 7.2 mil tons (2012).

Trade flows of metal scrap in Danube region (in mil tons)				
2008	**2009**	**2010**	**2011**	**2012**
Exports of metal scrap in Danube region				
14.9	13.8	16.7	16.5	15.1
Imports of metal scrap in Danube region				
9.2	6.4	8.1	7.9	7.2

Table 75: Trade flows of metal scrap in Danube region[416]

Germany's position as the leading scrap exporter in the region stayed stable from 2010 to 2012 with a 60% share in average in total metal scrap exports of all Danube riparian countries. A peak in absolute figures was achieved in 2010 with round 9.2 mil tons.

[415] Valorlux: Steel
[416] Worldsteel Association (2013), p.48-52

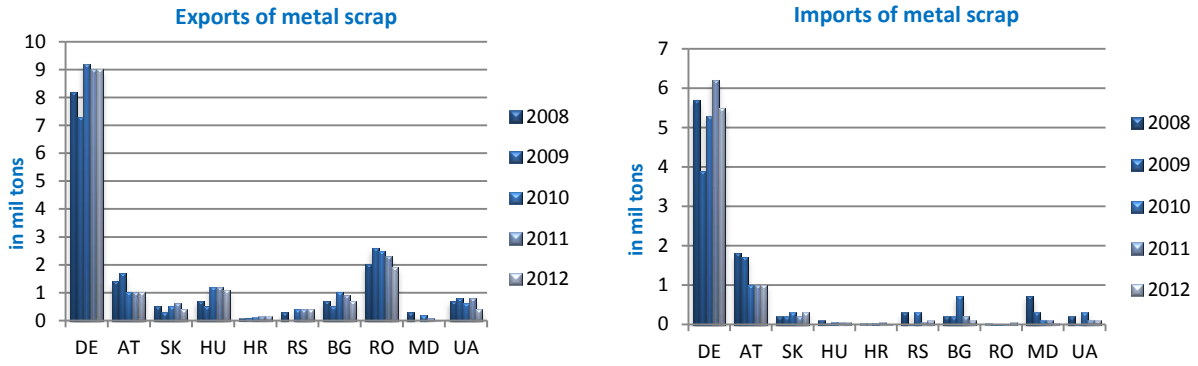


Figure 191: Trade of metal scrap in Danube region[417]

Romanian metal scrap exports amounted round 1/5 of the German volume which was sufficient to ensure the second important position in metal scrap export business in the region. In contrast to Germany, where export activities decreased in the year of crises 2009, exports in Romania increased by 600,000 tons from 2008 to 2009 and achieved the export maximum value of 2.6 mil tons. After 2009 exports steadily decreased lately reached 1.9 mil tons.

The third important exporters are Austria and Hungary with volumes round 1.1 mil tons per year since 2010.

Looking at metal scrap imports in the region it appears obvious that there are only two countries worth mentioning, Germany and Austria. With the exception of 2009, Germany imports amounted between 5.3 and 6.2 mil tons per year. Austria, on the other hand, reduced its imports by 700,000 tons in 2010 and they stayed unchanged at 1 mil tons annually until 2012.

Germany

From the figure to the right it is clear, that the importance of steel scrap in steel production grew strongly since the end of the 1980ies. The current share of metal scrap accounts for 46% compared to the record low in 1988 with 32%. Due to the continues rise in this segment it can be expected that Germany's demand for metal scrap will increase which can either be satisfied through domestic products or through imports, which might be a chance for IWT.

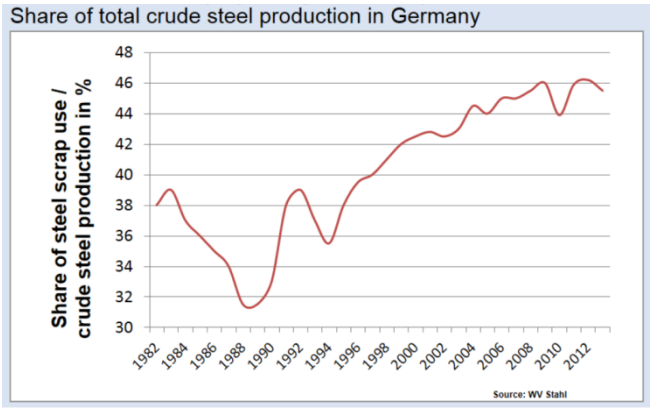


Figure 192: Share of steel scrap use in crude steel production in %[418]

The following graphs again demonstrate Germany's realized trade data. Besides the increasing need for metal scrap for domestic usage, exports of metal scrap seems important for this business field.

[417] Worldsteel Association (2013)
[418] Wirtschaftsvereinigung Stahl (2014)

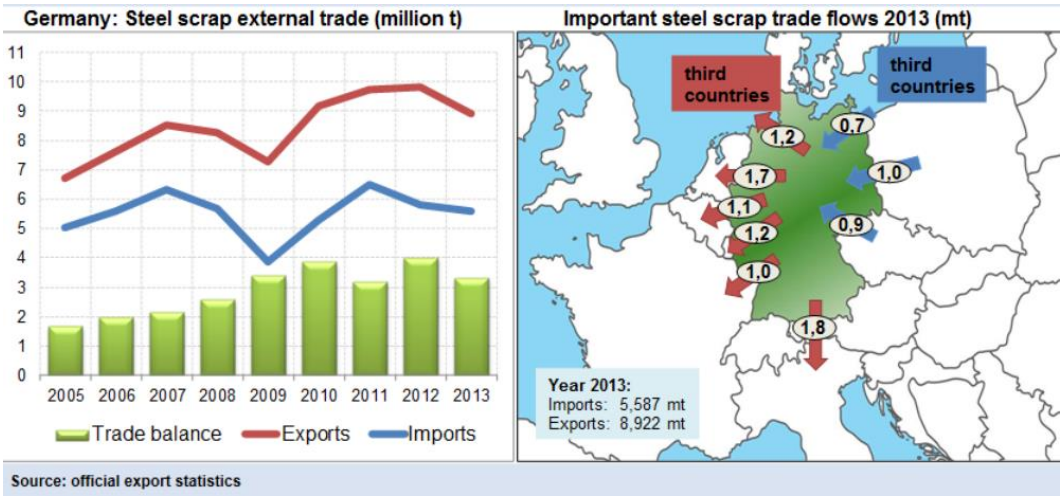


Figure 193: Steel scrap trade in DE[419]

As illustrated below, Danube riparian countries seem not to be a significant trade region of metal scrap for Germany. However, trade with Austria must not be ignored. Nevertheless, comparing the trade volumes which were realized with the Danube region with volumes realized on global scale (see above) it is clear that Germany is not focused on Danube countries neither as target markets nor as source markets.

Exports from Germany to Austria increased since 2011 by more than 100,000 tons and accounted in the recent year 2013 375,000 tons. Due to the strong fluctuations in the observed period no trend regarding exports volume between the two countries can be identified.

In regard to imports, Austria was again the main trade partner resp. main source market followed by Hungary and Slovakia. Imports from Austria show a continuous declining development from 2008 to 2013 (not taking 2009 into account), accounting lately 300,000 tons which is a reduction by half since 2008. Hungary's volumes were round 50,000 tons per year while Slovak metal scrap remained pretty unchanged since 2010 with approx. 30,000 tons annually.

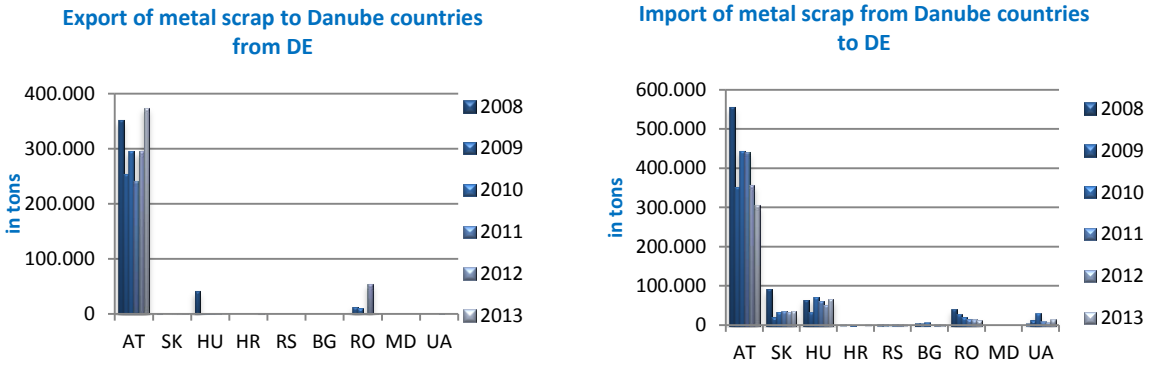


Figure 194: Trade metal scrap DE and Danube countries[420]

According to the Austrian Statistical Office[421], in 2013 round 6,000 tons of ores and metal scrap were shipped **via inland navigation** from Germany to Austria, while 12,000 tons of the same products left Austria towards Germany on the waterway.

[419] Wirtschaftsvereinigung Stahl (2014)
[420] Destatis-Federal Statistical Office Germany (2014)

As already analyzed earlier in this study (see chapter Steel; Germany), Germany's steel production is focused in the province of Rhine-Westphalia in close proximity to the Rhine River. Having in mind that only 6,000 tons of ores and metal scrap left and 12,000 tons entered Germany via inland waterways compared to the total exports of 375,000 tons and imports of 300,000 tons in 2013, it appears obvious that inland navigation is not sufficiently used yet. The potential of transporting metal scrap on inland waterways between Germany and Austria should be not ignored due to the favorable geographical location of steel processing sites and the free capacities of IWT for this product.

Metal processing plants already are listed in the "Steel" chapter earlier in this study.

10.1.2. Transport requirements[422]

Inland navigation is particularly suited for transporting cargo of low value in large volumes. Metal scrap is usually transported as bulk, however, container shipping is becoming more important in regard of maritime global trade. Bulk transports allow visual inspections of the cargo and the identification of apparent hazards and potential danger factors.

Metal scrap in the form of borings, shavings, turnings, cuttings, dross is liable to self heating and to ignite spontaneously due to oxidation processes (rust) and the resulting heat. In case the material is wetted and or contamined with oil the oxidation process will be speeded up. These high temperatures may cause damages to the steelwork of the vessel.

Figure 195: Metal scrap in the Port of Straubing-Sand (DE); Storage of metal scrap[423]

Metal scrap is often stored outdoor, as for instance in the port of Staubing-Sand in Germany. The equipment used for transshipment of metal scrap includes predominantly grabbers.

10.2. Waste paper

More than 50% of the world's paper and cardboard production, which accounts for approx. 400 mil tons per year, comes from recovered paper based resources. Round 50% of recovered paper comes from industry and business which include paper trimmings, cuttings and shavings from manufacturers and converters, unsold newspapers and magazines. Nearly every type of paper can be recycled, including newspaper, cardboard, packaging, stationery, direct mail, magazines, catalogues, etc.[424]

[421] Statistics Austria (2013)
[422] Cargohandbook (2014j)
[423] ©Port of Straubing-Sand, ©viadonau
[424] Bureau of International Recycling (2014)

Recycling facts paper

- One ton of recycled paper saves up to 31 trees, 4,000 kWh energy, 270 liters oil, 26,000 liters water and 3.5 m3 landfill space.
- Burning that same ton of paper would generate about 750 kilograms of carbon dioxide.
- Recycling paper saves 65% of the energy needed to make new paper and also reduces water pollution by 35% and air pollution by 74%.
- Recycling one ton of corrugated containers saves 390 kWh of energy, 1.1 barrels (176 liters) of oil, 6.6 million Btu's of energy, and 5 m3 of landfill.
- Recycling cardboard requires only 75% of the energy required to make new cardboard.

Figure 196: Recycling facts paper[425]

10.2.1. Market overview

Europe is the global leader in paper recycling with recycling rates of 71% in 2012 and 2013. In 1991 only 40% of the consumed paper and paperboard in Europe originated from recovered resourced, as illustrated below.

The paper industry is the largest recycler in Europe which is underlined by the data listed below:[426]

- 90% of newspapers are printed on recycled paper
- 90% of corrugated boxes are made of recycled fiber
- 70 % of consumed paper is sent for recycling
- 54% of the fibers used in new paper and board are sourced from recovered paper

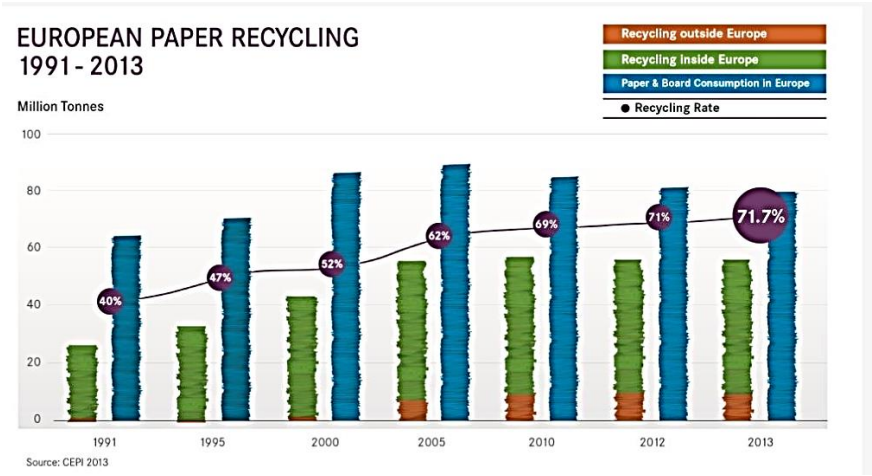


Figure 197: European paper recycling 1991-2013[427]

[425] Bureau of International Recycling (2014)
[426] Paper Online (2014)
[427] EPRC-European Recovered Paper Council (2014)

The paper industry estimates that paper can be recycled 4 to 6 times in average. Each time recycling occurs, the fibers become shorter and weaker and virgin pulp must be introduced into paper production to maintain the strength and quality of the fiber. Through this process, recovered paper and forest-based product complement each other ecologically and economically.

The paper recycling process starts with the collection of waste paper. Paper producers usually buy the raw material for recycling from recovered paper merchants or waste management companies, which also sort recovered paper for recycling. [428]

"The collecting system in operation must be cost-effective and efficiently organized so that the necessary volumes and qualities of recovered paper can be obtained and appropriately recycled. The paper mills that depend on recovered paper must have assurance of a regular supply."[429]

Having in mind, that not only collection but also delivery of waste paper to the processing sites should be cost-effective and that waste paper has become an attractive trade commodity (see following subchapter Trade), IWT of waste paper, especially in the Danube region can play a more important role.

As illustrated below, after the collection of waste paper sorting, pulping, cleaning and de-inking follow, before the paper making step is initiated. Inland waterway transports can be used for the delivery of "fresh" raw material (wood), paper scrap and for finished products.

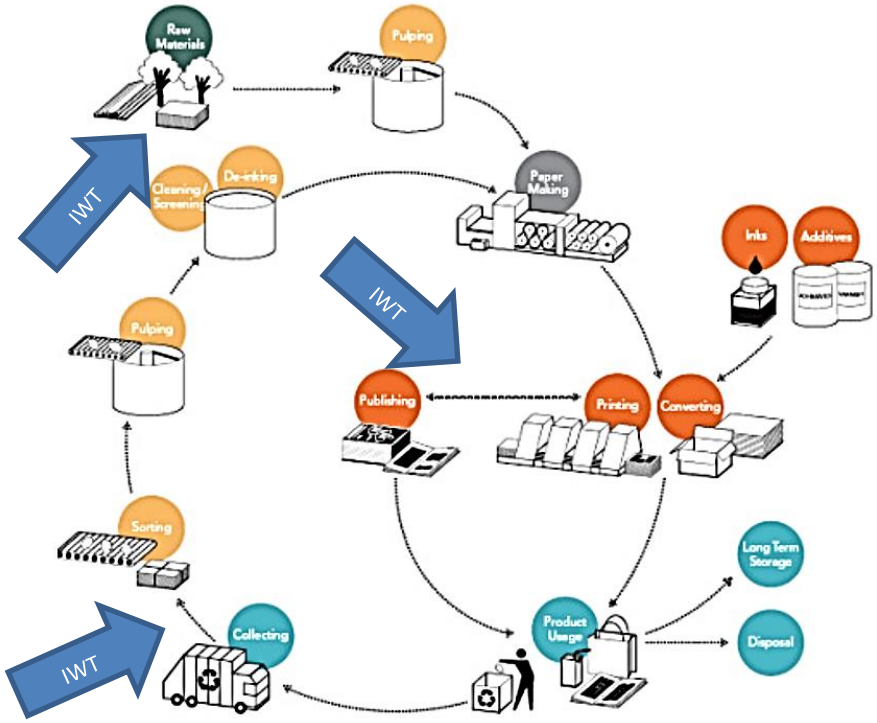


Figure 198: Paper recycling process[430]

[428] Paper Online (2014)
[429] Paper Online (2014)
[430] Paper Online (2014)

The total exported waste paper volume in the Danube region accounted for round 3.9 mil tons in 2013. As illustrated, no country in the region exported more waste paper than Germany. Approx. 70% (2.7 mil tons) of the total export volume of all countries were allocated to Germany.

The remaining 30% are split up among all Danube countries. The second largest exporter of this cargo group was Austria with waste paper exports of 340,000 tons in 2013. Other Danube riparian countries achieved exports between 320,000 tons
(SK) and 6,000 tons (UA).

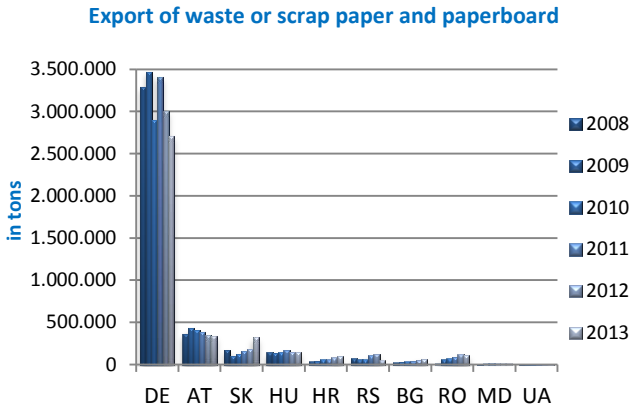


Figure 199: Export of waste paper in Danube countries[431]

Data analysis showed that waste paper imports play a more important role than exports. In 2013 more than 6 mil tons of waste paper were imported to the Danube region which is 1.2 mil tons more than in 2008. Significant volumes were imported to Germany (4 mil tons) and Austria (1.2 mil tons). Hungary's imports slightly increased on an annual basis since 2009 and lately amounted 443,000 tons. An increasing development was also detected in Ukraine where imports doubled from 2008 to 2013.

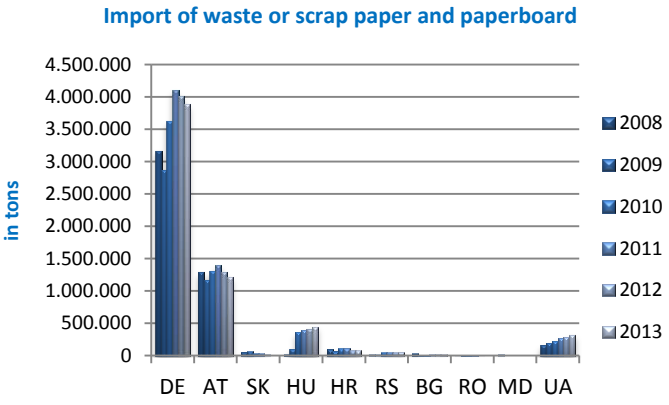


Figure 200: Imports of waste paper to Danube countries

10.2.1.1. Germany

Austria is the only waste paper trade partner for Germany with significant volumes. In 2013 Germany exported round 355,000 tons to Austria while 233,000 tons were imported from Austria. No country except Austria is an important target market however, also Slovakia as a source market provided round 18,000 tons in 2013. From 2009 to 2011 Germany imported waste paper also from Hungary, these important sharply declined in 2012 and accounted lately less than 9,000 tons per year.

[431] Comtrade database

Figure 201: Trade flows of waste paper of Germany and Danube countries 2013[432]

Paper processing plants in Germany in vicinity of the Danube were already analyzed and listed in chapter “Paper, paperboard and pulp” earlier in this study.

10.2.1.2. Austria

The Austrian target market and source market no.1 is its neighboring country Germany. The record high in exports was achieved in 2008 when more than 350,000 tons of Austrian waste paper entered Germany. Export volumes stayed stable from 2009 to 2011 followed by a decline in 2012 and accounting for round 260,000 tons. The remaining Danube countries absorbed small volumes from Austria which are negligible.

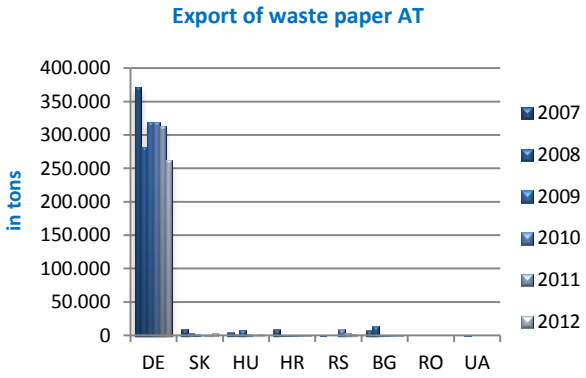


Figure 202: Export of waste paper from AT to Danube countries[433]

It is not surprising that Germany is also the most important source market for scrap paper. Despite of strong fluctuations since 2007 when more than 50% (700,000 tons) of Austrian global imports originated from Germany and 2013 when round 450,000 tons (34% of total Austrian) imports came from Germany, this country stayed the predominant trade partner in the observed period of time. Slovakia and Hungary are important source market too with volume round 100,000 per year.

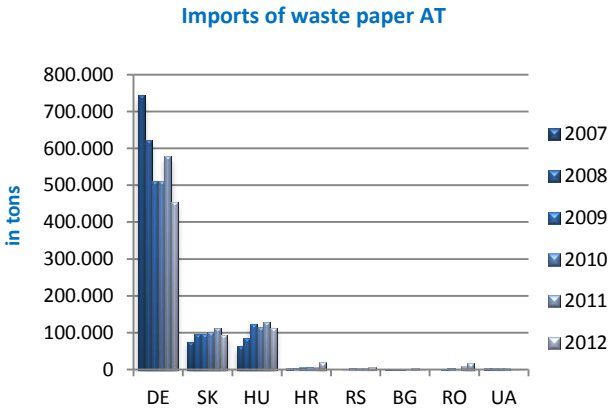


Figure 203: Import of waste paper to AT from Danube countries[434]

Paper processing plants in Austria are listed in the chapter “Paper, paperboard and pulp”.

[432] viadonau: adapted; Data source: Destatis
[433] Statistics Austria (2013)
[434] Statistics Austria (2013)

10.2.2. Transport requirements[435]

Before waste paper is strapped with wire it is pressed together into bales. Waste paper should always be protected from humidity during storage and transshipment (rain and snow) due to risk of spontaneous combustion.

The damage of the bales and wires should be avoided in order to ensure the compression of the bales during the transport.

Figure 204: Transshipment of waste paper in Ennshafen (AT)[436]

Example of Waste Paper	
Facts	
Origin	-
Stowage factor (in m³/t)	4.10 m³/t (bales, unpackaged, wire-strapped, from Cuba) 2.69 m³/t (old newspapers, bales unpackaged)
Humidity / moisture	▸ Relative humidity: 65 - 70% ▸ Water content: 6 - 12% ▸ Maximum equilibrium moisture content 70%
Ventilation	Recommended ventilation conditions: air exchange rate: 6 changes/hour (airing), if the dew point of the external air is lower than the dew point of the hold air.
Risk factors	Waste paper which has been compressed into compacted bales, is impregnated with unsaturated oils and is not completely dry constitutes a fire hazard. Reference is made to the relevant IMO regulations on hazardous cargo.

Figure 205: Infobox waste paper[437]

10.3. Used glass

Glass has a recycling rate of 100% and can be recycled endless times. The quality of the recycled glass does not decrease in the course of time which is a unique characteristic in comparison to any other food and beverage packaging alternative.[438]

Recycling facts glass

- 1 ton recycled glass saves more than 1 ton natural resources.
- 2-3% energy costs savings for every 10% cullet used in the manufacturing process.
- 1 ton CO2 saves for 5 tons recycled container glass.

Figure 206: Recycling facts glass[439]

From 1990 to 2012 European glass products consumption rose by nearly 40% however, glass recycling even increased by 130% in the same period of time. Consequently, more than 189 mil tons raw materials were saved and 138 mil tons of glass waste did not end up in landfills.[440]

[435] Cargohandbook (2014j)
[436] ©Ennshafen
[437] Cargohandbook (2014j)
[438] Glass packaging institute
[439] Glass packaging institute

In 2012 more than 25 bil bottles and jars were collected in order to produce new bottles in the European Union which results in an average collection rate of 70%, as shown in the figure to the right.

The leader in glass collection for recycling in the Danube region was Austria with 85% followed by Germany with 83% while Slovakia's rate accounted for 38% which was one of the lowest rates in the whole European Union.

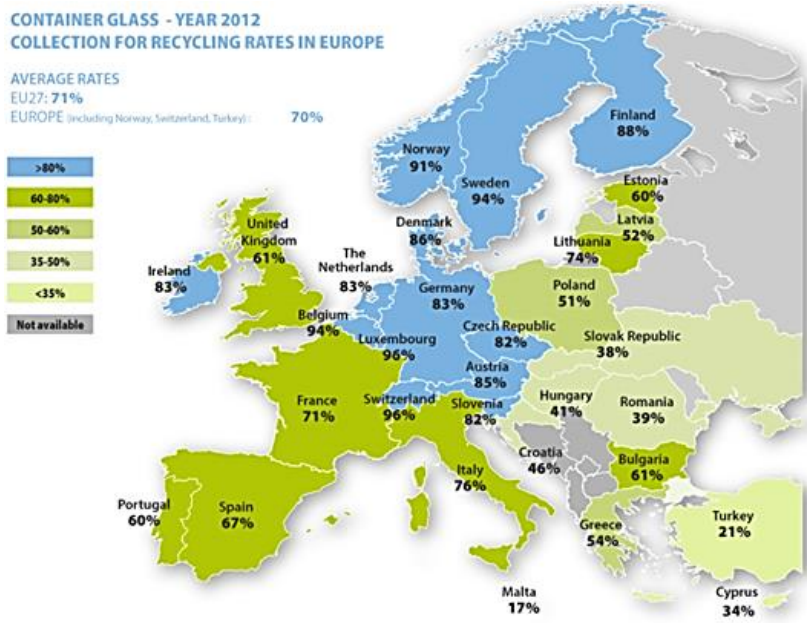


Figure 207: Glass collection rates EU 2012[441]

Glass is made out of sand, soda ash and limestone which are heated to extremely high temperatures and further processed to container glass or flat glass, as shown in the graph to the right. Recycled glass which is firstly melted and cut into cullets[442], is then added to the mentioned raw materials and again heated in the furnace. The molten glass is finally molded to final products like bottles, jars, etc.

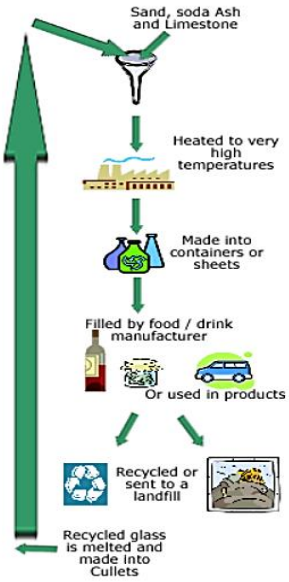


Figure 208: Glass production process[443]

There are three categories of glass which differ in respect to the production process and their field utilization:

1. **Flat glass** is mostly used in the automotive (60%) and construction (30%) industry for windows and doors while the remaining 10% are assigned to the production of mirrors, solar panels, signs and optical glass.

2. **Container glass** is dominated by beverage bottles with beer bottles at the head, followed by wine and non-alcoholic drinks bottles. Other important segments are food container market and other sectors like toiletries and cosmetics, and laboratory glassware.

[440] The European Glass Container Federation (2014a)
[441] The European Glass Container Federation (2014b)
[442] Cullet is furnace-ready scrap glass
[443] Break glass (2014)

3. Glass for lighting, technical glass for video screens, solar panels; insulation glass (fibers); foam glass; and many other "specialty" glasses are allocated to **other industries**.

10.3.1. Market overview

Trade flows of old glass in Danube region (in 1,000 tons)				
2008	**2009**	**2010**	**2011**	**2012**
Exports of used glass in Danube region				
318	341	436	636	424
Imports of used glass in Danube region				
375	464	455	607	590

Figure 209: Trade flows of old glass in Danube region[444]

Concerning the fact that Germany and Austria have the highest rates of glass collection in the whole Danube region, it is not surprising these two countries are the most active in foreign trade. As illustrated below, exports and imports are generated mainly by Germany and Austria. The figure shows clearly that the old glass market is volatile especially in respect to exports activities. While export of glass scrap decreased sharply since 2011 in Germany and Austria, imports of this product increased, in Germany imports of old glass almost doubled within five years while Austria increased its imports steadily from year to year. Hungary exported between 35,000 tons and 50,000 tons while imports did not exceed 12,000 tons per year.

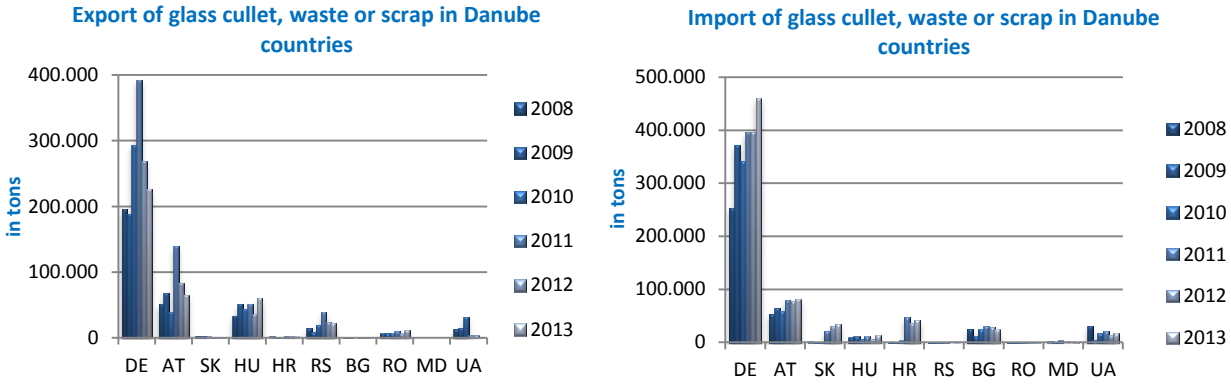


Figure 210: Trade flows of old glass in Danube countries[445]

Germany and Austria

Germany's only trade partner in the Danube region worth mentioning is Austria. The data analysis of German and Austrian statistics showed however that there are differing numbers regarding trade volumes of glass scrap between the two countries. The result of the German Statistical database Destatis[446] showed that Germany imported between 11,560 tons and 22,090 tons old glass from Austria as shown in the following table.

[444] Comtrade (2014-09-08)
[445] Comtrade databse
[446] Destatis-Federal Statistical Office Germany (2014); KN: 7001

Import of glass cullet, waste or scrap, glass in the mass to DE from AT (in tons)					
2008	**2009**	**2010**	**2011**	**2012**	**2013**
19,515	18,371	11,530	22,090	21,772	19,612

Figure 211: Imports of old glass to DE from AT

Austrian Statistics data[447] on the other side indicates other volumes (exports from Austria to Germany) namely:

Exports of glass cullet, waste or scrap, glass in the mass from AT to DE (in tons)					
2008	**2009**	**2010**	**2011**	**2012**	**2013**
26,594	28,256	16,957	53,946	33,053	n.a.

Figure 212: Exports of old glass from AT to DE[448]

Despite of the incoherent data of the two sources, it is clear that the cargo volume is not significantly large nevertheless, inland navigation can become an important mode of transport for used glass for Austria and Germany due to its connectivity as single partners in old glass trade.

10.3.2. Companies in the vicinity of the Danube River

The following table contains companies which are active in glass production and glass processing in Germany, Austria and Hungary.

Country	Company and location	Truck travel time to a port
DE[449]	Ardagh Glass Group, Germersheim	Located at Rhine river bank. 15min to next Rhine Port (Speyer)
	Ardagh Glass Group, Weißenthurm	Located at Rhine river bank. 20min to next Rhine port (Koblenz)
	Ardagh Glass Group, Erftstadt	35min (Cologne, Rhine)
	Gerresheimer AG, Düsseldorf	0min (Düsseldorf, Rhine)
	Gerresheimer Essen GmbH, Essen	35 Duisburg (Rhine)
	Gerresheimer Lohr GmbH, Lohr	50min (Aschaffenburg, Main)
	O-I Sales & Distribution Germany GmbH, Düsseldorf	25min (Düsseldorf, Rhine)
	SGD Kipfenberg GmbH, Kipfenberg	65min (Regensburg)
	Saint-Gobain Oberland AG, Essen	35 Duisburg (Rhine)
	Saint-Gobain Oberland AG, Neuburg	80min (Nuremberg)
	Saint-Gobain Oberland AG, Wirges	25min (Bendorf, Rhine)
	Pilkington Deutschland AG, Gelsenkirchen	40min Duisburg (Rhine)
	Pilkington Deutschland AG, Gladbeck	35 Duisburg (Rhine)
	Pilkington Deutschland AG, Weiherhammer	80min (Nuremberg)
	SAINT-GOBAIN GLASS Deutschland, Aachen	70min (Cologne, Rhine)
	SAINT-GOBAIN GLASS Deutschland, Herzogenrath	70min (Cologne, Rhine)
	SAINT-GOBAIN GLASS Deutschland, Cologne	25min (Cologne, Rhine)
	SAINT-GOBAIN GLASS Deutschland, Stolberg	65min (Cologne, Rhine)
	SAINT-GOBAIN GLASS Deutschland, Mannheim	10min (Mannheim, Rhine)
	Dennert Poraver GmbH, Schlüsselfeld	65min (Nuremberg)
	Glashütte Limburg, Limburg	45min (Koblenz, Rhine)
	OWA Odenwald Faserplattenwerk GmbH, Amorbach	90min (Worms, Main)

[447] Statistics Austria (2012) KN: 7001
[448] Statistics Austria (2012) KN: 7001
[449] Bundesverband Glasindustrie

	SCHOTT AG, Mainz	5min (Mainz, Rhine)
	Amarell GmbH & Co. KG, Kreuzwertheim	45min (Würzburg, Main)
	DURAN Produktions GmbH & Co. KG, Mainz	5min (Mainz, Rhine)
	FLABEG GmbH, Nuremberg	10min
	FLABEG Deutschland GmbH, Furth im Walde	80min (Regensburg)
	Gerresheimer Wertheim GmbH, Wertheim	50min (Würzburg, Main)
	Lutz GmbH & Co. KG, Wertheim	50min (Würzburg, Main)
	SCHOTT AG, Mühlheim	70min (Kehl, Rhine)
	WITEG LABORTECHNIK GmbH, Wertheim	50min (Würzburg, Main)
AT[450]	Eckelt Glas GmbH, Steyr	40min (Linz)
	Vetrotech Austria, Steyr	40min (Linz)
	Vetropack Austria GmbH, Pöchlarn	45min (Krems)
	AGF Aluminium Glas Feuerschutz GmbH, Vöcklabruck	50min (Linz)
	Lisec Maschinenbau GmbH, Amstetten	40min (Linz)
	Ertl Glas AG, Amstetten	40min (Linz)
	Ertex Sicherheitsglas AG, Amstetten	40min (Linz)
	Internorm International GmbH (Traun), Linz	0min (Linz)
	Wenna Glas GmbH, Linz	0min (Linz)
	wema Glasbau GmbH, Linz	0min (Linz)
	Vetropack Austria GmbH, Kremsmünster	35min (Linz)
	Bohle AG, Vienna	0min (Vienna)
	MULTIPRINT Elektronik GmbH & SKE Ing. Karl Koberger Spezial, Vienna	0min (Vienna)
	Kork und Glas Ges.m.b.H., Stockerau	30min (Vienna/Krems)
	Huber Glas GesmbH, Wiener Neustadt	55min (Vienna)
	Glasbau Gerald Mutzl e.U., Vienna	0min (Vienna)
	Fritsch Stiassny GesmbH, Vienna	0min (Vienna)
	Glaserei Sadovszky, Vienna	0min (Vienna)
	E. Lackinger GmbH Glaserei, Vienna	0min (Vienna)
	Glaskaiser GmbH, Marchtrenk	30min (Vienna/Krems)
	Sunhouse Wintergärten GmbH, Marchtrenk	35min (Linz)
	Kraus GmbH, Brunn am Gebirge	30min (Vienna)
	Pilkington Austria GmbH, Brunn am Gebirge	30min (Vienna)
	PRIMUS Alu-Glastechnik GmbH - PRIMUS Alu-Glastechnik GmbH, Wels	20min (Linz)
	HFS Holzfenstersanierungs-Ges.m.b.H. , Wels	20min (Linz)
	Thomas Zottl GmbH - Glaserei - Sämtliche Verglasungsarbeiten, Neunkirchen	60min (Vienna)
	Glas Ebersmüller, Perg	30min (Linz)
HU	MASTERPLAST Kft.	70min (Dunaújváros)
	Mosaic World Kft, Budapest	0min (Budapest)
	Orosházaglas Kft., Budapest	0min (Budapest)
	FIANA FOLIA, Veszprem	90min (Györ)
	Tarján Glass Kft, Salgótarján	90min (Budapest)
	CE GLASS INDUSTRIES, Szeged	90min (Baja)
	KILINCSGURU KERESKEDELMI ÉS SZOLGÁLTATÓ KFT, Budapest	0min (Budapest)
	PALOTA GLAS ÜVEGFELDOLGOZÓ KFT, Budapest	0min (Budapest)

Table 76: Glass production and processing plants

[450] viadonau, own research includes glass processing companies

10.3.3. Transport requirements

Small amounts of stained glass have the ability to color large volumes of white glass (1 green bottle can color 500 kg white glass) for that reason used glass should be separated in order to enable a smooth recycling process. Furthermore, used glass should be protected from humidity because of unfavorable chemical processes during the recycling process which result from water content. The entire logistic chain should ensure protection from contamination and water/snow ingress.[451]

Used glass is mainly transported as bulk. Equipment for transshipment includes mainly grabbers.

Recycling products in general are especially suitable for inland waterway transport due to several favorable characteristics of the cargo group: Recycling products are of low value and therefore, require low transportation costs in order to ensure economic efficiency. On the other hand, recycling products are mostly destined for primary storage and for that reason no time-sensitivity of the product group is given, which would otherwise question the suitability of inland navigation. Finally, there is a huge potential for increase of recycling rates in all Danube countries with the exception of Germany and Austria and it can be expected that the efficient collection, processing and transportation of recycling products will become more and more important in these countries in future.

11. High & Heavy

High & Heavy (H&H) cargo is not allocated to any specific economic sector but to the specific features of the products and the transports. H&H examples are large (agricultural) machines and vehicles, turbines, locomotives, etc.

According to the Austrian law for motor vehicles, H&H cargo is defined as cargo which cannot be transported as regular load, but requires special measures resulting from its weight and /or big dimensions. Moreover, goods with more than 100 tons weight are classified as H&H.

Inland navigation is suitable for H&H transports for many reasons. In terms of space, there are almost no limitations. A typically used pushed lighter on the Danube is 76.5 meters long, 11 meter wide and has a load capacity of 1,700 tons. The dimensions of the cargo hold of a typical motor vessel varies, depending on the type, from 67 to 87 meters length, 8.2 to 8.7 meters width with loading capacities up of 2,400 tons and more.

A further advantage of inland waterways transports of H&H is that no special cost-intensive transit permissions are required as for road transports and there are no obstructions through traffic lights, signs, tunnels and bridge passages.

11.1. Market overview

National and international statistics do not calculate H&H cargo separately, but included it in other groups such as machinery and metal products. Due to the difficulty to extract H&H products from the mentioned group, no analysis of trade flows among the Danube countries can be conducted in this part of the study.

Another difficulty which occurs when evaluating this special cargo group, is the identification and localization of companies. Since the term H&H products does not refer to one single business sector

[451] Austria Glas Recycling (2014)

but only describes the oversize dimensions and/or weight of cargo, it is almost impossible to filter companies which manufacture H&H products. Consequently, no company list for H&H can be provided at this part of the point.

Despite of the missing data, it is essential to underline the importance of shifting H&H transports on the waterway not only because of the obvious advantages mentioned above but also because of the feedback from the logistics sector

11.2. Transport requirements

The transshipment of H&H cargo is in every single case a new and complex undertaking which is individually coordinated in relation to the features of the cargo. According to the cargo characteristics two transshipment possibilities are at one's disposal:

1. Horizontal transshipment

Horizontal transshipment can be facilitated through Ro-Ro ramps for cargo which can be used by self-rolling cargo and by non self-rolling cargo on low loaders.

The existing Ro-Ro ramps long the Danube are illustrated in the chapter "Cars and vehicle components" earlier in this study.

Figure 213: Horizontal transshipment H&H[452]

2. Vertical transshipment with heavy lift cranes

The cranes which are used for transshipment are classified as gantry cranes, luffing and sewing cranes, mobile cranes and floating cranes. While the first two cranes types are fixed to the ground and have limited movement possibilities, mobile and floating cranes can be placed at various, suitable locations either at the river bank (mobile crane) or in water (floating crane).

[452] ©EcoDanube

Figure 214: H&H transshipment with mobile crane[453]

Currently there are six H&H ports along the Danube which have stationary equipment for more than 100 tons H; they are listed below. Ports with mobile equipment are not included in the map but can be looked up in Annex 1.

High & Heavy Ports	Country
Linz Felbermayr	Austrian
Bratislava	Slovakia
Smederevo	Serbia
Belene	Bulgaria
Galati	Romania
Constanta	Romania

Figure 215: High & Heavy ports in the Danube region[454]

[453] ©viadonau, Eva Kelety
[454] ©viadonau

12. Summary

The aim of this study is to give an overview of the current potential for modal shift towards inland navigation in the Danube corridor. The following table summarizes the results of the analysis in terms of production, trading activities and trade relations among the Danube riparian countries in particular (see chapters on specific products). Furthermore, the presence of production and processing locations in the vicinity of the Danube waterway was an important factor in evaluating the most promising markets. The use of a “traffic light system” clearly illustrated the identified potential for modal shift towards inland navigation.

The use of a “traffic light system” clearly illustrated the identified potential for modal shift towards inland navigation.

- Green = great potential → IWT should be considered
- Yellow = moderate potential → IWT suitability should be checked on a case-to-case basis
- Red = low potential

Based on the evaluation of statistical data, following result can be presented.

Cargo	Main points of origin	Main points of destination	Potential
Round wood	DE, AT, HU, BG, UA	DE, AT, RO	
Sawn wood	DE, AT, BG, RO, UA,	DE, AT, HU	
Wood-based Panels	DE, AT, RO	All (except MD)	
Pellets	DE, AT, RO	DE, AT	
Wheat	DE, AT, HU, RS, BG, RO, UA,	DE, AT	
Maize	HU, RS, BG, RO, UA	DE, AT	
Bioethanol	Domestic		
Soybean	AT, HR, RS, RO, MD, UA	DE	
Rape	AT, HU	DE, AT	
Sunflower seeds	HU, BG, RO, UA	DE, AT, RO	
Biodiesel	DE, AT, BG, RO, UA	DE, AT, RO	
Sugar beet	Regional		
Cars	DE, SK, RO	DE, AT, HU, UA	
Chemical products	DE, AT, SK, HU	DE, AT, SK, HU, RO	
Cement	DE, SK, HR	DE, AT, HU, UA	
Salt	DE, AT, RO, UA	DE, HU	
Iron ore	UA	AT, SK, (RS), RO	
Steel	DE, UA	DE	
Crude oil	NON-EU	All	
Diesel & gas fuel	DE, SK, HU	SK, HU	
Gasoline	DE, AT, SK, HU, HR, BG, MD, UA	DE, AT, SK, HR, BG, MD, UA	
LNG	Non-EU		
Coal	DE, AT, HU,	AT, SK, HU, RO	
Metal scrap	DE, AT, RO	DE, AT	
Waste paper	DE, AT, HU	DE, AT	
Used glass	DE, AT	AT, DE	
High & Heavy	All	All	

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Annex 1: Overview Danubeports

The following chapter gives an overview of the most important Danube between Kelheim in Germany and the Black Sea. The selection of the ports corresponds to the data available on the internet platform "Danube Ports Online"[455] and does not include all existing Danube Ports.

		Rail connection	Road connection	Bulk cargo	Liquid cargo	Ro-Ro ramps	High & Heavy	Storage capacity (overall port)
Germany								
	Kelheim River-km 2411.00 | Right bank	x	x	x		x		Covered: 40.000m² Open: 45.000m² Silos: -30.000m³ (grain), -10.000m³ (animal fodder) -30.000m³ (fertilizers)
	Regensburg River-km 2373.00 to km: 2379.00 | Right bank	x	x	x	x	x		Covered: 133.000m² Open: 185.000m² Tanks: - 81.000m³ (oil products) -108.000m³ (gas)
	Staubing-Sand River-km 2313.30 | Right bank	x	x	x		x	x	n.a.
	Deggendorf River-km 2282.97 | Left bank	x	x	x		x		Covered: 15.000m² Open: 50.000m²
	Passau River-km 2228.38 to km:	x	x	x	x	x		n.a.

[455] Danube Ports Online (2014)

	2233.45 | Right bank							
Austria	**Linz AG** River-km 2128.19 to km: 2130.80 | Right bank	x	x	x	x	x		Covered: 110.000m² Open: 10.000m² Dangerous goods: 7.000m² Special storage: 9.000m² Tanks: 300.000m³ (oil products)
	Linz Felbermayr River-km 2124.73 | Right bank	x	x	x			x	Covered: 55.000m² Open: 100.000m²
	Ennshafen River-km 2111.83 | Right bank	x	x	x	x	x		Covered: 76.390m² Open: 178.346m² Dangerous goods: 600m² Tanks: 2.700m³ (gas) Silos: -41.960m³ (grain) -4.000m³ (cement)
	Mierka Krems River-km 1998.00 | Left bank	x	x	x		x	x	Covered: 25.640m² Open: 61.000m² Dangerous goods: 600m² Tanks: 2.700m³ (gas) Silos: -25.000m³ (grain), -4.000m³ (fertilizers) -Bulk: 13 Boxes with roof opening - direct crane operation from barge: 22.900m³
	Korneuburg River-km 1942.95 | Left bank	x	x	x				Silos: -80.000m³ (grain) -80.000m³ (animal fodder)
	Vienna Port River-km 1920.00 to km: 1917.00 | Right bank	x	x	x	x	x	x	Covered: 70.000m² Open: 270.000m² Tanks: 200.000m³ (oil products) Silos: -55.000m³
Slovakia	**Bratislava** River-km 1865.00 to km: 1866.25 | Left bank	x	x	x	x	x	x	Covered: 25.790m² Open: 75.335m²
	Komárno River-km 1767.10 | Left bank	x	x	x				Covered: 6.597m² Open: 26.130m²

	Štúrovo River-km 1722.00 | Left bank	x	x					n.a.
Hungary	**Győr-Gönyű** River-km 1794.00 | Right bank	x	x	x	x	x		Covered: 6.200m² Open: 68.000m² Silos: 1.000m³ (grain)
	Budapest Szabadkikötö River-km 1640.00 | Left bank	x	x	x	x	x		Covered: 92.800m² Open: 49.120m² Silos: 5.000m³ (grain)
	Budapest Ferroport River-km 1639.70 | Left bank	x	x	x				Covered: 9.000m² Open: 32.000m² Silos: 3.000m³ (animal fodder)
	Dunaújváros Dunaferr River-km 1579.00 | Right bank	x	x	x	x			Covered: 1.200m² Open: 11.550m²
	Dunaújváros Centroport River-km 1580.00 | Right bank	x	x	x				Covered: 2.123m²
	Dunavecse River-km 1572.00 | Left bank		x	x				Open: 20.000m²
	Paks River-km 1528.00 | Right bank	x	x	x				Covered: 15.000m² Open: 20.000m² Silos: 80.000m³ (grain)
	Bogyiszló River-km 1503.00 | Right bank		x	x				Silos: 900m³ (grain)
	Baja River-km 1479.00 | Left bank	x	x	x	x	x	x	Covered: 19.800m² Open: 14.000m² Silos: 45.000m³ (grain)
	Mohács Bóly River-km 1450.00 to km: 1450.00 | Right bank	x	x	x				Covered storage: 3.500m² | Open storage: 5.000m² Silos: - 32.000m³ (grain), -5.000m³ (animal fodder)
	Mohács Kreatív Stúdió Kft. River-km 1449.00 | Right bank	x	x	x				Open: 1.000m²
	Mohács Margitta		x	x		x		Covered: 6.000m² Silos: 90.00m³

	River-km 1446.00 | Left bank							(grain)
Croatia	**Osijek** River-km 13.00 | Right bank (Drava River)	x	x	x				Covered: 10.000m² Open: 100.000m²
	Vukovar River-km 1335.00 | Right bank	x	x	x	x		x	Covered: 30.00m² Open: 12.000m² Silos: 45.000m³ (grain)
Serbia	**Apatin** River-km 1401.00 | Left bank	x	x	x				Open: 25.000m²
	Bogojevo River-km 1366.00 | Left bank	x	x	x				Silos: 30.000m³ (grain)
	Bačka Palanka River-km 1295.00 | Left bank		x	x				Covered: 1.000m² Open: 12.000m²
	Novi Sad River-km 1254.00 | Left bank	x	x				x	Covered: 40.000m² Open: 45.000m²
	Beograd River-km 1168.00 | Right bank	x	x	x			x	Covered: 300.000m² Open: 650.000m² Dangerous goods: 900m²
	Pančevo River-km 1153.00 | Left bank	x	x	x	x		x	Covered storage: 40.000m² Open storage: 200.000m² Capacity of silos: 55.000m³ (grain)
	Smederevo Feranex AG River-km 1118.00 | Right bank	x	x				x	n.a.
	Smederevo Tomi Trade Port River-km 1113.00 | Right bank		x				x	Covered storage: 2.400m² Open storage: 20.000m²
	Prahovo River-km 861.00 | Right bank	x	x	x			x	Covered storage: 2.000m² Open storage: 2.000m²
Bulgaria	**Vidin** River-km 785.00 | Right bank		x	x				Open: 15.000m²
	Lom	x	x	x				Covered: 5.245m²

	River-km 742.00 | Right bank							Open: 115.769m²
	Somovit River-km 608.00 | Right bank	x	x	x				Covered storage: 3.375m² Open storage: 9.700m²
	Belene River-km 567.00 | Right bank	x	x	x			x	Open: 21.200m²
	Svishtov River-km 554.00 | Right bank		x	x	x	x		Covered: 6.000m² Open: 80.000m²
	Svishtov Sviloza River-km 558.30 to km: 558.70 | Right bank	n.a.	n.a.	x				n.a.
	Rousse Zapad River-km 497.63 to km: 495.92 | Right bank	x	x	x	x			Covered storage: 8.900m² Open storage: 27.600m²
	Rousse Iztok River-km 491.00 to km: 48929.00 | Right bank	x	x	x	x	x	x	Covered: 15.800m² Open: 180.500m²
	Rousse Bulmarket River-km 484.20 to km: 485.30 | Right bank	x	x	x	x			Covered: 29.900m² Open: 38.000m² Tanks: LPG: 2.600m³ Silos: 35.142m³ (grain)
	Tutrakan River-km 432.68 to km: 432.53 | Right bank		x	x				Open: 3.500m²
Romania	**Moldova Veche**		x	x	x			Covered storage: 2000m² Open storage: 30.000m² Tanks 1.000m³ (oil products),
	Orsova River-km 953.00 to km: 957.00 | Left bank	x	x	x				Open: 16.000m² Silos: 6.650m³ (grain)
	Drobeta Turnu Severin River-km 927.00 to km: 933.15 | Left	x	x	x			x	Open: 13.725m²

	bank							
	Giurgiu	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	Giurgiu Freeport River km 492.10 | Left bank	x	x	x				Covered: 72.00m²
	Cernavoda River Bank 298.00 | Right bank	x	x	x				Covered: 2.000m² Open: 20.000m²
	Medgidia River-km 37.50 | Right bank	x	x	x				Covered: 1.484m² Open: 86.514m²
	Murfatlar River-km 25.00 | Right bank	x	x	x				Covered: 1.266m² Open: 13.913m²
	Constanta	x	x	x	x	x	x	n.a.
	Braila River-km 160.00 to km: 175.80 | Left bank	x	x	x				Covered: 10.804m² Open: 250.350m² Silos: -22.750m³ (grain) -6.000m³ (animal fodder)
	Galati River-km 160.00 to km: 140.75 | Left bank	x	x	x	x		x	Covered: 7.200m² Open: 53.8320m²
	Tulcea River-km 70.00 to km: 73.50 | Right bank	x	x	x				Open: 70.000m²
Ukraine	**Reni** River-km 127.80 | Left bank	x	x	x	x	x	x	Covered: 30.000m² Open: 195.000m² Tanks: -120.000m³ (oil products) -3.000m³ (gas) Silos: 12.000m³ (grain),
	Izmail River-km 85.00 to km: 94.00 | Left bank	x	x	x				Covered: 19700m² Open: 195100m²
	Kilia River-km 46.50 to km: 47.00 | Left bank		x	x				Covered: 960m² Open: 17.630m²
	Ust-Dunaysk River-km 0.01 | Right bank	x		x				Covered: 22.600m² Open: 162.800m²

Moldova	**Giurgiulesti River-km** 133.80 | Left bank	x	x	x	x			Open: 4000m² Tanks: 63.600m³ (oil products) Silos: 50.000m³ (grain),

Annex 2:

CARGO TURNOVER OF THE DANUBE PORTS in 2011 -2012

(accordingly to Goods Nomenclature)

Goods Nomenclature NST-2007 [1]

01	Products of agriculture, hunting, forestry and fishing		11	Machinery a nd eq uipment not el sewhere cl assified (n.e.c.); products of ICT and precision instruments
02	Coal and lignite; crude petroleum and natural gas		12	Transport equipment
03	Metal ores, peat and other mining and quarrying products		13	Furniture, other manufactured goods n.e.c.
04	Food products, beverages and tobacco		14	Secondary raw materials, wastes
05	Textile, leather and their products		15	Mail, parcels
06	Wood, paper, pulp and publishing products		16	Equipment utilized in transport of goods
07	Coke and refined petroleum products		17	Goods moved and non-market goods, baggage and motor vehicles being moved for repair
08	Chemicals, rubber, plastic and nuclear fuel		18	Grouped goods
09	Other non-metallic mineral products		19	Unidentifiable goods
10	Basic metals, fabricated metal products		20	Other goods n.e.c.