



READER – TRANSPORT MODES - COMPARISON

Extract of relevant passages from the "Manual of Danube Navigation", via donau (2012) and the "Annual Report 2014" from via donau



Strengths and weaknesses of Danube navigation

The **strengths** of Danube navigation lie mainly with its ability to convey large quantities of goods per vessel unit, its low transport costs and its environmental friendliness. Furthermore, it is available around the clock, with no prohibition on driving at weekends or during the night. In addition, it has a high level of safety and low infrastructure costs.

The **weaknesses** of this mode of transport are its dependence on current fairway conditions and the associated variable load factor of the vessels, its low transportation speed and network density which means that pre- and end-haulage by road or rail are often necessary.

Danube navigation at a glance

The main **opportunities** for Danube navigation are the enormous amount of spare capacities that the waterway has to offer, international development initiatives such as the Strategy for the Danube Region, the internalisation of external costs on a European scale, cooperation activities with road and rail, as well as the application of modern and harmonised River Information Services (RIS).

The key **threats** to Danube navigation are its variable weighting on the political agenda, and consequently in the budget debates of the various Danube countries, as well as the need for modernisation of many Danube ports and parts of the Danube fleet.

STRENGTHS

- · low transport costs
- · ability to convey large quantities of goods per unit
- · environmental friendliness
- safety
- · availability around the clock
- low infrastructure costs

OPPORTUNITIES

- · spare capacity of the waterway
- rising demand for environmentally friendly transport modes
- modern and harmonised cross-border information services (RIS)
- · cooperation activities with road and rail
- international development initiatives (e.g.
 - NAIADES, Strategy for the Danube Region)

SWOT analysis of Danube navigation

Danube navigation compared to other modes of transport

In comparison to other modes of transport, several factors demonstrate the advantages of inland navigation. For example, it features the lowest specific energy consumption and the lowest external costs of any land transport mode. Furthermore, it has the ability to transport large quantities of goods per unit (bulk freight capacity) and requires comparably low investment in maintaining and expanding its infrastructure.

WEAKNESSES

- · dependence on variable fairway conditions
- · low transport velocity
- low network connectivity, often requiring pre- and end-haulage

THREATS

- inadequate maintenance of the waterway in some Danube riparian countries
- high requirement for modernisation of ports and fleet

Source: via donau

Specific energy use

With regard to specific energy use, inland navigation can be described as the most effective and most environmentally friendly mode of transport. An inland vessel is able to transport one ton of cargo almost four times further than a truck using the same consumption of energy.



Source: via donau

Transport distances for one ton of cargo requiring the same amount of energy

External costs

External costs for inland navigation, i.e. costs deriving from climate gases, air pollutants, accidents and noise, are the lowest when compared to other transport modes. CO₂ emissions are, in comparison to other modes of transport, especially low and this enables inland navigation to contribute to the achievement of climate goals set by the European Union.

Bulk freight capacity

Compared with other land transport modes, Danube navigation offers significantly higher transport capacity per transport unit. A single convoy with four pushed lighters can move 7,000 tons of goods, which corresponds to a load of 175 railway wagons each containing 40 net tons or 280 trucks each containing 25 net tons. Raising the amount of goods transported on the Danube will consequently result in a reduction of traffic jams, noise, pollution and accidents on roads and relieve strain on the railway system.

Infrastructure costs

Infrastructure costs consist of costs for constructing and maintaining transport routes. In the case of inland navigation, natural infrastructure is usually available, resulting in comparably low infrastructure costs. Detailed comparisons of aspects regarding inland transport modes are available for Germany: infrastructure costs per ton-kilometre are roughly four times higher

Danube navigation at a glance



The sum of external costs for inland vessels is by far the lowest (average values for selected transports of bulk goods)

1 convoy with four pushed lighters: 7,000 net tons

Inland vessels beat road and rail in terms of transport capacity

Source: via donau

Source: PLANCO Consulting & Bundesanstalt für Gewässerkunde 2007



Comparison of infrastructure costs (example of German inland transport modes)

for road or rail than for waterways (<a>PLANCO Consulting & Bundesanstalt für Gewässerkunde 2007).

Improving the complete infrastructure of the 2,415 km long Danube waterway would require an investment of 1.2 billion EUR according to current cost estimations for infrastructure projects in the Danube riparian states. This corresponds roughly with the cost of constructing 50 km of road or rail infrastructure. The costs for current railway tunnel projects in Europe amount to between10 and 20 billion EUR.

Relevance of Danube navigation

Danube waterway transport in comparison to Europe

In 2010, 485 million tons of goods were transported on the **inland waterways of the European Union**. Transport performance accounted for 148 billion ton-kilometres. Accordingly, the mean average distance of freight transport on European inland waterways amounted to 305 kilometres.

The **Main-Danube Canal** forms an important part of the Rhine-Main-Danube inland waterway which extends, with a length of 3,500 kilometres, through the European mainland from the Port of Rotterdam on the North Sea to the Port of Constanţa on the Black Sea. With a transport volume of 300 million tons, the **Rhine** clearly has a more intense utilisation of transport than the **Danube**, on which about 43 million tons were transported in 2010. Nevertheless, Danube traffic is characterised by longer distances, and this becomes obvious when comparing the transport performance of these two main European waterways: 26 billion ton-kilometres on the Danube (average transport distance of about 600 kilometres) compared to 90 billion ton-kilometres on the Rhine (average transport distance of about 300 kilometres).



Statistical data for the EU-27 countries were taken from the online database of Eurostat, the Statistical Office of the European Union: <u>ec.europa.</u> <u>eu/eurostat</u>; this comprises of estimated and preliminary values. Values for the Danube region are based on enquiries by via donau, which were conducted on the basis of national statistics.

Danube navigation at a glance

Regarding the **transport volume of single Danube riparian states** achieved on the Danube waterway and its navigable tributaries in 2010, Romania was by far the largest transporter of goods (21.6 million tons), followed by Serbia with 14.3 million tons and Austria with 11.3 million tons.

Maritime transport on the Danube, i.e. transport on river-sea or sea-going vessels on the Lower Danube (Romania and Ukraine), accounted for 4.8 million tons in 2010, the majority being handled via the Sulina Canal.



The European inland waterways Rhine and Danube in comparison

Modal split

For the **27 countries of the European Union**, the share of inland waterways in the modal split in 2010 was around 6.5% – meaning that 6.5% of all freight ton-kilometres were handled on waterways. This share differs sharply throughout individual EU countries. The Netherlands, for example, have important seaports and a highly integrated inland waterway network which is divided into small sections. This results in the highest inland navigation share of the EU-27 (32.9% in 2010).

In the **Danube region**, however, different infrastructural preconditions exist: waterway cargo transport is mainly concentrated on a principal river, on which very large amounts of cargo can be handled. However, the limited ramification of the waterway enables only a spatially concentrated use, confining the Danube to a limited form of transport requiring longer pre- and end-haulage by road or rail. For this reason, inland navigation in the Danube region usually has a lower share of national modal split figures. Detailed statistics on transport in the European Union: epp.eurostat.ec.europa.eu



(a)

Statistics on Danube navigation from the Danube Commission: www.danubecommission.org



Annual reports on Danube navigation in Austria are published by via donau and are available for download on www.donauschifffahrt.info/en.

Danube waterway transport in Austria

In Austria, between 9 and 12 million tons of goods are transported on the Danube annually. About one third of these goods are ores and scrap metal; about one fifth accounts for petroleum products as well as agricultural and forestry products.

The waterway share in the modal split in the Austrian Danube corridor is about 14%. The Danube plays an important role mainly in upstream transport, especially in imports via the eastern border and in transit. In these transport segments, the Danube is approximately neck and neck with rail. With regard to the entire territory of Austria, the Danube has a share of approximately 5% of the modal split.

The Danube region as an economic area

The Danube as an axis of economic development

In its function as a transport axis the Danube connects key procurement, production and sales markets that have significant European importance. The **gradual integration of the Danube riparian states into the European Un-***ion* has led to the establishment of dynamic economic areas and trading links along the waterway. Slovakia's and Hungary's accession to the EU in the year 2004 followed by Bulgaria and Romania in 2007 saw the start of a new phase of economic development in the Danube region. Accession negotiations got underway with Croatia in October 2005 and Serbia received accession candidate status in March 2012.

With approximately **90 million inhabitants**, the Danube region is of great economic interest. The economic and political heterogeneity that distinguishes the region is coupled with a dynamic development that is unparalleled anywhere else in Europe. The focus of this economic development lies in the capital cities of the Danube countries. Other urban areas are also playing an ever increasing role, in particular as consumer and sales markets. The Danube waterway as a transport mode can make a major contribution here with the provision of these centres with raw materials, semi-finished and finished products as well as the disposal of used materials and waste.

The Danube is of particular importance as a transport mode for the **industrial sites** that are located along the Danube corridor. Bulk freight capacity, the proximity to raw material markets, large free transport capacities and low transport costs all add up to make inland navigation the logical partner for resource-intensive industries. Many production facilities for the steel, paper, petroleum and chemical industries along with the mechanical engineering and automotive industry are to be found within the catchment area of the Danube. Project cargo and high-quality general cargo are now being transported on the Danube in ever increasing numbers in addition to traditional bulk cargo.

Due to its fertile soil, the Danube region is an important area for the cultivation of **agricultural raw materials**. These not only serve to ensure the sustainable provision of the conurbations in the vicinity of the Danube, but are also transported along the logistical axis of the Danube to be further processed. The ports and transhipment sites along the Danube play an important role here as locations for storage and processing and as goods collection points and distribution centres. A not inconsiderable part of these agricultural goods are exported overseas via the Rhine-Main-Danube axis and the respective seaports (North Sea and Black Sea).

Commodity groups

COMMODITY GROUPS

Ore and metal waste at the forefront Increase in solid fuels

FIGURES_DATA_FACTS

Transport volumes by commodity groups on the Austrian Danube 2014



"We, the Team Transport Development, always have an open ear for users of the Danube waterway. We support the Danube logistics sector with customised services and initiatives, thereby opening up new markets and attracting new customers."

> SIMON HARTI Head of Transport Development

As in previous years, ores and metal waste accounted for the highest volume of transport in 2014 with an amount of over 2.6 million tons, despite a drop of 11.3% compared to 2013. This group of goods was transported mainly as imports into Austria along the waterway and enjoyed a share of 25.8% of total volume shipped. The transportation of agricultural and forestry products achieved a volume of around 1.8 million tons and, despite a decline of 12.5% or 260,996 tons, was in second place. More than 60% of these products were shipped in transit through Austria, with imports registering approximately 30% or 546.877 tons. The transportation of petroleum products decreased by 13.0% or 271,609 tons compared to 2013 and, with a total volume of 1.8 million tons, accounted for 17.9% of the total volume shipped. These goods were primarily shipped in or out of Austria as cross-border traffic (74.0% or 1.3 million tons) with transit traffic playing only a minor role.

After a two-year decline in fertiliser shipments on the Austrian stretch of the Danube, transport volumes for this commodity group increased in 2014 by 6.8% amounting to just under 1.1 million tons, with more than half being exported. In contrast to 2013, when metal products posted a strong increase, the transportation of this group of goods decreased in 2014 by 8.0% and amounted to 964,630 tons. Metal products were transported on the Danube predominantly as export and transit goods. The transportation of crude and manufactured minerals registered an increase of 23.3% with a total volume of 870,654 tons. This corresponds to a share of 8.6% of total volumes. This increase can be explained by the fact that after the floods in 2013, extensive dredging had to be carried out on the Danube which continued into the first half of 2014. The figures for this commodity group therefore include the substantial quantities of material removed from the fairway. A slight increase of 5.4% or 21,298 was recorded for foodstuffs and animal fodder. In total, 418,634 tons of this commodity were shipped on the Danube, with more than half recorded as imports.

The largest percentage increase is attributable to the commodity group solid fuels. Goods volumes for this segment increased by 106.7%, or 144,681 tons and were almost entirely imports. With a total of 280,324 tons, solid fuels enjoyed a share of 2.8% of the total transport volume.

The commodity group machinery, vehicles and other articles accounted for 260.214 tons of goods shipped – a decrease of 14.7% compared with 2013. Nearly 70% of goods from this group were shipped as transit traffic through Austria. A relatively high increase of 51.1% was recorded for chemical products. However, with a mere 19,053 tons, the volume of goods transported was relatively low compared to the other categories.



Goods classification according to NST/R*	Domestic	Import	Export	Transit	Total 2014	Change
Agricultural and forestry products	991	546,877	158,274	1,126,238	1,832,380	-12.5%
Foodstuffs and animal fodder	-	223,915	71,126	123,593	418,634	+5.4%
Solid fuels	-	234,765	5,443	40,116	280,324	+106.7%
Petroleum products	407,775	807,027	534,992	63,395	1,813,189	-13.0%
Ores and metal waste	-	2,586,284	25,829	-	2,612,113	-11.3%
Metal products	16,874	156,119	455,128	336,509	964,630	-8.0%
Crude and manufactured materials, building materials	370,637	227,068	158,470	114,479	870,654	+23.3%
Fertilisers	1,616	186,555	549,542	312,820	1,050,533	+6.8%
Chemical products	-	-	8,265	10,788	19,053	+51.1%
Machinery, vehicles, and other articles	905	13,519	64,517	181,273	260,214	-14.7%
Total	798,798	4,982,129	2,031,586	2,309,211	10,121,724	-5.5%

* NST/R = Standard Goods Classification for Transport Statistics/revised

Source: Statistics Austria, adapted by viadonau

Ores and metal waste 25.8%

R

Agricultural and forestry products 18.1%

С

Petroleum products 17.9%

D

Fertilisers 10.4%

Metal products 9.5%

Modal split

MODAL SPLIT

Dominance of road transport unbroken Danube's share around 12%

FIGURES DATA FACTS

Cross-border freight traffic in the Austrian Danube corridor 2014

- Road transport increased its share of the market by 4.2%
- Growth for rail
- The Danube achieves a modal split share of around 30% for imports from Eastern Europe and around 17% for upstream transit

Transport volumes along the Austrian Danube corridor have increased rapidly since the mid-1990s. In 2014 they summed up to nearly 79.3 million tons, an amount which corresponds to a growth of nearly 124% over the last 20 years (1995-2014). (Data on road transport for 2014 is based on estimates by the Austrian Institute for Spatial Planning, as official data is still pending.) Compared to 2013, transport volumes in the corridor increased by 3.4% or 2.6 million tons.

The chart shows the cross-border transport volume (net tons) for the three transport modes of rail, road and waterway in the Austrian Danube corridor according to transport type. A look at the figures for all transport modes reveals that the quantity of goods transported to and from the west is significantly higher than the volume of goods crossing the eastern border of Austria: In 2014, approximately 58.8 million tons of goods, including transit transport, passed through the western border of the Austrian Danube corridor (+5.1% compared to 2013), while approximately 41.7 million tons (+2.7%) crossed the eastern border. With about 58.0 million tons transported, the level of originating and terminating traffic (western and eastern borders taken together) was significantly higher in 2014 than transit transport with 21.3 million tons. However, transit transport in particular has increased significantly over the last 20 years; today, its volume is 2.6 times higher than in 1995, with transit road transport having increased by a factor of 5.7.

Following a significant growth in 2013 (+5.6%), 2014 saw cross-border freight traffic fall by 6.9% to 9.3 million tons. Only westbound traffic saw an increase in volumes shipped (+11.9% compared to 2013). All other transport types suffered a slowdown in 2014. After a slight decrease in 2013 (-3.7%), the volume of goods transported by rail increased by 6.2%. Road traffic once again increased its market share by 4.2%.

In 2014, the modal split along the Austrian Danube was as follows: 58% road, 30% rail and 12% Danube. The largest percentage of traffic volume on the Danube in 2014 was 30% imports on the eastern border and 17% in upstream transit traffic.



Source: Austrian Institute for Spatial Planning (ÖIR), adapted by viadonau

FIGURES_DATA_FACTS

In millions of tons

Export

Import

Transit

Total

Domestic

DE

1.05

2.29

3.62

0.09

7.05

Freight transport on the entire Danube 2013

FREIGHT TRANSPORT ON THE ENTIRE DANUBE

Nearly 38 million tons Moderate plus of 1.7%

The most current available figures regarding the volume of freight transport on inland waterways in the Danube region are from the year 2013. In total, 37.7 million tons of goods were carried on the Danube waterway and its tributaries that year. This represents a plus of 1.7% or around 0.6 million tons more than in 2012. The figures for inland waterway transport on the Danube (including tributaries) are laid out in the following paragraphs and the chart opposite. River-sea transport will be dealt with further below.

In 2013, the largest transport volume was again achieved by Romania, amounting to over 16.9 million tons, followed by Serbia with nearly 12.4 million tons and Austria with around 11.2 million tons. While countries in the upper and middle regions of the Danube recorded a slight increase in the amount of goods shipped on the waterway compared to 2012 (Germany: +7.0%, Austria: +0.7%, Slovakia: +1.6%, Hungary: +3.6%, Croatia: +2.5%, Serbia: +2.1%), transport volumes in the lower Danube regions suffered a dramatic average decrease in traffic volumes of 10% (Romania: -4.0%, Bulgaria: -15.5%, Ukraine: -16.1%).

The largest exporter on the Danube in 2013 was Romania with almost 3.5 million tons (+22.7% compared to 2012), followed by Hungary with around 3.4 million tons (-15.0%) and the Ukraine with just under 3.0 million tons of goods (-14.9%). Romania, with more than 5.5 million tons (-3.8% compared to 2012), was also the largest importer. The second strongest importing country on the Danube in 2013 was once again Austria with nearly 5.5 million tons (-1.1%), Germany imported a little less than 2.3 million tons (+11.2%).

A total of nearly 13.9 million tons were transported on the Romanian Danube-Black Sea Canal (including its side channel). This figure includes river-sea shipping amounting to approximately 0.3 million tons. This represents a slight increase of 0.1% over 2012.

In 2013, maritime transport on the Danube, i.e. transport by river-sea vessels or by sea-going vessels, accounted for a total of around 4.5 million tons – a significant increase of 29.5% or 1.0 million tons compared to 2012. This represents a remarkable turnaround from the previous year and more than compensates for the 24.5% downturn suffered in 2012. The majority of this traffic, amounting to nearly 3.2 million tons of goods, was shipped via the Romanian Sulina Canal (+33.5% compared to 2012), while about 1.0 million tons were transported via the Ukrainian Bystroe or Kilia arm (+52.6%).

AT

1.99

5.46

3.04

0.70

11.19

SK

2.18

0.19

5.76

0.02

8.15

ΗU

3.39

2.05

3.04

0.03

8.51



HR

0.27

0.24

5.39

0.04

5.94

ΒA

0.03

0.03

0.00

0.00

0.06

RS

2.74

2.25

4.83

2.55

12.37

RO

3.46

5.52

1.52

6.42

16.92

BG

1.26

1.51

1.52

1.19

5.48

MD

0.04

0.17

0.00

0.00

0.21

UA 2.96

0.09

0.00

0.02

3.07

- Total transport volume on the Danube in 2013 at about the previous year's level
- Romania is the most significant exporter (+22.7% on 2012) and importer (-3.9%) on the waterway
- 4.5 million tons of maritime traffic on the Danube (+29.5% on 2012)

Traditional markets of Danube navigation

Due to the large volume of goods that can be transported on a vessel unit, inland navigation vessels are ideally suited to the transport of bulk cargo. If planned and carried out correctly, transport costs can be reduced in comparison to road and rail and this in turn compensates for longer transport times. The inland vessel is especially suitable for the transport of large quantities of cargo of low-value goods.

However the system requires the availability of high-quality logistics services along the waterway (transhipment, storage, processing, collection and/or distribution). Many companies use Danube navigation as a fixed part of their logistics chain. Currently, the great bulk freight capacity of inland vessels is utilised predominantly by the metal industry, agriculture and forestry and the petroleum industry.

Inland navigation is an extremely important mode of transport for the **steel industry**. Approximately 25-30% of the total amount of the raw material ore, for example, is transported on the Austrian stretch of the Danube. Due to their heavy weight, semi-finished and finished goods such as steel coils can also be transported economically using inland navigation.



Transhipment of steel coils

The most important steelworks in Austria is voestalpine, which is located in Linz. This company operates a factory port on its own premises that has an

The market for Danube navigation

annual waterside transhipment of 3–4 million tons. This is also Austria's most important port in that it has handled almost half of all waterside transhipment in Austria in recent years.

Other major steel plants in the Danube region are located in Dunaújváros/ Hungary (ISD Dunaferr Group) and Galaţi/Romania (ArcelorMittal).

The demand and, therefore, also the flow of goods from the **agriculture and forestry sector** can fluctuate greatly from one year to the next. Agriculture is dependent to a great extent on weather conditions (precipitation, temperature, days of sunshine per year). Crop failures in a region due to bad weather conditions can lead to a fluctuation in the volume of transported goods required to cover the needs of the affected region. Grain and oilseed are the main products transported on the Danube. Although the transport of wood is also growing in importance due to the increasing demand from the processing industry and biomass plants.



Log wood

Agricultural and forestry products together account for around 20% of the total volume of goods transported annually on the Austrian stretch of the Danube. Many Austrian companies trading in agricultural products or involved in the processing of such goods (i.e. starch, foodstuffs and animal fodder, biogenic fuel, log wood) have settled directly on the waterway. Many companies have already set up factory transhipment sites or have settled in a port where they operate their silos or processing facilities. This enables transport on inland vessels with no pre- or end-haulage, thereby enabling companies to benefit from particularly low transport costs.

Source: via donau





Petroleum products from the mineral oil industry account for another 20% of the total transport volume on the Austrian stretch of the Danube and therefore constitute a major market. In the Danube region there are many refineries located either on or near the Danube.

Due to their great bulk freight capacity, low transport costs and high level of safety, inland vessels are predestined as a significant means of transport for petroleum products in addition to pipelines. The fuel tanks of around 20,000 cars can be filled up with the cargo of a single tanker.

Petroleum products and their derivatives are classed as hazardous goods and for this reason are transported in special vessel units equipped with the



High & heavy goods transport

Source: via donau

The market for Danube navigation

respective safety equipment. European regulations and national hazardous goods legislation have particular relevance for tanker shipping.

Other branch-specific potential for Danube navigation

In addition to traditional bulk cargo transport, there are numerous sectors involved in the transport of high-value goods, which, due to their specific requirements, represent a great challenge but at the same time a substantial potential for the development of logistics services along the waterway.

Due to their size and the available infrastructure, inland vessels are ideally suited for special transport such as **heavy goods or oversized loads** ("high & heavy"), e.g. construction machinery, generators, turbines or wind power plants. The greatest advantage here compared to conventional road transport is that no special modifications need to be made along route, e.g. the dismantling of traffic lights and traffic signs or protective covers for plants. Another benefit is the fact that there is no inconvenience to the general public due to street closures, restrictions on overtaking or noise when such goods are transported by inland vessel.

The Danube has also developed today to become a logistics axis of pan-European importance for the bundling, storage and processing of **biogenic**



Rapeseed

(renewable) raw materials (e.g. grain, oilseed, log wood). The increasing shortage of non-renewable resources and the creation of cross-sector value-added chains that result from this (e.g. the food and fodder industry, chemical industry and energy generation sector) enable the development of new types of cargo on the Danube. Transport costs can be reduced and the negative impact on the environment minimised thanks to targeted improvement in logistic



Construction material

services available on the Danube (port infrastructure, special transhipment equipment) and the operation of inland vessels along the resource-intensive value-added chains. This entails the necessity of logistics chains that meet the high requirements of the respective goods.

A favourable development can also be expected in Central and South-Eastern Europe as far as the **construction material industry** is concerned. This is due mainly to the high requirements of renovating and expanding the infrastructure, although structural and civil engineering as well as residential construction also play a significant role. The resulting transport volumes and growing exchange of goods with South-Eastern Europe suggest a high potential for inland navigation. Inland vessels could be used here for both bulk



Transhipment of waste paper

The market for Danube navigation



New cars on board an inland vessel

cargo (e.g. mineral raw materials) as well as general cargo (e.g. construction materials, construction machinery).

Inland vessels come up trumps where the **paper industry** is concerned, thanks to their low transportation costs over long distances and the fact that it can be integrated so easily in multimodal logistics chains. Finished and semi-finished products (paper, carton, cardboard) as well as raw, additional and auxiliary materials (log wood, waste paper, bulking agents and pigments) are among the goods transported for the paper industry. Paper products, in contrast to many other bulk cargo, are sensitive logistics goods which place high demands on transport, storage and transhipment.

Strategies such as just-in-time or just-in-sequence are among the determin-



Storage of chemical products

ing factors for success or failure in the **automotive industry**. Due to their long transport times inland vessels only play a role in the logistics chain here where the transport of less time-critical components is concerned. However, specific carrier potential can be exploited (high transport capacity, low transport costs) with the use of Ro-Ro vessels for the transport of new vehicles due to the high concentration of production plants in the Danube region (e.g. in Slovakia and Romania).

Another major sector is **fertilisers**, which are currently being transported in large quantities on the Danube. These account for approximately 10% of the total transport volume on the Austrian stretch of the Danube. Plants from the **petrochemical industry** are often found in the immediate vicinity of refineries; these plants manufacture plastics and other oil-based products from the oil derivatives. Due to its great bulk freight capacity Danube navigation is also the ideal solution for this market segment. However, economical concepts for pre- and end-haulage are required here. Combined transport represents an attractive alternative for integrating the inland vessel into the logistics chain of the chemical industry in addition to the construction of warehouses for bulk cargo.

Used materials and waste are bulk goods of relatively low value and are therefore not usually associated with time-critical transport. Because of these characteristics, inland navigation is an interesting alternative to road and rail for waste management. In principle, all waste material can be transported by inland vessels, regardless of whether it is in the form of bulk cargo or containers. The major urban areas located directly on the Danube (e.g. Vienna, Bratislava, Budapest and Belgrade) are reliable suppliers of waste metal, household refuse and other waste materials. Energetic utilisation by waste power plants is leading to an additional demand for the transport of waste.



Scrap