Interreg
Danube Transnational Programme
ENERGY BARGE

ENERGY BARGE

Building a Green Energy and Logistics Belt

Project Code: DTP1-175-3.2

Deliverable 5.1.1

Transnational Implementation Plan

31st December, 2017

Project co-funded by European Union funds (ERDF)

For the implementation of the project "ENERGY BARGE – Building a Green Energy and Logistics Belt" a subsidy is awarded from the European Regional Development Fund under the Danube Transnational Programme.

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ARA ports	Amsterdam, Rotterdam, Antwerp
CEF	Connecting Europe Facility
DTP	Danube Transnational Programme
EIHP	Energy Institute, Croatia
IWW	inland water way
JIT	just in time
KSH	Central Statistical Office, Hungary
MTA EK KFL	Hungarian Academy of Sciences, Centre for Energy Search, Environmental Physics Department
PPs	project partners
rkm	river kilometre
SR	Slovak Republic
TEN-T	Trans-European Transport Network
tOE	tons of oil equivalent
VDG	Gabcikovo Water Dam
VITUKI	VITUKI Environmental and Water Management Research Institute Non-profit Ltd (former company)
ZVH	Zweckverband Hafen Straubing-Sand

About the ENERGY BARGE project

The Danube region offers a great potential for green energy in the form of biomass. The main objective of ENERGY BARGE is to exploit this potential in a sustainable way, considering the Renewable Energy Directive 2009/28/EC, thereby increasing energy security and efficiency in the Danube countries. The project brings together key actors along the entire value chain, biomass companies and Danube ports as well as relevant public authorities and policy stakeholders. The project maps value chains and facilitate the market uptake of biomass, support better connected transport systems for green logistics and provide practical solutions and policy guidelines. FNR coordinates the project with its fourteen partners from Austria, Bulgaria, Croatia, Germany, Hungary, Slovakia and Romania.

Project coordinator

Agency for Renewable Resources		
Fachagentur Nachwachsende Rohstoffe e.V.	FNR	Germany

Project partners

BioCampus Straubing GmbH	BCG	Germany
Deggendorf Institute of Technology	DIT	Germany
Austrian Waterway Company	VIA	Austria
Port of Vienna	PoVi	Austria
Bioenergy2020+ GmbH	BE2020	Austria
International Centre of Applied Research and Sustainable Technology	ICARST	Slovakia
Slovak Shipping and Ports JSC	SPaP	Slovakia
National Agricultural Research and Innovation Center	NARIC	Hungary
MAHART-Freeport Co. Ltd.	MAHART	Hungary
International Centre for Sustainable Development of Energy, Water and Environment Systems	SDEWES Centre	Croatia
Public Institution Port Authority Vukovar	PoVu	Croatia
Technology Center Sofia Ltd.	TCS	Bulgaria
Romanian Association of Biomass and Biogas	ARBIO	Romania
Federation of owners of forests and grasslands in Romania	Nostra Silva	Romania
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About this document

This report corresponds to D 5.1.1 Transnational Implementation Plan of ENERGY BARGE. It has been prepared by:

Due date of deliverable:	2017-12-04 (extended)
Actual submission date:	2018-02-19
Start date of project:	2017-01-01
Duration:	30 months

Work package	WP5
Task	T3
Lead contractor for this deliverable	MAHART
Editor(s)	Zoltan Haasz, Bence Buday, Zoltan Erkel
Author	MAHART
Quality reviewer	Birger Kerckow

Version	Date	Author(s)	Reason for modification	Status
1.1	*2017-12-06*	*MAHART*	*First draft*	*Draft*
1.2	*2017-12-15*	*MAHART*	*Revision after QAM*	*QAM processed*
2.0	*2017-12-31*	*MAHART*	*Final (including QAM-requested revisions by the ports)*	*Final*

I. Executive summary

The **aim of the Transnational Implementation Plan (TIP)** is to assist project partners to identify the focus of bioenergy related developments in the ports and harmonize individual pre-feasibility pilot studies in order to avoid duplication and competing efforts. During the elaboration of the TIP special emphases were given to create interlinkage and cooperation between bioenergy related services and infrastructures of the participating ports. It particularly focuses on geographical location and embeddedness of the ports, hinterland areas in terms of biomass, regionally available raw materials, supply and demand side for upgraded products, transportability of biomass on the Danube and links with the bioenergy sector. The aim of the developments is to create a network of bioenergy/biomass hubs among the participating ports.

Situation analysis

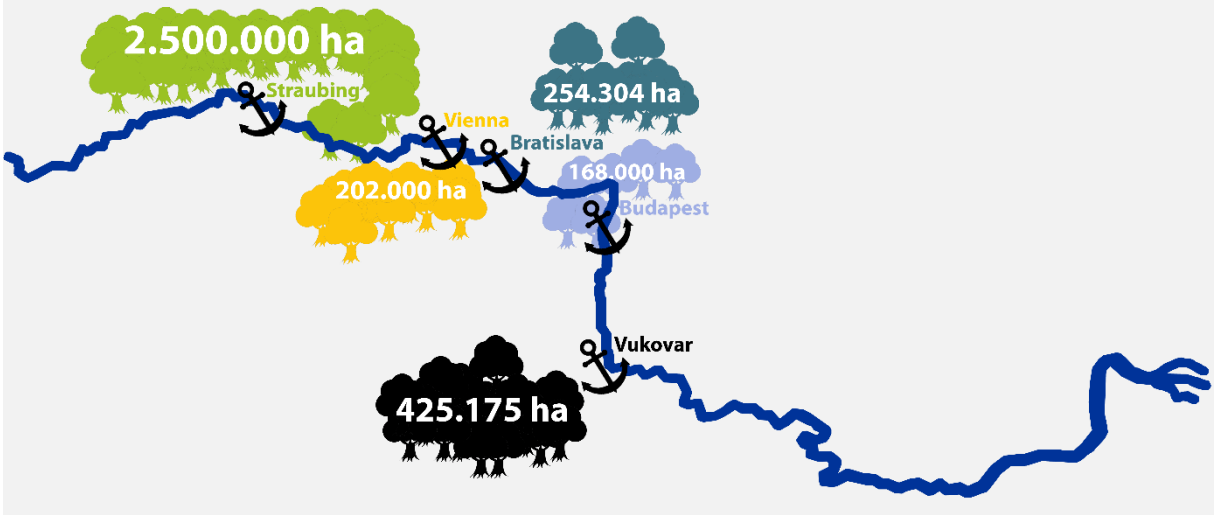
Regarding the **location of the ports**, all of them are important industrial and logistics centres of their regions located on average 180 kilometres away from each other. The closest two are Vienna and Bratislava approx. 60 km from each other, and Straubing is 330 km away from Vienna, which is the largest distance among two ports after one another. Ports have great **multimodal connections**, almost each of them has highways passing by or close to them, and they also have advantageous railway connections, mostly parts of international TEN-T core networks and corridors that – in the best case – cross the Danube and not go parallel with it. Four out of five ports have connections to airports. Certainly, the three capitals have their own airports. Straubing has its own regional airport and Munich international airport is also accessible in an hour from the port.

1. Figure Geographical location and infrastructural connection of ports

Source: Own editing based on national surveys

Most of the **hinterland areas of the ports** have good opportunities for biomass **raw material** production, since they are surrounded by mountains, forests, and/or great plains with agricultural utilization. As it turned out, there are various modes of utilization of raw materials among the five countries. In some cases, local market players are not specialised on either solid biomass or biogas or biofuel production, rather each of them are represented in the ports' hinterlands. The five ports

are different in terms of existing and potential network of suppliers and partners as well as the depths of connections with them.



2. Figure Size of forests in the hinterland areas of the ports

Source: Own editing based on national surveys

In terms of **demand and supply sides of upgraded energy biomass products**, none of the five ports are in bad situation. There are large agriculturally cultivated areas and forests around, and high volumes are exploited. Plenty of economic actors are located in the ports' hinterlands to process raw materials coming from natural resources and several biomass energy producers supply their clients with heat and electricity be them just a few institutes and households or entire neighbourhoods and districts in Bavaria, the Viennese Region, Central-Hungary and Transdanubia etc. Even if many of biomass materials are exploited and high volumes are processed, markets of upgraded products are still not developed yet in cases of hinterlands of Bratislava, Budapest and Vukovar.

Most of the five ports are well-equipped considering **transshipping capacities**. Warehousing and supporting modal shift are the main challenges for everyone, but the exact problems each partner faces are still different, therefore ideas to solve them differ. Concerning the **transportability of biomass on the Danube**, Straubing, Vienna and Bratislava are all facing issues related to navigability and water level. This is situation is independent from who governance the river (Germany, Austria and Slovakia) However, it is obvious that conditions of navigability are worse in the Hungarian and Croatian sections. Modal shift, mobility of both raw materials and energy utilization, too many trucks on road instead of distributors using inland waterways were mentioned in some way by all the partners in their subsequent national survey reports.

It turned out that there are major differences among ports concerning preparedness and readiness for **biomass handling and storing**. Straubing is well-equipped for biomass handling and thanks to its strategic thinking does not have to worry about further modernization as it will be implemented by interested companies settled in the port. Vienna has no biomass specific silos and machines (e.g. forklifts) available, meaning that PoVi is semi-prepared for biomass handling. They are equipped and ready for loading and unloading biomass materials and products arriving to the port either on rail, road or river, but they must transfer them JIT and not able to store the goods, their current silos are always full. Budapest and Vukovar have shown similarities in terms

of the large quantity of agricultural products handled and stored in their ports and the fact that both referred to facilities and machines that could be (but not yet) used for biomass loading as well besides other bulk cargos. Nevertheless, Vukovar has more experiences in biomass handling. Bratislava has absolutely no biomass in the port, and even agricultural products which are very similar types of goods, requiring similar infrastructure, are carried out in low quantity compared to other types of cargo handled in the port.

Development ideas

Ports of Straubing-Sand in Germany, Vienna in Austria, Bratislava in Slovakia, Budapest in Hungary and Vukovar in Croatia completed surveys aiming to map their competencies and opportunities to develop their ports to contribute to a cooperative energy biomass network along the Danube. Each of the five partner ports has discussed possible future project ideas with its local stakeholders according to a joint methodology including the following topics. Among their possible project drafts each port will choose a main development area that it is going to complete a pre-feasibility study about.

Because of different levels of development as far as their technological backgrounds, colourful networks with the biomass energy sector etc. are concerned including port operators with diverse profiles and activities, ports of Straubing, Vienna, Bratislava, Budapest and Vukovar face with various challenges that they are planning to manage differently. There are two kinds of ideas. Straubing-Sand and PoVi have cluster development related ideas based on their current infrastructure and existing excellent networks of raw material suppliers, bioenergy producers, distributors and the academic, science and research pillars of the sector. The other project idea that the ports of Bratislava, Budapest and Vukovar invented is to become biomass logistics hubs of their regions based on already being key actors of their hinterlands' industry and the fact, that supply and demand sides of the biomass energy sector in Slovakia, Hungary and Croatia need to be more accurately connected.

We can declare that no **competition** occurs among the development ideas, as different levels of development of current technological background and markets lead to different needs and purposes. What Straubing and Vienna plan to implement is a *market pulled* cluster-building where less, but important links are missing in the chain: facilitating new dimensions of renewable energy clusters by high-end service provision and by diverting road transport to river in higher volumes. On the other hand, what the ports of Bratislava, Budapest and Vukavar are planning is known as the *technology pushed* approach of forming logistics hubs into the centres of non-existing biomass markets.

Future investments planned in the frame of the project are mainly focusing on developments in individual ports however there are opportunities and market potential for possible further services for joint implementation as well. These **possible cooperation** and joint developments may increase the turnover of participating ports from energy biomass shipment and handling considerably. Possible main directions of further services for joint implementation may cover different elements of information and logistic services as well as direct assistance of commercial activities of the energy biomass market. The complexity of provided services may differ very much and the introduction of more complex activities will most probably require a step by step approach.

There are **different levels of services** which can be provided by the ports **in the form of joint implementation**, such as elaboration of information services for traders and end users, or setting

up a standard quality assurance system in each participating port in order to standardise quality (e.g. clarity, average unit size, homogeneity, calorific value, humidity content) and make buyers confident that they receive the expected raw material for their energy production even if it is shipped from a distant location, via waterway. In long term, an electronic solid biomass "stock exchange" could be developed in order to give the opportunity to end users and traders to buy their raw material on an optimal price (including shipment cost) independently of its production site using the Danube as shipment route. The system could provide up-to-date information for potential buyers, suppliers and forwarding companies and create an electronic platform to manage transactions as well.

Other **possible joint activities** to **increase the role of waterway transport** and Danube ports in the utilisation of energy biomass can include extending cluster and cooperation activities, as any extension of these already existing clusters to other countries could help the internationalisation of bioenergy supply and increasing the role and efficiency of energy biomass utilisation. These initiatives would probably increase the role of waterway transport and the possible services of Danube ports as well. Cooperation in technical innovation, e.g. the development of a mobile temporary loading **pontoon** and attached loading devices for forestry companies and agricultural residues the quantities of waterway transport of energy biomass could be increased. A further topic for possible cooperation in technical, technological innovation could be the drying of solid biomass (mainly woodchips) with environment friendly technical solutions. Ports could become a very valuable part of the value chain of energy biomass if solutions for the reduction of humidity would be available during biomass handling and processing. Best practices for the effective utilisation of waste heats, heat pumps, solar thermal or other technologies could help the development of new services. Another joint initiative could be supported by Danube ports towards decision makers and key players of the green energy production industry to increase the number of biomass based combined heat and power plants (CHP) and district heating power plants with direct access to ports. This way energy biomass end users and producers of biomass located close to the Danube (agricultural producers, forestry companies) could be connected directly via the Danube.

II. Objectives, structure and methodology applied

Background

Danube ports involved in the Energy Barge Project set the objective to become biomass hubs as part of a transnational network. The aim of the project is to initiate new services for the bioenergy sector and involve ports to the handling, storage and manipulation of energy biomass in the most competitive way. In order to drive this development forward, each port will define specific investment projects, taking into consideration market, technology and also financial issues in forms of pre-feasibility pilot studies.

As it has been discussed earlier in the process of the implementation of other thematical work packages of ENERGY BARGE biomass feedstock/resources, products and intermediaries can be both targeting/be produced by the bioenergy and the material use sector (e.g. furniture industry, paper industry, chemical industry). These could also be the sectors surrounding ports that are demanding biomass which could be transported via IWW.

Objectives of the Transnational Implementation Plan (TIP)

The TIP will assist project partners to identify the focus of bioenergy related developments in the ports and harmonize individual pre-feasibility pilot studies in order to avoid duplication and competing efforts. During the elaboration of the TIP special emphases will be taken to create interlinkage and cooperation between bioenergy related services and infrastructures of the participating ports. It will particularly focus on geographical location and embeddedness of the ports, hinterland areas in terms of biomass, regionally available raw materials, supply and demand side for upgraded products, transportability of biomass on the Danube and links with the bioenergy sector. The aim of the TIP is to create a network of bioenergy/biomass hubs among the participating ports.

Structure of the Transnational Implementation Plan

The TIP made by each participating port contains the following main chapters**:**

1. Geographical location and embeddedness of the ports *(general information on the geographical position and main transport – road, rail and waterway - links of the port, with text + maps, photos)*

2. Hinterland areas in terms of biomass (100 km radius) *(what is the geographical background area in terms of biomass supply side of the ports–text + maps)*

3. Regionally available raw materials – supply and demand side (in the 100 km radius) *(what kind of biomass is available in the 100 km radius of the ports–text + maps if any)*

4. Supply and demand side for upgraded products *(is there a market in the area of the ports for upgraded biomass products –text)*

5. Links with the bioenergy sector *(are there any current links OR can such links be established? - text)*

6. Transportability of biomass on the Danube, *(is there any biomass transported on the Danube section OR can be diverted to the waterway via the ports? –text)*

7. Presently available technical background of biomass processing and logistics in the ports *(description of currently available technology - text + photos, maps)*

8. Summary of preliminary development ideas of the ports *(description of what the ports want to do in terms of biomass-related investment – text)*

9. List of policy makers and stakeholders to be involved

Methodology applied

The elaboration of TIP consisted of 3 main phases:

- Description of the current situation (Chapter 1-7)
- Analysis of the situation (SWOT analysis)
- Elaboration of development ideas of the ports (Chapter 8.)

Partner ports of Straubing-Sand, Vienna, Bratislava, Budapest and Vukovar completed Chapter 1 by presenting contact data, name and address of their ports, gathering basic information on the regions they operate in and the currently or potentially most important ways of transport network their partners, traders, suppliers are using: already existing road and railway lines, IWW and/or soon available further modes of transport (e.g. soon to be reconstructed railway line next to Vukovar port).

Partner ports gathered all the relevant information on their hinterland areas in Chapter 2. They were counting on current or possible partner organisations, companies, traders, forestry, farmer associations who maintain and exploit natural resources for biomass energy. Also, available public data on national forestry and agriculture provided by statistical offices contributed to more precise research work.

In Chapter 3 partner ports defined the territorial and sectoral coverage of supplied raw materials with a possible contribution from their traders, companies they are in touch with. Afterwards, they gathered all the relevant information on available raw materials in their hinterlands using mostly databases published by statistical offices.

Each partner port completed its own research by the contribution of port operators in touch with the sector in Chapter 4. They were seeking after and contacting with companies, suppliers, distributors, traders, power plants, private and public institutes and buildings that are already or could be key figures of the biomass energy market. Volumes supplied and capacities of users in need were collected and presented in this chapter, if available.

The five ports completed Chapter 5 by presenting existing partnerships between their port operators and stakeholders of the bioenergy sector. Additionally, they contacted the relevant companies, distributors, power plants and other users and processors of biomass raw materials in the hinterland in order to form and develop business relations improving the supply chain of biomass products.

In Chapter 6 each port managing authority described current infrastructural conditions in its port area and presented the available technical capacities of port operators for transferring biomass and – in case of not dealing with biomass – other bulk cargo turnovers especially agricultural products. They listed experiences in terms of low water periods, difficulties on reducing truck transport in favour of IWW.

Partner ports, in their role as owner or management authority of their ports or both, completed databases and keep them up-to-date on the equipment available in their port area, whether they belong to port operator companies or administrative bodies. In Chapter 7 partners listed and briefly introduced their facilities and machines (i.e. type, brand, capacity, what it is used for), providing a big picture of the technological conditions of their ports.

Each of the five partner ports has discussed possible future project ideas with its local stakeholders according to a joint methodology in Chapter 8. Among their possible project drafts each port will choose a main development in view of the envisaged pre-feasibility studies.

III. Summary of the Transnational Implementation Plans provided by the ports

1. Geographical location and embeddedness of the ports

1.1. Objectives of the chapter, methodology

Geographical location

General data, name, address, location, ownership structure, possible concessionaries are presented in this chapter. Also, the size of the port area, most important economic actors located in the port, capacities regarding storage and loading could be voluntarily briefly introduced in writing as well as on photos and/or maps.

Embeddedness of the ports

This chapter was the basis for providing infrastructural background, as an external factor of port conditions. Presented are related infrastructural, mostly transport connections to make it clear how embedded the given port is in the regional and national network. This includes information on whether there are TEN-T or any other core corridors, important highways, railway lines passing by the port, or how far the closest airport is.

Although, all ports are Danube ports, possible further rivers, navigable or potentially navigable inland waterways could have been named here.

Multimodality shall have been emphasized and all relevant external, independent hard elements that can contribute to the competitiveness of the ports when it is about introducing new products and/or services or entering into new markets for instance energy biomass delivery and logistics.

Source of information

Partner ports of Straubing-Sand, Vienna, Bratislava, Budapest and Vukovar completed this chapter by presenting contact data, name and address of their ports, gathering basic information on the regions they operate in and the currently or potentially most important kinds of transport networks their partners, traders, suppliers are using: already existing road and railway lines, IWW and/or soon available further modes of transport (e.g. soon to be reconstructed railway line next to Vukovar port).

1.2. Summary of the surveys

Location

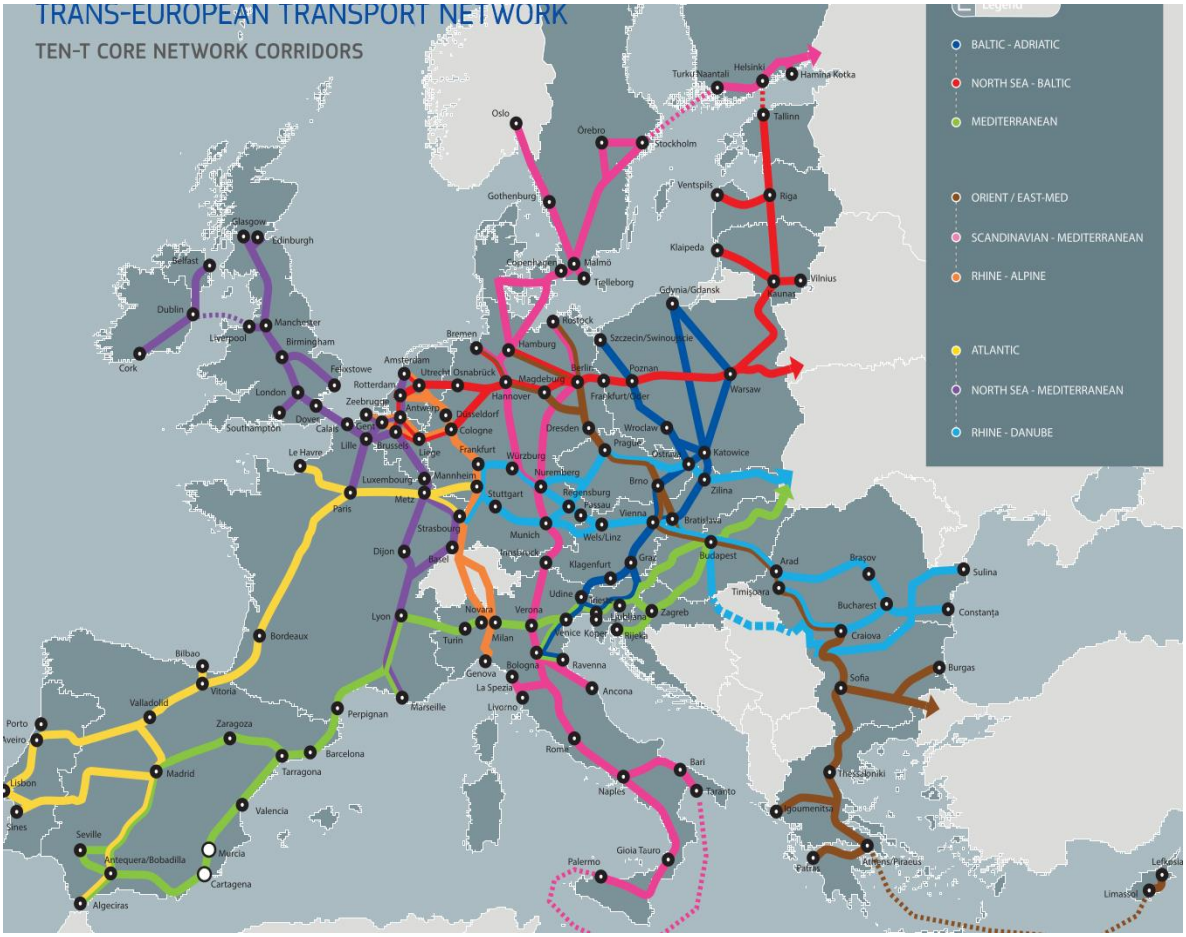
The five ports are important industrial and logistics centres of their regions located on average 180 kilometres away from each other. The closest two are Vienna and Bratislava approx. 60 km from each other, and Straubing is 330 km away from Vienna, which is the largest distance among two ports after one another. Three out of five ports are located in capital areas (Vienna, Bratislava and Budapest) with all the advantages coming from being part of a metropolitan milieu: excellent infrastructure, loads of companies, newer and newer markets to enter, coopetition in the environment etc. Straubing is also a big city, its closeness to Regensburg and Munich situates the port into an industrial, commercial and knowledge centre of Bavaria. Vukovar, being on the crossroad of more Balkan and Central-European countries, emphasized the commercial

advantages of the closeness of Hungary, Bosnia and Herzegovina, Serbia and Romania and also the Adriatic Sea on the west coast of Croatia.

Roads

Ports have great multimodal connections. Almost each of them has highways passing by or close to them. Straubing named 3, Vienna 2, Bratislava 1 and Budapest named 5 highways – thanks to ring road motorway M0 connecting all of them – that are relevant and used when accessing the ports. Vukovar is located the farthest from highways. Highway A3 connect the port to regional sub-centres. Although transport connections are still foreseen to be reconstructed mostly due to the destruction of the Yugoslavian war taken place in the 90s.

Railways



3. Figure Trans-Europen Transport Network – TEN-T core network corridors

Source: railwaypro.com

Ports have advantageous railway connections, mostly parts of international TEN-T core networks and corridors that – in the best case – cross the Danube and not go parallel with it.

The biggest railway corridors in the ports' hinterlands are

- Baltic-Adriatic corridor,
- Balkans-/Eastern-Med corridor,

- Orient-East Med.

Balkans-/Eastern-Med and Orient-East Med cross Budapest, Baltic-Adriatic goes through Vienna and Bratislava, Vukovar is connected to Zagreb and Rijeka, while Straubing is unfortunately avoided by Orient-East Med and Scandinavian-Mediterranean corridors, latter one crosses Regensburg and Munich.

In the Csepel Island, where port of Budapest is located, 3 rail tracks divide into 3 directions: one to the Freeport, one to the petrol basin, and one to the industrialized district, Csepel Factory, formerly known as Csepel Works.

Inland waterways

Besides the Danube, which is also a TEN-T corridor itself, especially important together with Rhine-Maine, ports have further IWW connections. Almost every partner emphasized the connection to ARA ports and Constantia that are accessible on the Danube. It is given for every port and not a speciality, however some are closer to the Black Sea, and some are to Lowlands' marine ports.

It is noticeable that Bratislava has a concessionaire partner port in Komárno specialized to handling agricultural products, while Vukovar operates together and shares a lot of its activity with a company called Vupik in town. Vienna operates three thematic, specialized terminals right next to each other, Freudenau focusing on general cargo, Albern is specialized to agricultural and bulk products, and Lobau is an oil terminal.

Croatia has more rivers that are temporarily navigable. Sava and Drava are international waterways, however, Sava is conditionally navigable. Transit port in Osijek is accessible on Drava, although, huge cargos usually end up at Vukovar – generating bigger turnover there – due to the weak navigability of Drava.

Other modes of transport

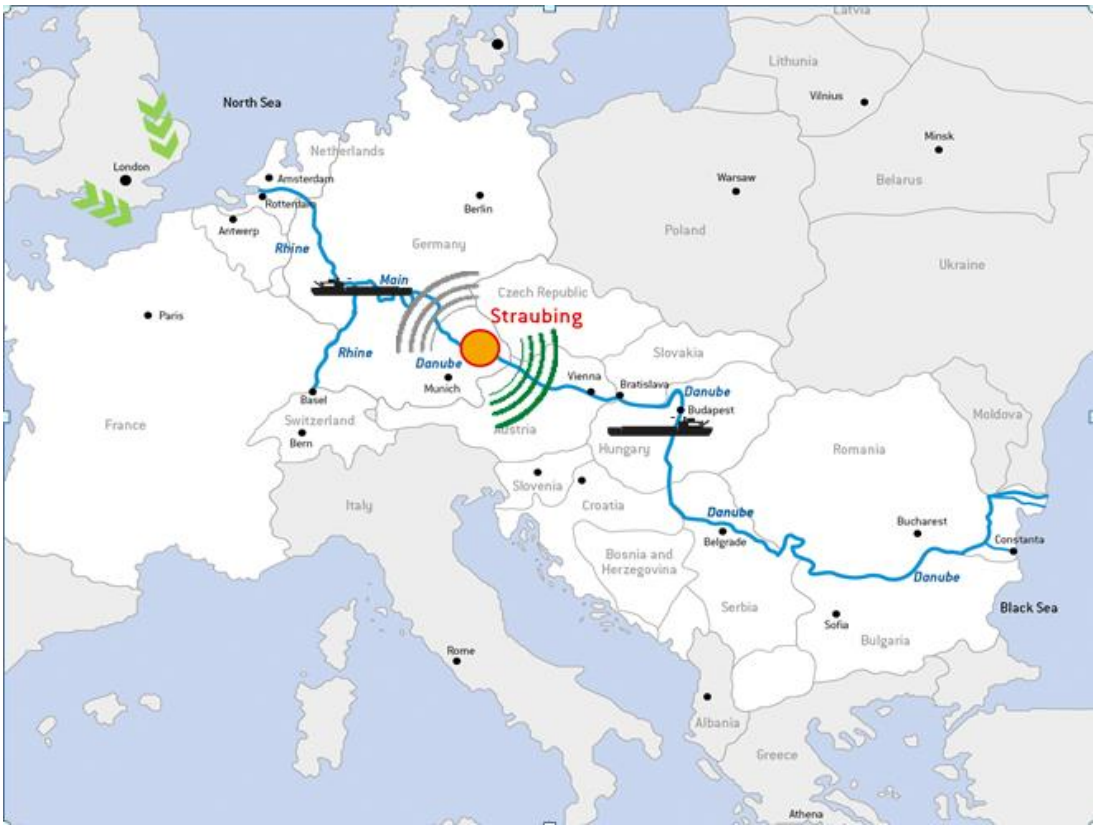
Four out of five ports have connections to airports. Certainly, the three capitals have their own airports. Straubing has its own regional airport and Munich international airport is also accessible in an hour from the port.

1.3. Chapters from national surveys

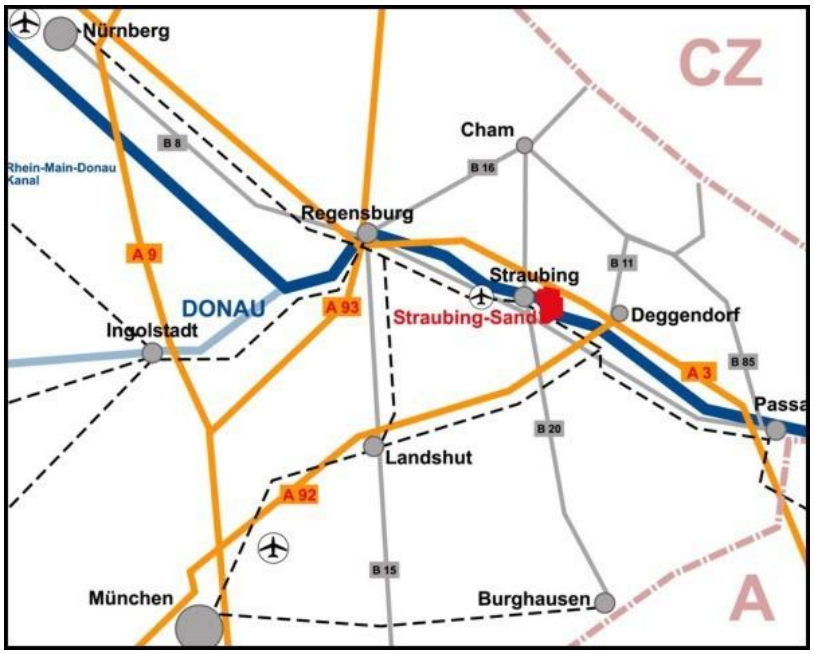
1.3.1. Straubing

The multimodal Danube port Straubing-Sand is located on Danube km 2,313 in Straubing, Lower Bavaria, Germany. The port was opened in 1996 and is Bavaria's youngest inland port. It is easily accessible through its connection to the Danube waterway and to the railway tracks. Furthermore the port is linked to the two highways A3 and A92 through the main road B20. Straubing, with its more than 45,000 inhabitants is equipped with a regional airport. Moreover, the international airport Munich is accessible in less than 1 hour. A container terminal for intermodal transport on the port area is currently being planned.

The Danube port Straubing-Sand builds a geographical connection between the Rhine and the macro region Danube.



4. Figure Geographical location of Straubing in Europe
Source: Own editing based on own data



5. Figure Modal connection of Straubing
Source: Own editing based on own data

3.7 million t goods are handled in the trimodal port (water, road, rail) per year. The majority thereof is transacted via road. In 2016 the amount of the annual handled goods was 2,733 tt per

truck and 300 tt per train. Transshipment on waterside in total was 621 tt. The mass of received cargo amounts to 446 t and 175 t forwarded cargo. These quantities were shipped by 693 vessels.

6. Figure Danube port Straubing-Sand, including port, Industrial Park, Business Start-Up Centre and BioCampus
Source: Own editing

The whole area and establishments are managed by the Zweckverband Hafen Straubing-Sand (the administration unit for the port Straubing-Sand). An intercommunal coalition of the city Straubing, the county Straubing Bogen and the municipality Aiterhofen, is for operating the port and the corresponding constitutions. For the operational activities, a cooperation contract is used with the Hafen Straubing Sand GmbH (Port Straubing-Sand GmbH), which has the same shareholders as the Zweckverband.

The port area is 220 ha large – most of the plots are being marketed to settled companies. Moreover, the ZVH runs a Start-up Centre at the port entrance area and focusses on business development in the segment of bioeconomy and bioenergy. The 220 hectares large area counts around 70 companies with more than 2,800 employees. Thereof around 35 companies are located in the Business Start-Up Centre and the BioCubator. The main economic sectors are trade & logistics, production and services.

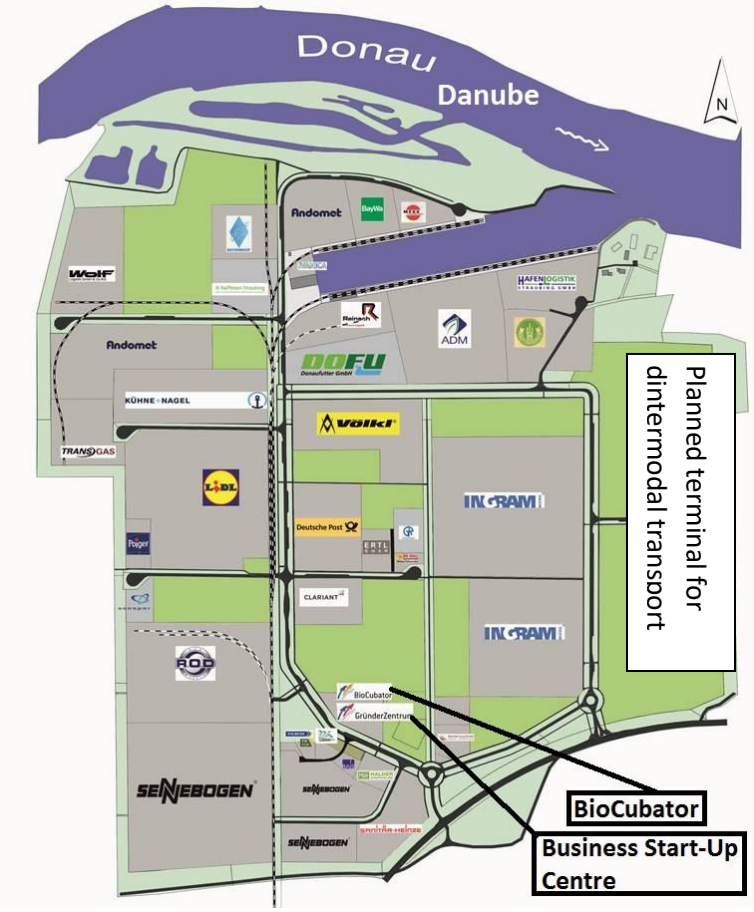
The ports' surrounding trimodal Industrial Park offers completely developed industrial and commercial sites in different sizes, varying from 1,000 m^2 to 150,000 m^2. Medium-sized enterprises as well as global companies are counted among the residents. It has customers from bio-based industry, trade and services together with lots of companies from the logistics sector.

The Business Start-Up Centre offers affordable and flexible area for offices and workshops for young enterprises. The Centre provides meeting and conference rooms together with additional services.

Another special feature is the BioCampus. Straubing is the region of Renewable Raw Materials. A lot of research and development facilities, companies as well as the Technical University Munich Campus for Biotechnology and Sustainability are located in the city of Straubing, some 10 minutes away from the port area. This leads to short ways to new innovations. Responsible for the networking is the Cluster for Renewable Raw Materials which is led by the BioCampus Straubing

GmbH. Furthermore the BioCampus Straubing GmbH is responsible for the site development to extent the strength of the Region of Renewable Raw Materials.

The BioCubator is placed next to the Business Start-Up Centre. This is the Bavarian Competence Centre for Renewable Raw Materials. High-quality offices, laboratories and technology school areas are available. The tenants can also use all benefits, facilities and services, offered by the neighbouring Business Start-Up Centre.



7. Figure Danube port Straubing-Sand
Source: Own editing

1.3.2. Vienna

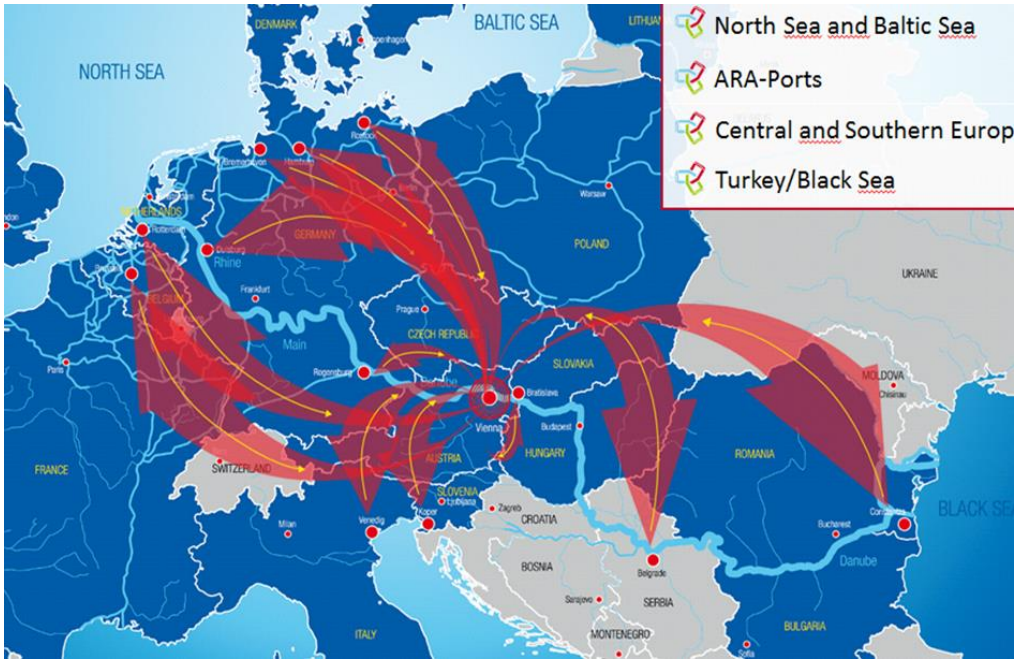
The Hafen Wien has an area of 3 million square meters. Wiener Hafen group is part of the Wien Holding group and with its subsidiaries it operates three large cargo terminals including the corresponding infrastructure: Freudenau harbour, Albern harbour and Lobau oil terminal. These three harbours handle around 1,000 cargo vessels a year. The Danube is used for the transport in particular of oil products, road salt, building materials such as cement, sand or steel products, and agricultural products such as grain and fertilizers. The passenger terminal close to the Reichsbrücke and Marina Wien are also part of the Wiener Hafen group.

Hafen Wien is a multifunctional service company offering decades of experience and also the latest technologies. Thanks to its optimum rail, road and water links and the proximity to Vienna

International Airport in Schwechat, it provides an important and practical interface for international trade and transportation.

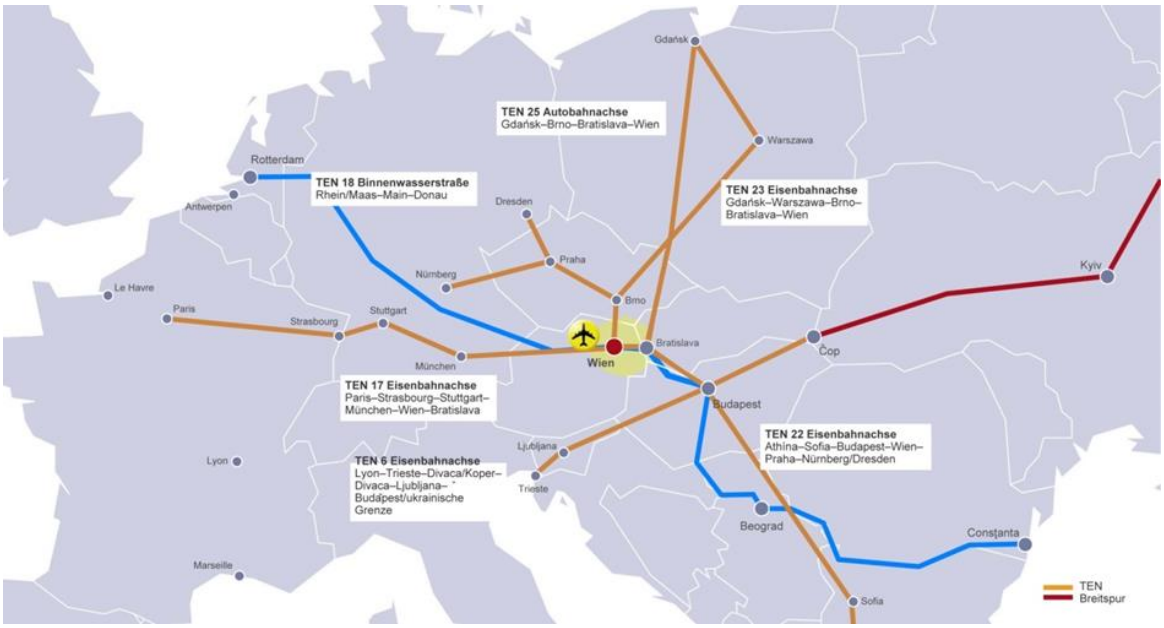
Hafen Wien operates the largest free port in Austria. There are modern warehouses and well trained and equipped staff for the storage and handling of customs and domestic goods as well as a customs office for rapid clearance. The site is guarded round the clock and feeder roads are exempt from the night driving ban in Vienna. The three ports on the Danube in Vienna are notable for their modern handling facilities, excellent infrastructure and dependable, well trained workers, ensuring the reliable and rapid handling of all goods, e.g. building materials, containers, general cargo or bulk goods.

Around 2,000 kilometres from the Black Sea and 1,500 from the North Sea, the Port in Vienna serves as an optimal direct connection to three modes of transport: ship, rail and truck (keyword tri-modality). Addionally it is within proximity to the Vienna international airport as high-performance interface for international trade and transport.



8. Figure International accessibility (a)
Source: Own editing

The Hafen Wien Group and its subsidiary WienCont are situated right on the main artery for inland shipping. As a result of the opening of the Rheine-Main-Danube waterway it is yielding new transport perspectives from the ARA ports of (Amsterdam, Rotterdam and Antwerp) to the Black Sea (Constantia)



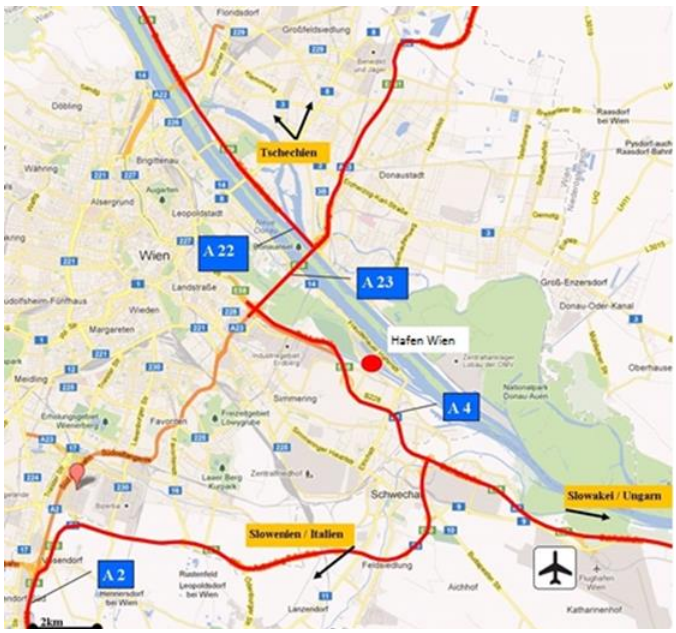
9. Figure International accessibility (b)
Source: Own editing

The Port of Vienna is a very attractive transport nodal point through its connection to the 3 TEN-T corridors:

- Rheine – Danube corridor
- Baltic – Adriatic corridor
- Balkans-/Eastern-Med. corridor

The Hafen Wien Group and its subsidiary WienCont are situated right on the main artery for inland shipping. As a result of the opening of the Rheine-Main-Danube waterway yielding new transport perspectives from the ARA Ports of (Amsterdam, Rotterdam and Antwerp) to the Black Sea (Constantia).

The Harbour Vienna is only a few minutes by car from the center of the city. Nevertheless, with its trimodal transshipment possibilities, it's situated in the heart of Vienna. The central shunting station Wien-Kledering and the international airport are also nearby. The large warehousing zone and harbor area are perfectly situated between the A23 ring road and the A4 east motorway.



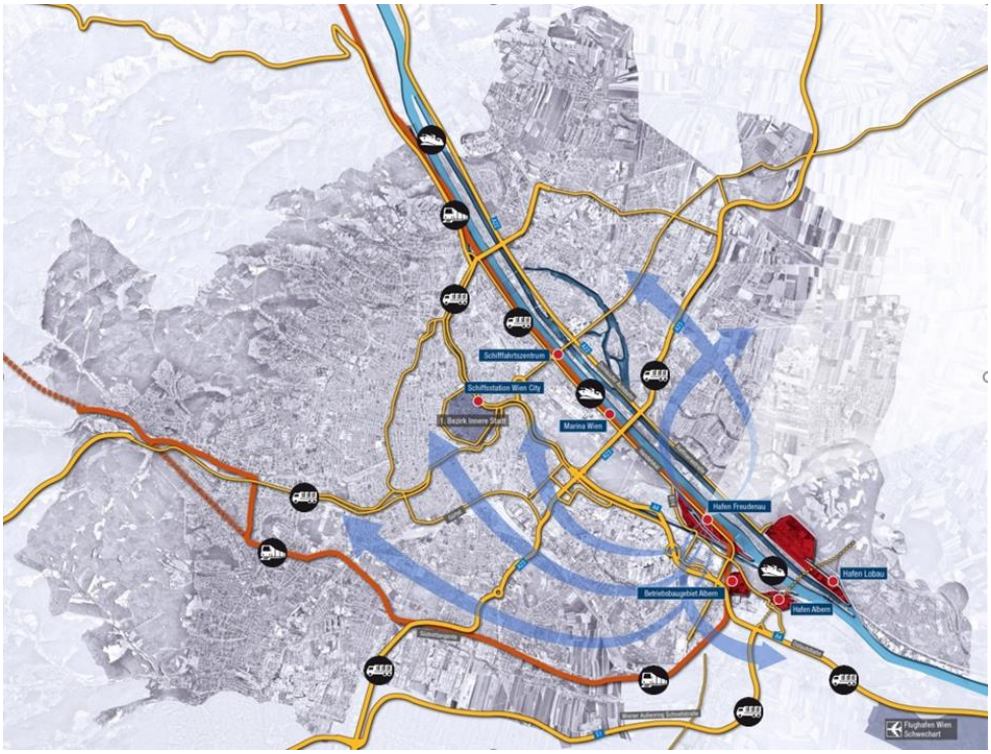
10. Figure Regional accessiblity (a)
Source: Own editing

The goods distribution center is used by many well-known companies. Fast moving goods are processed at ground level via the central warehouse. The same can be said for slower moving goods, or goods with special security requirements. The presence of large forwarding companies on the premises at the Harbour Vienna provides an ideal cooperation platform.

- Rhein-Main-Danube-Axis
- Highway Connection via A4 and A23
- Railway Connection
- Near by the Airport Vienna

- Lobau (oil terminal, tank Port)
- Albern (grain, construction materials)
- Freudenau (storage, handling, car, container, Property Man.)
- Marina Wien (leisure and sports harbour)

- Passenger Shipping Wien City (Twin City Liner to Bratislava)
- Passenger Shipping Wien Reichsbrücke (cruise liners)



11. Figure Regional accessibility (b)
Source: Own editing

Locations

The port of Vienna is the largest public port on the Danube and consists of the cargo terminals of Freudenau and Albern and the Lobau oil terminal. The passenger terminal next to the Reichsbrücke bridge and Marina Wien are also part of the Wiener Hafen group.

Freudenau harbour
Kilometer: 1920.1
Longitude: 16° 29' 16.45'' N
Latitude: 48° 10' 12.63'' E
Freudenau harbour is the center of the cargo handling facilities on the Danube in Vienna.

12. Figure Freudenau harbour

Albern harbour
Kilometer: 1918.3
Longitude: 16° 30' 23.60'' N
Latitude: 48° 09' 38.59'' E

Albern harbour handles building materials, agricultural and steel products. There are five large grain silos on the site with a capacity of 90,000 tons,making Albern the most important grain handling location in Eastern Austria.

13. Figure Albern harbour

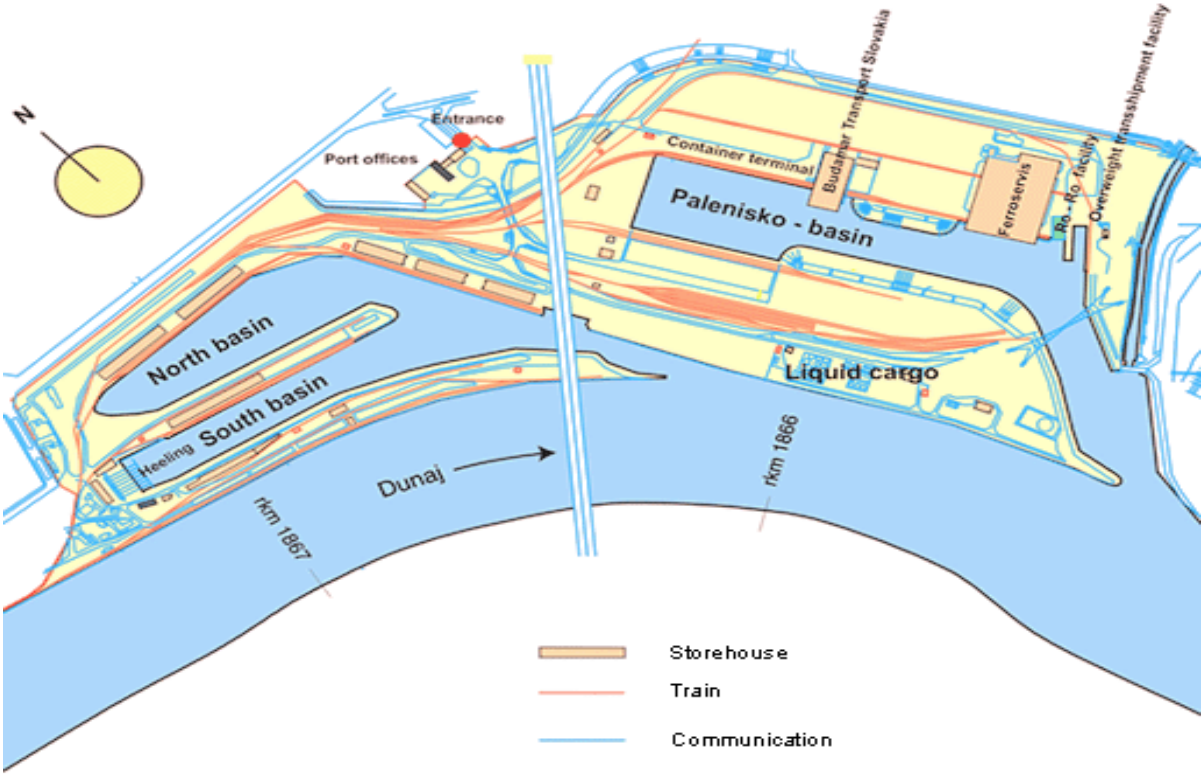
Lobau oil terminal
Kilometer: 1916.4
Longitude: 16° 31' 43.49'' N
Latitude: 48° 09' 28.28'' E

14. Figure Lobau oil terminal

Every year around 1,000 tankers dock in the seven berths in the oil terminal and around one million tons of mineral oil products are handled there. The oil terminal is connected by pipelines to the central Lobau fuel depot and the oil refinery in Schwechat.

1.3.3. Bratislava

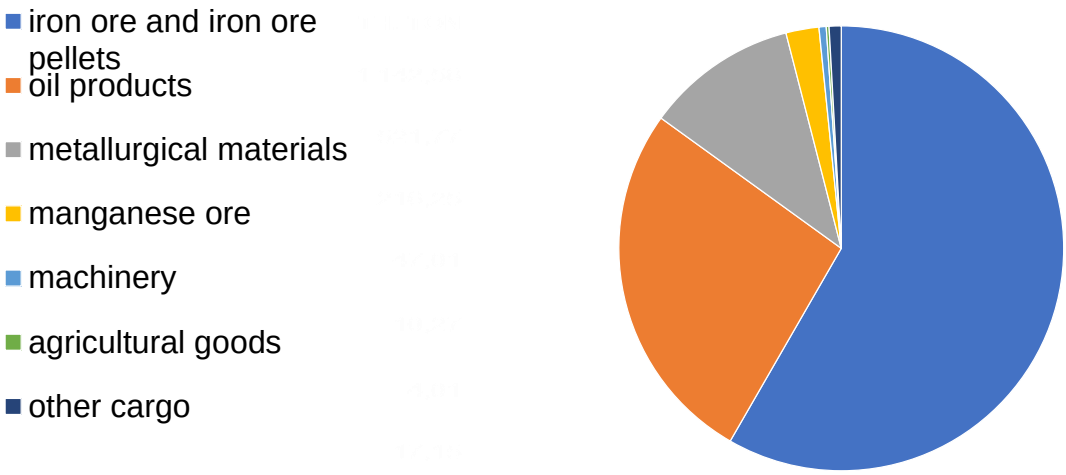
Bratislava's port is located on both banks of the Danube River from rkm 1 871,450 to r. km 1,862,000. It consists of 3 port basins on the left bank, where cargo handling is carried out and at the same time serving as a protective part of the harbor in case of unfavorable navigation conditions (large water, ice, etc.). From the point of view of the activities, the Bratislava port is divided into thirteen sections, i.e section 0. up to 12. The company Verejné prístavy a.s., sets a buffer zone under the bridges that cross the Danube in the port's aquatoria. This band is 20 meters downstream and upstream for security reasons. Port has covered areas of 25 790 m2 and open areas of 75,335 m2. The Bratislava port - has a connection to the road network (D1 motorway) and the railway network, so it is possible to carry out the transshipment of goods between the different modes of transport (road - water - railway).



15. Figure Map of Port of Bratislava with basins, rail and road connections
Source: Own editing

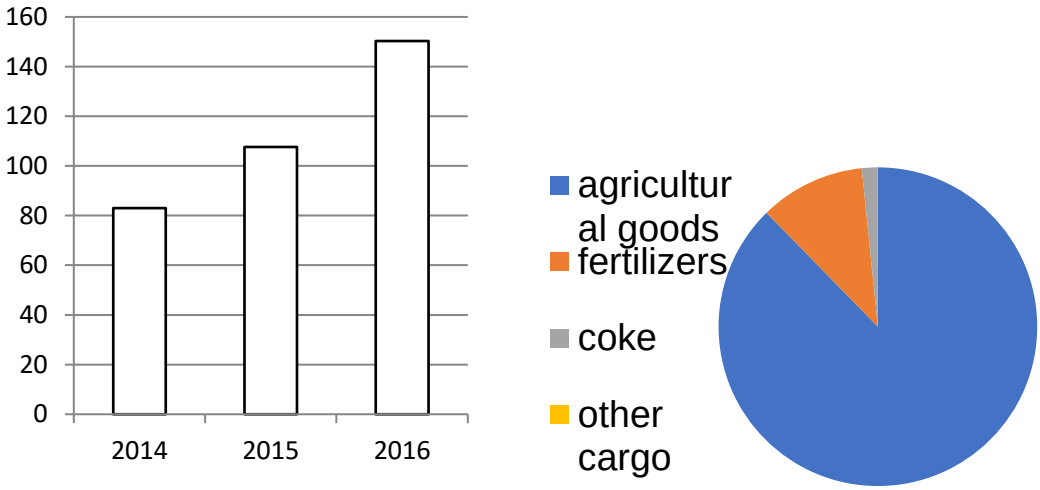
At the port of Bratislava, the following commodities are transported: transshipment of bulk goods, transshipment of piece goods, ferro-material transfer, transshipping of liquid goods, (PMO),transshipment of heavy and oversized goods, Ro-Ro position.

The Bratislva port is also equipped with its own internal pipeline straight from the Slovnaft refinery and provides the Service Pontoon P-65 on rkm 1866. The services include loading of diesel fuel into boats, technical oil and drinking water.



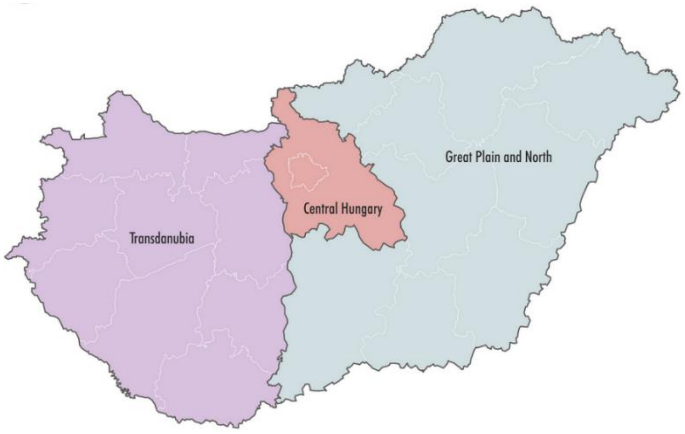
16. Figure Chart of transshipped cargo in Port of Bratislava
Source: Own editing based on own data

The public harbor of Komárno forms the left bank of the river Danube along the left edge of the seawayin the section rkm 1,770,000 to 1,762,000, both banks of the river Váh up to the railway bridge, defined coast. The port of Komárno is divided into six sections. The activity is focused on the handling of liquid goods, ferro-materials and bulk goods. The company Verejné prístavy a.s., establishes a buffer zone beneath the bridges that preach the Danube in the port's aquarium. This band is 20 meters downstream and upstream for security reasons. Port of Komárno has covered area of 6 597 m2 and open areas of 26,130 m2.



17. Figure Coloumns on the left: total transhipped cargo in Port of Komárno, thousand tons, pie chart on the right: share of the cargo groups
Source: Own editing based on own data

1.3.4. Budapest



18. Figure NUTS 1 regions of Hungary

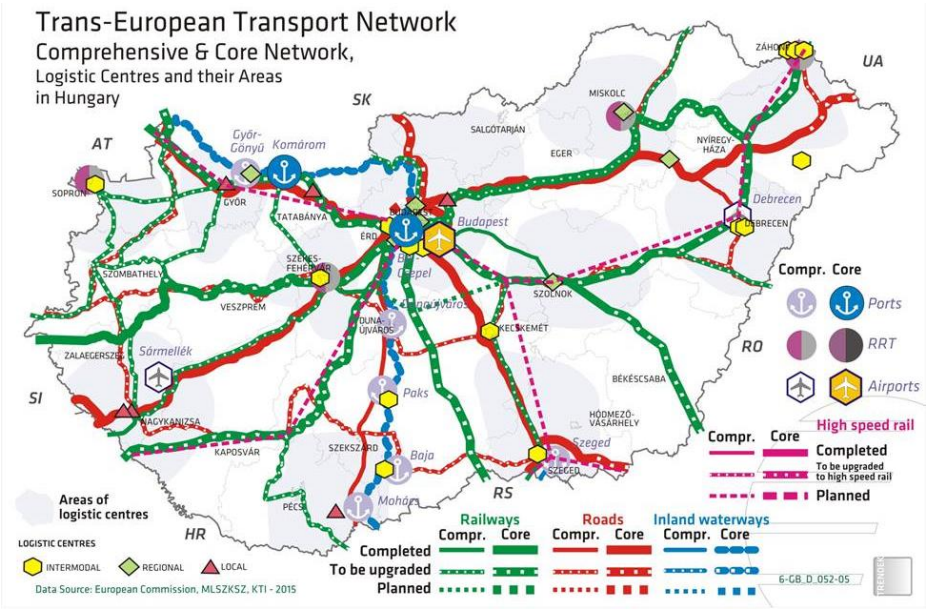
Source: ksh.hu (KSH Central Statistical Office)

Freeport of Budapest is in the southern part of the capital of Hungary, in Csepel Island. Budapest is inside Pest county, these two altogether create Central Hungary (NUTS 1 equals NUTS 2). Csepel is the 21st district of Budapest. The address of the port is 1211 Budapest, Weiss Manfréd Road 5. The freeport is located in the Danube-Mainland Rhine waterway on the Danube section crossing the continent from northwest to south-east in the inland waterways of Europe, at the 1.640 km of riverbank.

Road, rail- and waterway network

Since the Freeport of Budapest is in the metropolitan area, and is one of the biggest ports of the country, the most important international corridors (TEN-T corridors) are passing by the port. Three core network corridors (CNC) – out of nine identified by the CEF Regulation – cross the capital:

- Mediterranean Railway Corridor (MED),
- Orient-East Med Railway Corridor (OEM),
- Rhine-Danube Inland Waterway Corridor (RHD IWW).



19. Figure Highways and railways crossing Hungary

Source: KTI (Institute for Transport Sciences Non-Profit Ltd.)

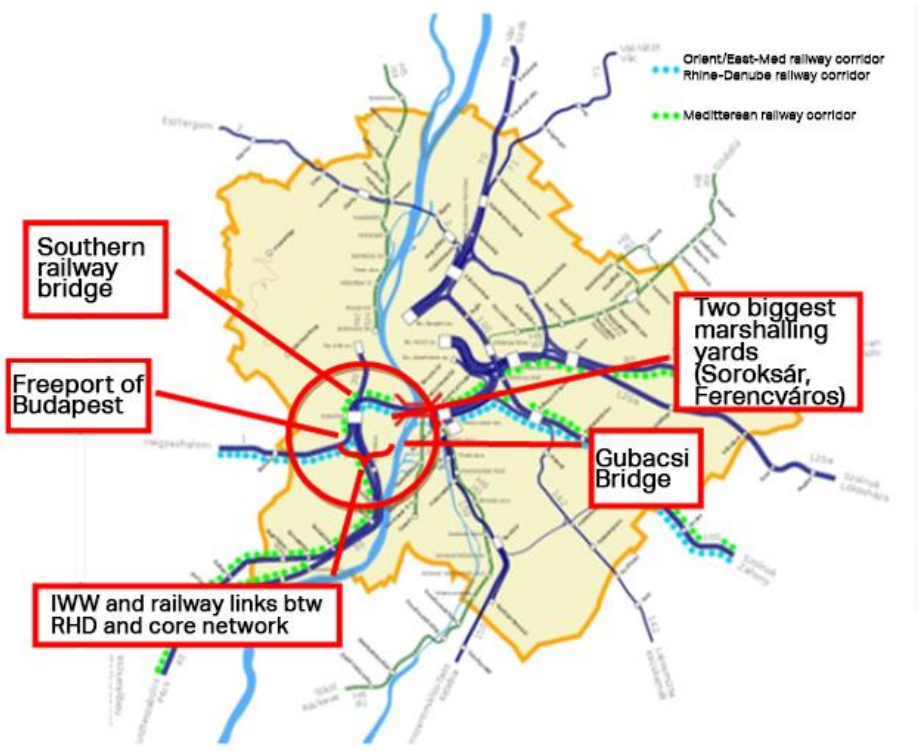
Railway lines

Csepel Island as well as the port itself are embedded into nationwide and international transportation network. The railway line connects through the Gubacsi bridge located on the north-eastern part of the island. Hungary has 28 border crossing points to the neighbouring countries on railway, and 16 organizer stations. Besides, two main freight railway corridors are crossing Budapest:

- Almería-Valencia/Madrid-Zaragoza/Barcelona-Marseille-Lyon-Turin-Milan-Verona-Padua/Venice-Trieste/Koper-Ljubljana-Budapest-Zahony (RFC6)
- Prague-Vienna/Bratislava-Budapest – Bucharest-Constanta / - Vidin-Sofia-Thessaloniki-Athens (RFC7)

These railway corridors are supported by the two largest marshalling yards in the capital: in Soroksár and Ferencváros, both located close to them, the Southern Railway Bridge and the Freeport of Budapest.

The connecting track runs into the western side of the Budapest – Kelebia railway line from the marshalling yard to Gubacsi Bridge, then it continues its way on the northern side of Védgát street, and reaches Corvin junction (crossing of Corvin street – Weiss Manfréd street). Before the junction, the connecting track divides into 3 directions: 1. one track goes towards Csepel Factory (former Csepel Works, together with the new METRANS container terminal as well); 2. the second one leads to the Petróleum port (owned by MOL, Hungarian multinational oil and gas company), 3. the third one is heading for the direction of Freeport of Budapest.



20. Figure Freight railway links of the Freeport

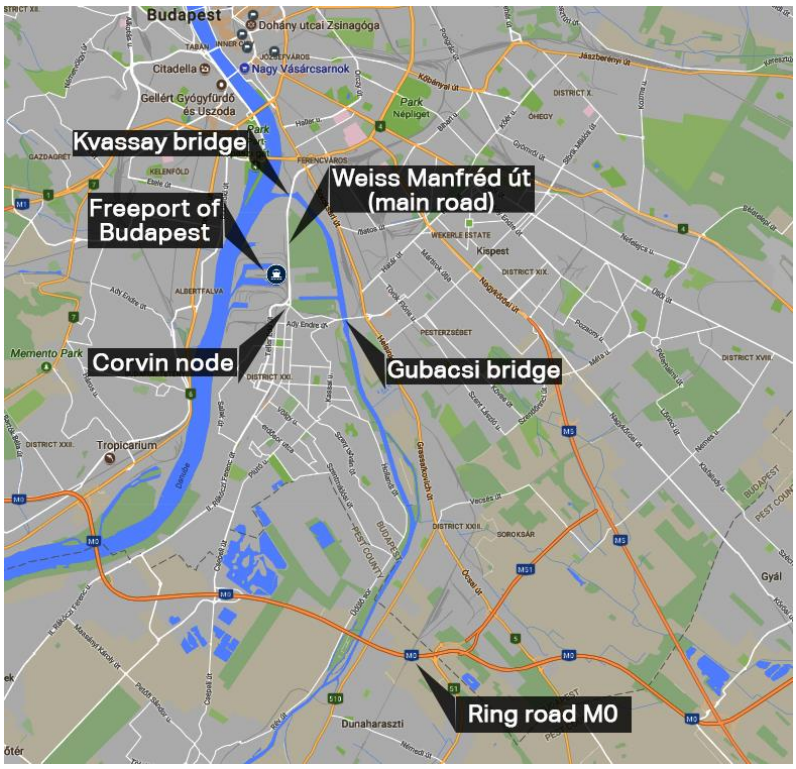
Source: Own editing

Inland waterway, greatest Hungarian Danube ports

Csepel Island is surrounded by the Danube, the freeport is on its north part, reachable on water on the right branch. Approaching from Austria and Slovakia, Budapest is the third freight port among the big ones in Hungary, after Győr-Gönyű and Komárom. On the way to the south, there are Dunaújváros, Baja and vessels' last possible stop before crossing the Serbian border is at the port of Mohács. Besides, there are some smaller, middle size ports as well, such as Dunakeszi, Paks or Bogyiszló.

Road connections

Concerning road connections, the port is approachable on highways M1 and M7 from west, M6 and M5 from south, M3 from the east through the ring-road, M0. Trucks can reach the port from highways through M0 – M51 – Ócsai road – Grassalkovics road – Helsinki road – Gubacsi bridge, or M0 – II. Rákóczi Ferenc road – Weiss Manfréd road, or via the Kvassay Jenő bridge from the city of Budapest. However, the Corvin node is an important rail and road crossroad between the port and Gubacsi bridge, it has a very low permeability causing daily traffic jams.



21. Figure Road connections to the Freeport
Source: Own editing

1.3.5. Vukovar

Vukovar port is situated on rkm 1335 of the downstream flow of the Danube River, on its right coast in the middle part of the Danube.

The Port stretches from the East to the West and it is 1700m long and 45m wide. The port is very well situated to the main current of the river Danube, which makes it possible for the port to be navigable during the whole year regardless of water level. It is located on the crossroads of trade

routes between Croatia on the West and Bosnia and Herzegovina on the South, and Hungary on the North and Romania and Serbia on the East. Vukovar port can receive ships Class 5, while the navigability and reliability of the Danube River throughout the whole year make Vukovar port the most important port in Croatia. The port is operational even during the period of the lowest water levels of the Danube, except in the case it is not allowed to navigate along the Danube. Vukovar port has a significant geographical and transport position. It's located on the crossroads of transport lines, on 3500 km long trans-European The Rhine–Main–Danube Canal (Corridor VII North Sea-Black Sea), and it is connected by rail and road traffic with the Adriatic Sea (Corridor Vc).

Within the Trans- European Transport Networks (TEN- T), port Vukovar has been defined as the core network port, which highlights the importance of the port and the corridor.

The overall capacity of transshipment of all port operators is estimated to be around 2 million tons.

Traffic connection of Vukovar port

Croatia is located on the two corridors of the main transport network: The Mediterranean and the Rhine-Danube corridor. The Mediterranean corridor connects the south of the Iberian Peninsula, across Spanish and French cost, it goes all the way to the Alps in the north of Italy, then it continues to Slovenia and carries on to the Hungarian-Ukrainian border. The Mediterranean corridor is a road and rail corridor, and its constituent part is Rijeka-Zagreb-Budapest line (rail and road line also known as corridor Vb). It continues further to road and rail line Zagreb-Slovenija, known as corridor X. This corridor will connect Croatia with the Baltic-Adriatic corridor, which stretches from the Baltic Sea through Poland, across Vienna and Bratislava to northern Italy. The Rhine-Danube corridor is a river line which connects Strasbourg, Frankfurt, Vienna, Bratislava, Budapest (one part goes towards Romania, and the other goes through the Danube between Croatia and Serbia and towards the Black Sea), and it is known as corridor VII.

22. Figure Position of Vukovar port compared to TEN-T
Source: Own editing based on own data

Road infrastructure

In the County area, four A3 highway exist (Babina Grda, Županja, Vrbanja, Lipovac). State roads interconnect cities (Ilok, Otok, Vinkovci, Vukovar and Županja), while other settlements within the County are accessible by means of local and county roads, as well as state roads. At the moment Vinkovci, Vukovar and Ilok bypasses are being built, while some parts have already been built and function as a part of public road networks. Vukovar port is located near the crossroads of the Mediterranean and Vc corridor.

23. Figure Highway and express road network in eastern Croatia
Source: Ministry of the Sea, Transport and Infrastructure

Rail transport

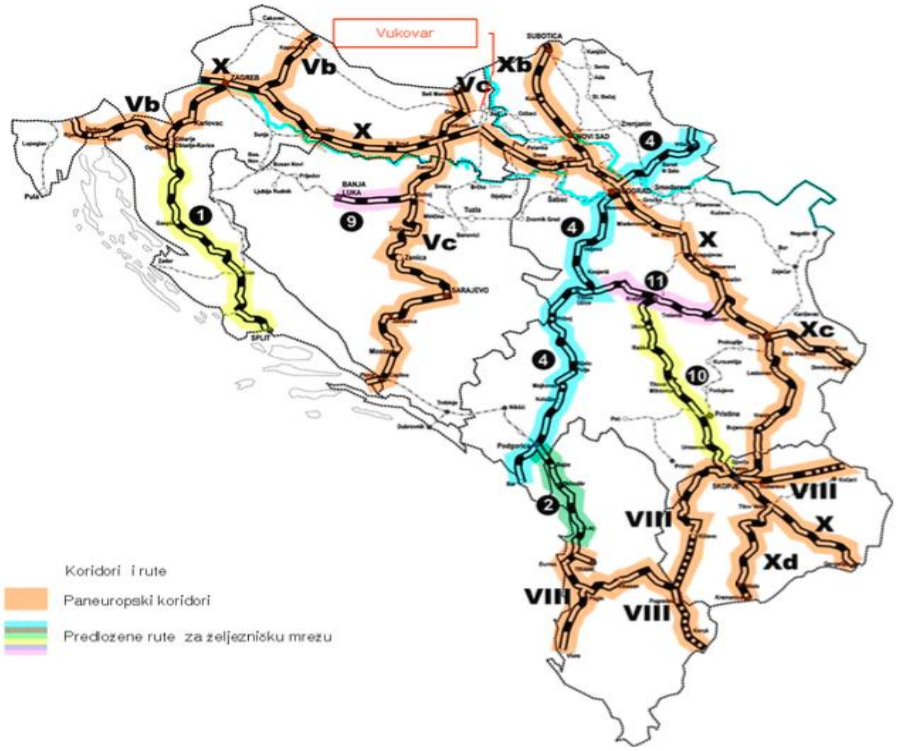
European rail corridor X crosses through Županja. Bearing in mind that significant investments are being planned and implemented in rebuilding the railway, further increase of traffic is to be expected. One track railway 18.7 km long is being rebuilt and electrified (Vinkovci-Vukovar). This is significantly important not just for the economy of Vukovar-Srijem County and Slavonia, but for the whole region. The railway was built in 1878, and today it connects RH1 corridor (ex X pan – European corridor) and TEN-T the Rhine-Danube corridor, i.e. rail line Salzburg-Villach-Ljubljana-Zagreb-Beograd-Skopje-Solun and inland waterway on the Danube.

Alongside, better integration of railways and using the Danube River for transport, i.e. intermodal type of transport, should also contribute to the increase in traffic. Moreover, it is necessary to emphasize the existence of RO-LA terminal (a terminal for the transport of road tractors in railway wagons) in Spačva.

Currently rail traffic has seven different routes in the County area.

The railway network shows construction alongside corridor X. Once electrified, the two track infrastrastructure of railways currently having a capacity of 250 trains (freight and passanger) could be increased up to 350 trains. The capacity of the electrified one track railway is 60 trains

per day, and it could go up to 100 trains. Vukovar port has its own infrastructure of railways (rail tracks 300m long), and, because of its vicinity to the important railway corridors X and Vc, is very well geographically positioned - only 20 km from the regional railway center Vinkovci.



24. Figure Corridors and railway network

In general, the port is well connected to other parts of the region and it is located near all major rail and road corridors. The main focus of improving traffic connectivity is the upgrading and modernization of existing connections in the context of upgrading of existing road lines that would be raised to the rank of highways in order to connect to the X and Vc corridors and raise safety, speed and quality as well as to reduce transport costs. Currently in progress is the project of the modernization of the Vinkovci - Vukovar railway line, which was built before 1968, where the existing railway is reconstructed and electrified in order to increase the safety and speed of the trains.

Waterway transport

The waterway network of inland water in Slavonia and Baranja consists of the Danube River, (137.5 km long), the Sava River (446 km long) and the Drava River (198.6 km long).

The waterway of the Danube River (E-80) in Croatia, from Batina to Ilok (from its 1433 rkm to 1295.5 rkm) is suitable for daily and nightly navigation and its capacity is in accordance with international VI c Class requirements (Official Gazette 2011).

Waterway of the Sava River (E-80-12) in Croatia from the estuary of the Kupa River to Jamene – border with Serbia (from 583 rkm to 207 rkm) meets the requirements of Class III, while the part from 583 rkm until Rugvice, 653 rkm, meets the requirements of Class II.

Waterway of the Drava River (E-80-08) in Croatia from the estuary of the Danube River rkm 0 to Osijek rkm 22 meets the requirements of Class VI, the part of the Drava from Osijek rkm 22 to Donji Miholjac rkm 82 has Class III, and the part from Donji Miholjac rkm 82 to rkm 198,6 has Class II. From the estuary to the Danube to the new port rkm 13 waterway is suitable for daily and nightly navigation and it is highly navigated, while the part from rkm 13 to 198,6 is used for daily navigation only and it mainly serves to exploit gravel, sand and wood mass.

In the Vukovar-Srijem County area there are two international waterways – the Danube and the Sava. The Danube is completely navigable in Croatia and according to European Agreement on main inland waterways of international importance (AGN) it has Class Vic. The Danube is suitable for international, regional and local traffic. The Sava is conditionally navigable, i.e. there are some restrictions and it is connected with a poorly constructed waterway (insufficient draught in specific sectors, critical points, unmarked waterway, etc.) Traffic on the Sava River depends on the water level and it is mainly of local and regional character.

According to the Regulation on inland waterway classification (the Official Gazette NO 77/11 and 66/14) waterways where load-carrying vehicles can navigate and to which international rules of navigation apply are:

Table 1 Waterways where load-carrying vehicles navigate according to international rules of navigation

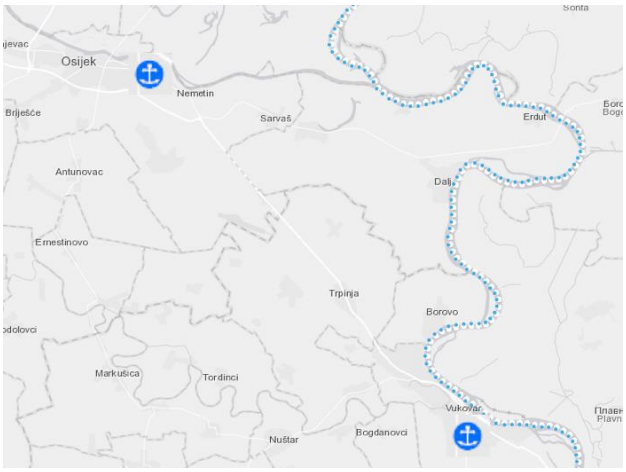
River	Section	Length	Class
The DANUBE	1295+500 (Ilok) – 1433+100 (Batina)	137,50	Class VI.c
The SAVA	210+800 (Račinovci) – 313+700 (Sl. Šamac)	102,90	Class IV
	313+700 (Sl. Šamac) – 338+200 (Oprisavci)	24,50	Class III
	338+200 (Oprisavci) – 371+200 (Sl. Brod-city)	33,00	Class IV
	371+200 (Sl. Brod-city) – 594+000 (Sisak-Galdovo)	222,80	Class III
The DRAVA	0+000 (estuary of the Danube) – 14+000 (Osijek port Nemetin)	14,00	Class IV

25. Figure Aerial view of Vukovar port

Source: Own editing

Tranzit port in Osijek

In the Vukovar hinterland there is Tranzit port in Osijek. The position of Tranzit port in Osijek is rkm 12+265 to 16+428 the Drava (port area), and it covers a surface of 160 ha with 240m of sloped bank and 100m of vertical shore. The port has 6 industrial tracks 3264 m long, 4 loading places, two port cranes with the load capacity of 20 (200t/h), 4 port cranes with the capacity of 5t with grabs and 6t (100t/h) with hooks, and a floating crane with the capacity of 5t (100t/h).



26. Figure The position of Transit port in Osijek in relation to Vukovar port

Source: Own editing

Although Tranzit port has a capacity of around 3 million tons per year, it actually transships around 120.00 tons of goods. The reason for this is that the navigation through the Drava is highly dependent on its water level, so goods often end up in Vukovar port. In the proximity of the Port there is a cogeneration plant in development (investment of HEP).

1.4. Conclusion and analysis – key findings

Advantages, disadvantages of situation

Straubing port is a site of a Business Start-up Centre hosting dozens of companies, mostly in trade and logistics, both producers and service providers as well. The BioCampus, being a partner organization of Munich University is a place of knowledge spill-over, R&D in biotechnology and sustainability. Not surprisingly, this is the centre of the Regional Cluster of Renewable Raw Materials. Further R&D in biotechnology, sustainability, biomass energy, methods of establishing and improving synergies within the port and with the environment could be copied and adapted by the other ports.

Neither Vienna nor Bratislava mentioned any issues or difficulties due to the closeness of each other. Port of Albern is the most important grain handling location in Eastern Austria. Bratislava on the other hand has very small quantity of agricultural products transshipped. Considering biomass handling, profiles and main activities of the two ports are not a reason of competition yet, but they can be competing in the future unless they consequently carry different types of biomass materials and upgraded products.

The Freeport of Budapest is located in a historically industrialized district of the Hungarian capital, being one of the oldest freight ports of the country. Having strategic partnerships with several companies in and outside of the port area, this could be a key location to introduce new products and enter new markets.

Vukovar currently takes advantages concerning annual turnover from Osijek not being accessible. As they mentioned the negative impacts of presently weak railway capacities in the region, further

increase is foreseen in volumes of transshipment in case of possible reconstruction of currently slow rail lines.

Intermodality

Road connections are well developed and all the ports are easily accessible on either international motorways or via main state routes and efforts of the infrastructure development projects tend to be concentrated on road and rail development. This also means a major advantage of all the partner ports as they can effectively operate as logistical hubs, however, waterside connection is weak due to mostly external conditions. A main unfavourable condition is the issue of navigability: there are several bottlenecks and natural obstacles which hinder the otherwise Belgrade convention-guaranteed freedom of navigation. This is the main obstacle to develop a stronger waterway linkage however ports can still design and implement various development projects to attract more waterway-borne cargo.

Impacts of foreseen external infrastructural development

Future developments will contribute to bigger turnovers, more stable operation at the ports and cause even stronger embeddedness and synergies with their local and regional environment. Although, it also can happen, that future projects cause difficulties, e.g. planned to be reconstructed railway line passing by Vukovar port will make it to lose areas from its territory. Infrastructural conditions will be improved in cases of

- Mobile dam in Csepel, Budapest
- Reconstruction of Gubacsi bridge in Csepel, Budapest
- Reconstruction of M601 railway line next to Vukovar

2. Hinterland areas in terms of biomass – supply side

2.1. Objectives of the chapter, methodology

Focus

Each chapter from 2 to 5 provide a closer and closer look on opportunities for the biomass energy industry in the hinterland areas of the ports. First, discovered resources are described, then their exploiters and end-users are listed and mapped, finally the question will be tackled whether the hinterlands are connected to the given ports.

Here shall have been presented what would count as the hinterland area of the ports in each country. Hinterland in this document is defined as a region of 100 km radius of a port. Conditions and geographical characteristics of biomass production have impacts on the size of the territorial coverage. In case of that or due to other e.g. economical or administrative reasons, given territorial coverage shall be explained.

Expectations

The hinterland of the ports is various: can be mountainous, hilly areas that can facilitate forestry and energy wood industry. Also, agricultural utilization of the surrounding area would assume higher volumes of by-products and/or main products grown and harvested for bioenergy purposes. Urban areas can also mean a source of biomass and be the subject of the survey: in order to establish environmental friendly conditions in cities, more and more green areas are created. During the maintenance of parks and green urban areas “bio-waste” is produced that can also be potential raw material for the sector.

By describing these areas, defining their size in hectare or square-meter this chapter provides the base for further observation and surveys on potentials of the supply side.

Source of information

Partner ports gathered all the relevant information on their hinterland areas. They were counting on current or possible partner organizations, companies, traders, forestry organisations, farmer associations who maintain and exploit natural resources for biomass energy. Also, available public data on national forestry and agriculture provided by statistical offices contributed to more precise research.

These areas, locations of major resources were shown on maps and photos too besides written description to be sure hinterland and the situation of the port could make an organic whole with the River Danube.

2.2. Summary of the surveys

Most of the hinterland areas of the ports have good opportunities for biomass raw material production, since they are surrounded by mountains, forests, and/or great plains with agricultural utilization.

Hinterland of **Straubing-Sand** is the woody Bavaria. It has two main locations of natural biomass resources: Bavarian forests and Gäuboden’s agricultural areas. In total, there are 2.5 million

hectares of forest in Bavaria. 57% of that is private, 30% belongs to the Freestate of Bavaria, 11% is owned by entities and 2% belongs to the State of Germany.

There are three separate parks which form together the Bavarian Forest: 1 National Park and 2 Nature Parks). Nature Park Bavarian Forest covers 24.222 ha; Nature Park Bavarian Forest covers 278.272 ha and Nature Park Upper Bavarian Forest has 179.600 ha. Gäuboden is the home for agricultural activity. 10% of habitants work in the sector. 2700 farms are operating on 522 km^2 and producing fertile soils, potatoes, sugar beets etc.

Main economic actors supplied with resources planted and harvested in the port's hinterland are the sugar plant in Platting and the starch plant in Sünching.

The main raw material for PoVi and its partner companies operating in the energy biomass industry is wood. Therefore, Port of **Vienna** considered almost the entire Austria to its hinterland. Forests are everywhere except Lower Austria and Burgenland on the North-East, but basically the Alpine regions are covered with wood resulting high biomass potential forestry areas. Austria has mostly coniferous forests. The deciduous forest area of Austria is in the Viennese Forest with 70.000 ha (52%) forest within the 135.000 ha territory. 30% of Wienerwald is beech forest, horn-beech takes 25%. Additionally, the overwhelming share of the Viennese Forest in Lower Austria belongs to the Flysch- or Sandstein-Wienerwald. Moreover, one of the largest contiguous beech forest areas in Europe is the 67.000 ha Biosphere park in Wienerwald.

In the hinterland, there are 25 forestry companies maintaining beech and oak, oak hornbeam, high-yield forests, small-scale meadows and black alder forests. There are regional specialities: black pine forests, warm-growing downy woodlands, summit ash forests. Key forest ecosystem services are wood production, nature conservation, carbon storage, recreation and habitat certification. Theoretical exploitation of potential of beech and oak stocks is approx. 12-20% comparing to previous forestry use depending on the age of total biomass. Around 8-10 (5%) to 16-20 (10%) trees per hectare of forest area are to be available as dead or old wood, and old wood contenders depending on the stock (400-600 m^3/ha).

Not only at forests, but region of Vienna is rich at sugar beets and oil seeds fields. Eastern-Austria has plenty of agrarian farming regions cultivating grain cereals.

Region of **Bratislava** has the warmest and driest climate in Slovakia. As such, and having fertile soil, hinterland of the port is the major source of agricultural products, especially wheat, rape seeds, barley, corn, sugar beets, vegetables etc. Bratislava did not provide any specific quantities.

Here continues a huge range of mountains, the Carpathians. Little Carpathians are densely forested with 90% of broad-leaved trees. Due to opposite interests in the field of economic and ecological, environmental views, Bratislava has reduced wood harvesting by over 50% in favour of nature protection.

Several forests are in the hinterland of the Freeport of **Budapest**. Forestry in Central-Hungary is higher than the national average. The biggest, Pilisi Parkerdő operates on 65.000 ha, Ipoly Erdő on 64.000 ha, HM Budapesti Erdőgazdaság on 37.000 ha. Pilisi Parkerdő maintains parks and suburban green areas as well in the city and does it by sharing responsibility with the capital government and district level governments. Parks cover 2370 ha green area in Budapest.

Chopped wood from forests either goes to local composting sites or will be used for heating and warming water in public institutes (schools, offices etc.). The energetic use of biomass created in capital parks and public places, has recently been spreading increasingly.

Agricultural products are grown on hundreds of thousands of hectares in Central-Hungary. 7.2 million tons of grain and 5.2 million tons of wheat are harvested. Sunflower is grown on 600.000 ha, rape on 190.000 ha contributing to the utilization of rape stalk in biodiesel production.

5 Croatian counties are identified as **Vukovar's** hinterland. This 100-km radius has loads of agricultural areas with the most fertile soil in the country. 569.064 ha is utilized out of 743.770 ha agricultural area in the region. 69% of the utilized area, i.e. 392.900 ha is used for growing corn and cereals. Corn is annually harvested on 159.500 ha, wheat on 111.200 ha, soy on 37.700 ha and barley on 30.400 ha etc.

Vukovar mentioned the importance of livestock since it is a respective part of biogas production. There are hundreds of thousands of bovines, sheep, goats, pigs and equidae.

Slavonia and Baranja are rich in forests (80% is owned by the state and managed by state-owned company, Hrvatske sume). Oak groves are located near Sava river. Forest area in Vukovar's hinterland is 425.175 ha. 46.090 ha is private property and 379.084 is owned by the State of Croatia.

2.3. Chapters from national surveys

2.3.1. Straubing

Straubing is surrounded by two main natural/cultural areas: the Bavarian Forest and the Gäuboden. While the Bavarian Forest is a source of wood, the Gäuboden is one of the most fertile agricultural areas in Germany.

27. Figure Bavarian Forest and Gäuboden

Bavarian Forest

The Bavarian Forest is an area with fundamental importance for the whole region. Together with the connected national park Šumava in the Czech Republic, it forms the biggest connected forest area in Central Europe (Bayerisches Landesamt für Umwelt (b); 2017). Due to that fact and the sparse settlement, the region is home for many animal and plant species, which already got extremely rare or even extinct in Germany. Hence it has an important role in species conservation (Naturpark Bayerischer Wald (d); 2017).

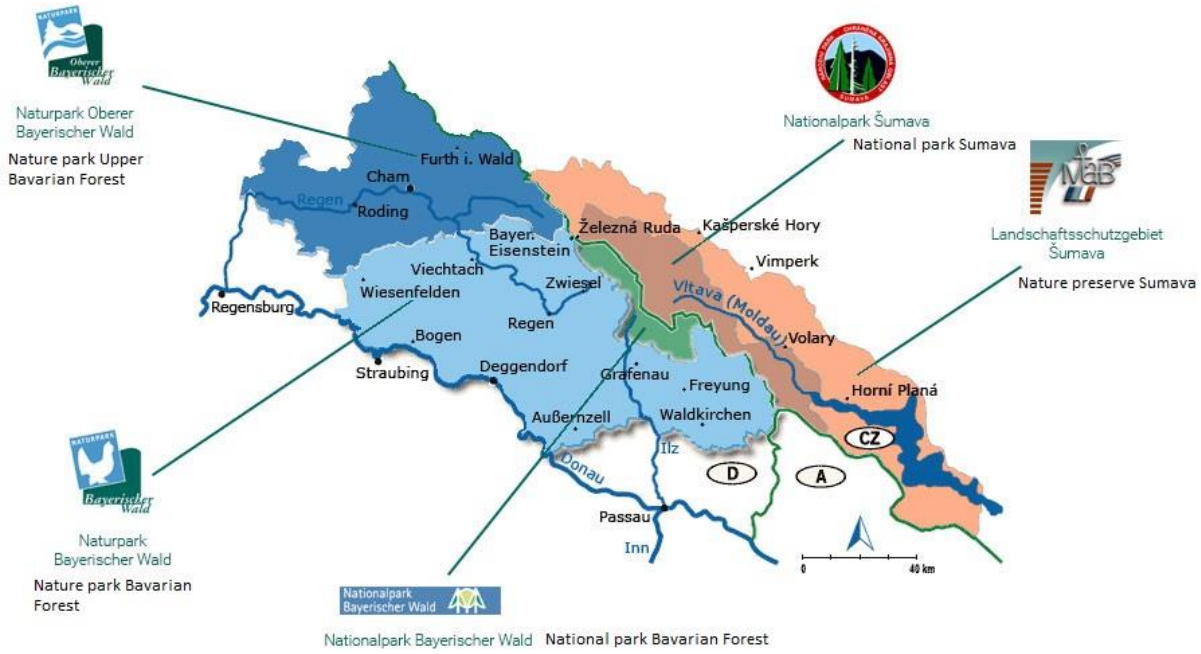
28. Figure Location of the Bavarian Forest (Bayerischer Wald, Germany)
Source: Nationalpark Land; 2017

The Bavarian Forest is a low mountain landscape covered with forest stands. The altitude reaches from 500 m to 1450 m at the Great Arber (Bayerisches Landesamt für Umwelt (b); 2017), the highest mountain in the Bavarian Forest (Bayerisches Landesamt für Umwelt (a); 2017). The climate is characterized through special conditions like icy winds, abundant snowfalls and long frosts during the winter period. In the higher areas (above 1150 m) spruce forests are dominating, whereas in the middle areas it is fir and beech (Bayerisches Landesamt für Umwelt (b); 2017). But also grassland for agricultural use occurs. (Bayerisches Landesamt für Umwelt (a); 2017) In lower areas agricultural usage is possible. The dewatering primary takes place through the Danube (Bayerisches Landesamt für Umwelt (b); 2017).

The economical usage is characterized through forest and wood production. Large parts were settled with production sites for glass. The so called 'Wanderglasshütten' used the resources and afterwards moved to another place in earlier times. Further forest pastures were located in this area. The mining and rock mining industry, especially granite and quartz also played a role in higher areas. Nowadays the tourism sector is from essential importance. The whole region is

advertised with its nature-oriented relaxing vacation opportunities, as well as a paradise for hiking and winter sports (Bayerisches Landesamt für Umwelt (a); 2017).

The Bavarian Forest is divided in three parts. The nature parks Upper Bavarian Forest and Bavarian Forest and the national park Bavarian Forest. See Figure 26.



29. Figure Nature parks and national park of the Bavarian Forest
Source: Naturpark Bayerischer Wald (a); 2017

National parks have the aim to ensure that natural processes can take part without disturbance (Nationalparkverwaltung Bayerischer Wald (a); 2017). A main part of the park has to stay untouched from human impacts. As long as the protection is ensured, national parks shall enable the scientific observation of the environment as well as the natural history education. Economic usages are only allowed in very rare occasions with strict regulations (BfN (a); 2017).

National park Bavarian Forest

The park was founded in 1970 and was the first national park in Germany. It got extended in 1997. Currently it has an expanse of 24,222 hectares (Nationalparkverwaltung Bayerischer Wald(b); 2017). At the moment (2017) Germany has 16 national parks (BfN (a); 2017). The forest area amounts 99 % in this national park and it is home for 14,000 species. The aims are protecting the environment, research as well as education and recovery. At the moment 60 % of the area is entirely left on itself. The target is to extend this value to 75 % until 2027. Annual 1 Million people visit the park (Naturparkverwaltung Bayerischer Wald (c); 2014).

Nature park Bavarian Forest

The park has an area of 278,272 ha (BfN (b); 2016)and the forest cover amounts 48 %. In the region there can be found mainly natural or near-natural forest areas (Naturpark Bayerischer Wald (c); 2017).

Nature park Upper Bavarian Forest

With its 179,600 ha, the nature park Upper Bavarian Forest is one of the largest nature parks in Bavaria (Naturpark Oberer Bayerischer Wald(a); 2017). Of these, 850 ha are declared as a natural reserve (Naturpark Oberer Bayerischer Wald (b); 2017).

Forest owner structure in Bavaria

2.5 Mio ha in Bavaria are declared as forest area. 57 % is private owned, 30 % belong to the free state of Bavaria, 11 % is owned by entities and 2 % belong to the state of Germany (LWF (a); 2017).

The private forest is separated in small areas which belong to a lot of different owners. Altogether around 635,000 habitants in Bavaria own forest area. Thereof 72 % sole owner, 23 % belongs to 2 persons and 5 % of the area belongs to 3 or more persons. This leads to circa 491,000 property situations (LWF (c); 2017) meaning that it can lead to challenges due to the many different usages, cultivations, treatments, and interests. Therefore, it is difficult for the policy stakeholders to develop solutions for all different necessities.

Also, the property size groups are broadly distributed. From 1.45 Mio ha private forest, nearly 950.000 ha belong to owners with less than 20 ha properties. These are labelled as scale forestry owners (LWF (b); 2017). Furthermore 71 % of the forest owners possess areas with less than 2 ha. This fact causes some problems, because a minority of larger forest areas owners own the majority of the area; whereas the majority of the forest holder, only own a small share of the forest areas. Especially the last group often lives further away from their forests. They mostly use their land for personal needs and do not sell wood in contrast to persons with larger forest areas. Moreover they are less qualified and have fewer economic interests (LWF (c); 2017).

This general forest owner structure occurring in the entirety of Bavaria also is true for the Bavarian forest as closest forest area to the port of Straubing.

Gäuboden

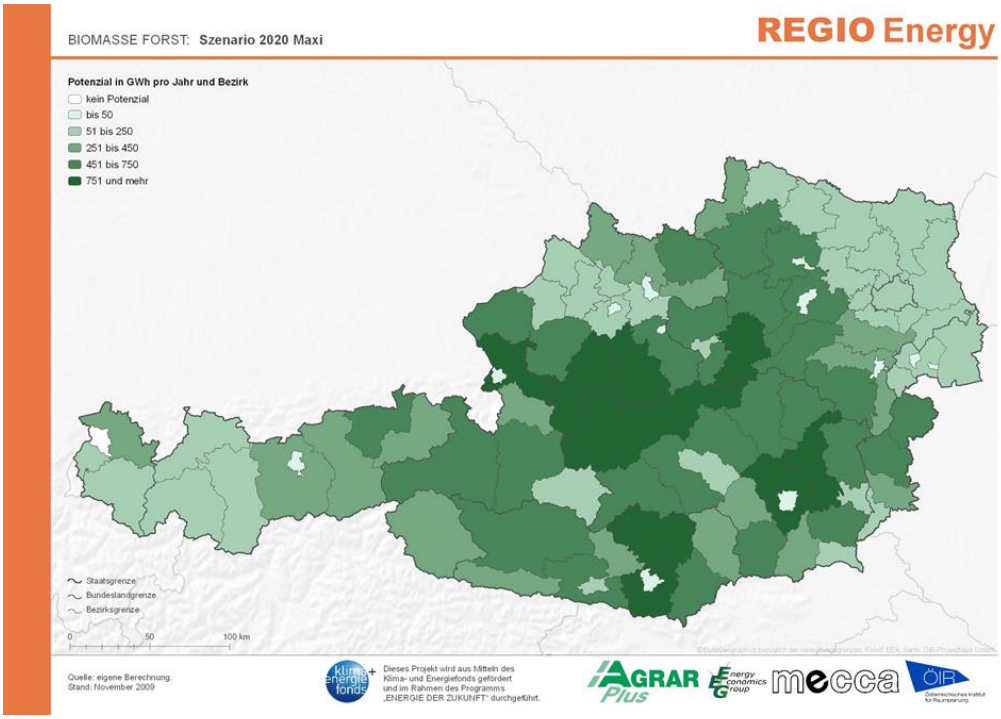
The appellation goes back to the german expression ‘Gau’. This term means ‘good acreage’. Another expression for Gäuboden is the term ‘Dungau’. Nowadays the area counts 522 km^2. In the length it is located in the Danube valley between Regensburg and Vilshofen. (Bayerisches Landesamt für Umwelt (c); 2017). The territory is circa 15 km broad and is situated in the South of the Danube and the Bavarian Forest (Gemeinde Strasskirchen; 2017).The Gäuboden can be splitted in two subspaces. The Gäuboden landscape is characterised by Straubing as the urban center and simultaneously the biggest city in the whole Gäuboden area, and a river landscape with the Danube and the estuary of the Isar (Bayerisches Landesamt für Umwelt (c); 2017). The whole region is relatively sparsely populated (Gemeinde Strasskirchen; 2017).

30. Figure Gäuboden area

80 to 90 % of the area is agriculturally used, mostly as arable land. There is almost no forest area. The Gäuboden is labelled as 'Granary of Bavaria', because the soils are one of the best in Bavaria and even Germany. Due to the 6 m deep mineral-rich and good aerated loess soil it is very fertile and easy workable. (Bayerisches Landesamt für Umwelt (c); 2017). Also the low altitudes between 320 and 340 m lead to generous climatic conditions. It is termed as moderate continental climate and is characterized through cold winters and warm or hot summers. The annual precipitation is 750 to 800 mm and the average temperature is 8.5 °C. The Gäuboden serves as a habitat for rare plants and animals, although it is intensively agricultural used (Private Wetterstation Eggerszell; 2017).

The basin landscape got settled 6000 years ago and the habitants started to use it for agricultural purposes (Gemeinde Strasskirchen; 2017). Nowadays the main economic sector is agriculture, included the trade with the products as well as processing, for example sugar refineries and breweries. For example in the county Straubing–Bogen 10 % of the habitants work in the agricultural sector. More than 2.700 farms are located there. Two third of them are run as supplementary income. The fertile soils can be used especially for the cultivation of grains. But also potatoes and sugar beets are important crops. The beets get transported to the sugar plant in Plattling whereas the potatoes go to the starch plant in Sünching (Bayerischer Bauernverband; 2015). Other branches are gravel and sand extraction as well as loam construction and the brick industry. Tourism is rather concentrated to the city of Straubing (Bayerisches Landesamt für Umwelt (c); 2017).

2.3.2. Vienna



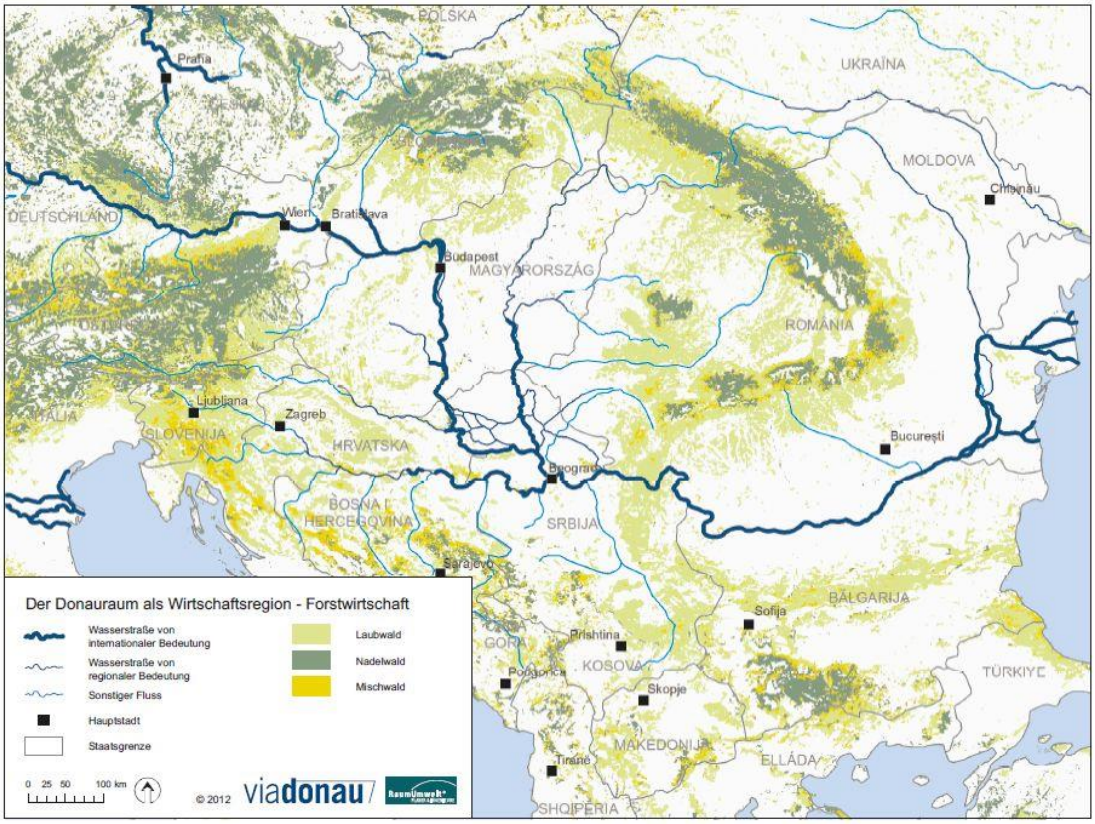
31. Figure Potential of Giga Watt Hours per Year and District of Austria

The darker fields characterize the alpine regions. This picture shows a very good overview of Vienna's Biomass potential, which is very reserved. Lower Austria and the Burgenland are characterized by flat areas without high potential forestry areas.

32. Figure The Danube Region as an Economical Region and its agricultural areas

The regions with a darker brown color characterize grain areas. The Yellow Circle marks oil seeds areas and the plant symbol stands for sugar beets.

This graph shows that the Viennese Region is rich on sugar beets and oil seeds fields and almost a full coverage in terms of grain cereal cultivation. Vienna is also a logistical hub for transit from the south-east of Austria to Germany, or eastern neighbourhood countries. The topography of Austria centralizes agrarian farming regions in the east of Austria, in the Viennese region.



33. Figure The Danube Region as an Economical Region and its forestry areas

The regions with a darker green colour characterize a coniferous forest. The lighter green marked areas are deciduous forest and the Yellow field stands for a mixed forest.

This graph shows that the Viennese Region is rich on deciduous forests, the Wienerwald and the Alps.

Vienna is surrounded by one main cultural and natural Area: The Viennese Forestis a source of wood and also a Biosphere Park. The Wienerwald is a hilly mountain range with heights of 200 m to a maximum of 890 m. It forms the north-eastern foothills of the Alps and represents the largest contiguous.

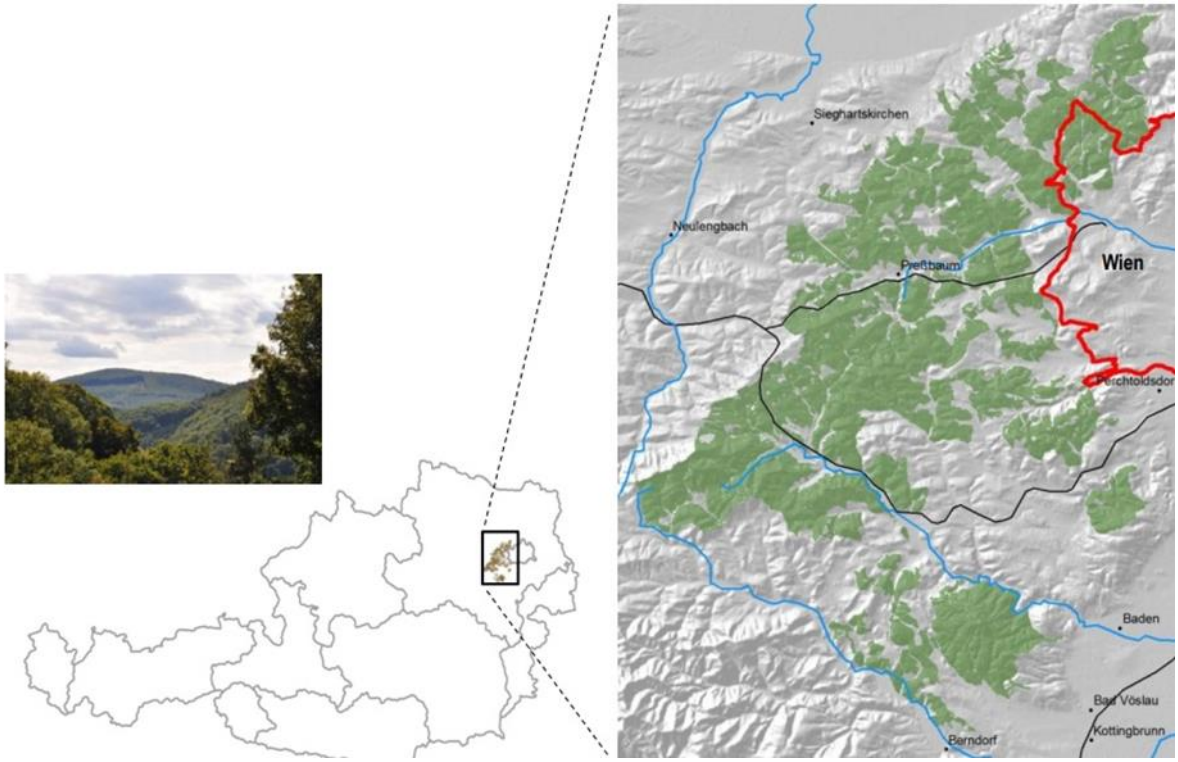
The area of the Viennese Forest covers about 135,000 ha, of which about 70,000 ha (52%) are forest. The characteristics of the Viennese forest are defined by two factors decisively shaped: Concerning the geological background between the Flyschzone (mostly low - calm marl and slate with sand deposits) in the north and west (Flyschwienerwald) as well as the limestone and

Dolomite rocks in the south (Kalkwienerwald). The climate is from a west-east gradient with a westward declining average temperature and rising precipitation quantity.

For the most part, the Wienerwald consists of beech forests (often pure Stands) and oak grove forests. The overwhelming share of the Viennese Forest is in Lower Austria, which includes Vienna's share an area of about 54 km^2 and belongs to the Flysch- or Sandstein-Wienerwald, which has more profound soils and belongs to the Kalkwienerwald. The stock of trees in the Viennese area is mainly formed by deciduous trees. The Oak is significantly more represented in the Viennese Forest than in the rest of Austria.Beech has a share of 30% and the horn beech is with 25% the third most populous tree species of the Viennese share of the Viennese Forest.

Biosphere park Wienerwald - Characteristics

- about 67,000 ha (~ 63% of the total biosphere reserve area)
- one of the largest contiguous beech forest areas in Europe
- 25 different forestry companies (various beech and oak forests, oak hornbeam forests, high-yield forests, small-scale meadows and black alder forests; regional specialties: black pine forests, warm-growing downy woodlands, summit ash forests)
- used throughout centuries +/- intensively used (wood production, planned forestry, hunting, pasture, spreading and resin production, recreation and recreation Recreational use)
- very heterogeneous ownership structure, very different operating and farming systems.



34. Figure Biosphere Park Wienerwald

Forest ecosystem services

- Wood production
- Nature conservation

- Carbon storage
- Recreation
- Habitat certification

Sustainable forest biomass management

The generation of energy from biomass is a brand-new issue - especially with regard to climate change. Due to its proximity to the capital city of Vienna and the related energy supplies, the Wienerwald is of particular interest.

The biosphere reserve Wienerwald Management and the Austrian Federal Forestry together with the University for Soil Culture and the Vienna Institute for Nature Conservation and Analysis have examined the sustainable use of forest biomass in the biosphere park in Wienerwald and have developed recommendations for the economic forest of the Biosphere Park in the sense of the Biosphere Park targets. The research project was supported by the Austrian Academy of Sciences as part of the "Man and Biosphere" program and was concluded in April 2007 (Österreichische Bundesforste, BIOSPHÄRENPARK WIENERWALD MANAGEMENT 2016).

The aim of the project was to collect the potential for an economically and ecologically sustainable use of biomass and to develop guidelines for the conservation of deadwood and old wood as an important prerequisite for the conservation of biodiversity in the economic forests.

Overview of results – exploratory project

The theoretical exploitation potential of the studied beech and oak denominated stocks (considered to be stocks with an age of more than 80 years and with a stock of 400 to 600m^3 per hectare) in contrast to previous forestry use is about 12-20% depending on the age of total biomass. This is a branch wood, which has largely remained in the forest. In addition to foliage, these parts contain the most nutrients. Too much extraction is therefore not economically sustainable. Depending on the location, intensive use of biomass has an impact on the growth performance of a crop, As a result, branch material should not be taken to a greater extent for biomass use but should remain as in the forest as before. In addition, the additional extraction of biomass affects biodiversity - including mosses, fungi, lichens, snails, beetles, birds and mammals. Many species are dependent on so-called deadwood - as living and living space or food. The term deadwood means dead trees or parts thereof which remain in the forest and are slowly decomposed in the natural cycle. They form an important habitat for numerous species. Many of the deadwood inhabitants are already rare or even threatened with extinction. Even a share of 5% to 10% of deadwood makes it possible to survive in the economic forest even for more demanding species. The values refer to oak and beech forests with an age of more than 80 years and a stock between 400 and 600 m^3 / ha.

According to the results of the interdisciplinary study (Österreichische Bundesforste, BIOSPHÄRENPARK WIENERWALD MANAGEMENT 2016), approximately 8-10 (5%) to 16-20 (10%) trees per hectare of forest area are to be available as dead wood / old wood as well as old wood contenders depending on the stock (supply 400 to 600m^3 / ha). (As a tree an "ideal beech" with a BHD of 50cm was assumed.) About half of this should be "standing deadwood". These include dead and dying trees which are still standing upright. Deciduous trees are particularly valuable, as are particularly thick trees from 40 cm in diameter.

Old and deadwood should also be available not only island-like, but also well-networked and distributed in the economic forest, since a network is of great importance for the long-term

existence of the populations of respective kind of wood. Natural forest cells and other areas not used for forestry - e.g. the core zones in the biosphere reserve are of great importance for the conservation of rare species but cannot replace the dead wood / old wood in the economic forest.

2.3.3. Bratislava

Bratislava is mostly surrounded with Danubian lowland, which is the name of the part of Little Alföld situated in Slovakia, located between the Danube, the Little Carpathians and all other parts of the Western Carpathians.

In terms of geomorphology, it forms one unit together with the Neusiedl Basin in Austria and the Győr Basin in Hungary. It is an extensive tectonic depression filled with layers of Neogene Quaternary to a height of between 100 and 350 meters. Danubian Plain is known for its fertile soil and is in general the most fertile territory of Slovakia. It is a major source of agricultural products (wheat, rape seeds, barley, corn etc.)

It consists of the following two parts:

Danubian Hills (also translated as Danubian Upland) in the north

Danubian Flat (also translated as Danubian Plain) in the south

Many urban and other settlements can be found in this primarily agricultural area. The towns Topoľčany, Nové Zámky, Komárno, Levice, Dunajská Streda and Galanta are administrative centers. They are centers of industry and the processing of agricultural products. Old wine growing towns (Svätý Jur, Pezinok, Modra) and health resorts (Piešťany, Dudince) can be also found in the lowland. (https://en.wikipedia.org/wiki/Danubian_Lowland)

Danubian Flat

The Danubian Flat, also translated as Danubian Plain, is the south-western, flatter, part of the Danubian Lowland in Slovakia. The border with the Danubian Hills runs approx. along the line of cities Bratislava – Senec – Sereď – Nové Zámky – Patince. It has been formed by the arms of the Danube (Little Danube and others) and by the southern Váh, Nitra and Žitava rivers. It is filled with huge layers of gravel from the Danube and other rivers of the area. These Danubian gravels are covered with loess and other very fertile soils.

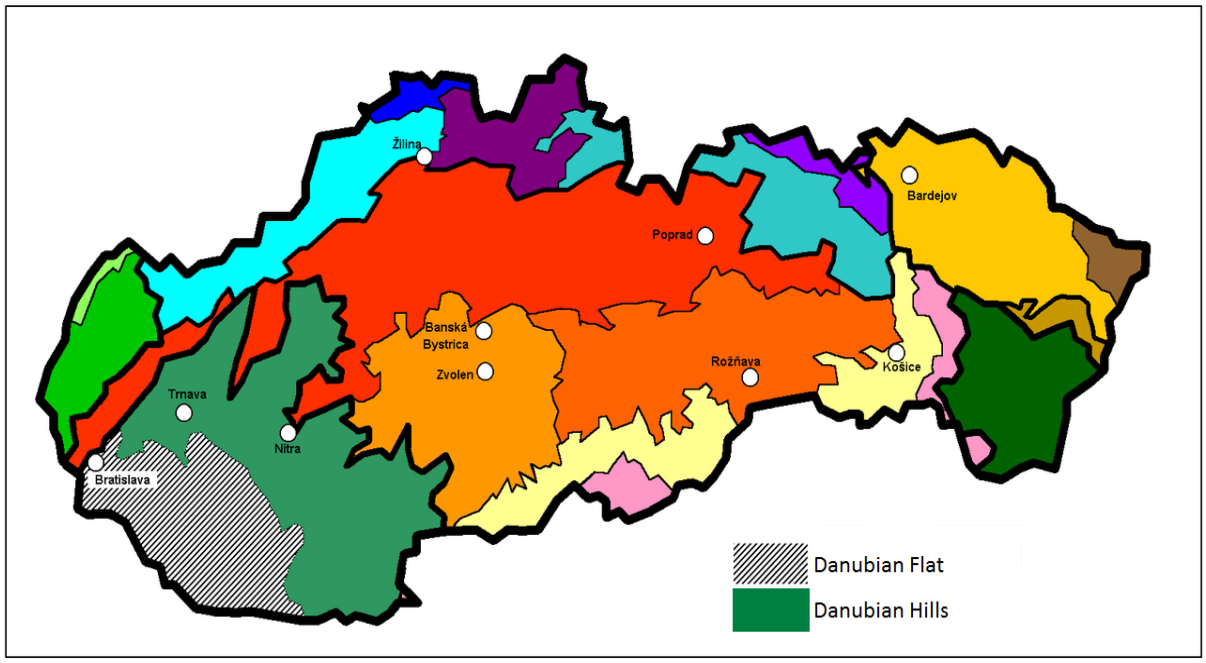
Here, the Danube forms a unique continental delta system of meanders and dead arms. The area between one of those arms called Little Danube and the Danube is known as the Žitný ostrov, the biggest river island in Europe. The Žitný ostrov is an area with marsh depressions, natural lakes and artificial lakes and is the largest reservoir of drinking water in Central Europe.

The drainage system of the southern area was significantly changed by the construction of the Gabčíkovo Dam on the Danube. The Žitný ostrov has been a "Protected Water Management Area" since 1978. The area is rich in forest glades, water and marsh fauna and flora. It has rich subterranean water reservoirs. Those in Žitný ostrov are among the largest in Central Europe. The area has the warmest and driest climate in Slovakia. This, and the fact that it has fertile soils, makes it the ideal place for agriculture. Wheat, barley, rape seed, sugar beets, sweet corn, vegetables and tobacco are grown here. Fruit and vine growing are also important. The most important towns of the area are the Slovak capital Bratislava (the Danube Flat begins in below Bratislava Castle in central Bratislava), Galanta, Sereď, Dunajská Streda, Komárno, and Nové Zámky.

The area features many small-scale protected areas, such as Ostov Kopáč in Bratislava or the Vlčianske mŕtve rameno, Čičovské mŕtve rameno. Protected marshes are for example the unique Šúr area in Svätý Jur. The area of Zlatná na Ostrove provides an extensive habitat for great bustards. (https://en.wikipedia.org/wiki/Danubian_Flat).

Danubian Hills

The Danubian Hills, also translated as Danubian Upland, is the north-eastern, more mountainous, part of the Danubian Lowland in Slovakia. It lies between the Danubian Flat and the Danube in the south, the Little Carpathians in the west and all the other Western Carpathians in the north and east. The border with the Danubian Flat runs approx. along the line Bratislava – Senec – Sereď – Nové Zámky – Patince. The area has varied rocks (clay, gravel, sands), which are covered by quaternary sediments and very fertile soils (black and brown earths). Major towns of the area are Trnava, Topoľčany, Nitra, Levice, Dudince and Štúrovo. (https://en.wikipedia.org/wiki/Danubian_Hills)



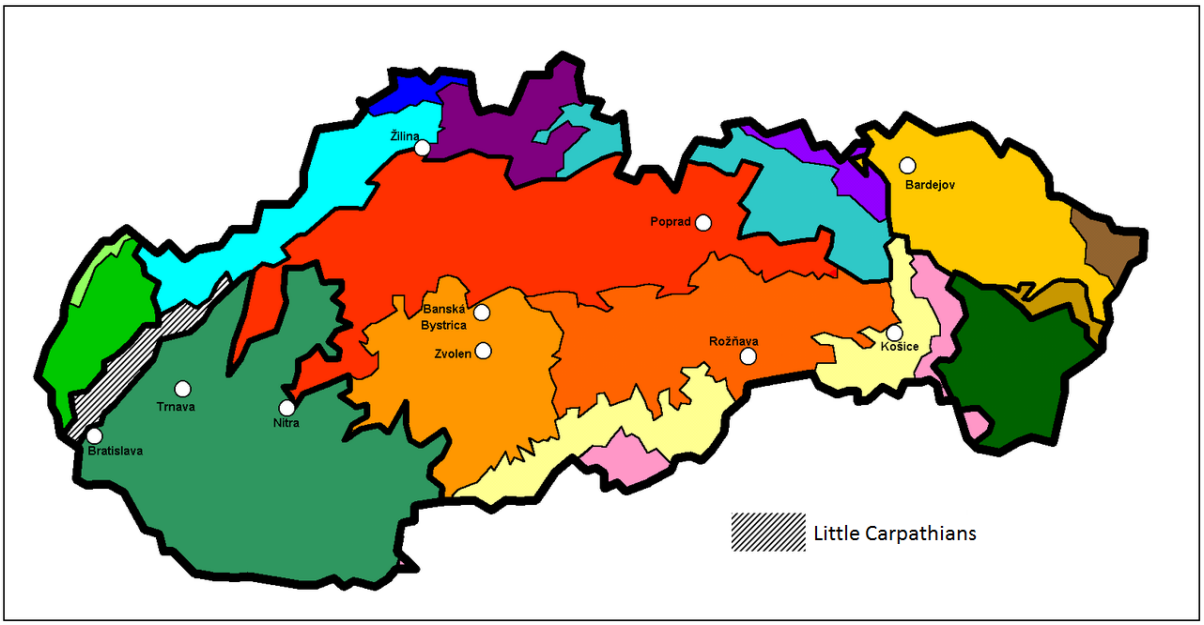
35. Figure Location of Bratislava and Danubian Lowland (Danubian Flat and Danubian Hills) in Slovakia

Source: https://en.wikipedia.org/wiki/Danubian_Hills

From Northwest side, Bratislava is surrounded by Little Carpathians. The Little Carpathians are a low, about 100 km long, mountain range, part of the Carpathian Mountains. The mountains are situated in Western Slovakia, covering the area from Bratislava to Nové Mesto nad Váhom, and northeastern Austria, where a very small part called Hundsheimer Berge is located south of the Devín Gate. The Little Carpathians are bordered by Záhorie Lowland in the west and the Danubian Lowland in the east. In 1976, the Little Carpathians were declared a protected area under the name Little Carpathians Protected Landscape Area, covering 646.1 km2. The area is rich in flora and fauna and contains numerous castles, most notably the Bratislava Castle and caves, cave Driny being the only one open to the public. The three highest mountains are Záruby at 768 m, Vysoká at 754 m and Vápenná at 752 m. The mountains are densely forested (90% being broad-leaved

trees), the south-eastern part contains extensive vineyards. (https://en.wikipedia.org/wiki/Little_Carpathians).

Even though Little Carpathians are declared a protected area, wood extraction have been always a part of the region. Citizens, tourists and activists have been complaining about unfriendly ways of harvesting wood with no respect for nature where the heavy force supported by the heavy machinery comes into play. Such way of handling wood turns the hiking and cycling trails into the mud baths and the depressive landscape. The very insensitive method of extraction is a frequent conflict between foresters and the public. In cooperation with the foresters a manual entitled "Safe Methods of Wood Harvesting - Forests for People" have been developed. These are 10 specific measures for timber harvesting that eliminate negative phenomena. In order to support the recreational function of the forest, Bratislava has reduced wood harvesting by over 50% of the original volume. https://pava.blog.sme.sk/c/409077/karpatske-lesy-sa-menia-na-rubanisko-ako-dalej.html



36. Figure Position of Little Carpathians next to Bratislava in a map of Slovakia

Source: https://en.wikipedia.org/wiki/Little_Carpathians

2.3.4. Budapest

Hinterland's geography

Raw materials for biomass processing are coming from forests and agriculture. However, huge mountains cannot be found in Hungary, and the Great Plain is farer from the capital, the port's hinterland, that is mainly Central-Hungary and a little bit beyond, still has potentials in the field of different types of biomass. Certainly, a significant amount of biomass comes from public parks of Budapest, approximately 2370 hectares.

Forests and agriculture

Forest areas are concentrated in the country. Extensive forests – primarily due to geological and weather conditions – were developed in the hilly regions of Northern Hungary and Southern Transdanubia. The proportion of forests – forest area from total area – varies greatly depending on the territorial features. Although, Central Hungary has the least forest among the Hungarian regions, forestry is still higher than the national average.

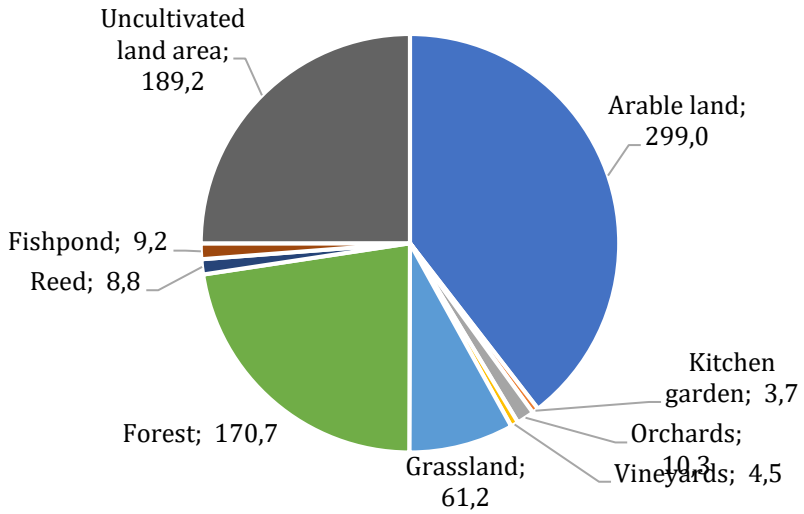
In terms of land-use, as presented in the table below, the amount of grassland, forest, reed and uncultivated land area have increased since the year 2000 in Central Hungary (marked with green), while arable land, orchards and vineyards have decreased (marked with red).

Table 2: Changes of land area by land-use in Central Hungary (thousand ha)

Source: Own editing based on KSH (Central Statistical Office)

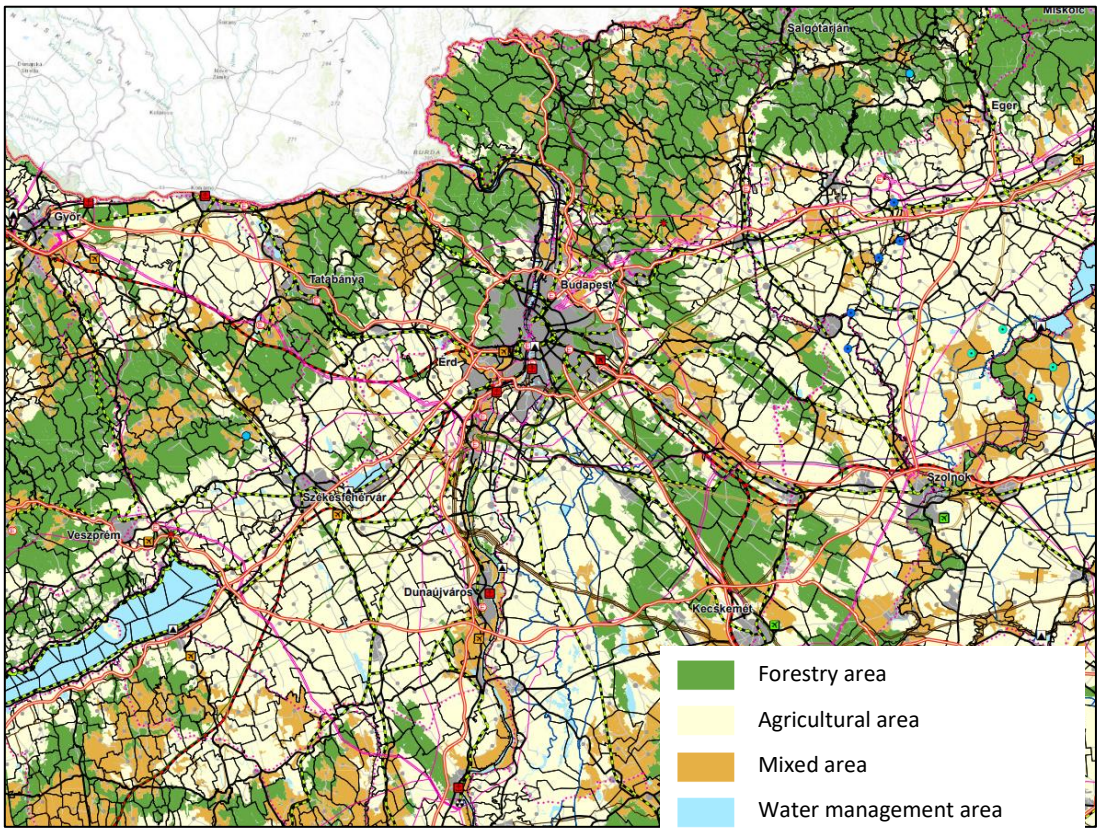
	2000	2017	
Arable land	305,0	299,0	
Orchards	12,4	10,3	
Vineyards	8,7	4,5	
Grassland	57,1	61,2	
Forest	149,8	170,7	
Reed	3,8	8,8	
Uncultivated land area	181,0	189,2	

Big changes did not happen concerning the size of areas in the last decade. Their share in 2017 from the total area of the region is shown in the figure below. According to the most recent data from KSH (Central Statistical Office), in 2017 there are 299 thousand ha of arable land, 189 thousand ha of uncultivated land, 170 thousand ha of forest in Central Hungary. The biggest 3 areas are, in this order, 7%, 10% and 9% of the national totals, but reed yield in the region is a significant 21,31% on national level. Certainly, these numbers and shares are due to geographical conditions. The region is very populated and poor in large natural and agricultural fields comparing to rural areas and other regions of the country.



37. Figure Land area by land-use in Central Hungary (thousand ha)
Source: Own editing based on KSH (Central Statistical Office)

The following map shows national land use categories around the Freeport of Budapest, including forestry, agricultural, mixed and water management areas.



38. Figure National land use categories (Central Hungary)
Source: National Spatial Planning Plan of Hungary, Annex II. 2014. (http://www.terport.hu)

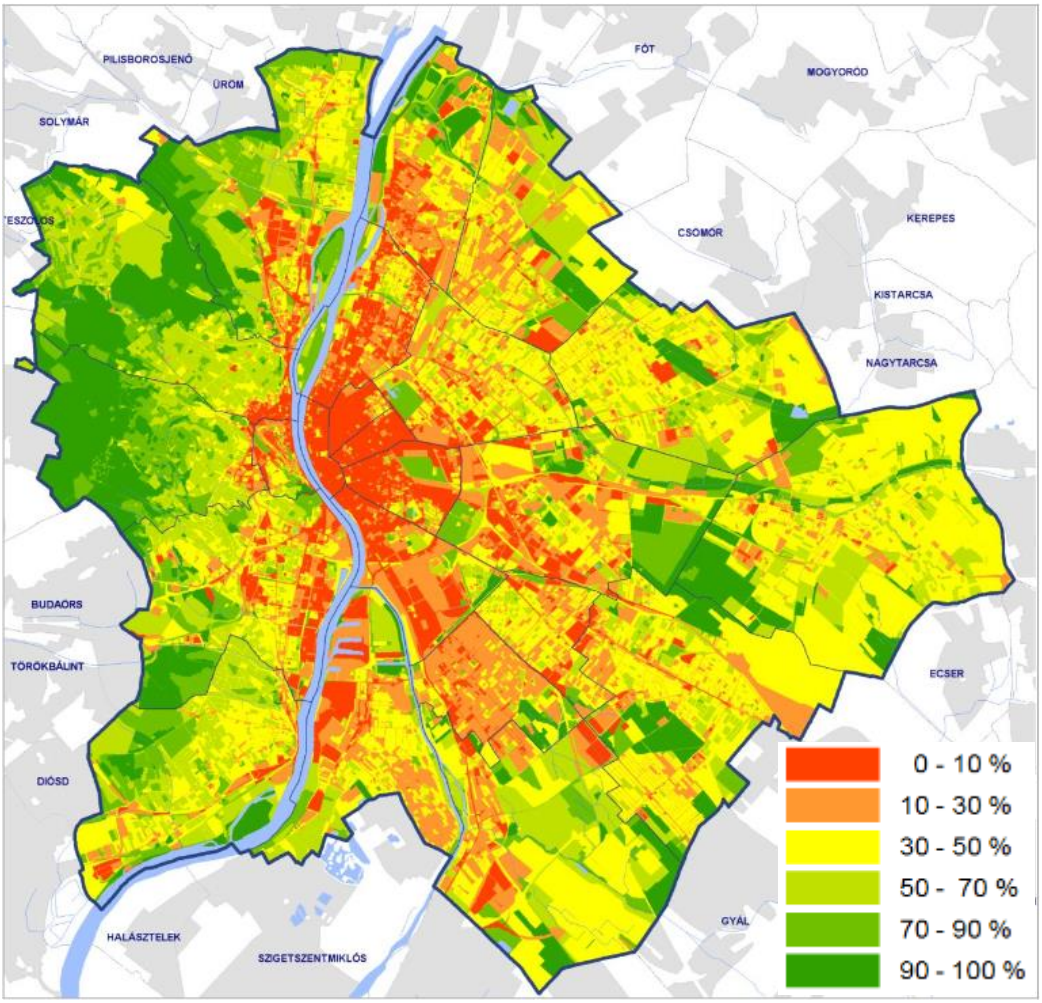
Regarding the main cultivated plants and their by-products in Hungary, maize is produced on 1.1-1.2 million hectares per year. In better years, the yield is over 8 million tonnes. The yield of the last five years averaged 6.1 tonnes per ton, taking into account the drought periods. Compared with maize production, large amounts of corn stalk and husk remain in the area. In 2014, 7.2 million tons of grain was produced, which is 6.1% more than in the previous year. This growth was primarily due to favourable weather conditions during the growing season. In 2014, wheat yielded 5.2 million tons. In the last few years, straw has been harvested on the 80-87% of the area of cereals. Sunflower and rape stalk also represent a significant quantity of agricultural by-products. In recent years sunflower was grown on 600,000 hectares, rape grown on 190,000 hectares. The utilisation of the rape stalk started to grow with the increase of biodiesel production.

Parks in Budapest

The first composting site in Hungary was established in District 10 of the capital using biomass coming from parks of the metropolitan region. On the one hectare composting area there are 50-60 thousand m^3 organic waste processed. 70% of the annual 5000-6000 m^3 compost produced is delivered back to their original sites making modern waste management possible at green areas. Residues are sold as bulk product. Applied technology is an open, high-gloss procedure co-designed by the Research Institute of Agrology of Hungarian Science Academy. Furthermore, another capital organization responsible for maintenance and cleaning of public space is operating a composting site. FKF Zrt. has been collecting garden green waste for a decade, in the green belt districts of Budapest. Green waste is collected separately for this purpose in waste bags and then delivered to Pusztazámor Regional Waste Management Centre for composting.

Secondly, besides composting, energetic use of biomass created in parks and public places has recently been spreading increasingly. In case of ligneous plants, more and more district municipalities in Budapest accept chopping usually in the framework of community service[1]. Chips created will be used for heating and warming water in public institutes (schools, offices etc.).

In case of herbaceous plants (lawn, flowers in parks), they could be grown for biogas production purposes, though, this mode of utilization has not been spread yet. The map below shows green intensity of Budapest. Hilly Buda side has more green areas because of the garden suburbs and little forests in the edge of the city, while inner parts have less.



39. Figure Green intensity in the City of Budapest

Source: Budapest Környezeti Állapotértékelése 2014 (Analysis of status of environment of Budapest)

Parks and forests are partially (not jointly) maintained by the capital and districts, and also, a forestry, called Pilisi Parkerdő Zrt. Moreover, responsibilities are fragmented further as two public organizations represent the Capital of Budapest on maintaining and cleaning public green places: FŐKERT (capital garden co.) and FKF Zrt. (capital public place operator). This causes unclear data or information on exact quantities extracted, grass cut, trees chopped in public places

[1] Community service or 'public works' is a governmental programme for creating jobs instead of providing unemployment aids; this means mostly physical works done by low-educated people.

in m^3 or ton. However, one can state, that there is a big potential in the capital districts' green waste to transport for biomass use, but there is also competition between composting and energetic utilization.

Case of Óbuda-Békásmegyer, the 3rd district of Budapest

Parks, public green places owned by the district level local government are outsourced to be maintained by a contracted private partner. The contracted company must transport green waste (grass cut, chips, branches, twigs) from the operation area to composting in 48 hours. Annually, 6 times in inner places and 5 times in the suburbs and outer places there are mowing. Plus, in the framework of another community programme, household green waste is collected from residents: 10 m^3 per households were composted.

Ownership and maintenance companies

Forests and green zones in the area of Budapest and Pest country's agglomeration are maintained by

Pilisi Parkerdő Zrt.	**65 000 ha**
HM Budapesti Erdőgazdaság Zrt.	37 000 ha
Ipoly Erdő Zrt.	64 000 ha

Ipoly Erdő Zrt. operates on the border of Pest and Nógrád counties. Pilisi Parkerdő operates in Komárom-Esztergom and Bács-Kiskun counties as well and also, it maintains state-, municipality and private owned forests. Basically, in the hinterland 60% of forests belong to the state and less than 40% is private owned (KSH 2008).

2.3.5. Vukovar

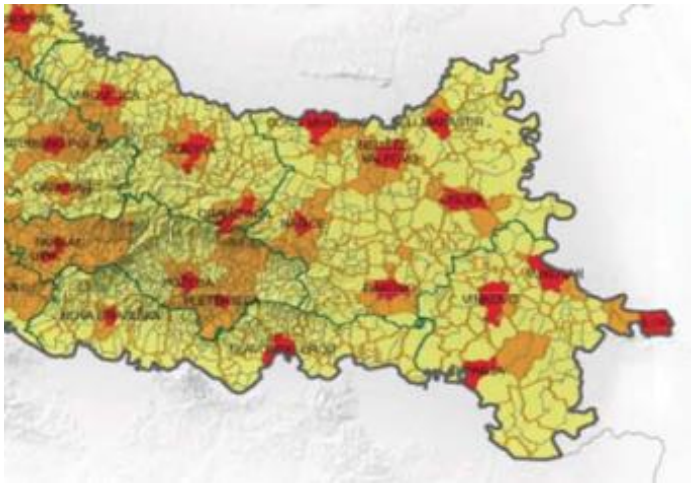
Accepting as a framework criteria 100 km distance form Vukovar port, in the further analysis as Vukovar port hinterland five counties will be analysed:

40. Figure Area of Slavonia and Baranja

Vukovar- Srijem County with the seat in Vukovar,
Osijek- Baranja County with the seat in Osijek,
Brod- Posavina County with the seat in Slavonski Brod,
Požega- Slavonia County with the seat in Požega and
Birovitica- Podravina County with the seat in Virovitica.

These five counties form the region of Slavonia and Baranja, the least economically developed region in Croatia, below 1/3 of EU average. The area consists of the valleys of the Drava, Sava and the Danube which are utilised in agricultural purposes, but also for cattle and forestry. Bearing in mind all mineral resources, oil, gas, water and

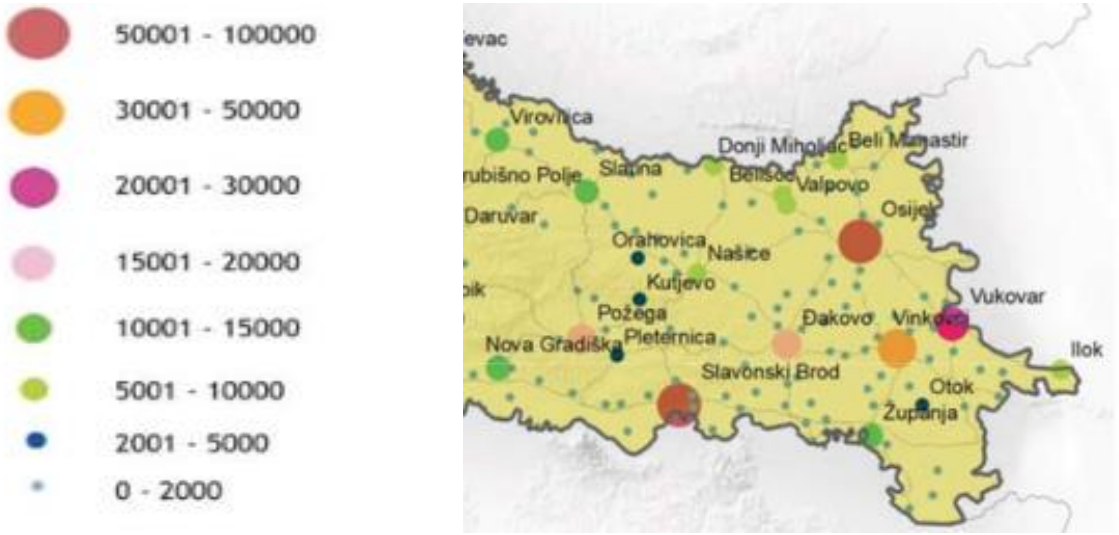
waterways one can find the most fertile soil in Croatia. Hills are located alongside the right coast of the Danube, while near the Sava, Drava and Danube one find wetlands (the biggest is Kopački rit Nature Park in Baranja). In the proximity of the Sava there are oak groves.



According to the data from 2012 the population of the observed area is 806.998. There are 22 cities (Figure 38), and the structure according to the population is shown in Figure 39. Town seats are marked with red, urban areas are marked with orange on Figure 38.

41. Figure Urban hinterland of Vukovar port

The area of Slavonia and Baranja is rich in forest, which is in the mostly property of the State (80%), and is managed by *Hrvatske šume*. The total surface of forests in Vukovar port hinterland is 425.175 ha.



42. Figure Urban settlements structure according to population

Table 3: Forest area in Vukovar port hinterland

	Forest area (ha)	Percentage in the total forest area in Croatia	Forest area in private property (ha)	Forest area owned by the state (ha)
THE REPUBLIC OF CROATIA	**2.759.039,05**	**100%**		
VUKOVAR-SRIJEM	68.450,00	2,48%	1.400,00	67.050,00
BROD-POSAVINA	56.669,07	2,05%	8.502,74	48.166,33
OSJIJEK-BARANJA	122.476,00	4,44%	24.390,00	98.086,00
POŽEGA-SLAVONIA	112.016,99	4,06%	6.552,99	105.463,99
VIROVITICA-PODRAVINA	65.562,88	2,38%	5.245,03	60.317,85
TOTAL	**425.174,94**	**15,41%**	**46.090,76**	**379.084,17**

According to Croatian Bureau of Statistics agricultural areas cover 743.770 hectares, out of which 569.064 are being utilized. Agricultural areas in different counties are shown in the following table.

Table 4: Agricultural and utilized agricultural areas

County	Agricultural areas (ha)	Utilised agricultural areas
THE REPUBLIC OF CROATIA	2.693.874	1.571.200
VUKOVAR-SRIJEM	150.856	131.722
BROD-POSAVINA	120.429	72.853
OSIJEK-BARANJA	266.245	221.725
POŽEGA-SLAVONIA	89.489	50.069
VIROVITICA-PODRAVINA	116.751	92.695
TOTAL	**743.770**	**569.064**

Out of all utilized agricultural areas as much as 69% (392.900 ha) are being used to grown corn and cereals, while 19.836 hectares is being used to grow fruit and vineyards.

Table 5: Annual harvest levels

Culture	Harvested area
WHEAT	111.200
BARLEY	30.400
RAY	500
OATS	13.100
CORN (ST)	159.500
SOY	37.700
SUNFLOWER (ST)	22.800
RAPESEED	13.300
TOBACCO	4.400
TOTAL	**392.900**

Table 6: Annual levels of planted fruit and vineyard areas

Culture	Area (ha)
FRUIT	12.111
VINEYARD	7.725
TOTAL	**19.836**

Considering the potential for producing biogas livestock in Slavonia and Baranja in 2017 has been analysed.

Table 7: Livestock in Slavonia and Baranja

Farm animals	Farms	Owners	Quantity
BOVINE	5.354	5.888	160.840
SHEEP	4.485	4559	117.525
GOATS			7.096
PIGS	33.804	34.544	793.688
EQUIDAE	1.559	6.202	26.416

The area of western Slavonia was not analysed as it gravitates towards Zagreb as the economic center of Croatia. However, western Slavonia has many agricultural and forest areas and significant potential for producing biogas.

2.4. Conclusion and analysis – key findings

Consequences of methodology

The approach, i.e. how and what partner ports emphasized within this chapter and what they consider their hinterlands determined upcoming topics and territorial focus. Another significant factor regarding further research and development on energy utilization, trade and manipulation of biomass is what sort of plants, grain and wood partners were listed. When the importance of rape seed fields among other agricultural products grown in the hinterland is stressed, it is an indication that the focus is likely to be on biofuel production. Also, building on the large quantities available from wood coming from sustainable and responsible forestry will contribute to energy generation from solid biomass in the certain port. On the other hand, listing almost every kind of agricultural products among the most spread and common ones make further research work and project development less focused. However, it also can open up several opportunities ahead of the ports planning to become logistics centres of their regions.

Links with upcoming chapters

Speaking of determination of the following chapters, interlinkages could be already observed. It would have been difficult to avoid naming the major actors on the market purchasing core and by-products planted in certain hinterlands. In case there were only a few key industrial players e.g. demanding for agricultural products in Bavaria, ports have already named them.

Which port is in the best situation?

As it turned out, Straubing and Vienna are most probably the richest in wood resources, Vukovar however has the widest agricultural fields. Due to different ranges of focus on territorial coverage and products named – as mentioned above – it is hard to determine, which port has the most diverse hinterland, and also, whether having diverse hinterland an advantage. Based on the first two chapters it can be said that, success stories come from responsible and well-designed industry development that Straubing and Vienna implemented counting on one or maximum two core products grown, harvested, manipulated and utilized.

Main challenges

It could be observed that due to various forests ecosystem services provided in every country among the partners', there are competing functions of wooden areas. As long as they can serve for recreation, cleaning polluted air, industrial utilization, but also, as biomass raw material provider, there will be oppositions regarding environment protection and exploitation – even if it also goes hand in hand with sustainability and responsible forestry.

3. Regionally available raw materials – supply and demand side (in the 100-km radius)

3.1. Objectives of the chapter, methodology

Geographic and thematic focus

Chapters 2-5 are strongly linked to each other. The survey takes into consideration a wide range of opportunities of the biomass energy industry has: from the potentials in the hinterland as a starting point via mapping raw materials actually utilized through markets of upgraded products to exact network of stakeholders in the sector with a regional focus. Previously defined hinterland area i.e. 100 km radius of the port has impacts on which products are observed in which sectors. This chapter aims to answer not only what kind of biomass materials are available in the ports' hinterland areas, but also, what ports consider as potential raw materials to deal with.

Certainly, 100 km radius is not a strict rule, as long as important and relevant potentials shall be exploited beyond that region, territorial coverage could include that. A main goal is to have estimated quantities, volumes of harvested products in the region, even trends of biomass production if possible: for instance, the share of rape seed harvested is decreasing due to reduced capacities and imperfect farming conditions in Slovakia, resulting in less raw materials available for biofuel production.

Description of interlinkages with the other chapters/topics of the survey was also required as well as connection to other actors of the sector. Main suppliers and competitors were analyzed in this chapter, too.

Raw materials' availability and their producers shall have been presented on maps if possible. This could contribute to realizing the existing or potential connections between the network of stakeholders on the market and the ports.

Source of information

Partner ports defined the territorial and sectoral coverage of supplied raw materials with a possible contribution from their traders and companies they are in touch with. Afterwards, they gathered all the relevant information on available raw materials in their hinterlands using mostly databases published by statistical offices.

3.2. Summary of the surveys

Most of the ports are in great conditions in terms of regionally available raw materials as it was based in the previous chapter. Mountainous areas have more coniferous trees, while plains are richer in agricultural products. Ports have already taken into consideration the possibility to exchange raw materials with Danubian countries.

As hinterland was defined for **Straubing** in the previous chapter, its major natural resources are from Bavaria and Gäuboden. On 36,9% of the territory of Bavaria there is 2.5-2.6 million ha forest area. Actual forest include 236.852 ha with 33% of hard trees and 67% of coniferous trees in stand. Available raw materials include 26 million m^3 deciduous trees and 76 million m^3 coniferous trees. After processing 10.82 m^3/ha logged wood is generated per year. This resulted in 7.46

million solid m^3 of coniferous, 0.44 million m^3 hard and 1.32 million solid m^3 industry wood logs in 2012, and 5.03 solid m^3 fuel wood.

Forestry and saw mills are the main suppliers in the region processing wood pellets, construction timber, combustion timber, squared timber for packaging, laths, timber for shuttering etc.

In Gäuboden which has 7140 agricultural farms with 241.098 ha land property, there were 474.43 tons of sugar beets, 302.71 tons of maize and 251.72 tons of potatoes yielded in 2015. Agriculture and forestry constitute huge potentials for Straubing's hinterland.

Biomass use has increased significantly in **Austria**. Hence, wood is the most important for biomass energy market in forms of logs (27%), chips, sawed products and bark (35%). Biofuels also are accounted for 10% of gross domestic consumption of fuels in 2011, but biogenic solid fuels and biogas were significant too. Future development potentials are accounted for 52% by wood-based raw materials, 25% by biofuels, 18% by biogas and 5% by other biogenic solid fuels. By 2020 biomass use shall increase by 25% in the country according to the Österreichische Bundesforste, BIOSPHÄRENPARK WIENERWALD MANAGEMENT (2016). In order that, mobility of raw materials is a key factor.

Forests have expanded by 4 million hectares in a decade, resulting in increased but sustainable supply. Forestry Act (Bundeskanzleramt Rechtsinformationssystem 2012) also facilitates environmental sustainability. Between 2005 and 2011 the consumption of bioenergy increased by 43%. Biomass market thrives regarding heat, biofuels, electricity from biomass and biogas and further expansion is foreseen in case of improving conditions of mobilization according to the expectations of PoVi's experts and Österreichische Bundesforste, BIOSPHÄRENPARK WIENERWALD MANAGEMENT (2016).

Region of Smolenice as the hinterland of **SPaP** covers Little Carpathians including 6 forest administrations. Having 40.299 ha of forest land managed, economic forests are 73% while 14% is under protection and 12% is special forest according to Slovakia's national categorization. The stock of forest stands is 9.736 million m^3 of wood from which the annual timber production is 184.000 m^3 mostly coming from beech, oak and hornbeam.

The cadastral area covers 254.304 ha of forestry providing timber composition (22%) as a service. Main competition does not occur in the industry, but in terms of the infrastructure: road and rail are profitable to transport while IWW is not as far as SPaP's experiences are concerned.

Having the most fertile soil and largest areas for products to grow in the country, Bratislava region is in great conditions for agriculture. However, statistics are only available for the entire Slovakia and not for regions and lower levels of administration. Wheat, barley, corn, sunflower, rape seed are agricultural products that are grown on the largest fields and yielded in the highest volumes. In terms of biomass potentials based on raw materials, rape seed production is decreasing yearly by 25% as an average yield per hectare. At the same time EU directives, demand from Slovakia to increase the share of bio-components in motor fuels by 10% until 2020.

Several forests are operating in the hinterland of **Budapest** port, which is basically Central-Hungary but also, beyond. Pilisi Parkerdő operates on 65.000 ha and 60.000 ha is covered with forests. Vértesi Erdő Zrt is an umbrella organization of local Forester's districts across Central-Transdanubia processing and offering logs from oak, beech, acacia, hornbeam, ash, cherry, hazel, alder, pine, spruce and larch for industrial use. However, residues could be further utilized in

biomass energy industry. Budapesti Erdőgazdaság has 10 hubs in 10 counties across Hungary resulting in easier and more fluent logistics services.

In 2012 there was 7.7 million m^3 wood extracted in Hungary. The capital had certainly the lowest, 36% logging rate, meanwhile Pest county which is surrounding Budapest had approximately 67-77% more wood planted than extracted in 2012.

There is enough firewood extracted annually for 500.000 households, however by improving extraction and utilization of green waste leftovers, this number could be raised to 700.000 - 800.000.

In Central-Hungary in 2016, there were 76.710 kg/ha of sugar beet, 7280 kg/ha of maize, 4930 kg/ha of winter barley and 4700 kg/ha of wheat yielded.

80% of rape in Hungary is used for biodiesel production and 1.4 million tons of maize are processed to bioethanol. In Budapest, hundreds of tons of used cooking oil are collected by specialized companies to produce biodiesel. The Directorate of Agriculture within the National Food Chain Safety Agency is in touch with 81 active companies in the region from biomass processing, biomass distribution and biofuel distribution sectors.

In **Vukovar's** hinterland corn and grains account for more than 80% of annual quantities of biomass from agriculture. This means 2.408.300 tons in total, including 20.691 tons of biomass from pruning residues (fruit trees and vineyards). Private farming is very common, 34% (94.879 ha) of households own and cultivate agricultural land in the region. 5381 farms of the region generate 1.516.632 tons of manure which is a main feedstock for biogas production.

There are 1.010.244 m^3 of forest biomass estimated in Vukovar annually. In the hinterland of the Croatian port, there are dozens of forests, but as long as private forests holdersown only 20% of the forests in the country, they cannot compete with the state-owned company Hrvatske sume whichhas the license to collect on average 8000 m^3 of wood from the forest.

After processing and delivery, 3.5% of total primary energy is utilized by households filling their own biomass boilers with fuel wood. Besides local use, there is a tendency of continuous annual growth of forest biomass trade exchange with neighbouring countries mostly in the Danube region. This would contribute to Vukovar to become part of the biomass market.

3.3. Chapters from national surveys

3.3.1. Straubing

Based on the previous chapter, the quantities and the trends of the biomass were analysed separately for the regions Bavarian Forest and Gäuboden.

Bavarian Forest

Bavaria in total has around 2.6 Mio ha forest area, which means that Bavaria is forested to 36.9 %. (LWF (d); 2017). The amount of hard trees is steadily rising. Nevertheless, there are regional gaps (LWF (e); 2017). The Bavarian forest has a total area of 236,852 ha. 33 % are hard trees and the main species is beech with more than 50%. Up to 67 % the Bavarian Forest consists of coniferous trees. Spruces make three quarters of the coniferous trees and 50.6 % of the whole tree species (hard and coniferous trees summed up) (LWF (f); 2017). See Table 8.

Table 8: Forest areas by tree species groups in the Bavarian Forest

Source: LWF (f); 2017

Forest area by tree species groups	ha	in %
Oak	7,430	3.1
Beech	41,045	17.3
other hard trees with high life expectancy	8,902	3.8
other hard trees with low life expectancy	20,718	8.7
hard trees in total	**78,095**	**33.0**
Spruce	119,940	50.6
Fir	21,677	9.2
Douglas fir	2,675	1.1
Pine	13,195	5.6
Larch	1,270	0.5
coniferous trees in total	**158,757**	**67.0**
Total	**236,852**	

The stock of wood in the Bavarian Forest accounts 26,598,782 m^3 deciduous trees and 76,339,575 m^3 coniferous trees (LWF (g); 2017). From the years 2002 to 2012 the state Bavaria had an annual increment from around 29.5 Mio m^3 wood. In this period Bavaria had the second highest increment compared to other German states. Compared to the last period, these increments have decreased (LWF (h); 2017). The Bavarian Forest had a total accretion from around 32.2 Mio m^3 wood during the years 2002 to 2012 (LWF (i); 2017). In total around 26.4 Mio m^3 have been used in the Bavarian Forest between 2002 to 2012. Thereof around 3.8 Mio m^3 descend from hard trees. The highest amount of this type is beech. Around 22.6 Mio m^3 descend from coniferous trees. Here spruces have the highest amount. In total the logging accounts 10.82 m^3/ha per year. (LWF (j); 2017). See Table 9.

Table 9: Usage from 2002 to 2012 by tree species groups in the Bavarian Forest

Source: LWF (j); 2017

Usage from 2002 to 2012 by tree species groups	m^3	$m^3/ha*a$
Oak	266,166	
Beech	2,481,671	
other hard trees with high life expectancy	338,406	
other hard trees with low life expectancy	786,475	
hard trees in total	3,872,718	
Spruce	18,991,855	
Fir	1,675,501	
Douglas fir	5,865	
Pine	1,718,257	
Larch	196,919	
coniferous trees in total	22,588,397	
Total	26,461,115	10,82

If the logging is only accounted in the national park Bavarian Forest, the annual amount fluctuates strongly. See Table 10. Unfortunately, the data is only available in solid cubic meters. This makes it hard to compare with the logging data from the whole Bavarian Forest area. But it can be seen that the logging amount is dependent of calamities like bark beetle infestation or damage of the trees through storms. This happened for example in July 2011, when a strong storm occurred in the region (Wälder in Deutschland; 2015).

Table 10: Logging in the national park Bavarian Forest by calamities from 2010 to 2013 (data in solid cubic metre)

Source: Wälder in Deutschland; 2015

	2010	2011	2012	2013
bark beetle	147,431	81,663	20,604	25,801
windfall	228	86,776	6,740	495
snow breakage	0	237	641	126
regular	702	1,505	3,216	2,353
Total	148,361	170,181	31,201	28,775

In Bavaria in 2012 7.46 Mio solid cubic metres (scm) wood were used as coniferous wood logs, 0.44 Mio scm as hard wood logs, 1.32 Mio scm as industry wood and 5.03 Mio scm as wood fuel (Hastreiter; 2014).

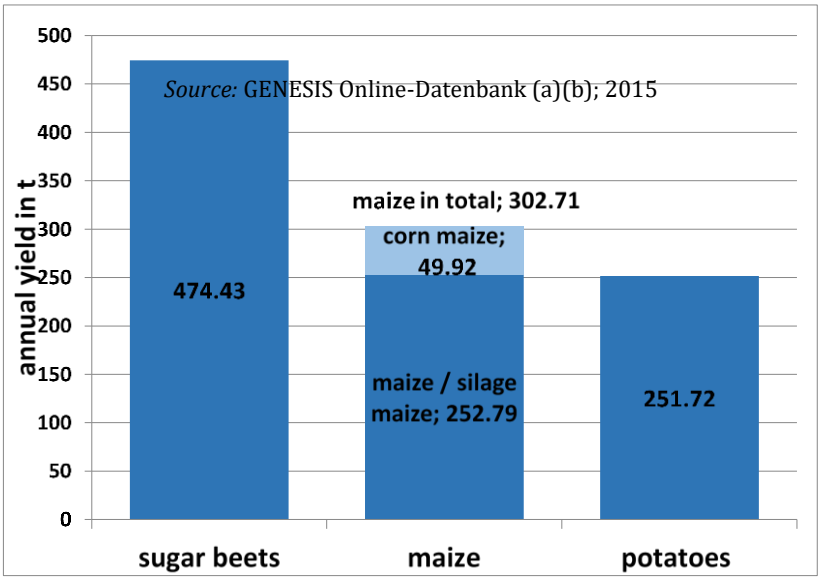
The main suppliers of wood are saw mills and forestries. One example is the large sawmill 'Holzwerke Weinzierl GmbH' in Vilshofen. The company only uses wood from Bavarian forests. Their product assortment contains wood pellets, construction timber, combustion timber, squared timber for packaging, laths, timber for shuttering and many more (Holzwerke Weinzierl; 2017).

Gäuboden

The regions Deggendorf, Dingolfing-Landau, Regensburg, Straubing-Bogen as well as the cities Regensburg and Straubing were analysed for the yield evaluation in the Gäuboden.

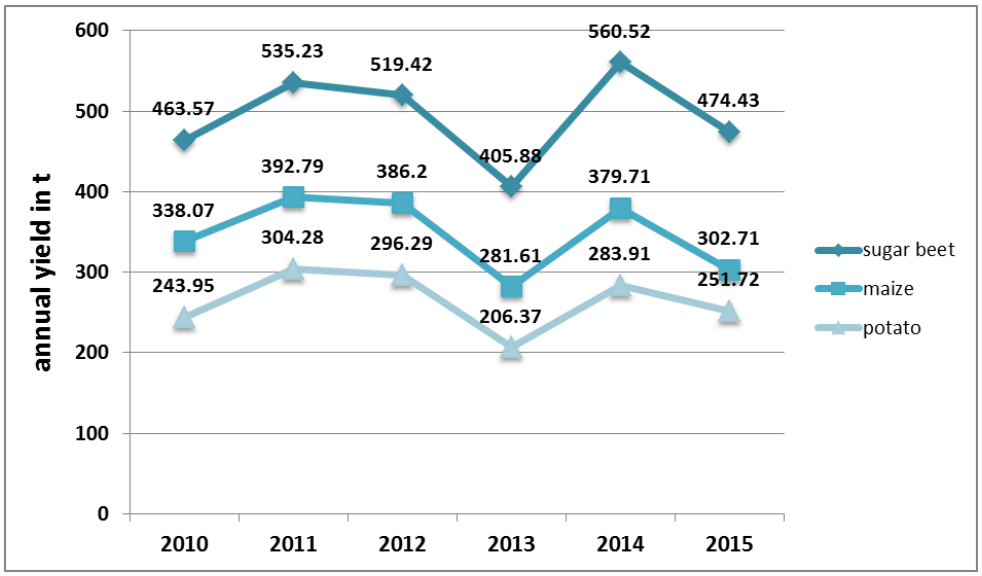
7140 agricultural farms with a property of 241,098 ha land are situated in these counties (Regionalstatistik Deutschland; 2010).

The three main crops in the region are sugar beets, potatoes and maize. The data was collected in 2015. In this year, sugar beets had the highest rate with a yield quantity of 474.43 t, followed by maize with a total amount of 302.71 t. A distinction is made here between corn maize with maize to mature (including corn-cob-mix) and maize with silage maize (including residual products). The majority is maize with silage maize with 252.79 t per year. Corn maize only has an amount of 49.92 t. Potatoes are on third place with a harvest amount of 251.72 t per year (GENESIS Online-Datenbank (a)(b); 2015). See Figure 40.



43. Figure The three main crops by yield in the Gäuboden area (2015)

From 2010 to 2015 the yields for the three main crops varied. See Figure 41. The drop in 2013 can be explained with the severe rainfall and the flood which took part in Eastern Bavaria along the Danube. Fields and grasslands got overflowed. This led to the destruction of young plants and complete harvests (Deter; 2013). Due to heat and drought in 2015, there was also a drop in the yield in (Noll; 2015).



44. Figure Yield of the three main crops in the Gäuboden area from 2010 – 2015

Source: GENESIS Online-Datenbank (a)(b); 2015

It is difficult to capture the amount of residuals in the Gäuboden region, because there is hardly data available. But especially for stakeholders like farmers and food processors this knowledge would be useful. The utilization of residuals is getting progressively relevant and it is important to implement a reliable survey during the next years. It is possible to calculate the amounts with the yield, but this is very complicated and not the best way. Also, the biomass potentials would be higher if the residuals would be taken into account.

Main suppliers which refine the products are residents in the Danube port Straubing-Sand. These are agricultural trade companies like the BayWa AG (an agricultural hub and logistics service provider), the Bayernhof Erzeugergemeinschaften Vertriebs GmbH (an agricultural trade company) and the Raiffeisen Straubing GmbH (an agricultural and building materials trade company).

3.3.2. Vienna

Biomass use has increased by 44% since 2005. Between 2005 and 2011, the gross domestic consumption of bioenergy (including biogenic household waste) increased from 159 PJ to 229 PJ, or 44%. Wood is and remains the most important resource for the bioenergy market. 79% of the total biomass used in Austria in 2011 is wood in various forms (including lye). With a share of 27%, logs (firewood) are the most important biogenic energy carriers. In total, more primary energy was provided by wood chips, sawed products and bark (35%) than by logwood. Biofuels accounted for 10% of the gross domestic product in 2011. This was followed by other biogenic solid fuels with 5.5%, biogas, sewage gas and landfill gas with 2.9% and biogenic waste with 2.5%.

By 2020, biomass use in Austria could be increased by 25% to a total of 287 PJ. The prerequisite is that it is possible to mobilize the available potentials of 58 PJ from agriculture, forestry and timber as well as the waste sector. Around 52% of the development potential is accounted for by wood-based raw materials (including lye), 25% by biofuels, 18% by biogas, and 5% by other biogenic solid fuels. Without the mobilization of the raw material potentials outside the forestry

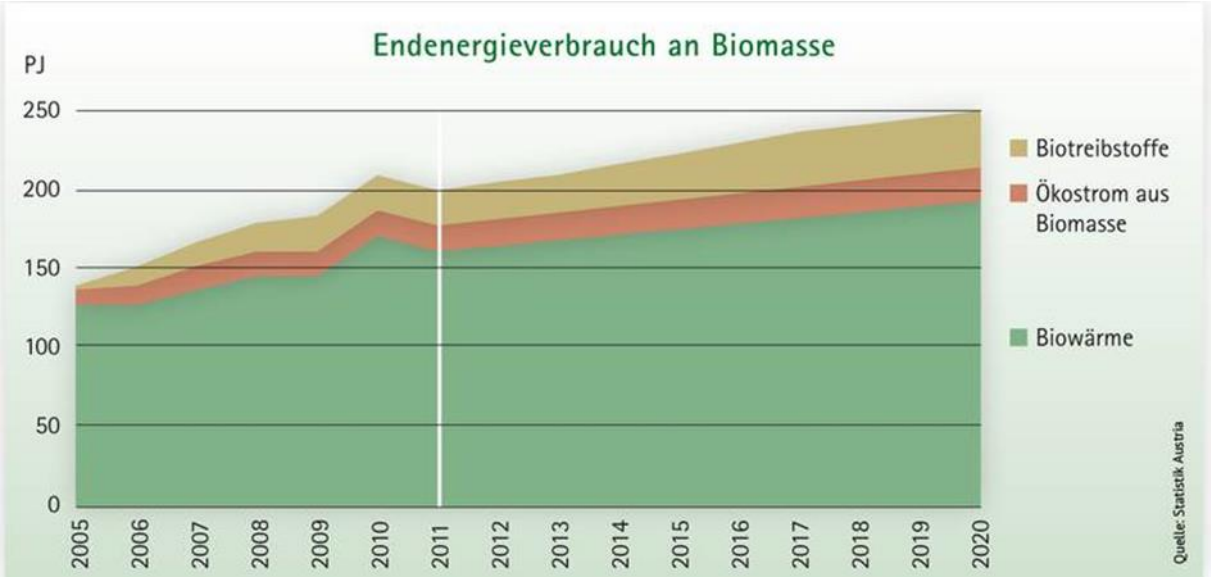
and timber industry, biomass use can be increased by a maximum of 14%, as the further potential for exploitation from the forest is limited. Altogether, around 24.3 million solid meters of wood were used in Austria in 2010. Of this, around 51.4% accounted for raw materials from the cascadic use of wood (bark, sawed products, industrial wood, pressed products, lye). About 48.6% of the energy wood came directly from forestry (firewood, wood chips) as well as from woody shrubs, shrubs, old wood and other sources.

Energy production in Austria could be increased by 12% or 2.9 million fixed meters to 27.2 million fixed meters by 2020. However, this is only successful if the wood use in Austria combines material as well as in energy utilization, and rapid measures are being taken to mobilize the potential, especially in small peasants' forests. To this end, infrastructure in the forestry sector needs to be improved. Investments in the expansion of the forestry network are necessary. The ecological limits must be taken into account when using biomass.

The stock of wood in the Austrian forest has exceeded the billions of fixed meters by the turn of the millennium. A decade later, it has already risen to 1.135 billion cubic meters. At the same time, the public Austrian forestry enterprises expanded their forest areas from 30,000 hectares to 3.99 million hectares.

As a result, Austria's forest share is 47.6%. The Federal Research and Training Center for Forest, Natural Hazards and Landscape (BFW) assumes that even in case of an intensification of use, the supply form the small-scale forest will continue to increase, unless large-scale calamities lead to an overnight stay. The sustainable use of forests is laid down in the Austrian Forestry Act and has been practiced by generational family forestry for several hundred years.

The final energy consumption of bioenergy has increased by almost 43% in Austria from 139 PJ in 2005 to 199 PJ in 2011. With a share of 80.8%, the heat market is the central market for biomass, followed by biofuels with a market share of 11% and green electricity generation from biomass and biogas with an 8.2% share. By 2020, the final consumption of bioenergy could be increased by about 25% to 249 PJ, if the available resource potential can be mobilized. In the year 2020 the heat market with an expected market share of around 77% will be the dominant biomass application area. Biofuels are likely to have a share of 14% and green electricity generation from biomass and biogas a share of 9%.



45. Figure Power consumption

3.3.3. Bratislava

Based on the previous part, it is clear that the region of Bratislava and its 100km radius provides 2 major types of raw materials. First and the bigger one is agricultural products (wheat, barley, corn, colza, sunflower) and second one is wood. The following information is divided into these 2 groups.

Agricultural products

Relevant information about Bratislava region separately could not be found, but the Ministry of Agriculture and Rural Development of the Slovak Republic keeps statistics for the whole region of Slovakia. Since Danubian Lowland is considered to be the most fertile region of Slovakia and the largest area where agricultural products are grown, these information or statistics will give a decent overview of the situation.

Wheat

In 2016, the Statistical Office of the Slovak Republic (SR) registered wheat volumes of 417.7 thousand ha, which was 38.3 thousand ha (by 10.1%) more than in 2015. Farmers in 2016 picked up wheat crops 416.6 thousand ha, which is 38.7 thousand ha more (10.2%) than in 2015.. With an average hectare crop of 5.84 tons, the harvest reached 2 434.2 thousand tons of wheat, which is 352.1 thousand tons more (by 16.9%) in 2016-17 compared to 2015-16 period.

Barley

The definitive data from the Statistical Office of the SR for year 2016 show a barley area of 115,4 thousand ha, which is a year-on-year decrease of 25.3 thousand ha (18.0%). The crop was harvested from 115.0 thousand ha, which is 25.0 thousand ha (17.9%) less than in 2015. The average hectare crop in 2016 was 5.08 tons and increased by 0.30 compared to the previous year

tons (+ 6.3%). The barley yield reached 584.6 thousand tons, which is 84.0 thousand tons (12.6%) less than in the 2015.

Corn

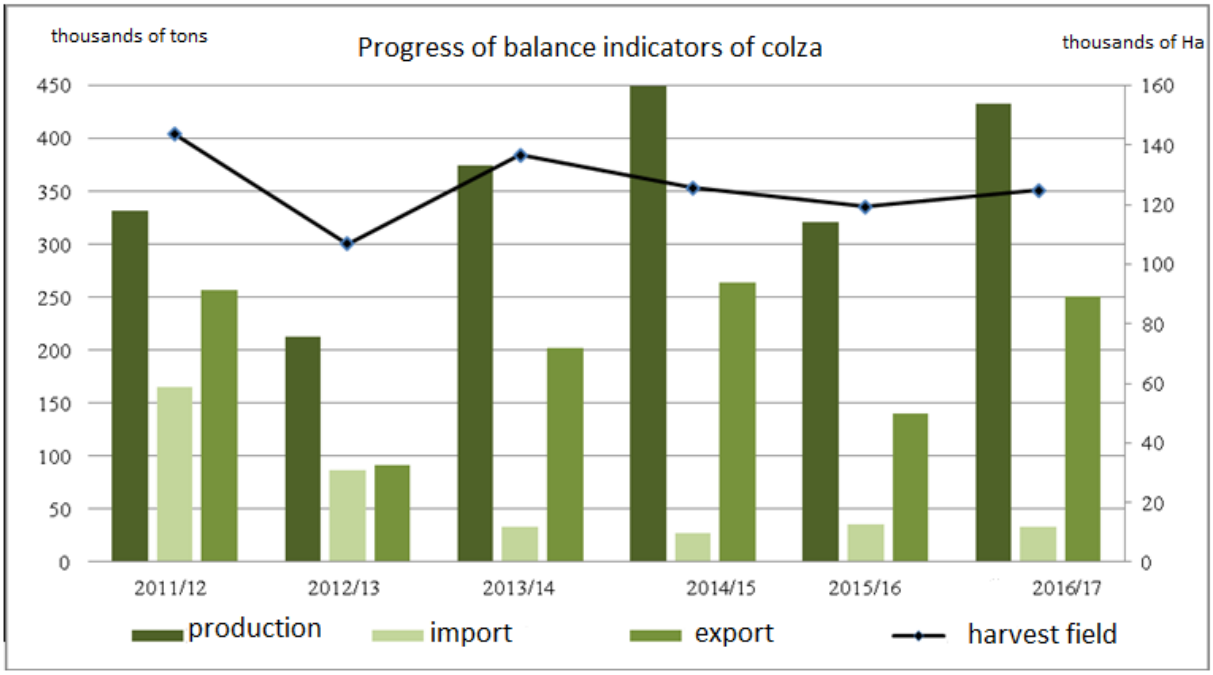
In 2016, the Statistical Office of the SR recorded a production volume of grain maize of 184,4 thousand ha, which was 12.8 thousand ha less (6.5%) than in 2015. Maize was cultivated on 184.8 thousand ha, which was 6.6 thousand ha (3.4%) less than in 2015. Harvest maize in the cultivation year 2016-17 was 1,710.2 thousand tons, which represents a significant increase of 780.9 thousand tons (by 84.0%) compared to the previous season. (http://www.vuepp.sk/dokumenty/komodity/2017/Obilniny06_17.pdf)

Sunflower

The area of the sunflower harvest decreased by 1,189 ha (-1.6%) between 2014 and 2015, the average yield per hectare fell by 0.31 t (-11.8%) and production decreased by 26 407 t (-13.2%). Due to the lower production of sunflower in 2015/16, even with its increased import (+35.8%) the overall supply decreased by 11.1%. Of this, domestic production was 93.4%, which is 2.3 percentage points less than 2014/15. Due to the very low productivity of the processors in Slovakia, 5.7% of the production was processed at home, the rest was exported.

Colza

The area with rape declined for the second consecutive year by 6,264 ha (-5.0%) in 2015. Compared to record production in 2014, production declined in 2015 by 128,232 tons (-28.6%). Similarly, the average yield per hectare decreased compared to the record of 24.6% in 2016. Import of rape increased by 30.6%. The largest volume of rape was imported from the Czech Republic (58.5%) and Austria (18.3%). Rape exports decreased by 46.9%. Most of the rape was exported to Austria (65.8%), Poland (15.8%) and to the Czech Republic (15.1%). Rape production accounted for 89.9% of the total supply of oilseed plant, which results in 4.3 percentage point less than in 2015. Due to the persistent absence of processing capacities of oilseeds, the total supply of rapeseed used at home is 67.6%, of which 3.2% of the rape was used for food and the remainder used for the production of MERA. (methyl of rapeseed oil, used as bio-part of motor fuels) (http://www.vuepp.sk/dokumenty/komodity/2016/Olej10-16.pdf)



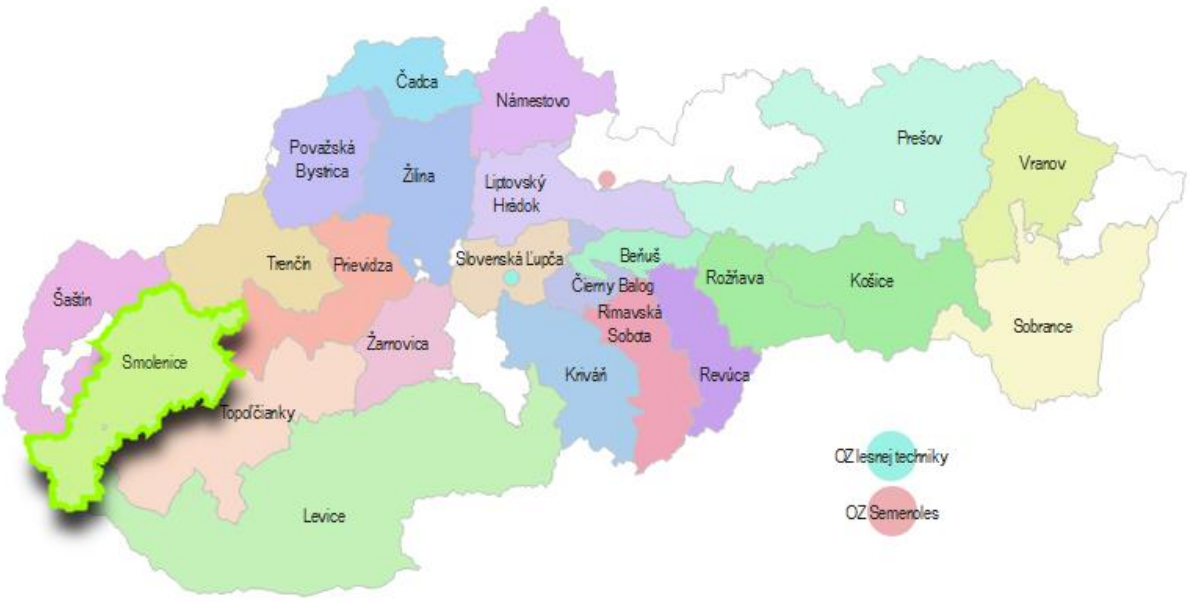
46. Figure Progress of balance indicator of colza

Source: http://www.vuepp.sk/dokumenty/komodity/2016/Olej10-16.pdf

The most frequent trend in biomass production regarding agricultural products would be production of Biofuels. It is a part of plan of European Union that by 2020, motor fuels in Slovakia will have to contain up to ten percent of bio-components (European Reference Regulatory).

Wood

The authority that is in charge of forests of Slovakia is called Forests of the Slovak Republic. The State Enterprise Forests of the Slovak Republic is a state-owned enterprise whose main task is the management of forests and other property owned by the Slovak Republic. In accordance with the Commercial Code, it is an economic organization with the right of permanent business activity, permanent production and trade. (http://www.lesy.sk/showdoc.do?docid=53) Slovak Republic is devided into several smaller regions to manage them. The one that covers the area of Little Carpathians near Bratislava is called Smolenice. At present, Smolenice Spedition Plant is organizationally divided into 6 forest administrations (Bratislava, Pezinok, Pila, Majdan, Dechtice, Moravany nad Vahom).



47. Figure Thick bright green part shows the part of forests where Smolenice Spedition Plant is in charge

Source: http://www.lesy.sk/showdoc.do?docid=1625

The Spedition Plant manages 40,299 hectares of forest land. Of which 31239 ha are owned by the state and 9060 ha are non-state forests. In terms of categories economic forests are 73.2%, protective forests 14.4% and special forests 12.4%. The stock of forest stands is 9,736 mil. m^3 of wood, the annual production of timber is 184 thousand. m^3. The woody composition of forests is very diverse. The most represented species are beech (51%), oak (15%), hornbeam (9%). Coniferous woods provide for a 10% share, of which pine is the most represented (6%).

Table 11: Summary of core information about Smolenice Spedition Plant

Source: lesy.sk; 2012

Basic information about Smolenice Spedition Plant	
Cadastral area	254 304 ha
Forestry	22%
Timber composition	coniferous 10%, deciduous 90%
Amount of forest land in use	40 299 ha
Annual renewal of the forest	165 ha
Costs of annual forest protection	36,40 €
Annual production volume	184,000 m3
Length of forest roads	175 km

At the moment, main competitors of SPaP are companies DDSG (DDSG Blue Danube), UDP (UKRAINIAN DANUBE SHIPPING COMPANY), Navrom, TTS Romania, but also companies providing road and train transport (ZSSK CARGO, Železničná spoločnosť Slovensko a.s., Metrans, Gefco Slovakia a.s.) due to fact that river Danube is placed on southern borderline of Slovakia and

covers 172 km (from 1880,26 rkm –1708,20rkm) while there is high dense network of roads and rail covering the whole country. Another reason is that while shipping goods transnationaly on Danube, transporting at least 1000 tonne of goods or more in one go/one shipment is financially interesting, anything less might not be interesting for customer for this reason: in most cases, if demanded transshipment of goods is less then 1000t, the price would be as if it was 1000t to keep it rentable for SPaP.

3.3.4. Budapest

Forests – trends of solid biomass material production

In the area of Central Hungary, in the 100-km radius of the Freeport of Budapest, there are mountainous, woodland parts especially into the directions of Slovakia and Transdanubia. Egererdő Zrt, Ipoly Erdő Rt, Pilisi Parkerdő Zrt, Vértesi Erdő Zrt, Verga Zrt, Vadex Zrt, Nefag Zrt and Budapesti Erdőgazdaság Zrt are those forests that possibly can contribute to the biomass production in the region.

48. Figure Forestries in the area and agglomeration of Central Hungary
Source: Own editing

In 2012, 7.7 million m^3 of wood was extracted, mostly from Zala, Somogy and Pest counties. Increment, meaning the average annual expansion of total extraction expected in the upcoming 10 years, did not change much; it was 13 million m^3 in 2012. Budapest had the lowest logging rate, i.e. there were only 36% more wood planted than extracted, however Pest county had a ration of approximately 67-77%.

Budapesti Erdőgazdaság Zrt. (Budapest Forestry) is operating on 37 000 hectares in cooperation with the Ministry of Defence. However, while it causes administrative difficulties, to have 10 hubs located in 10 counties across Hungary, it has several logistics advantages.

In the area of Ipoly Erdő Zrt. 22% of wood extracted is by-product. 41% of net wood extraction is firewood, 59% is for industrial use. Industrial processes cause enormous amount of by-product

and waste. By-products are just partially utilized for energetic use. However, 250.000-300.000 tons of waste from wood extraction or processing could be utilized resulting in 90.000 tOE.

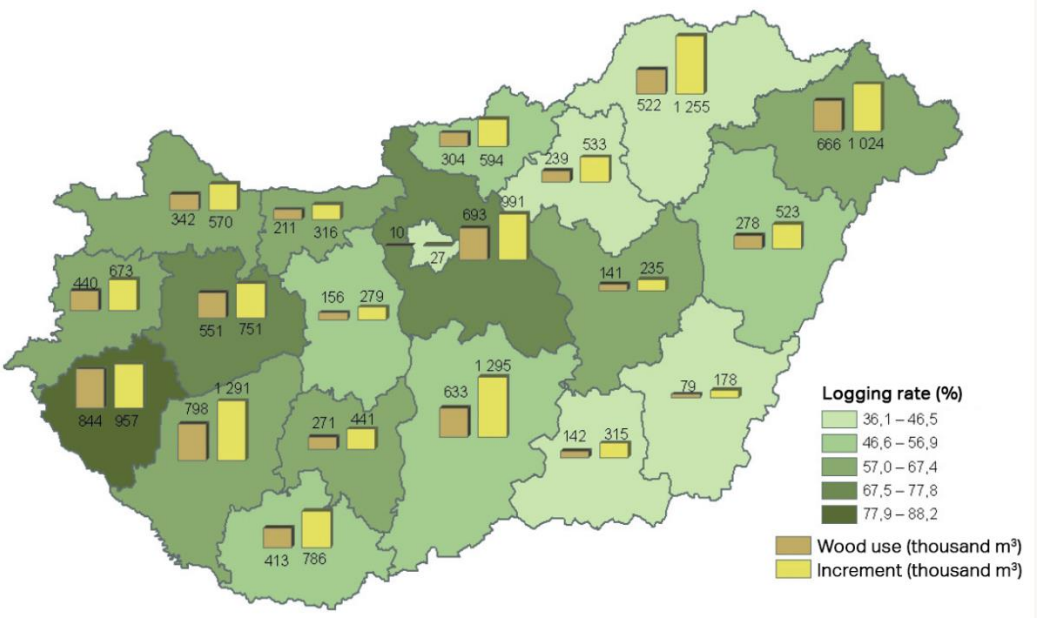
49. Figure Area managed by Pilisi Parkerdő Zrt.

Source: Pilisi Parkerdő Zrt.

Pilisi Parkerdő Zrt. is operating on 117 municipalities amongst which, 16 capital districts. The handled area is approximately 65.000 hectares. 60.000 ha is covered with forests, the rest includes roads, paths and clearing etc. Two thirds of the 3877 ha handled in the capital are on the Buda side, one third is in Pest.

Handled forest area extends beyond the large cohesive forests of Pilis, Visegrád, Buda Hills and Gödöllő hills, along the Pesti and Csepeli plains and the eastern side of Gerecse. As shown on the map forests and parks operated and handled by the company are located by or at least very close to the Danube, providing a great opportunity to bring solid biomass onto the river. Nevertheless, 62% of the forest area is under protection. NATURA 2000 sites affect nearly 65% of the parks of which more than 18.000 ha is special bird protection area.

Vértesi Erdő Zrt. as an umbrella organization including the forests' of Tatabánya, Oroszlány, Csákvár, Pusztavám and Kisbér processes and offers logs made of oak, beech, acacia, hornbeam, ash, cherry, hazel, alder, pine, spruce and larch, although, these are for sale for industrial use and not for biomass utilization..



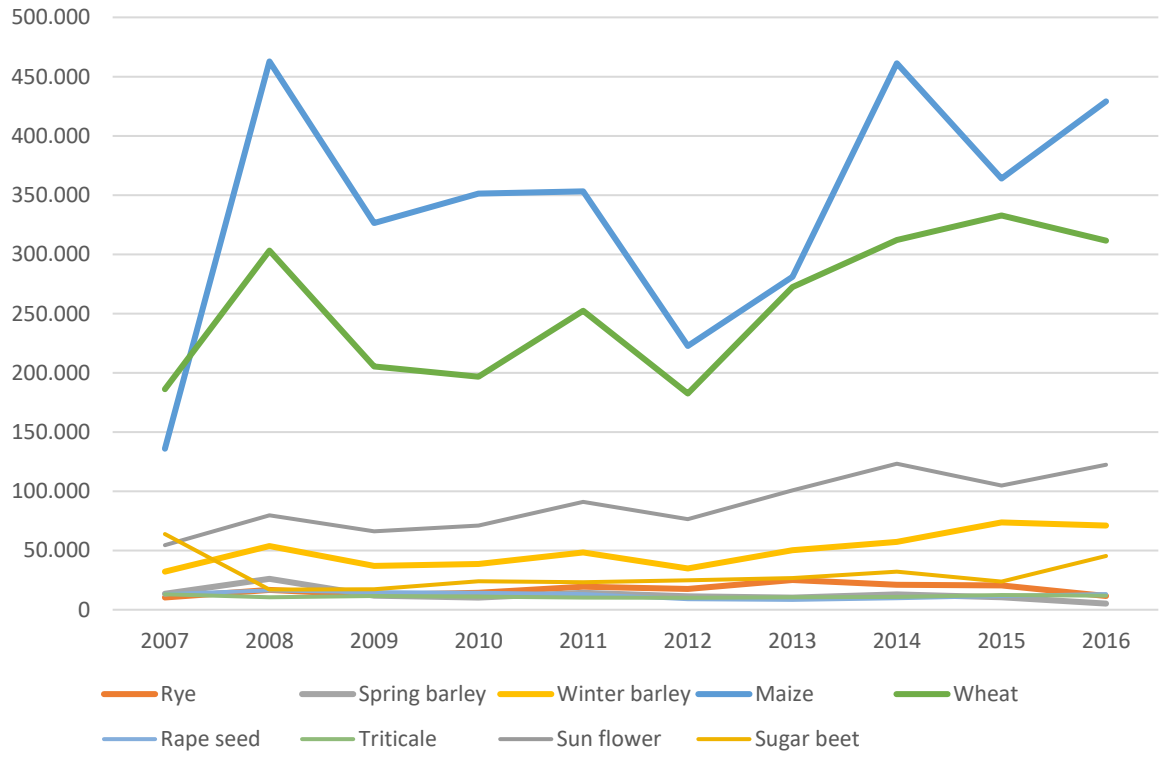
50. Figure Logging, growth, logging rate (2012)

Source: KSH (Central Statistical Office)

To sum up, in Hungary there are 7-7,5 million cubic metre of wood extracted per year out of 9 million m^3 wood grown. Currently, annual firewood extracted is enough for 500.000 households for heating. By improving extraction and utilization of green waste leftover in forests, even 700.000-800.000 households could be supplied.

Agriculture – trends of solid biomass and biofuel material production

Due to the boom and continuous development of biofuel production, the industry also produces a significant amount of biodiesel and bioethanol in Hungary, which supports efficient and environmentally-friendly production and raw material production. Over the past seven to ten years a lot of big investments have been implemented. In Hungary there are many factories producing large quantities: 80% of rape is produced for biodiesel, while about 1.4 million tons of maize are annually processed to bioethanol and are exported to bioethanol production in the order of magnitude. Currently about 5 million tons of maize and 4 million tons of wheat are produced in Europe.[2] To be exact on quantities, different types of cereals harvested in Central Hungary between 2007 are 2016 are presented in the figure below. It shows, that 2012 was a very dry year, but before and since then, there have been quite large amounts harvested. Maize and wheat produced in much bigger amounts than barley, rape seed, triticale, rye, sun flower or sugar beet. Former two are utilized as raw materials when producing biomass energy and biofuel. Third biggest amount is from barley.



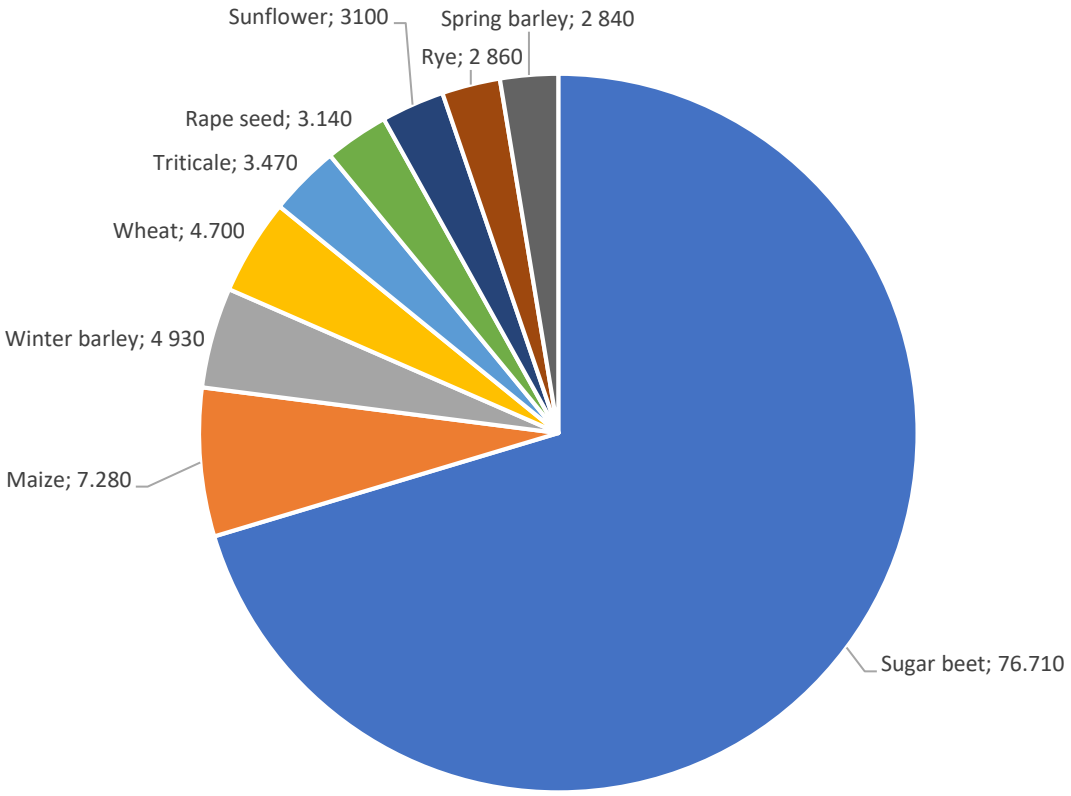
51. Figure Grains harvested in Central-Hungary (ton)

Source: Own editing based on KSH data (Central Statistical Office)

[2] https://www.agrarszektor.hu/agrotechnologia/valtozo_kornyezetben_a_mezogazdasag.7963.html

Among the main oil seeds, the harvested area of sunflower and rape seed also increased since 2016, and both exceeded the previous years. The volume of the former one (1.9 million tons) was 22, the latter (nearly 900.000 tons) was 49% higher than in 2015. Apart from 2014, the efficiency of Hungarian rape seed production has been affected by unfavourable weather (inland water, drought, strong frosts) but in 2016 the conditions were ideal again. The size of the area for producing beet did not change, but in 2016 the yield increased by 18%, which is 1.1 million ton produced. This quantity (67 tons / hectares) was the second largest since the peak of 2014 according to KSH data.

Taking the average yield into consideration, sunflower and sugar beet have potentials in Central-Hungary, as the amounts harvested per hectares exceeded the national level in 2016. Other grains could not reach this level of extraction. The figure below shows exact quantities in kg/ha and rates of different type of grains comparing each other.



52. Figure Average yield of all crops in Central-Hungary in 2016 (kg/ha)

Source: Own editing based on KSH data (Central Statistical Office)

Great amounts of used cooking oil from restaurants, cafeterias collected by specialized companies are an important feedstock for biodiesel production. Annual quantity of used cooking oil in Budapest exceeds hundreds of tons. Nowadays, used cooking oil is collected firstly from big users, but more and more private households are involved into the chain in order to reuse cooking oil. Biofilter Ltd. for instance covering the whole country, is a company specialized on collecting used cooking oil and works in close cooperation with MOL Ltd., which is the greatest Hungarian Oil Company.

Competition

When estimating the raw material base, it is not enough to estimate the quantity of by-products generated in the area, but also what competing markets exists, which can reduce the amount of available raw material. The main areas of utilization of agricultural by-products in Hungary are soil improvement, animal husbandry, power plants, heating plants, bale-fired boilers, paper and biogas plants and pellet plants.

Raw materials for biomass are seasonal goods. So are the agricultural main products. It is recommended not to compete with food supply chain. Furthermore, creating a stable biomass supply chain would support the entire agricultural sector to become less dependent and improve its profitability.

Another restrictive factor for solid biomass suppliers is delivery distance. Due to the characteristics of raw materials such as pellets and chips, they are supposed to be transported for 50-100 km. The only accepted exception is in case of return logistics, when biomass could be delivered from approximately 200 km in order to avoid empty barges navigating on the river. In case of biofuels, it can be a longer distance depending on actual market competition (efficiency, production costs, shipping costs) and on where processing plants purchase their raw materials.

On the other hand, volume weight of biomass being shipped is an important factor. For instance raw materials such as solid wood with high volume weight or logs coming from bigger distances could be profitable, while materials with lower volume weight like chops would not.

As good practice examples across the country, a business model is to set up integrated supply chains by districts (REKK 2009). The purpose of a contracted organization is to coordinate farmers and forests owners to deliver raw materials to bioenergy power plants (e.g. Pannonpower in Pécs, South-West Hungary, with a supply chain in Baranya county and its neighbourhood counties, and Bioenergy power plant in Szakoly, North-East Hungary, with a contributor organization Tisza Association).

The Bureau of Public Health records greenhouse gas (GHG) emissions from biofuel. The register contains data on biomass distributors, processors and fuel distributors and sustainability verification and GHG emission values.

According to the database of companies dealing with biomass, which is ran by the National Food Chain Safety Agency, within the Directorate of Agriculture, there are 81 active companies located in Central-Hungary. Among them, there are 7 biomass processors, 69 biomass dealers and 4 biofuel distributors.

3.3.5. Vukovar

The forest surface area in in the hinterland of the port of Vukovar is given in the table below, and as there are no accurate data on the available biomass at county level, the data were estimated using the data at the level of Croatia, corrected based on the share of forest surface areas in the counties concerned.

Table 12: Assessment of potential available forest biomass in the hinterland of the port of Vukovar

County	Eestimated available forest biomass m^3/year
VUKOVAR-SRIJEM	162,642
BROD-POSAVINA	134,649
OSIJEK-BARANJA	291,011
POŽEGA-SLAVONIA	266,160
VIROVITICA-PODRAVINA	155,782
TOTAL	**1,010,244**

Croatian Forests Inc. as major supplier of forest biomass, as well as smaller suppliers, operate on the territory of all counties in the hinterland of the port of Vukovar:

Vukovar-Srijem County:

- Craft for export, production and cutting wood, Bošnjaci;
- Craft for export wood from the forest Start, Otok;
- Production and export of wood products from forest Kran, Vrbanja;
- Sani Ltd., Tordinci;
- Craft for branching, exporting and selling wood Bibor, Bošnjaci;
- Čandić log exports, Gunja;
- Production and export of wood assortments Nikolić, Drenovci;
- Craft for export of wood assortments Žir, Vrbanja;
- Craft Xylotehna, Vrbanja.

Brod-Posavina County:

- Cutting, processing and exporting of firewood, Petrovo Selo;
- Forestry craft Blaško, Okučani;
- LKT forest services, Sibinj;
- Vukelić forest services and trade, Kujnik;
- Šurkalović forest craft, Nova Gradiška;
- Transport services, Donji Andrijevci;
- Family farm Oljenik, Garčin;
- Craft Paladium, Nova Gradiška;
- Forestry craft Gorje, Cage;
- Forestry craft Kaurić, Brodski Stupnik;
- Forestry craft Holenda, Nova Kapela.

Osijek-Baranja County:

- Čečura transportation, Đakovo;
- Processing, drawing and sale of wood from the forest Samarice, Našice;
- Forest servcies Mirko, Belišće;
- Zeba Holz craft for processing wood, Feričanci;
- Agroeuropa Ltd., Donji Miholjac;

- Dion craft for services of forestry and transport, Beli Manastir.

Požega-Slavonia County:

- Forestry Dilj-Rakiće, Imrijevci;
- Forest Šugić, Pakrac;
- Craft, Kutjevo;
- Kobzinek d.o.o. Brestovac;
- Forestry craft Šapina, Čaglin;
- Forestry craft Grgić, Velika;
- Caffe bar Mario, Brestovac;
- Šah d.o.o., Brestovac.

Virovitica-Podravina County:

- Aero-tec Ltd., Virovitica;
- Drvomercant d.o.o., Slatina;
- Drvopromet, Čačinci;
- Craft Božičković, Voćin;
- Cutting and production of firewood, Nova Bukovica;
- Zoki, Slatina;
- Processing, drawing and sale of wood assortments, Orahovica;
- Forestry Jukić d.o.o., Slatina;
- Forestry Tonc, Mikleuš;
- Wood processing Robert, Virovitica;
- Acer services of forestry, Čačinci;
- Forestry Jerbić, Virovitica;
- Domaći forestry services, Mikleuš;
- Jela Ltd., Slatina;
- Quercus forestry and cutting wood, Lukač;
- Tilija, Slatina;
- Processing and drowing wood, Orahovica;
- Ruda Ltd., Slatina.

The main supplier of forest biomass is Hrvatske šume. It manages more than 80% of forest and forest land in Croatia. Therefore owners of private forests are smaller suppliers which cannot compete with Hrvatske šume. The situation is the same in the area of Slavonia and Baranja. Hrvatske šume also give license to collect wood from the forest. Companies and crafts that have that license are limited by the annual amount (on average 8000 m^3).

According to the Study of the Faculty of Electrical Engineering Osijek, the University of J.J. Strossmayer in Osijek (Ivanović 2013), the largest source of biomass in the agricultural production in Slavonia and Baranja is generated through cultivation of corn and grains, which accounts for more than 80% of the annual quantities of biomass from agriculture, while the larger part of the remaining quantities is accounted for by pruning of fruit trees and vineyards.

Table 13: Annual level of biomass from residues of agricultural production in Slavonia and Baranja

Culture	Biomass from agricultural production (t)
WHEAT	563,000.0
BARLEY	127,000.0
RYE	1,400.0
OATS	33,400.0
CORN (ST.)	1,060,000.0
CORN (COB)	211,900.0
SOYBEAN	190,100.0
SUNFLOWER (ST.)	127,500.0
SUNFLOWER (HEAD)	19,100.0
RAPESEED	71,700.0
TOBACCO	3,200.0
TOTAL	**2,408,300.0**

Table 14: Annual level of estimated biomass from pruning residues in Slavonia and Baranja

Culture	Biomass from pruning residues (t)
FRUIT TREES	13,352
VINEYARD	7,339
TOTAL	**20,691**

Crop biomass is a product of small agricultural households and as such is used in the household where it is produced.

A consolidation of agricultural land would increase a possibility of collecting more quantity of a biomass. Croatia had numerous attempts of consolidation of land but until now all the attempts failed.

According to the last census in 2011 (dzs.hr), and data from the Central Bureau of Statistics in the area of Vukovar port hinterland 34% of the total number of households or 94,879 households owns and cultivates agricultural land (Vukovar County 20.174, Brod-Posavina 18.628, Osijek-Baranja County 30.737, Požega-Slavonia and 10.809 Virovitica 14.531).

For the production of biogas, it has been assumed that the total amount of manure produced on farms in the hinterland would be exploited. The amount of waste from livestock farming, generated on an annual basis, is calculated on the basis of the number of livestock. The potential of this source is theoretical and depends on the method of livestock farming and farm size. The data were summed up using the REPAM project data (door.hr) from 2012.

Table 15: Annual level of estimated manure availability

County	Manure availability (t)
VUKOVAR-SRIJEM	361,904
BROD-POSAVINA	222,587
OSIJEK-BARANJA	596,665
POŽEGA-SLAVONIA	149,225
VIROVITICA-PODRAVINA	186,251
TOTAL	**1,516,632**

According to information provided directly by the Croatian Agricultural Agency in October 2017 manure is produced on the total of 5.381 farms in the hinterland of the port of Vukovar (Vukovar-Srijem County 1.312, Brod-Posavina County 913, Osijek-Baranja County 1.652, Požega-Slavonia County 627 and Virovitica-Podravina County 877). These are small family farms that use their manure fertilizer capacities mainly for their own needs.

Biomass from waste will largely be disposed of through collection and disposal systems in waste disposal centers. It is not advisable to count on these resources for other purposes. According to data provided by utility companies in 2015 approx. 63% of the total municipal waste disposed of is biodegradable.

Since small household boilers are the most widely used type of bioenergy plants in Croatia, the largest part of fuel wood is used for their operation, i.e. for heating the living spaces and preparing hot water in households. In areas that have not been covered by the gas distribution network and where there are no heating plants or district heating, fuel wood is the main source of primary heating. Most of the fuel wood is harvested by cutting forests for energy purposes. Except for heating, large amounts of fuel wood are also used for the purposes of cooking in households due to low fuel wood prices, specific type of food preparation and tradition. According to 2010 data (Šegon-Rajić 2011), approximately 3.5% of total primary energy is obtained from fuel wood. However, regardless of the estimated total consumption at the national level, reliable statistical data for the regional and local level do not exist and are estimated based on the data available from the Central Bureau of Statistics (2017), that contain the number and surface area of households that use wood as the primary source of heating energy. For Slavonia and Baranja, annual consumption is estimated at 1-2 m3 per capita, which amounts to about 1.5 million m^3 per year.

At the level of Croatia, according to Energy Institute Hrvoje Požar – EIHP data, (eihpr.hr), in the period from 2008 to date, a steady increase in biomass exports has been recorded with an annual rate of 25%. Export data at national level are shown in Table 21. Out of total energy exports, biomass accounts for more than 10%, and this almost in the total amount as forest biomass. The trend of biomass imports increased by 32% in the observed period. Given the lack of localized data for the needs of this demand and supply analysis, it will be assumed that national data is applicable to the hinterland of the port of Vukovar.

Considering:

- the trend of continuous annual growth of forest biomass trade exchange with the neighbouring countries, most notably in the Danube River Basin area countries (Austria, Slovenia, Bulgaria, Germany and Serbia),
- the quantities of potential forest biomass shown above,
- the volume of demand on the domestic market as raw materials in the analysis of the production of refined products, as well as,
- forest capacities in the hinterland of the port of Vukovar,

it becomes fully logical to look at the development of the port of Vukovar through further development of the biomass market.

The main competitor Tranzit port in Osijek in the regional area was already mentioned. According to information provided by Port of Osijek and similar to port Vukovar, this port does not transship biomass, although it is equipped for these operations. Analogous to Vukovar, this situation exists because the port is not competitive enough because of a lack of optimal quantities that would render the river transport acceptable in term of prices. Furthermore, the Tranzit port in Osijek and its transships depend highly on the water level of river Drava, which limits operations during the low water season.

As mentioned, truck transport is the most common type of transport used today to export biomass and biomass products from the region of Slavonia and Baranja. Considering present transport of biomass, competitors are mainly recognized in a road transport companies. Two main reasons are that quantities are too small and cost of reloading are avoided by using truck transport.

The road transport companies are mostly small regional companies that are not specialized in biomass transports only. For transportation to smaller distances (up to 10 km) tractor with trailers are used, while trucks are used for transport to medium and longer distances. Reducing overall expenditures like transshipment fee, port due, storage fee and giving opportunity to store higher quantities of biomass would make ports more competitive than the road transportation.

3.4. Conclusion and analysis – key findings

As it turned out, there are various modes of utilization of raw materials among the five countries. In some cases, local market players are not specified on either solid biomass or biogas or biofuel production, rather each of them are represented in the ports' hinterlands. The five ports are different in terms of existing and potential networks of suppliers and partners as well as the depths of connections with them.

Main challenges – nature and politics

What could affect the industry very much are often external factors, besides the hard elements of production and supply chain. Weather is one of these factors. According to many partners, the intensity of productivity varies, hence, the sector could become exposed easily. Therefore, preductabke, sustainable economics in the biomass industry and clear ownership structures with responsibilities in forestry industry and agriculture are crucial.

Further external factors are the EU directives and objectives co-defined by the EU and member states. They declare the importance or necessity of taking biomass raw material production or share of biomass components in fuels onto higher levels. Both natural and political factors have impacts on production.

Main challenges – mobility of regional sources

Partners began to focus on transportability of products in this chapter, since it has a huge impact on the territorial coverage and which areas, which producers should be taken into consideration.

First of all, they observed that once resources are exploited, raw materials and sometimes upgraded products too, stay local and will not become exported. More partners mentioned the importance of mobilization as the key to exploit natural sources in higher volumes, which is the second challenge.

Most of the ports noticed that modal shift must be encouraged, and referred that water infrastructure has to be improved. Reducing truck transport, for biomass exports from the counties of Slavonia and Baranja or the Viennese Region is a major issue.

From another perspective, non-equivalent data sources or lack of information could cause difficulties when discovering potentials in a given hinterland area. SPaP stated for example that there was no statistics available including only the region of Bratislava but only for the whole country. That might become a barrier for attracting stakeholders to enter or improve the market. Second, it will cause issues when searching for patterns and best practices to adapt for same industries in different countries.

4. Supply and demand side for upgraded products

4.1. Objectives of the chapter, methodology

After territorial coverage for port hinterland – including forests and cultivated areas – completed previously, volumes and trends of raw materials harvested were presented. More precise connections of biomass processors and end-users shall have been described. Economic actors forming networks in the biomass energy industry are shown here.

As such, conditions of the existing market of upgraded energy biomass products are presented by naming providers and identifying needs for creating a sustainable, renewable energy based supply system in the region. The analysis was required if there is demand for pellets, wood chips, briquettes, or any other type of biomass that is already processed. Also was required to present (if information was available) who sells what to whom.

The hinterland is a limiting factor but also provides the advantages of geographical closeness. Chapter includes information if ports have any role yet or potentially could take part in the supply chains.

In case there is no market developed surrounding the port, partners shall indicate which actors,what kind of connection between them or what type of products are missing in the ports' hinterland.

Source of information

Each partner port completed its own research by the contribution of port operators in touch with the sector. They were seeking after and contacting with companies, suppliers, distributors, traders, power plants, private and public institutes and buildings that are already or could be key figures of the biomass energy market. If available, volumes supplied and capacities of users in need were collected and presented in this chapter.

4.2. Summary of the surveys

Three out of five countries observed in the national surveys are among the largest pellet producers in the Danube Region. Straubing was the only one declaring that markets of upgraded products are well-developed in its hinterland and by having an entire cluster for biomass energy development and its supply chain; the German port is the strongest and most experienced. PoVi provided the smallest amount of data, but as it turned out, Austria is the fourth biggest pellet producer among the Danube countries. Slovakia has been tending to turn to another sector of the bioenergy industry, namely bioethanol and biofuel production. In comparison, this is not a priority for the other four countries which are moving towards the solid biomass market and supply chain development. Nonetheless partners also did not stress the importance of their biofuel sectors that much; and counted it as one of many activities.

In the hinterland of **Straubing-Sand**, there are developed markets for energetic and material use of upgraded biomass products. Several companies are located in the region processing raw materials and exporting upgraded biomass products for further processing and utilization. ADM Spyck GmbH processes oilseed in its plant with capacities of 700.000 tons of rapeseed and 200.000 tons of soy bean located in the port. Bayernhof Erzeugergemeinschaften Vertriebs GmbH is an umbrella company trading with Bavarian farmers. BayWa AG is a logistics service provider

in the biomass sector. Clariant Produkte GmbH is a cellulose-ethanol producer targeting the biofuel sector. Biofibre produces granulates for biobased plastic compound materials, CASCAT is in industrial and synthetic biotechnology, both are located in the BioCubator within the port area. Other relevant regional companies in the hinterland are wood bricks producer LEPFINGER BADER, wood based viscose fiber producer Kelheim Fibres GmbH and others. Additionally, the headquarter of the Regional Renewable Raw Materials Cluster is located within the port and managed by BioCampus Straubing GmbH (as both an institution and a physical area within the port of Straubing) including the biotechnological faculty of the University of Munich, R&D institutes and organizations.

Vienna has the fourth largest pellet production capacity in the Danube Region with 1.3 million tons after Germany, Romania and Slovakia.

Forests of the Slovak Republic as the main supplier of the region of **Bratislava** exploit 184.000 m^3 timber annually from wood and wood fiber assortments of deciduous and coniferous wood. Wood pellets and briquette sellers are located in the area of Bratislava port e.g. Drevo-Pak, Safira s.r.o., ENZO TUNING s.r.o. trading with woody materials and products, but no exact market has been developed.

In contrary to the other four partners' hinterland, in Slovakia, biofuel production is the largest relevant activity related to the bioenergy industry. Bioethanol production capacity is 145.000 m^3 annually in the country. Enviral founded in 2004 is the first bioethanol producer in the country, delivering to customers by rail. Meroco is a biodiesel and FAME (fatty acid methyl esther) producer company established in 2008. Annual production capacity is 100.000 tons of FAME and 13.000 tons of glycerine. Polnoservis has been operating since 2011. This company deals with oil pressings from rape seed. It is contributing to biodiesel production with a capacity of 85.000 tons.

In the hinterland of **Budapest**, there is a concentration of stakeholders, potential actors of biomass, biofuel producers from the demand, and forestry actors from the supply side. Economical potentials of biomass for energy use and biogas are very good in the capital area. Demand for heating with solid biomass was increasing. Also the use of solid biomass for heating by the public and institutes increased. This trend has stopped due to political reasons taking traditional gas consuming into a better position.

Although, wood from forests is mostly used for industrial and less for bioenergy purposes, the biggest actors in the sector have significant capacities and great infrastructural conditions situated either close to the Freeport of Budapest or the river. Rossi Biofuel is located in Komárom close to the river and close-by to Budapest. It has an annual capacity of 150.000 tons of biodiesel . Zöldolaj BB processes 90.000-100.000 tons of rapeseed of which 39.000 is refined technical vegetable oil and rapeseed oil which is sold for biodiesel production. Pannon Vegetable Oil Production is processing sunflower, rapeseed, soy, bean, corn germ, accessible on the Danube. Pannonia Ethanol in Dunaföldvár processes 450.000 million litre of bioethanol and 325.000 tons of DDGS by using 10.000 tons of corn oil. Among biomass based energy producers, Dorog is accessible on IWW. Additionally sawmills and furniture and construction industry also generate residues and by-products that could be utilized as biomass. Many companies are located by or close to the Danube, hence river transport is possible. District Heating Co. of the Capital will construct and develop 2 biomass based heating plats with 1 MW performance each. Other power plants with mixed-fired basis partly fuelled from biomass have 20-50 MW capacities.

In the hinterland of **Vukovar** are 10 sawmills generating residues from wood processing industry. Their capacity is 326.000 m^3 per year. 3 pellet and 4 wood chip manufacturers are refining 121.600 tons of products annually. 52 companies have the right to exploit forests in the region producing 311.000 m^3 per year. Markets for upgraded products have not been developed yet. More efficient warehousing is needed. Conifers from wood chips, shavings, wood pellets are exported in higher volumes than imported. The majority, of pellet produced annually is exported (88% of 79.040 tons). Reason is that the domestic market is based on households and the demand for plants fuelled by pellets is increasing a bit slowly. However, the Wood Cluster of Slavonian oak including processor companies and several other institutions, towns, development agencies and a technology school was established to serve for sustainability, environment protection and enhance the competitiveness of the forestry and wood industries.

4.3. Chapters from national surveys

4.3.1. Straubing

There is a market in the vicinity of the port of Straubing for upgraded biomass products both for energetic and material use, but not only there. Bio-based products demand, energetic as well as material used, increases and consumers become more aware of these solutions. An appropriate transport link can help the distinguishing of products on an international market. This does not count for raw materials. Upgraded products have a higher value when they get processed in the region and get shipped somewhere else for further processing – examples for this added value creation can be found in the port of Straubing.

Due to the fact that Straubing is the Region of Renewable Raw Materials, many companies specialised in processing of biomass are located in the area. In Deliverable 3.2.1. of project ENERGY BARGE a complete map with all relevant companies is included. Mentioned below are the most important ones for the region.

In the following the biomass-related companies in the Danube port Straubing-Sand are mentioned:

ADM Spyck GmbH, plant Straubing processes oilseeds to produce plant oil (rapeseed and soy) that is further transported by rail to biodiesel plants in the south-west of Germany. They are one of the main customers in the port, with a plant having a capacity of 700.000 t of rape seed per anno and a soy bean processing capacity of around 200.000 t which is being increased currently.

The **Bayernhof Erzeugergemeinschaften Vertriebs GmbH** is a trade organisation for Bavarian farmers. The company deals with the commercialisation of growing and harvesting combinable crops. See Figure 50.

The **BayWa AG** works as a logistics service provider and an agricultural hub. See Figure 50.

The **Clariant Produkte (Deutschland) GmbH** is one of the world's leading companies in the range of specialty chemicals. They operate a demonstration plant in Straubing, where lignocellulosic residue material, mainly straw, is converted to cellulose-ethanol which is primarily targeting the biofuels sector. Clariant also has an office in the BioCubator. See Figure 50.

The DoFu Donaufutter GmbH produces animal feed for pigs, cattle and horses. See Figure 50.

The Mega Tierernährung GmbH & Co. KG produces animal feed for poultry.

The Raiffeisen Straubing GmbH distributes agricultural products and building materials. Furthermore, it acts as a service provider in the transport sector and biomass logistics. See Figure 50.

In the following, biomass-related companies located in the BioCubator are mentioned:

The Biofibre GmbH develops bioplastics which are strengthened with natural fibres based on renewable raw materials. Thereof raw material pellets are produced.

CASCAT is a start-up in the range of industrial and synthetic biotechnology. Their concept is the production of basic and fine chemicals based on renewable raw materials via chemical and biological catalysts.

But also regional companies not directly located in the port play an important role in the market of upgraded biomass products, due to the international demand:

H. Hiendl GmbH & Co. KG, located in Bogen is a producer and service provider in the range of plastics technology. Apart from conventional polymers the company also uses plastics which are strengthened with natural fibres.

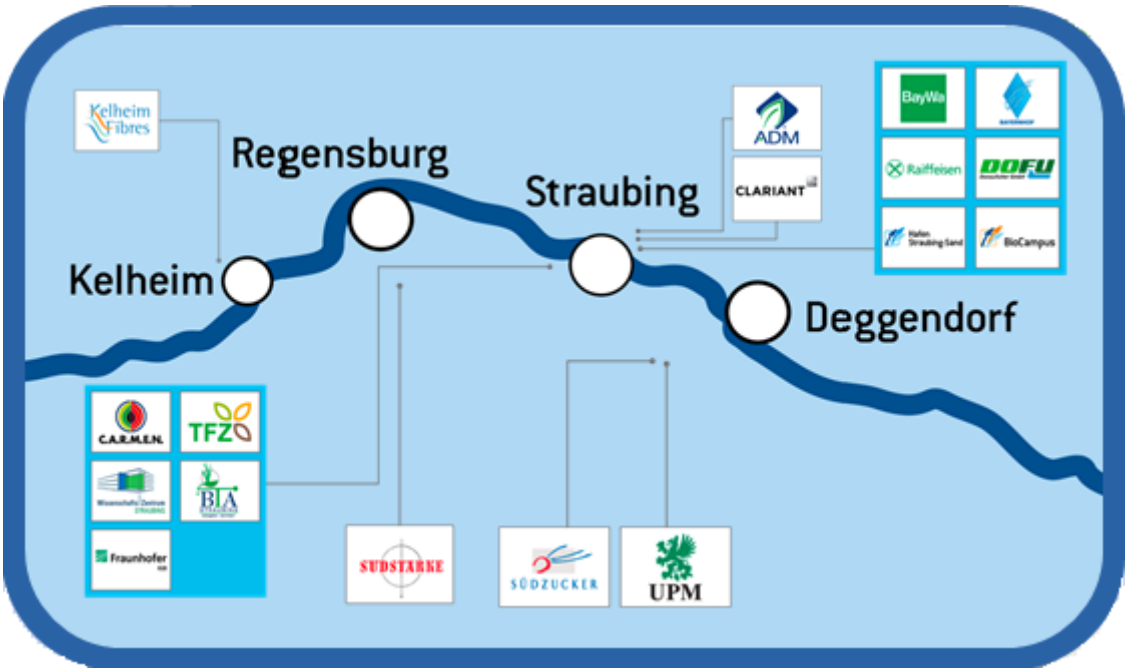
Kelheim Fibres GmbH is a worldwide leading company. The company produces viscose fibres based on wood from a sustainable forestry. These fibres are used in the textile-, health- and technical area as well as for special papers. See Figure 50.

LEIPFINGER BADER usually produces bricks. Recently they invented a new innovation: a brick which is insulated with 100 % natural wood fibres. This helps to generate a pleasant indoor climate. (LEIPFINGER BADER; 2017)

SENSOPOWER create additives for biogas plants, based on plant-based ingredients, which help to optimize the process of fermentation. (SENSOPOWER; 2017)

Südstärke GmbH conducts two factories for potato starch in Bavaria. Next to the starch, the plant also produces starch derivates and distributes by-products like potato protein, pulp, potato water and syrup. See Figure 50.

(If not marked otherwise, all informations are from the cluster partner index of the BioCampus website) (BioCampus; 2017)



53. Figure Main partners of the Renewable Raw Materials Cluster in the region

All companies mentioned above are partners in the Renewable Raw Materials cluster which is managed by the BioCampus Straubing GmbH. Its purpose is to promote cooperation and build networks. Potentials for innovations shall be recognized and used. Thereto cluster not just insists on companies which work with biomass, also businesses along the whole value chain are partners; for example, companies which offer specialised services. Additionally, research and development facilities are cluster partners. Due to the region of Renewable Raw Materials, especially in Straubing a lot of institutions specialized on biomass are located. Straubing is the fourth campus of the Technical University of Munich specialized on biotechnology and sustainability. Students can acquire their Bachelor degree in the study programmes: Chemical Biotechnology, Renewable Raw Materials and technologically and Management-Oriented Business Administration (WZ SR (a); 2017). Master degrees are possible in Biomass Technology and Renewable Raw Materials (WZ SR (b); 2017). Furthermore an institute of the Fraunhofer IGB which does research on biotechnology and bio- and chemo catalysis is settled in Straubing. Further facilities are the TFZ, the Technology and Support Centre which deals with the cultivation and usage of renewable raw materials and C.A.R.M.E.N. e.V. which is a marketing coordination unit. They initiate new technologies and products and advise farmers and consumers on possible applications of biomass and bio-based energy options.

4.3.2. Vienna

Pellet producers in the Danube region

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 million tons in 2008/2009 (without HR, RS, UA, MD).

Table 16: Annual level of estimated manure availability

DE	AT	SK	HU	HR	RS	BG	RO	UA	MD
97	34	20	20	3	8	39	37	38	3

The largest national production capacity has Germany and Romania with 2.6 million tons, followed by Slovakia with 1.4 and Austria with 1.3 million tons.

4.3.3. Bratislava

The biomass industry in Slovakia is not that developed compared to other countries of European Union. However, a functioning market for upgraded products has already been established. When it comes to agricultural products, it was mentioned before that the biggest trend and the biggest use is the production of biofuels.

Companies like Enviral, Meroco and Pol'noservis are the biggest and the most active companies when it comes to turning biomass into biofuels. Enviral was established in 2004 as the first producer of bioethanol in Slovakia. The commercial production of bioethanol was launched in July 2007. Current annual production capacity is 145,000 m^3 of bioethanol. The company's premises are large and aside from the production plant itself there are storage capacities for 1/3 of annual raw material needs. This raw material is delivered using their own railway siding, connected to a rail junction located in Leopoldov, or by trucks. All of the produced bioethanol is delivered to customers by rail, which further decreases the greenhouse gas emissions from transport. The bioethanol production in Enviral is a wasteless process. The plant also operates its own wastewater treatment plant, which ensures the high purity of discharged wastewater. In the wastewater treatment process biogas with high methane content is produced, which is subsequently used to produce steam in their boiler room. The whole process is focused on minimizing electricity and natural gas consumption, enabling the bioethanol produced by Enviral to reach a reduction of greenhouse gas emissions of at least 60%, when compared with the fossil equivalent - gasoline.

Meroco's production of biodiesel suitably complements the portfolio of the group. The production of FAME (Fatty Acid Methyl Esther), known also as biodiesel, has begun in 2008. The annual production capacity is 100,000 tons of FAME and 13,000 tons of glycerol.

The company Pol'noservis launched production in 2011. Its core activity is oil pressing, mainly from rapeseed (with the possibility to use sunflower seed as well) in hot process, and subsequent hexane extraction. Hexane is recovered in the process and reused in the production, which allows for minimal consumption of this agent. The plant is equipped with such technology that causes the least negative effect to the natural environment due to minimum waste and residues generated during the production. The main product is rapeseed oil, with annual production capacity of 85,000 tons. The oil produced by Pol'noservis is used mainly for the production of rapeseed methyl ester (biodiesel) (enviengroup.eu).

In the market with upgraded biomass products based on wood raw materials, the main supplier for the region is the company Forests of the Slovak Republic. The sale of raw wood is a major commodity in the realization of business activities of the state enterprise. The company not only generates income to finance forestry operations but also for other state activities. The company offers wood and wood fiber assortments of deciduous and coniferous wood. (lesy.sk Wood Business 2012) The Annual production volume of timber is 184,000 m^3.

According to energie-portal.sk (2015), there are several companies that sell wood pellets and briquette in the areas close to port of Bratislava.

54. Figure Area of Bratislava port and sellers of pellets and briquettes marked red

Source: Own editing based on information from Google Maps

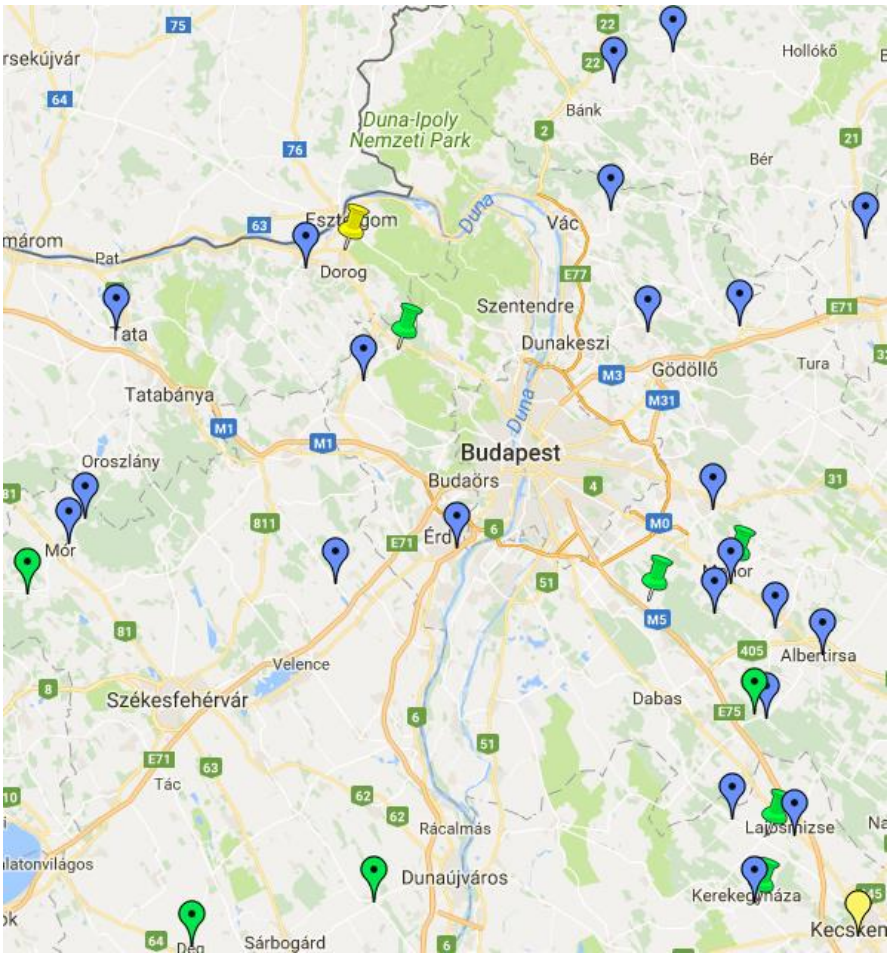
Companies like Drevo-Pak, Safira s.r.o., ENZO TUNING .s.r.o. are traders of woody materials and products and have wood based biomass products such as pellets and briquettes in their sales portfolio.

The port does not include any kind of market for biomass products, whether raw materials or upgraded products. The port in Bratislava is currently not fully equipped for handling biomass. This topic will be addressed in chapter 7 and 9.

4.3.4. Budapest

Concerning the supply and demand side of biomass potentials in the region of the Freeport of Budapest, i.e. mainly in Central Hungary and its area, there is a concentration of stakeholders, potential actors of biomass, biofuel producers and also, forest actors, but there has been still no specific market developed to connect them.

As it was detailed above, wood from forests partially is used for energy purposes; bigger parts for industrial use. Nevertheless, during industrial processes, a large amount of residues and by-products is generated. In 2010, FAGOSZ (National Federation of Forest Industry) surveyed 105 companies with the core activity of wood processing. (This means, that according to KSH there are thousands of wood processors, but only a few hundreds of them have marked that as a core activity.) 60 saw mills of the examined 105, processed hardwood, 44 softwood and 1 is specialized on pine. In 2009-2010 these companies had 3175 employees. There are many wood processing companies registered and or operating in and around Central Hungary, as this map shows below.



55. Figure Sawmills in and around Central Hungary (2010)

Source: fataj.hu

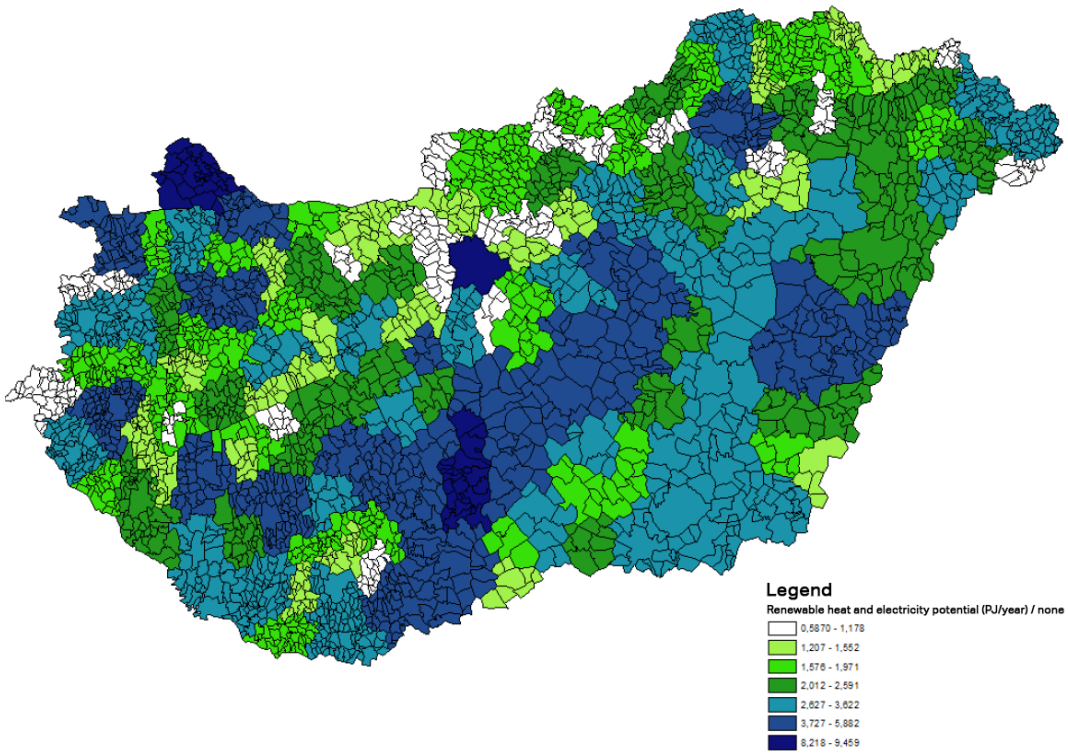
There is a huge potential in utilization of by-products coming from wood industry. Also, as can be seen on the map above, some companies are located close to Danube, so transshipping biomass residues on the river is possible.

General demand for renewable energy and heat sources

According to MTA EK KFL (2015), be it either electricity or heating potential of either biogas or other types of biomasses, Budapest has a huge advantage comparing to the majority of the project countries. In general, renewable heat and electricity potential is approximately 8200-9400 PJ annually in Budapest. In terms of biomass electric and heat economical potential, Győr-Moson-Sopron County, central parts of the Great Plain and the capital are in the best situation, meanwhile regarding biogas, only the capital is.

In recent years, demand for heating with solid biomass increased but traditional gas supply system is well-developed in Hungary: 90% of the country is supplied with traditional gas. Mostly due to security of supply and environmental protection reasons heating by using solid biomass increased, however it has been stopped by 'overhead reduction programme' of the government, taking traditional gas consuming into a better position (Kocsis 2014). Still, solid biomass use for heating inceased by the households and institutes as well. Several municipality offices switched

to biomass based heating systems (using mostly wood chips). According to the plans of District Heating Co. of the Capital (FŐTÁV Zrt.)[3], they will implement significant investments in Budapest: 2 biomass based heating plant will be developed with 1 MW performance each.



56. Figure Renewable heat and electricity potential

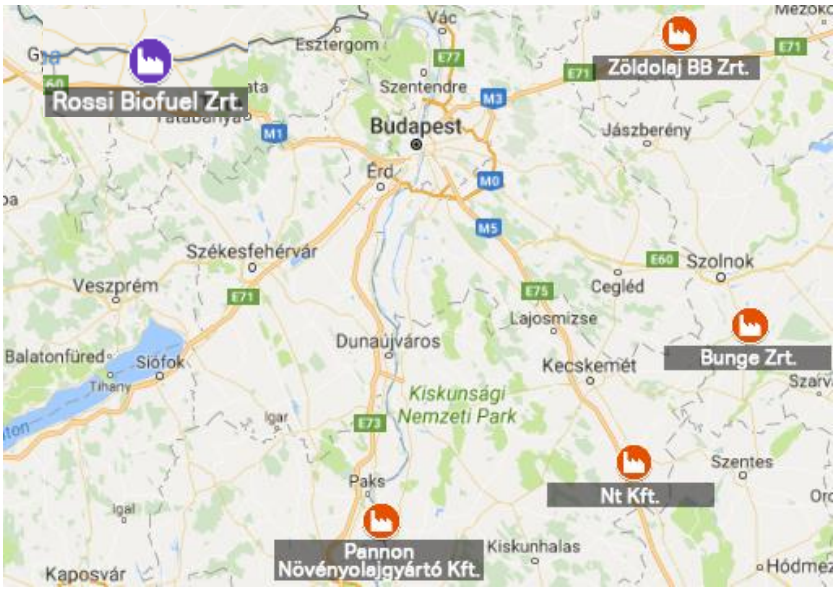
Source: MTA EK KFL (2015)

Demand for biofuel raw materials

Among the two biodiesel producers in Hungary, Rossi Biofuel Zrt. is located close enough to the Freeport of Budapest. However, since its factory is in Komárom, a city by the river, the Freeport of Budapest is accessible on the Danube. Pannon Vegetable Oil Production Kft. with its plant in Foktőclose to the River Danube, in the southern part of Hungary.

Rossi Biofuel Zrt. produces 150 thousand tons of biodiesel annually. Among vegetable oil producer companies, Zöldolaj BB Zrt. has close road connections, but Pannon Vegetable Oil Production Ltd. is reachable on river. even if it is farer from the capital. Zöldolaj BB Zrt. can process 90-100 thousand tons of rapeseed annually, of which 37-39 thousand tons of refined technical vegetable oil and rapeseed oil are produced and sold exclusively for biodiesel production.

[3] Based on the interview in the framework of ENERGY BARGE project 'D4.1.2 – Inventory of potential users of Danube logistics from the bioenergy industry' with József Metzing, senior consultant at FŐTÁV Zrt.

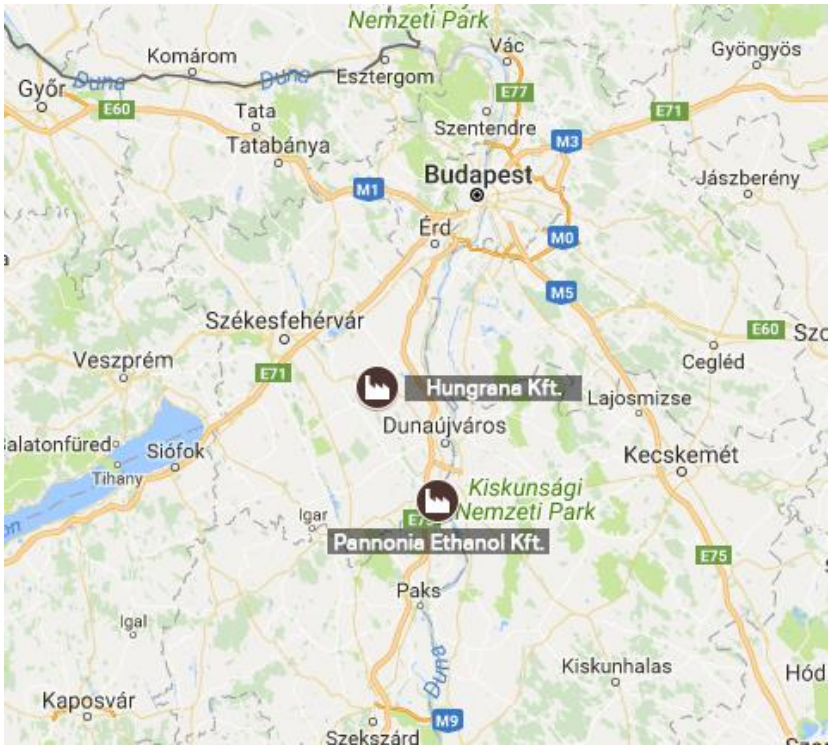


57. Figure Biodiesel (purple) and vegetable oil (orange) producers in Central-Hungary and neighbouring regions

Source: Own editing

Pannon Vegetable Oil Production Kft. in its Foktő Plant processes sunflower seed, rape seed, soy bean, corn germ.

Regarding bioethanol production, both producers in Hungary are located by the River Danube. Hungrana in Szabadegyháza and Pannonia Ethanol in Dunaföldvár could easily transport their materials on the river.



58. Figure Bioethanol plants in Central Hungary and neighbouring regions

Source: Own editing

Pannonia Ethanol utilizes one million ton of corn to produce 10 thousand tons of corn oil, 450 million litre of bioethanol and 325 thousand tons of Dried Distillers Grains with Solubles (DDGS).

Hungrana company uses maize from Hungary only and produces primarily starch, which is an indispensable raw material in many industries (eg food industry, paper industry). The plant utilizes 1 million tons of maize per year, making it the largest and most modern maize processing plant in Europe. In addition to the starch, it also produces isosugar, glucose, alcohols and feedstuffs. Hungara produced the bioethanol fuel called GreenPower E85 for several years, but this production was stopped in 2016, due to the changes in tax regulation in 2011[4] which almost completely inhibited domestic E85 trade (hungrana.hu).

Demand for solid biomass materials

In the radius of Central-Hungary, there are biomass based energy producers in Dorog, Tatabánya, Vértes and Mátra. Only Dorog is more or less close to the river, and since it doubled the renewable-based part in the fuelmix, the plant has been also contributing to sustainable environment and emission reduction. Dorog uses sunflower stalk for biomass firing. Tatabánya ensures heating for 23.000 households and institutions with biomass, by utilizing 150-170 thousand tons of wood chips. The wood is purchased from Vértes Forerstry (Vértesi Erdő Zrt.), meaning it does not make sense to transport it on Danube. Vértes powerplant also utilizes wood chips, straw, and further agricultural by-products in its 30% biomass-based plant.

59. Figure Biomass producers in Central Hungary and neighbouring regions

Source: Own editing

Today, most coal-fired power plants are mixed-fired by supplying some of their fuel to biomass. Biomass heating and power plants operate in several settlements in Hungary (Szigetvár, Mátészalka, Körmend, Szombathely, Sárospatak, Tata, Szentendre, Balassagyarmat, Papkeszi, Pécs, Kazincbarcika, Ajka). Their capacities are between 2-50 MW.

[4] Amendment 4662/87 to amend bill number T / 4662 amending the various tax laws and related laws has increased the excise tax on E85 [bioetanol based fuel] by HUF 70 and VAT too. (parlament.hu)

Table 17: List of power plants in Hungary operating with biomass and their distances from Danube ports

(*Source:* Own editing based on Wikipedia)

Name of power plant	Date of construction	Performance (MW)	Number of blocks, turbines	Performance per unit (MW)	Fuel	Distance on highways from the Freeport of Budapest (km)	Distance on highways from the closest Danube port (km)
Dorogi hőerőmű	1906/1916/1954-1955	3	1	3	lignite, natural gas, biomass	62	52 (Komárom)
Tatabányai Hőerőmű	1950-1954	21	2	17,4	lignite, natural gas, biomass	68	36 (Komárom)
Tatai Távhőszolgáltató Kft.	n.a	9,6-10	1	9,6-10	natural gas, biomass	74	20 (Komárom)
Oroszlányi Hőerőmű	1957-1963	200	4	52	lignite, biomass	81	36 (Komárom)
BC-Erőmű Kft. (Kazincbarcika)	n.a	4-50	n.a	n.a	n.a	232	
Szigetvár	n.a	4-50	n.a	n.a	n.a	230	81 (Mohács)
Körmend	n.a	4-50	n.a	n.a	n.a	230	139 (Győr-Gönyű)
Szombathelyi Távhő	n.a	94	n.a	n.a	n.a	227	112 (Győr-Gönyú)
Sárospatak	n.a	4-50	n.a	n.a	n.a	~271	
Biohő Kft. (Balassagyarmat)	n.a	4-50	n.a	n.a	n.a	~128	
Papkeszi	n.a	4-50	n.a	n.a	n.a	~127	95 (Dunaújváros)
Mátészalka	n.a	5	n.a	n.a	n.a	~302	
Szentendre	n.a	4-50	n.a	n.a	n.a	~38	
Szakolyi Hő- és villamoserőmű	n.a	20	1	20	biomass	~280	
Mátrai Erőmű (Gagarin) (Visonta)	1965-1973	950	5	100, 200	lignite, biomass	121	
Ajkai Hőerőmű	1957-1962	100	3	33	biomass, import black coal	154	136 (Dunaújváros)
Komlói Fűtőerőmű	1950-1952	7	1	7	lignite, natural gas, biomass	206	73 (Baja)
Pécsi Hőerőmű	1955-1966	215	6	23, 30, 50	natural gas, biomass	224	45 (Mohács)

Pellet plants

The pellet production is one potential area for solid biomass. During timber processing and furniture production wood chips and shavings are produced, which can be processed into wood pellets and briquettes. The wood based resources needed to increase production are limited. However, the agricultural by-products that are generated each year on arable land are part of residues that could be base material for the production of agri-pellets.

Table 18: List of pellet plants in Hungary and their used base material (2016)

Source: Examination of Base Materials in Agri-Pellet Production in Hungary (2016)

Company name	Location	Product	Used base material	Amount of used base material (ton/year)
Eko Fire Pellet	Tiszaújváros	Wood pellet	Hardwood, Forestry by-products, Energy plantation	30 000
Jákófa Ipari és Ker. Kft.	Bakonyjákó	Wood pellet, Wood briquette	By-products from sawmills, carpentries	5 000
Vertikál Zrt.	Polgárdi	Wood pellet	Wood industrial and agricultural by-products	1 000
Erdért-Tuzsér Zrt.	Tuzsér	Wood pellet	By-products from sawmills, carpentries	7 000
Németh-Fa Kft.	Lenti	Wood pellet	Wood industrial Wood industrial	1 000
Pannon Pellet Kft.	Belezna	Wood pellet	By-products from sawmills	13 000
Pellet Internat. Kft.	Tiszalök	Wood pellet	By-product of pallet factory	3 500
Pellet Produkt Kft.	Petőháza	Wood pellet	Bark-free pine	6 000
Lenes-Agrofa Cégcsoport	Cegléd, Érsekcsanád	Wood pellet	By-products from sawmills	30 000
Zalaerdő Zrt.	Lenti	Wood pellet	By-products from sawmills	2 000
Hungaropellet Kft.	Lajosmizse	Wood pellet	Wood industrial by-products	80 000
Wood Pellet Kft.	Cegléd	Wood pellet	By-products from sawmills	15 000
Gold Pellet Kft.	Zsira	Wood pellet	*data not available*	*data not available*
Mű-Pellet Zrt.	Kölked	Wood pellet	*data not available*	*data not available*
Pappel-T. Kft.	Szombathely	Wood pellet	*data not available*	*data not available*
Szigetvári P. Kft.	Szigetvár	Wood pellet	*data not available*	*data not available*
T&T Technik Kft.	Szentes	Agripellet	Energy grasses, wheat straw, corn stalk, rape stalk, energy reed	3 600
Agripellet Kft.	Agárd-Pálmajor	Agripellet	Wheat, wheat straw, rape stalk	4 200
Mű-Pellet Zrt.	Kölked	Agripellet	Straw	*data not available*
Agripellet Üzem	Vép	Agripellet	Straw	*data not available*
Gold Brikett Kft.	Jászladány	Agripellet	Straw	4 000
Summary		**Wood pellet**		**194 500**
		Agripellet		**12 000**

4.3.5. Vukovar

Below is data on the number of legal entities for wood processing by counties. For the purposes of this analysis, the respective legal entities represent the potential of the supply of refined products (in particular wood biomass). Residues from the wood processing industry are generated on ten sawmills located in the observed hinterland with the maximum capacities shown in the table below, and three pellets and four wood chip manufacturers are involved in the refining of the products.

Table 19: Sawmills in the region of Slavonia and Baranja

County	Sawmills	Max. capacity (m3/year)
VUKOVAR-SRIJEM	2	50,000
BROD-POSAVINA	1	30,000
OSIJEK-BARANJA	5	161,000
POŽEGA-SLAVONIA	1	50,000
VIROVITICA-PODRAVINA	1	35,000
TOTAL	**10**	**326,000**

Table 20: Pellet and wood chip manufacturers in the region of Slavonia and Baranja

County	Pellet manufacturers	Max. capacity (t/year)	Wood chip manufacturers
VUKOVAR-SRIJEM	2	100,000	1
OSIJEK-BARANJA			3
POŽEGA-SLAVONIA	1	21,600	
TOTAL	**3**	**121,600**	**4**

Table 21: Companies with the right to exploit forests in the region of Slavonia and Baranja

County	Companies with the right to exploit forests	Max. quantity from forests (m3/year)
VUKOVAR-SRIJEM	9	53,000
BROD-POSAVINA	11	80,000
OSIJEK-BARANJA	6	37,000
POŽEGA-SLAVONIA	8	48,000
VIROVITICA-PODRAVINA	18	93,000
TOTAL	**52**	**311,000**

According to the annual energy review of the Ministry of Environment and Energy (2015) Energy in Croatia, the utilization of the pellet production capacities is about 65% and the total production according to the data of 2013 at the level of Croatia was 181,568 tons.

By localizing the data, the estimated quantity of pellet production amounts to 79,040 tons per year. Of the total production of pellets, 88% was launched on foreign markets while the rest was used domestically.

Domestic demand for refined products is largely accounted for by households. Although most biomass in households is used in old and non-economic plants, according to the data at the level of the Republic of Croatia the demand for plants, primarily those fueled by pellets, is steadily increasing. This increase is the result of the co-financing program for the procurement of small heating and hot water installations for households and public institutions (fzoeu.hr). Demand at the hinterland level of the port of Vukovar or localized demand for refined products is not recorded in the data available.

The existence of the potential of the hinterland market of the port of Vukovar is also apparent from the work of the Wood Cluster of Slavonian oak made by wood processing companies (23 companies) and institutions including Vukovar-Srijem County, Vinkovci and Otok Towns, Andrijaševci and Privlaka, two development agencies and Vinkovci Wood Technology School (source from Slavonski hrast). The cluster aims at encouraging sustainable development, environmental protection and enhancing the competitiveness of forestry and wood industries with more efficient use of valuable Slavonian oak and other tree species.

Among the most important products of the cluster is veneer, parquet of all kinds, furniture and construction joinery, barrels, wooden houses and wood bioenergy. The cluster gathers all important stakeholders in the field of forestry and wood processing, and is linked to the Spačva pool with the largest oak forest in Europe. Within the cluster are Spačva Ltd. as the largest Croatian manufacturer of veneers, and Šišarka Ltd. as the largest Croatian pellet producer. A member of the cluster is also Alpi Aviation from Italy that uses wood in the manufacturing of light aircraft.

According to the Catalogue of the wood industry in Croatia (Croatian Chamber of Economy 2016) there are 46 furniture manufacturers and 24 manufacturers of wood for construction.

Due to the unavailability of import and export data for the Slavonia and Baranja region, an overview of imports and exports at the level of the Republic of Croatia is provided below.

Table 22: Export of refined products from the Republic of Croatia

Source: Central Bureau of Statistics

Name / Country	Export 2016 (t)	Export 2016 (EUR)
Conifers in form of wood chips, shavings	**48,430**	**2,028,690**
Austria	912	22,358
Germany	588	114,728
Hungary	9,181	358,395
Italy	21,353	892,624
Slovenia	16,396	640,585
Wood in form of chips, shavings and like	**321,785**	**14,980,563**
Austria	71,910	3,648,043
Bosnia and Herzegovina	18	10,735
Belgium	0	11
Germany	8	13,362
Hungary	110,133	4,023,756
Italy	22,609	994,564
Slovenia	117,107	6,290,092
Wood pellets	**235,925**	**34,225,855**
Austria	4,880	716,736
Bosnia and Herzegovina	25	3,681
Bulgaria	222	32,952
Switzerland	25	5.045
Germany	170	23,617
Denmark	873	139,157

Name / Country	Export 2016 (t)	Export 2016 (EUR)
Spain	66	8,834
France	3	705
Hong-Kong	24	3,034
Hungary	228	28,934
Italy	206,897	30,169,098
Latvia	24	3.427
Macedonja	16	2,523
Romania	6,702	904,273
Slovenia	13,381	1,844,723
Slovakia	221	36,208
Kosovo	24	3,454
Serbia	2,144	299,454

Table 23: Import of refined products in the Republic of Croatia

Name / Country	Import 2016 (t)	Import 2016 (EUR)
Conifers in form of wood chips, shavings	**17,107**	**849,599**
Austria	73	34,018
Bosnia and Herzegovina	136	13,967
Germany	1	385
United Kingdom	1	1,116
Italy	11	5,236
Netherlands	3	1,276
Slovenia	16,882	793,601
Wood in form of chips, shavings and like	**6.373**	**345,880**
Austria	103	42,732
Bosnia and Herzegovina	24	3,971

Name / Country	Import 2016 (t)	Import 2016 (EUR)
Belgium	0	273
Czech Republic	0	65
Germany	54	22,233
France	1	7,072
Hungary	1	461
Italy	2	9,610
The Netherlands	0	37
Poland	6	2,830
Slovenia	6,182	256,596
Wood pellets	**13,838**	**1,964,574**
Austria	287	53.468
Bosnia and Herzegovina	12,476	1,654,379
Belgium	0	148
Czech Republic	36	6,833
Germany	112	93,995
Italy	59	10,656
The Netherlands	0	222
Poland	2	2,707
Romania	0	47
Slovenia	609	102,439
Serbia	256	39,680

Considering its potentials, the market for the upgraded products of the port hinterland is still not developed enough. But analysing data from the past few years (dzs.hr) it is obvious that the market is growing yearly. Domestic demand for upgraded products and its steadily increase each year (mostly due to the co-financing programs: Program for energy renewal of family houses; Program of energy renewal of public institutions; Program of energy renewal of condo buildings; Program of energy renewal of commercial buildings by the Environmental Protection and Energy Efficiency Fund, fzoeu.hr) as well as increase of export (mostly pellets) are clear indicators of future development of the supply side as well. Consolidation of the quantities of raw material as

well as opportunity for more efficient storage would make those indicators even more representative. Collecting and processing higher quantities of raw materials, as well as importing biomass would contribute the port to better utilize its capacities and increase its overall transhipment. Therefore, the market of upgraded biomass products, as well as the biomass market, with its potentials, is expected to continue to grow.

4.4. Conclusion and analysis – key findings

Regarding the demand and supply side of upgraded energy biomass products, none of the five ports is in bad condition. There are large agriculturally cultivated areas and forests nearby, and high volumes are exploited. Many economic actors are located in the ports' hinterlands to process raw materials coming from natural resources and several biomass energy producers supply their clients with heat and electricity be them just a few institutes and households or entire neighbourhoods and districts in Bavaria, the Viennese Region, Central-Hungary and Transdanubia.

Even if a lot of biomass materials are exploited and high volumes are processed, markets of upgraded products are not developed yet in cases of hinterlands of Bratislava, Budapest and Vukovar. Latter one noticed, that Croatia produces so much pellets, 88% is for export markets. On the Austrian wood market there is an oversupply. Unbalanced national markets (with over or undersupply of raw materials) means a lot of potentials for the ports of the other countries as it will be discussed in detail under the conclusions of chapter 8.

The share of IWW transport should be increased at biomass exports. A core challenge is diverting truck transport from road to vessels on the Danube. Many biomass raw material producers, high-end service providers in the bioenergy sector are located within the regions of the ports. However, truck transport is the most flexible and profitable way of delivery on local level. None of the partners in this document elaborated on the possibility to exchange materials and upgraded products with each other. Therefore, modal shift from road to the Danube shall be facilitated in terms of international exchange, to sell residues on export markets.

International trade would this way contribute to local economic development and improvement of regional energy biomass supply systems. There are many fields, e.g. technological and political elements, knowledge transfer etc. that should be improved regionally to serve local biomass energy markets and supply chains. However market players on the demand side in Slovakia, Central-Hungary and Slavonia and Baranja regions have not started cooperating efficiently.

5. Links with the bioenergy sector – demand side.

5.1. Objectives of the chapter, methodology

The aim of the research behind this chapter was to discover opportunities that can improve the supply chain of biomass products. Current and possible future networks of biomass processors including e.g. power plants and distributors shall have been described in the following identifying logistics core points where the ports could enter and facilitate the supply chain.

It also shall have been presented in this chapter

- where demand side actors from the the bioenergy sector are located,
- how much of the biomass raw materials they need for what volume of performance,
- how ports could contribute to higher level of services in the biomass energy supply in case connections currently are weak,
- if traders are involved between processors and the ports, or if they have direct connections to each other.

If possible, connections and locations shall have been shown on maps and photos.

Source of information

The five ports completed this chapter by presenting existing partnerships between their port operators and stakeholders of the bioenergy sector. Additionally, they contacted with the relevant companies, distributors, power plants and other users and processors of biomass raw materials in the hinterland in order to form and develop business relations to improve the supply chain of biomass products.

5.2. Summary of the surveys

With different comprehensiveness partner ports provided information on performances of power plants and processors in their hinterlands. However, it is unquestionable, that most of them have a in good positions with a diverse mix of stakeholders surrounding them. All in all, Bratislava, Budapest and Vukovar must work extremely hard on developing networks in this new market by convincing regional economic actors that ports have to be part of the relevant supply chains.

Villages and public buildings are supplied, heated and electrified with biomass in the hinterland of **Straubing**. Though there is not overall design in the process: networks, links, connections built on previous projects and work on an ad hoc base. As long as bioenergy appliances use regional feedstock in relatively low volumes, it is not recommendable to transfer biomass on river.

Fortunately, the most important clients are settled in the port, and are processing or trading biomass in large quantity of feedstock which go directly or indirectly into the bioenergy sector. ZVH and the BioCampus have close connections to ADM Spyck GmbH, producing biodiesel from rapeseed and soy beans, and Clariant Produkte Deutschland GmbH in the bioethanol sector processing agricultural residues and straws.

The following distributors, traders are important actors too. BayWa AG brings maize slop as residue from Hungary. Bayernhof Erzeugergemeinshaften Vertriebs GmbH and Raiffeisen Straubing GmbH deal mainly with agricultural trade. TTW Waldpflege GmbH deals with energy wood, pellets, chips and transports round wood from Straubing to Austrian sawmills. There are

many more logistic companies which are either members of or in contact with the renewable raw materials cluster and its wide network of biomass and bioenergy experts.

Port of Albern in **Vienna** is the biggest round timber supplier and in touch with biomass power plant located at Simmering. Although, Simmering power plant refers its biomass from all over Austria and transports it to the capital mostly on road. State-owned companies do not use IWW for transporting, however there are 3 biomass power plants in the Viennese Region.

Core business in the port's hinterland is wood supply by creating sawn timber to biomass, large deliveries of abrasive and pulpwood processed for the pulp and paper industry. 80% of timber sold is conifers, 20% is hardwood used as raw materials in domestic sawmills. Wood chips and biomass wastes generated in sawmills for instance are used for energy production without harming forests.

The strategic approach in Austria goes beyond the provision of raw materials for generating electricity and heat. Wien Energie Bundesforste Biomass Kraftwerk GmbH & Co KG developed a sustainable energy partnership with Wien Energie and Fernwarme Wien and as a result, biomass power plants provide electricity and heat from forest biomass for dozens of thousands of households in Vienna.

Purkersdorf heating plant also contributes to cutting emissions and saving money by having more than 20 large buildings (schools, medical centres, residential buildings) connected to the supply network, including 300 apartments. Energy forms that are in use: biomass, natural gas, solar power.

On the other hand, Austrian market is full of wood. Import is not needed from long distance and power plants use local raw materials and locally upgraded products. As long as too much wood is available in Austria, biomass price decreases year by year making inland waterway transport less and less profitable. However, the Green Electricity Act (Bundeskanzleramt Rechtsinformationssystem 2012) will promote generation of electricity and heat from biomass but only from 2019, because of that the entire market is unpredictable till applying the act.

Bratislava port is not linked within the bioenergy sector which has more reasons. Using wood chips, agricultural products, heat distribution and biofuel production are the only forms of biomass utilization in the 100 km radius of Bratislava port. The two biggest users in the region are Slovenské Elektrárne a.s. and Envien group. The previous one deals with biomass co-combustion in Vojany Power Plant since 2009 and Nováky Power Plant since 2011. However, they are big actors on the market, and also, dedicated to a sustainable environment by reducing CO_2 emission, but both not within reach of the 100 km radius, making it port difficult to link with the port. Even though, there are no other power plants closer to the port yet, Vojany started to expand by evaluating the possibility to co-fire biomass up to 20%.

There is a chance to establish links with IWW companies like Slovak shipping and ports towards green logistics, but in case smaller companies and biogas stations operate on a local basis, they will not be supplied from the river since the Slovak Danube section is quite short. International cooperation must be further developed.

The Freeport of **Budapest** has no connection yet with the bioenergy sector. However, by developing a new logistics hub that provides services such as wood and agricultural by-product processing, the port could become a local distributor of solid biomass energy for public and private institutes. Demand for firewood and solid biomass is significant in Central-Hungary too.

In the framework of calls for proposals (palyazat.gov.hu/tamogatott_projektkereso) under the Environment and Energy Efficiency Operational Programme, hundreds of projects have been granted across the country facilitating hospitals, health care institutes, educational institutes, ministries and bureaus, sport centres, town halls, public spaces to switch from fossil to renewable (among others: biomass-based) energy and heating systems. These could be main clients supplied by the port, meanwhile boiler constructor companies and District Heating Co. of the capital could be key partners too in order to develop a renewable energy supply chain in Central-Hungary.

In **Croatia**, legislation regulates quotas (Official Gazette NN 100/15) incentivizing generation of electricity from renewable energy sources. Therefore, more and more biomass power plants enter into multi-year agreements on biomass supply with Hrvatske sume, a state-owned and the country's biggest forestry company exploiting natural resources of biomass from Croatian woods. Currently, in the 5 counties under the national survey there are 89 power plants operating or under construction, out of which 49 are or will be using biomass, while 40 are or will be using biogas to produce electricity and heat. Hrvatske sume supplies wood biomass for many of them. 800.000 tons of wood mass for cogeneration plants is provided annually. The market will continue growing towards more export and further processing. The number of energy producers using renewable sources and their connection to the national grid increases every year.

The 49 plants using or planning to use biomass presently generate more than 87.000 MW electric power and 96.000 MW heating power. 40 biogas based plants on the other hand generate 53.000 MW electric and 16.000 MW heating power. 7 biomass and 11 biogas plants concluded power purchase agreements for the national grid by entering into agreements to become eligible electricity producers.

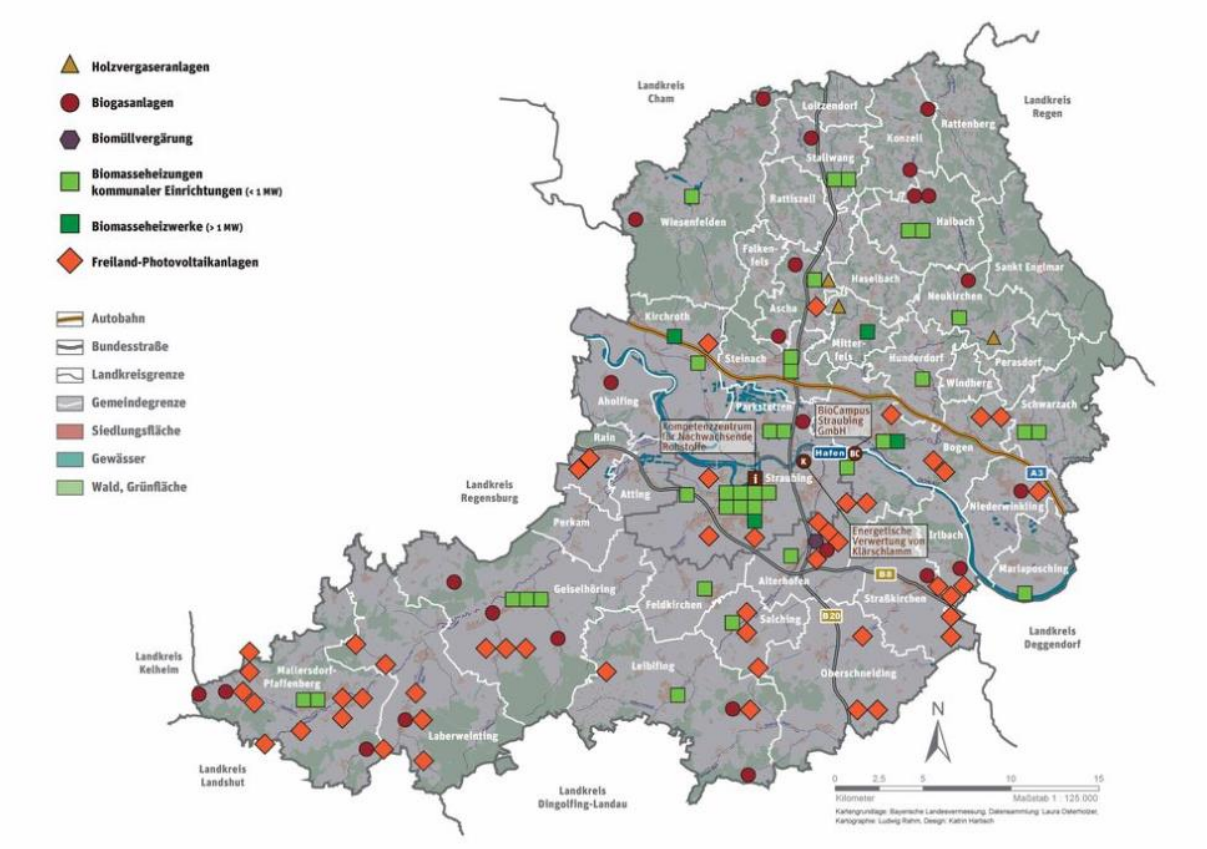
The Environment Operational Program in Croatia led use of renewable energy sources has risen. Biomass products are supplied and delivered for private and public utilization, to family houses, residential buildings, public sector buildings, educational institutions, etc.

The network is well-developed including raw material producers, upgraded biomass processors, distributors and end-users which is very positive, even if biomass energy market is affected by the State (since having a sector depending on the State that much is not healthy in general). The only problem here is that Vukovar port has no connection with power plants and distributors, as long as power plants use domestic, locally available raw materials which do not require to be transported for long distances.

5.3. Chapters from national surveys

5.3.1. Straubing

As has become visible in the chapters above, the port of Straubing is located in an area with an already sharp profile on bio-based industries. The region itself was one of Germany's "bioenergy regions" for a project runtime of five years. In the surrounding region, there are numerous, especially decentral bioenergy appliances, e.g. biomass heating plants supplying villages and public buildings with heat and sometimes also electricity or biogas plants, as shown below.



60. Figure The different bioenergy appliances in the administrative district of Straubing, surrounding the port

Source: Bioenergieregion Straubing-Bogen, 2015

The managing authorities of the port have indirect access to those decentral bioenergy appliances in the region through the administrative district's authorities that have organized the project "bioenergy region Straubing-Bogen". These connections have been used in the past already for several projects, but are only activated on occasion. However, the majority of these bioenergy appliances use regional feedstocks in comparatively small quantities and thus do not depict the classic potential customers for inland waterway transport.

Nevertheless, the most important clients settled in the port are processing or trading biomass – with a comparatively large quantity of feedstock going directly or indirectly into the bioenergy sector. The ZVH and the BioCampus have close connections to these companies.

The companies directly processing biomass for the bioenergy sector settled in the port are:

- ADM Spyck GmbH
    - Feedstock: Rapeseed & soy beans; intermediary product processed in port: Vegetable oil; Final bioenergy product: biodiesel (processed in Southwest Germany); other final products: food & feed, technical lubricants, R&D for vegetable oil utilization; currently using the port in a trimodal manner

- Clariant Produkte Deutschland GmbH
    - Feedstock: lignocellulosic agricultural residue material, mainly straw, however in demonstration scope (2.000 t of product p.a.); final bioenergy product: bioethanol for blends in biofuels; can also be used as platform chemical for chemical industry

The companies trading biomass feedstock or products/intermediaries with potential for the bioenergy sector or offering services for the bioenergy sector are:

- BayWa AG trading centre; mainly trade, also bioenergy market (e.g. receiving maize slop as residue material from Hungarian biogas plants via ship for further trading into feed industry, e.g. for the production plant of the DoFu animal feed plant located in the port of Straubing)

- Bayernhof Erzeugergemeinschaften Vertriebs GmbH, mainly agricultural trade

- The Raiffeisen Straubing GmbH, mainly agricultural trade

- TTW Waldpflege GmbH, Service provider for forest owners with own branch for energy wood products such as chips and pellets; occasional use of inland waterway transport to ship round wood from Straubing to Austrian saw mills (Enns)

Additionally, there are several logistics providers located in the port that can offer logistics and handling services for all kinds of biomass intermediaries and products.

Also, the managing authorities of the port of Straubing have access to a broad network of biomass and bioenergy experts both from the business landscape and the research landscape via their cluster network “Straubing Region of Renewable Raw materials”.

Besides these already existing connections and infrastructure, the strategic goal of the port of Straubing is to further extend and diversify the biomass freight being transshipped in the port, not only for energetic, but also for chemical-material purposes – mainly by settling companies using and processing these kinds of feedstock in the port. To do so, a specific business development strategy and active customer acquisition are part of the port management and shall be further strengthened in the following years.

However, the strategy to develop the Danube port in Straubing into a biomass and bioenergy hub has to be built on a second pillar besides the pillar of settling companies active along the value chain of biomass and bioenergy that could use the waterway as a logistics axis. This second pillar should be the direct generation of bioenergy on the port premises to fuel port superstructure or port settlers – this could either be done by the port authorities themselves, depending on the needs assessed, or a third company that uses the advantages available in the port area, as it is the case for example in the port of Aschaffenburg where a biomass power plant is run by the local public energy supplying company directly in the port. Ideally, the feedstock used there could either be provided via the waterway or utilized from waste/residue streams that occur in the processing industries settled in or near the port.

In the port of Straubing itself, there is currently no utility using biomass for direct generation of energy (heat and/or electricity), but there would be feedstock available that is currently not used for value-creation purposes. Ideas to tap this potential and increase the circular and environmentally friendly utilization of biomass feedstock for energetic and material purposes and which also increase the environmental performance of the port itself, are existing. These ideas are laid out below. Their viability and feasibility shall be assessed in the ENERGY BARGE feasibility studies.

5.3.2. Vienna

One of the biggest round timber suppliers of Austria is located at the port of Albern. It also supplies the biomass power plant in Simmering. It has access to biomass from all over Austria and transports it to Vienna, mainly by road. Both are state owned companies. Unfortunately, they do not use the inland waterways. There are 3 Biomass power plants located in the Vienna Region. .

Their CORE BUSINESS

The Bundesforste offer the right wood supply for every customer: from sawn timber to biomass, to large deliveries of abrasive and pulpwood for the pulp and paper industry.

About 80 percent of the timber sold is conifers, the other is hardwood. Spruce and sawn roundwood is the main branch of the Austrian Federal Forestry, which is mainly processed by domestic sawmills.

Development

Energy from growing raw materials: As Austria's largest supplier of renewable resources, it is the special responsibility of the Austrian Federal Ministry of Agriculture to make an active contribution to the use of forest biomass. In doing so, the strategic approach goes beyond the pure provision of the raw material for electricity and heat generation. With the founding of "Wien Energie Bundesforste Biomass Kraftwerk GmbH & Co KG" in May 2004, an important foundation stone for a sustainable energy partnership was laid. Together with "Wien Energie" and "Fernwärme Wien", the biomass power plant provides electricity and heat from forest biomass for about 48,000 Viennese households. The operation of the Simmering biomass power plant alone reduces the CO2 input to the atmosphere by around 144,000 tons per year.

The Simmering forest biomass power plant converts wood chips into energy – without harming any forests. This is because wood chips are waste produced when cultivating forests. Solid biomass currently covers almost four percent of Austria’s electricity needs. Around seven percent of this comes from Simmering. The Simmering biomass power plant saves around 144,000 tons of carbon dioxide every year. This is made possible by the use of highly effective co-generation technology, which enables electricity and heating to be produced at the same time and makes the best use of wood as a fuel. This power plant has been supplying around 41,000 households in Vienna with electricity and 17,000 with district heating since 2006. The biomass power plant in Simmering is supplied from a radius of 100 km. 30% of the wood in Wienerwald is enough for supplying the power plant, 70% is purchased.

The Purkersdorf communal heating network is always ideally adjusted for continued operations and peak loads. A variety of different energy forms is used such as biomass, natural gas and solar power, cutting emissions and saving money. In total, more than 20 large buildings including schools, medical centers and residential buildings are connected to the network, as well as almost 300 apartments. The heating plant was built right next to the Trumau waste water treatment plant. Using residual heat, it removes water from the sewage sludge, slashing its water content from 70 to 20 percent. This means around 1,000 tons less weight every year, thereby significantly reducing the costs associated with its disposal.

However, there is one big problem, there is enough wood on the Austrian market and an import from other countries connected with the transport is not profitable yet. In addition, there is a Green Electricity Act in Austria (Bundeskanzleramt Rechtsinformationssystem 2012), which promotes the generation of electricity and heat with biomass. This law comes into force only in 2019 and therefore the entire market and how it will be affected by the law are unpredictable. However, a power plant is only promoted if the biomass is provided within a radius of 60 kilometers – i.e. Wienerwald – according to the Green Electricity Act (Bundesrecht konsolidiert 2012).

Examples below show that the Port of Vienna has the potential to create a better logistics route for both groups of actors, creating an efficient link between wood suppliers and power plants.

Example:

At the moment the transport takes place by truck, about 95%. There was an attempt to transport biomass by ship from Romania to Vienna. At that time this transport was profitable, since the wood from Romania was much cheaper than the domestic one. We do have a perfectly working logistics chain with the inland waterways, but the wood import is nowadays not profitable anymore, cause of the cheap domestic wood price.

The port of Vienna can start another try of transporting the biomass to the power plant Simmering and Baden by ship.

Example

EVN Lower Austria:

The maximum biomass ratio for procurement is approx. 80 kilometer defined by the Austrian Green Electricity Act and self restrictions. The Danube region with its neighbourhood countries is not located in that radius, it's too far away to fulfil all the regulations. There have been experiments with the transport biomass with the inland waterway but it is not economically viable. Currently, too much wood is available at the Austrian market, so that the Biomass price decreases annually. At the moment the transport takes place by truck, about 95%. In the past the modal shift was 50% rail (main haulage) and 50% by truck. Railway transport is logistically not possible anymore due to the infrastructure. They continually block the freight depots that are not in demand.

Possible Project implementation 2018 – Port of Vienna, Port of Enns, Rumplmayr

Business Case: Esterhazy Wood from Eisenstadt to Vienna by truck – transshipment on Barge – transport to port of Enns by inland waterway;

Issue of the Business Case: paired transport operations are not possible, the trucks will leave empty for Eisenstadt, which increases the price of the haulage.

The Austrian wood marked is overcrowded with timber. The result of this is that the wood price is currently very low. The most sufficient way in transporting the wood is by truck. Marshalling yards and connections in remote forest areas are closing all over the country, caused by insufficient profitability. A sustainable supply chain is not possible any more. The operating companies are forced to use the timber trucks to get their wooden products out of the forest. A further problem is the requirement that a power station must be supplied from a radius of 60 kilometres. If the goods are already loaded on the truck, it is not profitable to transship it in case of that small radius of 60 kilometres. A solution for this issue would be a increase of the timber price. In this case it would be more profitable to import wood from neighbourhood countries.

As situation described above, the entire market is unpredictable, which means that biomass power plants do not know whether the generation of heat and electricity with biomass is going to be profitable after accepting the Green Electricity Act.

There is currently a project dealing with old wood, which is shredded and transported by barge to the port of Vienna, and currently transshiped by trucks which adds up to approximately 2000 tons per month. On top of the shredded old wood there are round timber logs to press the shredded wood down.

In the past, the port already had a wood liner service from Romania to Vienna via trader. It stopped, due to the overcapacity of timber on the Austrian market. It is very difficult and not sufficient to renew this cooperation. As described in the previous paragraphs, foreign wood is more expensive than domestic wood.

Table 24: Annual level of estimated manure availability

	Total cargo transhipped on waterside (tt)	Share of biomass (agricultural and forestry goods thereof)	Total volume of agricultural and forestry goods (tt)	Total volume thereof sent	Total volume thereof received	Share of transhipment to/from Danube region
Straubing	621	62.9%	390	313	77	66.4%
Vukovar	332	23.7%	79			
Budapest	1039	29.5%	307	300	7	n.a
Vienna	1068	14%	153	93	60	50%

	Total cargo transhipped on waterside (tt)	Share of biomass (agricultural and forestry goods thereof)	Total volume of agricultural and forestry goods (tt)	Total volume thereof sent	Total volume thereof received	Share of transhipment to/from Danube region
SPaP	1959	1%	4			
SPaP Komarno	150	88%	131			

The total waterside transshipment in the port of Vienna is 1.68 Million tons. The proportion of agricultural and forestry goods is 14 %. This means that 153 thousand tons of agricultural and forestry goods have been handled in the port of Vienna.

5.3.3. Bratislava

At the moment, there is no connection with the bioenergy sector. Bioenergy within the 100km radius of the port of Bratislava, and the Bratislava region itself, would be mostly represented by companies providing heat distribution and which use wood chips as form of biomass and companies producing biofuels whichuse agricultural products as form of biomass. Major companies worth mentioning are Slovenské Elektrárne a.s. (heating distributions) and Envien group (biofuels).

In 2009, Slovenské elektrárne started biomass co-combustion in the Vojany Power Plant, Eastern Slovakia, and in 2011 in the Nováky Power Plant, Central Slovakia. One black coal fired 110 MW unit can avoid about 21,000 tons of carbon dioxide emissions annually when co-firing biomass in the fluidised bed boilers at Vojany. The Company is evaluating the possibility to co-fire up to 20% of biomass in the near future. In the Nováky Power Plant co-combustion of biomass and brown coal takes place in the fluidised bed boilers of the operation ENO A.

The headquarter of Slovak Power Plants is in Bratislava while both Vojany and Nováky powerplants are outside of 100km radius of Bratislava port, however the company does distribute heat inside of 100km radius therefore it is relevant to mention both of them. They use wood chips as biomass fuel. Suppliers are both private and state-owned companies, for example state owned Forests of the Slovak Republic. Vojany powerplant co-fills 7% (80-90 tonnes per day) on block no. 6 and 22% on block no. 5, which is 400 tons of biomass per day. Between 2009 and 2015, the plant saved the environment from over 220,000 tonnes of CO2 emissions (seas.sk). Unfortunately, the power plant in Nováky recently stopped using biomass due to decision of the Ministry of Economy of the SR:

"Due to the need to fill the volume of domestic coal produced by the decision of the Ministry of Economy of the SR at the level of 1350 GWh of electricity supplied to the grid, it was necessary to limit co-incineration of wood chips at the Nováky power plants in 2016 and 2017. Slovenské elektrárne today incinerate wood chip only at the Vojany power plant" (energia.sk 2017).

The position of both power plants (further from the port and Danube River) mentioned above together with fact that wood chips are supplied by road and partly train transport; results in a situation, where there are no links between SPaP and power plants.

Envien Group (including Enviral, Meroco, Poľnoservis) is one of the largest and most significant groups of companies in the CEE region active in the production of biofuels, used in mixtures with conventional diesel and gasoline. The Group owns a logistic company that provides transport of biomass by roads and trains and so far, there have been no links between Envien Group and SPaP. A group of companies such as Envien Group with large annual productions, transnational reach and positive attitude towards green logistics has a potential to establish links with IWW companies like Slovak shipping and ports.

Within (and outside as well) the 100km radius of Bratislava port, there are also several smaller companies and biogas stations that operate on a local basis. Companies handling bioenergy try to use local sources. A lot of companies are also complex. They have their own source of raw product (rape seed, wood, etc.) and provide their own manufacture to turn the raw product in a bioenergy product such as biodiesel or fuel wood. According to CEO of Bratislavská teplárenská (one of energy companies in Bratislava), Vladimír Raček, the region is not yet ready to become mostly bioenergy fuelled region (energie-portal.sk 2015). Bratislava has no adapted infrastructure and transport of biomass to the city would be extremely uneconomic for the number of trucks that would have to carry it. It also makes no great sense to build new heat sources for the capital outside of Bratislava due to heat losses in heat transport.

That's where inland waterway transport could help. Biomass could be handled in our port in Komárno, and brought to Bratislava in large amounts by ships. This would be possible to happen once there is a massive demand for bioenergy in our region or in Slovakia as country. At the moment, bioenergy is still just an option, but was increasing in past years. There is a lot of companies that produce bioenergy, also there are areas that switched from old heating systems that are based on fossil fuels to new types of bioenergy. Lately, according to energie-portal.sk (2015) bioenergy business has been stagnating and a lot of new projects for biogas has been stopped. However, bioenergy is still considered to be a key component in achieving the ambitious energy and environmental goals of the European Union. For this reason, it is crucial to prepare appropriate legislation in place to restore the incentive to build up modern facilities processing products and raw materials in line with long-term sustainability and to take steps to deepen environmental awareness of the public.

5.3.4. Budapest

Currently there are no direct links between the Freeport of Budapest and the bioenergy sector. In case of implementation, project ideas detailed under Chapter 8 could attract new groups of customers. By developing a brand new logistic hub that provides services such as processing wood and agricultural by-products arrived into the port, Csepel could become a local distributor of solid biomass for energy purposes of public and private institutes.

Potentials to increase the links of the Freeport to the bioenergy sector

In the current programming period (2014-2020) in the framework of the Environment and Energy Efficiency Operational Programme (EEEOP) there have been several constructions calling for proposals to improve energetic sustainability of public and private institutes, buildings by reducing their fossil energy use in advantage of renewable energy. There have been hundreds of

projects granted all across the country and dozens in the area of Budapest and its agglomeration and all together in Central Hungary.

- Local hospitals and health care institutes,
- ministries and governmental departments,
- universities,
- educational institutes (elementary and high schools and also dormitories),
- religious institutions,
- sport centres,
- town halls,
- public spaces

have been awarded with billions of forints in total to switch from gas based boilers to using biomass based ones to reduce emission. In the framework of calls EEEOP 5.2.2, 5.2.3, 5.2.4 and 5.2.6 activities were granted dealing with renewable energy including settling solar panels, geothermic solutions and heat pumps and biomass, including agricultural by-products, gardening by-products, energy crops, forestry main and by-products, wood and other industrial waste and by-products or their mixed use for heating and or heating assistance.
Project owners of the grant awarded should be contacted to discover their demand and whether they could be supplied with the biomass material needed from the Freeport.

Secondly, supplying the public entails huge potentials. Demand for firewood and solid biomass is significant. Several boiler constructor companies are working in this field contributing to firewood supply besides selling their products. By building up a network including these companies and the public, a logistic hub could be ensuring the chopped firewood supply in the agglomeration and managing the delivery of big-bag products, fulfilling silos with chips.

Certainly, as mentioned earlier and detailed later, it is necessary to set up closer contacts with FŐTÁV Zrt. to dicuss and exchange biomass related development ideas.

5.3.5. Vukovar

In the hinterland of the port of Vukovar, or in the area of the observed five counties, 89 power plants are in operation or under construction, out of which 49 power plants are using or will use biomass, and 40 power plants use or will use biogas for the production of electricity and heating energy. A large number of biomass power plants have signed multi-year contracts with Hrvatske šume for supplying wood biomass. Hrvatske šume provide about 800,000 tons of wood biomass for cogeneration plants on an annual basis in the Republic of Croatia.

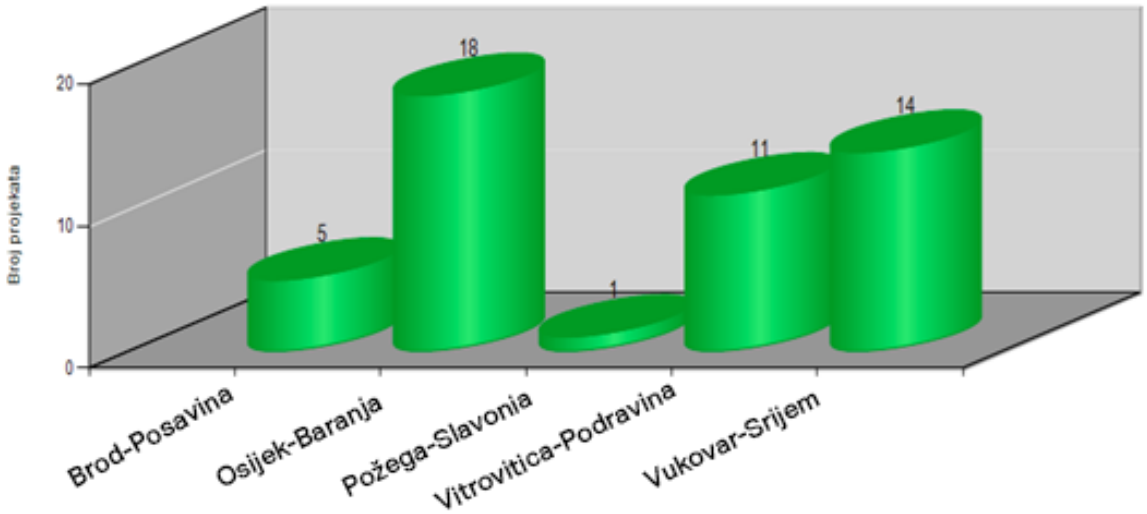
Table 25: Biomass power plants in Slavonia and Baranja

Country	Biomass power plants	Electric power (MW)	Thermal power (MW)
VUKOVAR-SRIJEM	14	28.325	13.144
BROD-POSAVINA	5	12.62	13.2
OSIJEK-BARANJA	18	17,406	30
POŽEGA-SLAVONIA	1	1,525	

Country	Biomass power plants	Electric power (MW)	Thermal power (MW)
VIROVITICA-PODRAVINA	11	27,956	39,527
TOTAL	**49**	**87,832**	**96,31**

Table 26: Biogas power plants in Slavonia and Baranja

County	Biogas power plants	Electric power (MW)	Thermal power (MW)
VUKOVAR-SRIJEM	14	24,099	2
BROD-POSAVINA	0	0	0
OSIJEK-BARANJA	18	17,589	5,092
POŽEGA-SLAVONIA	2	4	4
VIROVITICA-PODRAVINA	6	8	5,305
TOTAL	**40**	**53,688**	**16,397**

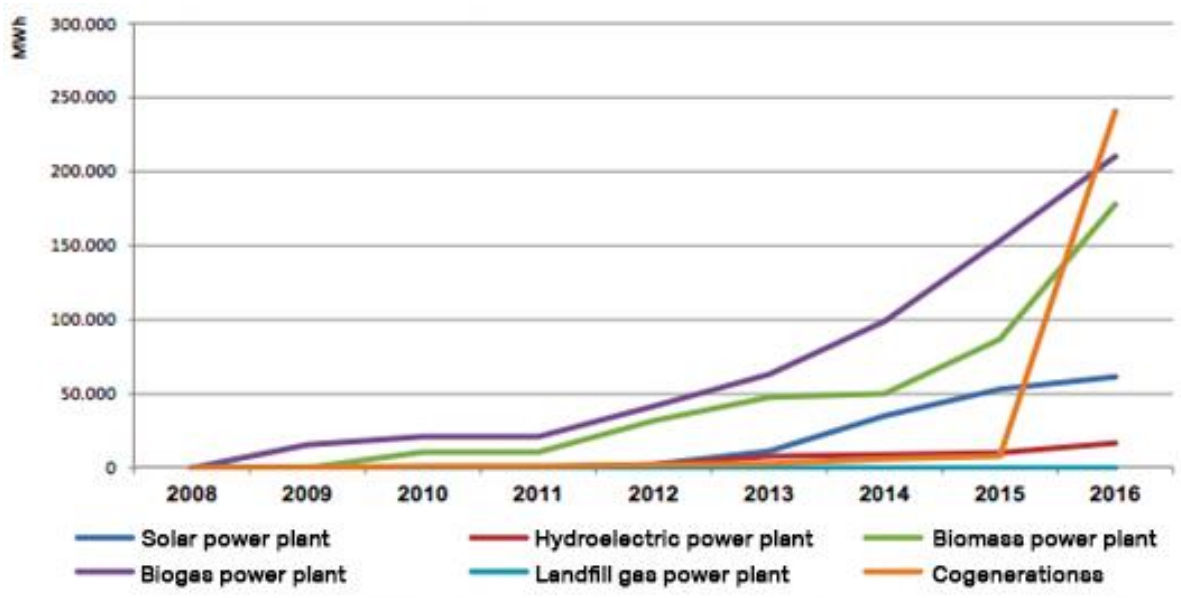


61. Figure Number of biomass power plants in the observed counties

According to the annual report of the Croatian Energy Market Operator (HROTE 2017) for the year 2016, seven biomass power plants and eleven biogas power plants in Slavonia and Baranja have entered into agreements to become eligible electricity producers and they have also concluded power purchase agreements for the national grid. The same HROTE report shows that the number of producers of energy from renewable sources increases year by year and so does their connection to the national grid. However, knowing that Slavonia and Baranja have 394 registered renewable energy sources power plants, all of which have the status of eligible electricity producers, it is clear that the development of biomass and biogas power plants needs to be continued.

Such development has so far been stimulated through the regulations that make up the energy regulation of the Republic of Croatia. On January 1, 2016, the Act on Renewable Energy Sources and Highly Effective Cogeneration (Official Gazette NN 100/15) (hereinafter: the OIEiVUK Act)

came into force, on the basis of which the earlier applicable regulations regulating the incentive system ceased to be in effect.

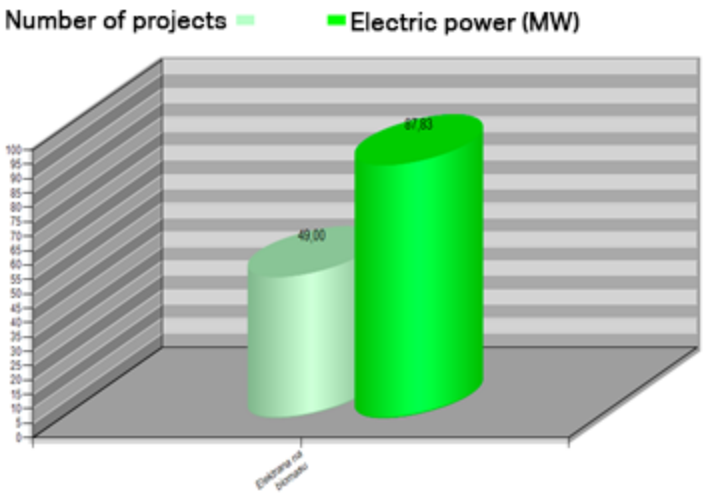


62. Figure Production of eligible electricity producers by type of plant, wind power plants excluded

With the entry into force of the OIEiVUK Act, a new approach for HROTE (HROTE 2017), among other things, has been envisaged when concluding power purchase agreements for energy from renewable sources and cogenerations. This approach (HROTE 2017) involves implementation of public tenders for awarding market premium as well as conclusion of agreements with a guaranteed purchase price, all based on the decision on the selection of the bidder with the economically most advantageous bid. Since the necessary by-laws have not yet been enacted, as envisaged by the provisions of the OIEiVUK Act (Regulation on quotas incentivizing generation of electricity from renewable energy sources, Ordinance on renewable energy sources and high-efficiency cogenerations and State Aid Program), HROTE has not concluded any new power purchase agreements for electricity from renewable energy sources and cogenerations.

This trend as well as the fact that biomass power plants are entering into multi-year agreements on biomass supply with Hrvatske šume will certainly have a significant impact on the quantities of biomass available for export or further processing in the future.

The port of Vukovar has no business connections with the stated power plants operating in Slavonia and Baranja as these are



63. Figure Production capacity of 49 biomass plants in Slavonia and Baranja

mostly supplied with biomass from domestic sources, guaranteed on the basis of multi-year raw material supply agreements

Within the framework of the Cohesion Competitiveness Operational Program (strukturnifondovi.hr), the Government of the Republic of Croatia has launched several incentive programs (fzoeu.hr) in the area of energy efficiency and renewable energy sources, which encourages the use of renewable energy sources and thus the use of biomass products. The program includes family houses, more residential buildings and public sector buildings. A special program (fzoeu.hr) that is currently being conducted focuses on educational institutions, and the Government of the Republic of Croatia in October of this year concluded EU co-financing contracts for renewable energy sources in 60 educational institutions. If this program continues as expected, both biomass and biomass products in the Slavonia and Baranja regions will have a significant increase in consumption.

As the ongoing calls are in progress, project performance data is not yet fully known. The expected result of the program is the increase in demand for biomass products, thus, as potential partners, i.e. customers; a greater number of citizens, as well as companies and institutions from the public sector are expected to increase considering ongoing programs.

5.4. Conclusion and analysis – key findings

Best practices

As seen in this chapter, Vienna and Straubing were able to develop regimes in the framework of which the energy supply system is based on renewable resources without harming forests and with responsible forestry. These shall be encouraging examples for the other three ports, that are not embedded into the bioenergy sector in their regions, and do not even have weak connections with it.

Top down approach

In cases of Hungary and Croatia, government led Operation Programs influence the market very much and from the ports' perspective, it is very difficult to tell whether such programs are efficient or not. However, it can be declared that sustainable, environment friendly way of using natural sources and utilizing renewable energy are supported, regulated and even supplied with grants by the government, on the other hand, also sustainable, environment friendly modes of transportation as IWW does not exist or happen in the required volumes.

Recommendations

From this, what ports of Bratislava, Budapest and Vukovar as key figures of the industry should accept when planning to develop logistics hubs on biomass and bioenergy supply are as follows:

First and for most, companies that are active members in the value chain of biomass and bioenergy are preferred to be settled by the river to be capable of IWW transportation. Second of all, it is suggested to have direct generation of bioenergy on the port premises to fuel port superstructure or port settlers. This service could be provided by either port authorities or third company settled in the port area (see project idea of the Freeport of Budapest).

6. Transportability of biomass on the Danube

6.1. Objectives of the chapter, methodology

The research work behind this chapter aimed at modal shifting from road to waterway transport. Here shall have been presented all relevant experiences on transportability of biomass on the Danube. Partner ports were asked to describe conditions of presently transported biomass products on their Danube sections, including the advantages and the main challenges in terms of navigability, policies, initiations, tendencies in modal shift, etc.

Technical background on water and in the ports is also in focus. In this chapter partners shall have presented technical capacities of port operators for transferring biomass on their Danube sections including requirements and bottlenecks:

- vessels
- handling low water periods
- possibilities to divert biomass to the waterway via the port

Infrastructural elements shall have been shown on maps and photos in this chapter.

Source of information

Each port managing authority described current infrastructural conditions in its port area and presented the available technical capacities of port operators for transferring biomass and – in case of not dealing with biomass – other bulk cargo turnovers especially agricultural products. They listed experiences in terms of low water periods, difficulties on reducing truck transport in favour of IWW.

6.2. Summary of the surveys

Most of the five ports are well-equipped considering transshipping capacities. Warehousing and supporting modal shift are the main challenges for everyone, but the exact problems each partner faces are still different. Therefore, they have various ideas to solve them.

Straubing has been increasing the share of biomass based products handled per train and per ship. Additionally, the port is more successful at this process than any other actor in Bavaria or Germany. Diverting freight transport from road to IWW is not a big challenge anymore compared to the past. There are still many trucks being used, but tendencies are encouraging.

The biggest demand is for rape, rape seeds and fertilizer among the agricultural and forestry commodities partly due to the port's close cooperation with ADM rapeseed mill. There are many of industry stakeholders processing raw materials from the surrounding area, as the hinterland has fertile soil for agriculture. Research and science support the industrial conversion and biomass logistics in the port. DoFu Donaufutter GmbH has newly settled its feed plant in the port due to its ideal connection to both raw materials and end-user markets in the Danube region.

Negative factors affecting transportability of biomass in Straubing's Danube section are low tides influencing ADM rapeseed mill's Just-In-Time processing structure. The plant has limited storage capacities, so does other logistics providers, and the port itself does not have storage capacities for rape seed at all. Secondly the port is located on the Straubing-Vilshofen stretch that is struck heavily when low-water periods arise.

The region of **Vienna** struggles with reducing truck transport and PoVi could contribute to the competitiveness of IWW. Activities on awareness-raising for this mode of transport started. Low tides have an influence on travel time in case of Vienna too, and closure of freight terminals also has negative effects on transportation. However, Viennese power plants have no limitations in their storage capacity, which means that they are not necessarily depending on regular deliveries. PoVi has experiences inter alia on transshipping wood to Germany and round timber to China.

The challenges regarding transportation **Bratislava** faces are the followings. Decades ago, Slovakia constructed Gabcikovo Water Dam (VDG). The dam and weather determine water level in the Danube's Slovakian section the most. However, too high (above 350 cm) and too low (below 150 cm) water levels can still cause damages, similar to the situation in the past. Operation, innovation and modernization of the dam's two chambers would help to increase capacity, reliability of waterway and potential water levels. By securing the reliability and speed of crossing the dam, it will be possible to develop and exploit the potential of the Danube waterway as far as regional development and job creation are concerned.

The other big challenge is the fact that no biomass and very low volume of agricultural products are handled in the port. There are no storage capacities for bulk biomass, neither dry nor closed, available in the port. Iron ore is a messy good stored almost everywhere in the port area. Planning to store agricultural or biomass products at the same place where dirty iron ores were stored before would demand massive cleaning every single time. A possible solution is to relocate cargo reloading. But it is important to notice, that building relations with companies which bring wood from long distances for profitability e.g. from Romania to Bratislava port would require huge investments in terms of machinery and equipment for loading and unloading wood.

In 2014, 31% of goods transported on IWW in the Hungarian Danube section were agricultural products. **Freeport of Budapest** singnificantly contributed to that too. Since that many agricultural products are already transported on water, Budapest could open up to handling biomass products on the river too. On the other hand, the most significant problems on Danube navigation are in Hungary due to shallow and narrow river sections. Moreover, IWW has a very low share in freight transport in Hungary compering to other modes of transport.

There are 4 concessionaires operating in the area of **Vukovar** port: Luka Vukovar, Vupik, Lukoil Croatio, Nautica Vukovar. Among them, Luka Vukovar and Vupik are equipped for solid and bulk cargo, meaning that they are able to participate in biomass transport.

In 2012 32.450 tons of agricultural products were transshipped. That volume doubled by 2016 to 78.857 tons. Unfortunately, truck transport is dominant when exporting biomass from Slavonia and Baranja because of the following reasons:

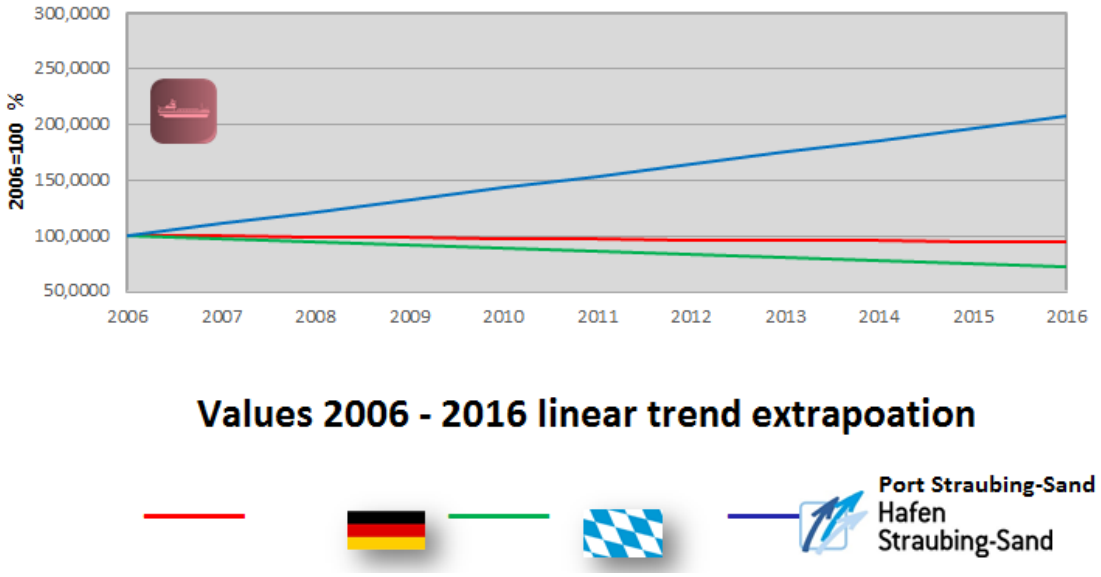
- quantities are still few
- costs of reloading/loading/unloading from one mode to another
- lack of width and four section lack of depth: channel Mohovo, section Sotin, Zidovski rukovac and section Apatin have bad navigating conditions

Based on the current technological background, the unused capacities of the port and the distribution needs there is a demand to establish a biomass hub and logistics centre in the Port of Vukovar.

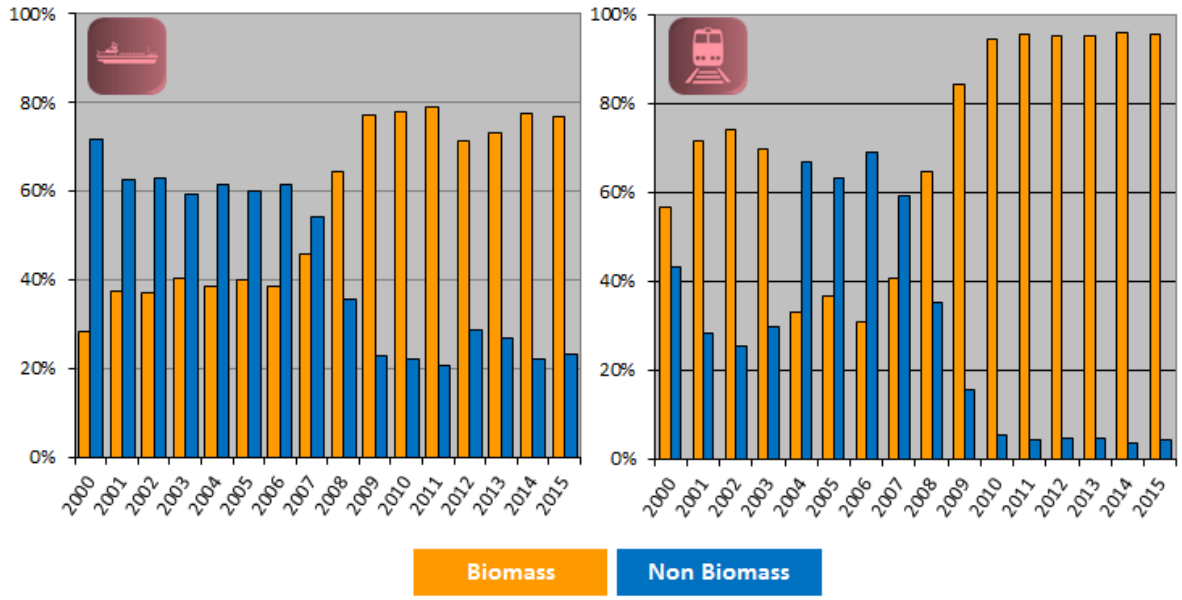
6.3. Chapters from national surveys

6.3.1. Straubing

The Danube port Straubing-Sand has a lot of experience with the shipping of biomass and is specialized on this topic. This has led to an increase of water-side transshipment since 2006. Especially compared to other Bavarian or German ports, the quantities have risen a lot. (See Figure 63) This is due to the increased biomass handling during the last years. One can see a change from a majority of non-biomass based products to biomass based products by handling per train as well as per ship. This change happened around 10 years ago. (Germany - red/Bavaria - green/Straubing - blue)



64. Figure Water-side transhipment in the inland ports 2006-2016 (Germany/Bavaria/Straubing)



65. Figure Amount of biomass transported by different modes

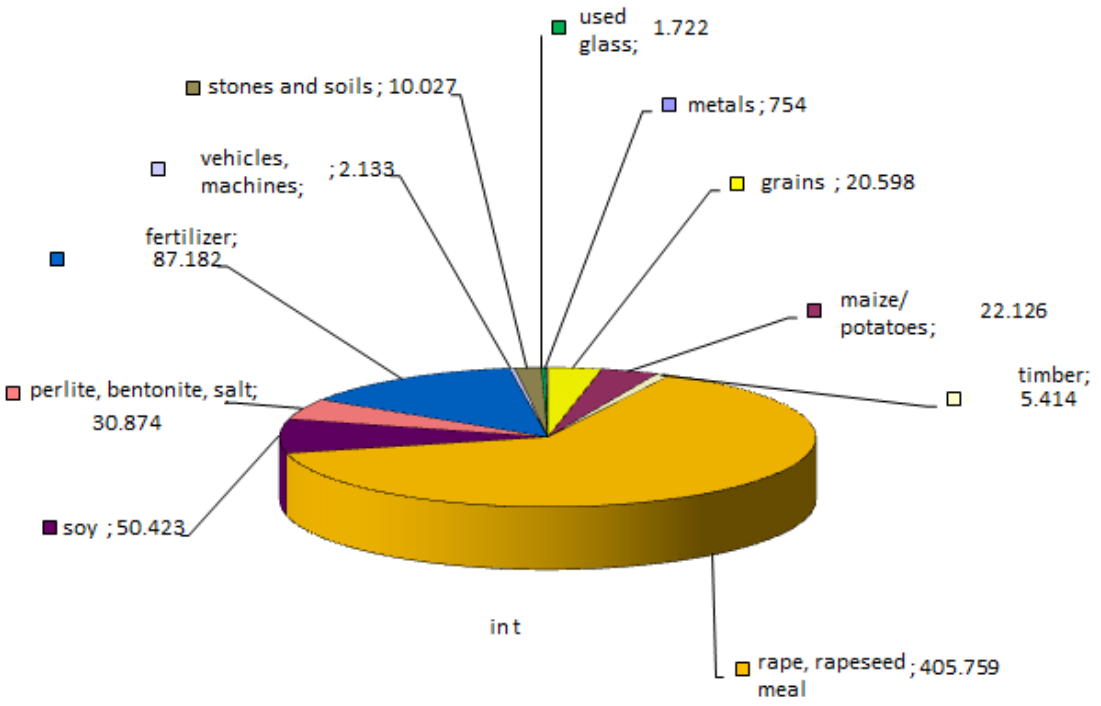
In 2016 commodities from agriculture and forestry were the main type of goods handled via ship traffic with an amount of 62.9 %, followed by chemical products with 17.9 %. Other traded goods are food and beverages plus ores, stones, soils and other mining products. See table 24 below.

Table 27: Type of goods handled via ship freight traffic in 2016

Type of Goods	Total (t)	Total (%)
Commodities from agriculture and forestry	390,592	62.9
Chemical products	109.751	17.6
Food and beverages	85,474	13.8
Ores, stones, soils and other mining products	27.,037	4.4
Other goods	8,155	1.3
Total	**621.009**	**100**

Rape and rapeseeds take the majority of the handled goods. This type takes more than two third of the whole handling. It is followed from fertilizer whereby this amounts are way less than rape. See figure 65 below.

This situation depicts a clear dependence of the port's performance on the ADM rapeseed mill. This situation needs to be improved via a diversification strategy as described above and has to be one of the major focal points in the port of Straubing in the coming years, especially when designing a port development plan as is foreseen for the next two to three years. Clearly, Straubing focuses on the waterside and to increase a modal shift to water – not quite as other trimodal ports. However, the outlook for the ADM performance in Straubing is positive: the company has announced to heavily invest in its Straubing plant.



66. Figure Handling of type of goods

The Danube port Straubing-Sand operates as a green chemistry port. Today there is a change from fossil to renewable raw materials. Biomass replaces more and more oil, coal and gas. Due to the fertile land around Straubing, a lot of industries settle here and get their raw materials from the surrounding area. Straubing develops itself to a place of bio-based chemistry, because of its strengths in research and science, industrial conversion and biomass logistics. But the raw materials not just find use in the region, but also the supply of the established chemistry locations along the Rhine can be managed via the port of Straubing. This generates connections between the Rhine and the Danube area.

Clearly, the generally known challenges the waterway transport branch faces also apply for the port of Straubing and the companies handling and processing biomass. Especially low tides have an influence on the mainly just-in-time processing structure of the ADM rapeseed mill. The plant only has very limited storage capacities, the port itself has no storage capacities for rape seed at all and the logistics providers also have limited options for rapeseed storage. Straubing is located at the 'complicated' Straubing-Vilshofen stretch that – due to the free-flowing character of the river here, is struck heavily when low-water periods arise. Ships have to discharge in Passau or have to stop there entirely. Therefore, it occasionally happens that instead of reaching Straubing by water, the rapeseed enters Straubing on trucks via road. This is not an ideal situation as Straubing aims at increasing the modal shift to the waterway and wants to offer its customers ideal circumstances to use and rely on the waterway. Generally, the business development activities for the port always actively promote the option to use the waterway and the fertile Danube region as a logistics advantage and site advantage when considering new settlements. The newly-settled company DoFu Donaufutter GmbH has decided to settle its feed plant in the port of Straubing due to the ideal connection to both raw material and end consumer markets in the

Danube region. Although not directly connected to the bioenergy market, this is an example for the type of business development result the port of Straubing aims at.

6.3.2. Vienna

The port does transshipments of biomass like round timber, old wooden chips and all kinds of agricultural goods. It is not necessarily a commodity which is burned in a power station. The port of Vienna and its transport branches is not competitive in this case. It also does not have the technical infrastructure like silos or a fork-lifter with specialized equipment. But the port is competitive in all cases where the inland waterways are involved. Unfortunately, it faces one big problem. There is enough wood on the Austrian market and an import from other countries connected with the transport is currently not profitable.

The transportability is given. There are no issues in kind of transportation to the port of Vienna and combined transshipments from the side.

Present biomass transport:

- **Old wood** Fundermax – Departure Germany
  Old and deadwood as a new transport and processing branch – Development takes already place. The port could develop conveyer infrastructure for faster transshipment operations.
  The conveyor systems are necessary to be able to unload modern/next generation wagons. The port of Vienna is already handling such business transactions.

- **Round timber** Alfons Köster – Destination China
  Round Timber - For a customer, the port stuffs round wood into containers, which are then transported to an ocean port and shipped overseas.

- **All kinds of agricultural products** like grains
  The port of Vienna has a special food approved warehouse, which is divided into six boxes. Most of the time it is used fully for agricultural products such as wheat and cereals.

Main Challenges:

- Domestic cheap wood price
- Closures of freight terminals
- Awareness Raising for the mode of transport

The biomass sector does not impose any special requirements on transport modalities. Clearly, the generally known challenges the waterway transport branch faces also apply for the port of Vienna and the companies handling and processing biomass. Especially low tides have an influence on the travel time. The Viennese power plants do not have any limitations in their storage capacity, which means they are not necessarily dependent on regular deliveries.

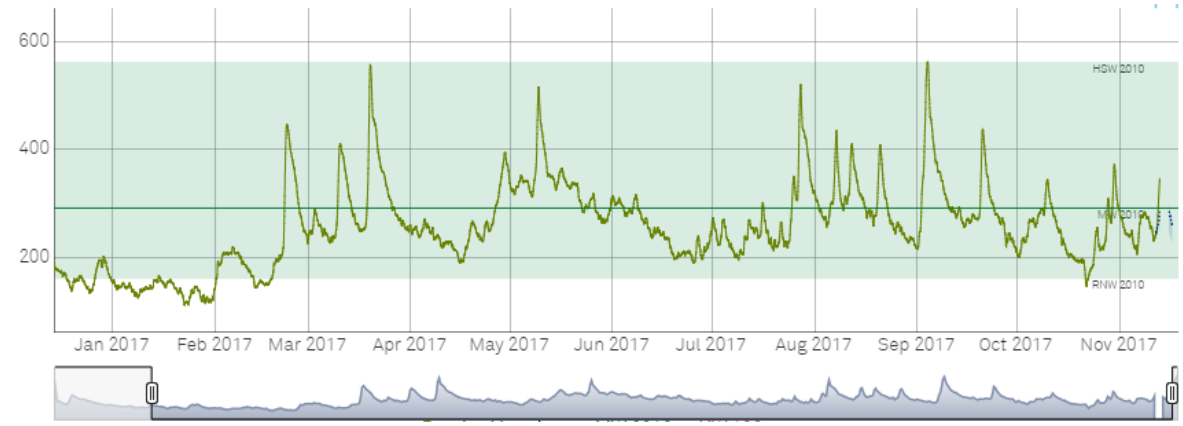
6.3.3. Bratislava

The past and current experiences with transport of biomass consist mostly of transports of agricultural products and certain types of wood materials, in the past the port handled some fertilizers as well. Main challenge has always been storage capacities of the Bratislava port. The prime transport goods have been coal, steel and iron ore so they have been given priority. Especially iron ore is a messy good to transport and store, large areas of the port are covered by it and when they are empty, it would require expensive and technically difficult cleaning to get them ready to store other goods. And since the iron ore keeps coming, there is no point to do so. Therefore the port prefers customers who want to transport wood products and reload it from train to ship or back, and ship it from our port straight away. When it comes to agricultural products, the port does not have capacities to store these kinds of products because they require dry places. In fact they require to be stored in bunkers which do not exist in Bratislava port. Again the port prefers customers that want reloading only and continue on the way. The port has been active in this way of dealing with agricultural products. The port in Komarno is more focused on loading and reloading of agricultural products and handled over 131 831 tons of such products and more than 14 726 tons of fertilizers in 2016. So far in 2017 it handled 51000 tons of agricultural products.

Water levels of Danube waterway in Slovak part of the river are affected mainly by the weather and VDG-Vodné dielo Gabčíkovo (Gabčíkovo water dam). Snow and rain can affect water levels in two ways. If the water level is too high, cruising might get stopped due to danger while passing under bridges of Danube waterway. If the water level is too low, ships and barges might get stuck on the bottom of the river. This can also cause damage of a barge and in the worst case scenario even damage of transshipped cargo. SPaP has recently experienced such case, where barge got stuck and damaged. Dangerous parts of waterway can be, and are taken care of by excavation. An example of problematic part is between the Lafranconi bridge and the river Moravia (in Bratislava) and the section between r. km 1866 - 1865. The effectiveness of treatment interventions (dredging) is in the section above the Lafranconi bridge exhausted - the bottom part of the section is exposed to the Neogene.

Sailing conditions according to SPaP nautic department and SPaP fleet:

- Ideal water level for most of our fleet: ca. 270 cm Wildungsmauer
- Minimal water level for most of our fleet: ca. 150 cm Wildungsmauer
- Maximal water level for normal regime of sailing: up to 350 cm Wildungsmauer
- Restricted regime of sailing: over 350 cm Wildungsmauer (suitable for certain vessels only)
- Sailing stopped : 420 cm Wildungsmauer and over



67. Figure Progress of water levels of Danube sailing route in Wildungsmauer over 2017 (cm)

Source: http://www.doris.bmvit.gv.at/fahrwasserinformation/pegelstaende/wildungsmauer/

VDG was built to create a reliable sailing route for a long time and to prevent regular flooding in this area (modification of the old riverbed of the Danube at rkm 1842 – 1811, deepen and regulation of the old river Danube at rkm 1811 – 1791 etc.). However, in recent years VDG has been considered a major bottleneck of the Danube waterway due to breakdowns and damages of lock chambers.

Due to the interrupted operation of the lock chambers of VDG, it was not possible to secure the conditions for a safe sale and navigation in the Slovak part the Danube River. The Gabčíkovo waterway chamber was defined as one of the most serious bottleneck of the entire Danube waterway. The project of modernization and innovation of VDG is aimed precisely at this most critical point of the Danube section, and it is necessary to do a comprehensive modernization of both chambers so that after the end of the project it is secure, uninterrupted and allows safe cruising through the water stage. At present, the average time to crawl through sailing chambers is approximately 45 minutes, it is assumed that after the modernization is completed, this time will be reduced approximately by half. By securing the reliability and speed of crossing the Gabčíkovo water course, it will be possible to develop and exploit the potential of the Danube waterway, thereby directly to support regional development and the creation of jobs in the Danube region. (source: Projekt č. 2015-SK-TM-0151-W "Modernizácia a Inovácia plavebných komôr vodného diela Gabčíkovo" available on https://www.arvd.gov.sk/sk/)

68. Figure Lock chamber of Gabcikovo water dam, damaged by collision with a vessel

The refurbishment of VDG has started on September 2017 and carries out following repairs:

The sealing of the Gabčíkovo (VDG) water supply channel will be repaired after 25 years of operation. It calls for a temporary reduction of the Danube water level in the 1.3meter feed channel. Excavation of some river sections ensures sufficient water depths and voyage is not to be stopped.

69. Figure Repairs of sealing of VDG supply channels

In addition to the exchange of swap chambers, the reconstruction will also include hydraulic systems, stabilization of substrates and improvement of control systems. At present only one of two sailing chambers is in operation. The aim of the work will therefore be the operation of both chambers, their innovation and modernization. This will increase the capacity of the waterway, its reliability and the differences of water levels will be used to increase the production of electricity. (http://www.teraz.sk/ekonomika/plavebne-komory-na-vodnom-diele-gabci/266053-clanok.html)

When it comes to transferring biomass on the relevant section of Danube, the port is able to transfer all kinds of agricultural products and fertilizers, and wood goods such as tree stumps, wood chips, pellets and briquettes; however transferring excessive amounts of wood would require investments in new technology. The port also lacks storage capacities for such products. The agricultural market has been decreasing in the region lately so that downfall of demand for this kind of services has been noticed.

If there is a low water period or any other circumstances that could stop ships, Slovak Transport Authority releases regulations which have to be followed. The ports nautic department also follows water levels to avoid accident.

6.3.4. Budapest

Main challenges and bottlenecks concerning navigability and low water

With regard to inland waterway freight data, Hungary has 1440 km long navigable waterway, approximately 15.6 km long bank available for freight loading, fleets and numerous companies dealing with inland freight. In Hungary, an average of 7 million tons of goods is transported on inland waterways. Regarding the distribution of the port facilities beside the River Danube, there are mainly public ports, three national public ports and ten ports of private use.

However, regarding the conditions of inland waterway navigation, the most significant problems are in Hungary, among the countries of the Rhine-Main- Danube Canal. In Hungary there are 200 days per year which are available for the inland freight services. This is due to weather conditions (e.g. ice haze, fog, strong storms, high or too low water levels), and there are many places to find gullies (e.g. Garamkövesd, Vác, Göd) and rocky sections that slow down and complicate shipping traffic. In these areas, only 60 to 80 percent of the load capacity can be utilized.

The navigability of the Upper-Danube is affected by the increased sediment formation ability of the river due to the low incidence angle, which influences the depth of water. The intensity of the deposition is constantly decreasing, but typically it disappears in the Győr-Gönyű area. The width of the river bed fluctuates around 400-420 meters above Budapest, reaching 600-620 meters in Budapest. In the central section of the Danube, water level is better, thanks to the water supply of the Garam, Vág and Ipoly rivers.

There are four critical sections identified by VITUKI where the core problems are the followings:

Szap-Gönyű

This section has suffered extreme changes in terms of depths for decades, is characterized by seven obstacles, which are mainly in the transitional section between the spurs: upper stenosis at Patkósziget, Medve, Szőgye, Csicsó, Vének, Gönyű and lower ford at Gönyű.

Gönyű-Szob

This section is characterized by the lack of regulation, that is why the river basin is almost over widening and the waterway is unstable. Out of many obstacles, fords with marl on the basement at Nyerges and Helemba are the most critical. In addition, fords and stenosis at Szőny, Almásfüzitő, Karva, Ebed, Istenhegy and Garamkövesd are on the way in this section.

Szob-Dunaföldvár

The navigability of the section between Szob and Dunaföldvár is limited by the fords at Dömös, Göd and Árpád bridge in Budapest, Budafok, Kulcs, Dunaújváros, Kisapostag and Dunaföldvár bridge as well as the stenosis at Dömös, Visegrád, Vác (even two), Sződliget, Százhalombatta, Dunafüred, Ercs, Kisapostag. Keeping the threshold effect at the ford at Budafok is necessary.

Between Dunaföldvár and the southern border of the country

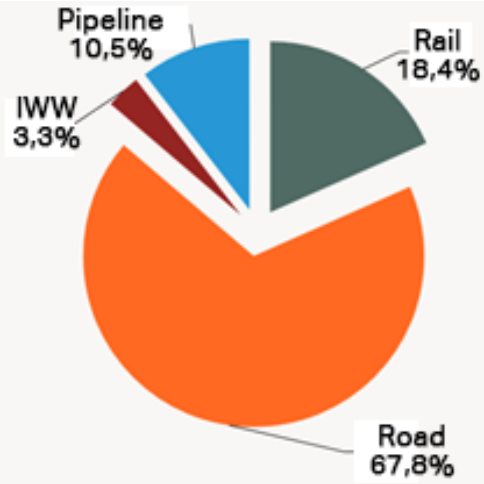
This section is made up of a series of thresholds and depth varies a lot. The most critical part is the section under the Dunaföldvár bridge and the Barákai ford. Difficulty of the former one is the safety of the marly materials and the latter one is due to the safety of the cooling water supply of the nuclear power plant. Ford and stenosis can be found in Solt, Bölcske, Harta, Paks, Kovácspuszta, Siótorok, Korpád, Koppány, Baja, Sárospart, Szeremle, Mohács, Repity and Béda.

The navigability of the Danube (water depth) can be understood as a combined result of geological and climatic factors. In Upper-Danube the water level is the lowest between October and March. In the case of the Central and Lower-Danube, low water usually occurs between August and October.

The fluctuating water depth obstructs the inland freight transport and restricts the capacity potential in many cases. The European fleet consists of about 12,000 boats, many of which may struggle with problems on the Danube's Hungarian section. Especially the Hungarian-Slovak section causes problems, where boats are forced to dive restricted in most of the year.

All types of ships used for inland waterway transport can be found on the Danube. Barges of 7 to 11,000 tonnes of loaded capacity, high-capacity vessels for the transport of solid goods with a capacity of 3,000 tonnes, tankers with a maximum capacity of 3,000 tonnes up to 470 TEU capacity vessels and Ro-Ro vessels, and also types of ship capable of transporting heavy and large goods.

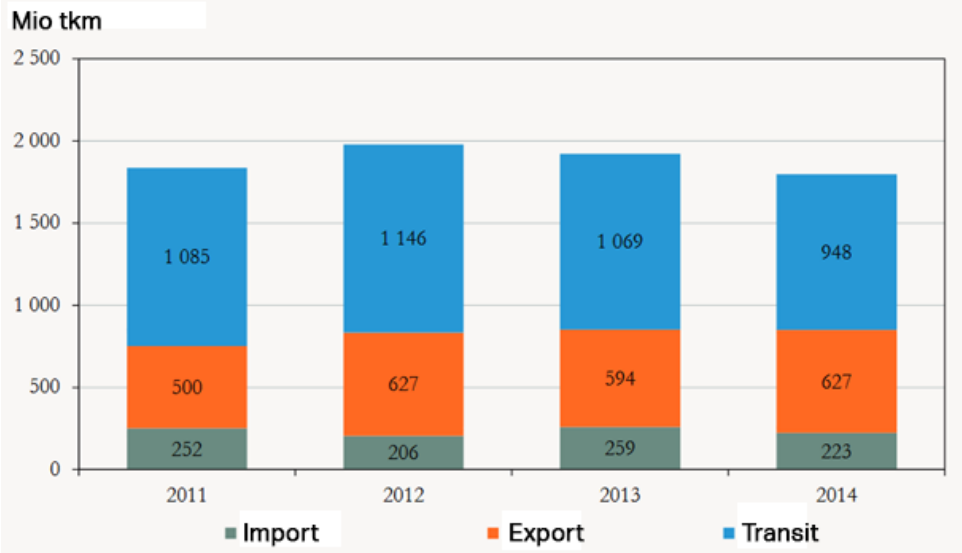
However there still are serious difficulties on the Hungarian Danube section making navigability heavier, as a result of the construction of the quays and ports on the Danube, domestic transport increased to a great extent by 9.5 times in 2014 according to KSH (Central Statistical Office). On the other hand, it has such a small share (4% in 2014) within the total IWW transport, that domestic transport did not affect overall IWW transport which even decreased in recent years: volume of IWW turnover was 1.8 billion tkm (7.8 million tkm, 0.4% lower than in 2013). IWW still has a very low share in freight transport compared to other modes of transport:



70. Figure Distribution of freight performance by tkm in 2014

Source: KSH (Central Statistical Office)

Also, within this 3.3% of IWW transportation, only 13% of goods were transshipped by Hungarian vessels in 2014 but rather by German, Romanian, Ukrainian, Dutch and Austrian vessels (24, 20 and 9-9-9% shares).



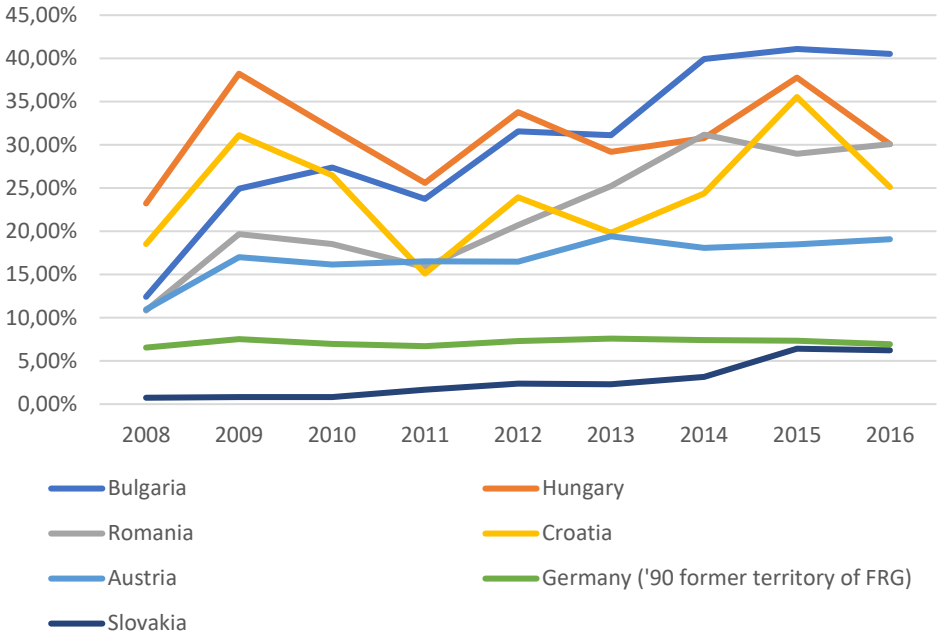
71. Figure Inland waterway freight performance trends in the directions without domestic water transport (million ton-kilometer)

Source: KSH (Central Statistical Office)

Nevertheless third of goods transported on river are agricultural products which share a lot of similarities with biomass (in 2014, 31% of the goods transported by IWW were agricultural products) which means that there is a potential for transporting biomass materials on water.

When comparing EU member states among Energy Barge PP's countries, the share of agricultural and forestry products transported on IWW is the highest in Bulgaria, Hungary and Romania, Austria by the total amount of products transported in ton (Eurostat 2016). Hungary, besides

South-Eastern European countries, being very experienced in transporting products of agriculture can use its facilities to open up to carrying, handling biomass products on the river.



72. Figure: Share of agricultural and forestry products transported on IWW

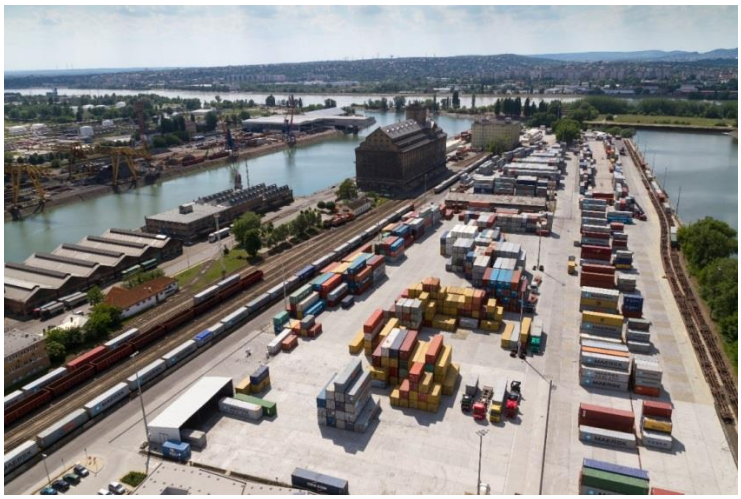
Source: Own editing based on Eurostat (iww_go_atygo)

Technical background of ports for transferring biomass

A significant part of the Hungarian inland ports has extra capacity, partly due to the periodic, unequable amount of goods, such as seasonal goods (e.g. agricultural products). For these goods, capacities should be adjusted for seasonality peaks, but some of the terminals are very often unused for up to half a year. There is also a significant capacity surplus for Ro-Ro terminals (Csepel, Baja and Győr), which, unlike agricultural products, is not related to the weather.

Beside this, increasing utilization also requires quality improvements, which in many cases do not mean increasing capacity but rather replacing. Of course, the question of the quality of waterways alone cannot justify the overcapacity in the majority of the ports. The limitations of all links of the transport process also contribute to it. The underdeveloped infrastructure network of internal areas, for example, results in higher transport costs.

Biomass is a new type of cargo transported on waterway. Therefore even though ports are not unprepared for receiving biomass, their facilities and equipment are used basically for loading, handling and storing agricultural products, bulk cargo. Some of the ports also handle oilseeds and agricultural by-products too. All in all, they have less experience related to biomass than to agricultural products. Hence, there is a lack of specialization among Hungarian Danube ports for each type of biomass.



73. Figure Freeport of Budapest

Source: BSZL – Budapest Dock Budapesti Szabadkikötő Logisztikai Zrt. (Freeport of Budapest Logistics)

Below, briefly the most important information regarding location, accessibility, capacities and main activities of ports on the Danube are presented in the order of how the river reaches them from north-west to south.

Table 28: Core data about capacities and biomass related experiences of ports and port users

(*Source:* Own editing based on own survey)

Port	Capacity for cargo turnover (ton/year)	Covered storage area (m^2)	Open storage area (m^2)	Storage of dangerous cargo (m^2)	Long term warehousing (m^2)	Other (m^2)	Biomass related experience
Port of Győr-Gönyű	300000	1000 ton					oilseeds
Freeport of Budapest	2000000	100000	160000	5000	0	0	-
Ferroport Kft. (Budapest)	1000000	24000	20000	0	0	3000	-
Port of Dunaújváros (ISD Dunaferr)	3200000	1200	7500	0	2500	0	-
Centroport Kft. (Dunaújváros)	300000	1000	1600	0	1600	0	oilseeds
Port of Paks (Sygnus Kft.)	500000	16500	100000	0	116500	0	oilseeds, agricultural by-products
Concordia Kft. (Fadd-Dombori)	30000	8*940m^3	0	0	0	0	oilseeds
Blóker Kft. (Bogyiszló)	150000	0	0	0	0	0	oilseeds
Port of Baja	800000	20900	1500	0	20900	45000 ton	oilseeds
RWA Hungary (Baja)	200000	2083,56	0	0	0	0	-
Bóly Zrt. (Mohács)	200000	36000 ton					

It is important to notice the huge potential **Budapest** has considering biomass loading since raw materials i.e. agricultural and forestry goods have a big proportion from the total cargo transshipped on waterside in the Freeport (29,5%, see table below). The share of biomass raw

materials of total cargo is one third in ton. However, grain is mostly sent from the port, meaning that it is arriving via other modes and it can be an argument against having a biomass based heating system installed and for having a logistics hub of biomass developed in the Freeport of Budapest. Both parts of the project idea will be detailed later under chapter 8.

Table 29: Cargo statistics in the Freeport of Budapest, 2016

Source: BSZL – Budapest Dock Budapesti Szabadkikötő Logisztikai Zrt. (Freeport of Budapest Logistics)

Product categories		Loading	Unloading
a. Grains			
Barley	t	30 308,18	0,00
Wheat	t	192 337,74	0,00
Maize	t	14 829,36	1 941,06
Sunflower	t	22 782,63	0,00
Rape seed	t	39 429,38	0,00
Soy	t	0,00	5 062,46
Other grain	t	0,00	0,00
Grains in total	*t*	*299 687,29*	*7 003,52*
Grains in total	***t***	***306 690,81***	
b. Other bulk cargo			
Coal, petroleum	t	51 683,72	0,00
Crude petroleum	t	13 566,15	422 750,14
Metal waste	t	41 490,12	1 022,50
Fertilizer	t	628,00	89 277,15
Glass scrap	t	0,00	0,00
Other	t	0,00	32 623,64
Other bulk cargos in total	*t*	*107 367,99*	*545 673,43*
Other bulk cargos in total	***t***	***653 041,42***	
c. Other products, cargos			
Iron and metal products	t	6 828,77	46 672,14
Machines, equipment	t	0,00	0,00
Vehicles	t	15 697,55	257,80
Vehicles	*pieces*	*13615*	*245*
Other break bulk goods	t	0,00	0,00
Containers	t	2 586,00	6 878,30
Other break bulk goods in total	*t*	*25 112,32*	*53 808,24*
Other break bulk goods in total	***t***	***78 920,56***	
Total transhipment	***t***	***432 167,60***	***606 485,19***
Total transhipment	***t***	***1 038 652,79***	

Bottlenecks of transporting biomass on waterway

The main reason of biomass not being transported on waterway is the higher flexibility and speed of managing logistic services on roads compared to the river. However, it is worth the calculations and lobbying to attract traders onto the cheaper water way, and especially to have a platform (interactive database, ICT tools) where ports and traders can notify destination ports if their barge is going there empty, to fill it with biomass products in order to manage return logistics more professionally and efficiently. Additionally, due to the characteristics of some types of biomass, they must be secured from fire, but also wet and dirt, since that could decrease its calorific value. Besides, liquid biomass (e.g. vegetable oil) is hard to transship during cold seasons as its density can change reducing its usability.

6.3.5. Vukovar

There are four concessionaires operating in the area of the port of Vukovar: Luka Vukovar d.o.o., Vupik d.d., Lukoil Croatia d.o.o. and Nautica Vukovar d.o.o.

According to the table below which shows the equipment of the concessionaires, it is evident that Luka Vukovar d.o.o. and Vupik d.d. are equipped for solid and bulk cargo. With the present level of equipment, they can take part in biomass transport. The other two concessionaires are specialized in reloading and storing fuel and petroleum products, and are not able or interested in working with biomass.

Table 30: Technical specifications of the port and its concessionaires

Technical data	Luka Vukovar d.o.o.	Vupik d.d.	Lukoil Croatia d.o.o.	Nautica Vukovar d.o.o.
Terminal purpose	Reloading of cargo on multipurpose terminal for bulk, palletined, break bulk containers, special cargo	Loading, unloading, reloading, transporting and storing of bulk cargo (grains and oilseeds)	Reloading, storing and transporting of petroleum products	Supply of fuel and lubricating vessels, transhipment and storage of petroleum products, port services and freight forwarding, sewerage and sewage disposal
Port position	1334	1336	1335 + 800	1335 + 500
Operational quay	cca 450 m	206	cca 75 m	cca 100 m
Number of berths	4	1	1	1
Type of quay		vertical	sloping + pontoon	sloping + pontoon
Floating dock length			75 m	P0-9-VK 76.50 m
				P0-1-VK 82.40 m

Technical data	Luka Vukovar d.o.o.	Vupik d.d.	Lukoil Croatia d.o.o.	Nautica Vukovar d.o.o.
Fuel tank capacity			R-1 V=3000 m^3 R-2 V=1000 m^3	P0-9-VK 3047 m^3
			R-2 V=2000 m^3 R-2 V=2000 m^3	P0-1-VK 1334 m^3
Equipment			Pumps, measuring instruments	Pumps, measuring instruments
Cranes	1 x 63 t Gotwald HMK 170	Static reloading tower with a mechanical elevator and transporters, capacity 200t/h (wheat 0.75t/m^3) and automatic vessel shifting system		
	1 x 16/27 t Ganz			
	2 x 5/6 t Ganz			
Enclosed storage facilities	cca 3.000 m^2	48.000 t	8.000 m^3	
Open storage area	cca 15.000 m^2			
Working machines	7 forklifts trucks with lifting capacity 2.5-5 t			
	1 forklift truck with lifting capacity 20 t			
	2 loaders with capacity 3 m^3			
	diesel locomotive			
	pusher vessel 480 KS			
Truck parking space	yes	yes – 50 parking spaces	yes – 10 parking spaces	
Own industrial railway track	3 tracks of cca 1300 m	2 tracks of 750 m	218 m	390 m
Maximum annual capacity	1.2-1.5 mil ton	300.000 t	100.000 m^3	

As can be seen from the table below which provids an overview of transshipment, the port of Vukovar currently does not participate in the transport of biomass along the Danube river. . However, both concessionaires would be able to transship biomass, as they, for the most part, already have the appropriate equipment and available capacities.

Table 31: Statistics on the transshipment in Luka Vukovar from 2012 to 2016 (tons)

Year Type of goods	2012	2013	2014	2015	2016
Agricultural, hunting and forestry products; fish and other fish products	32,450	110,846	81,766	125,223	78,857
Coal and lignite; crude oil and natural gas	0	0	12,434	0	12,130
Metal ores and other mining and quarrying products; peat; uranium and thorium	277,662	241,717	195,917	265,285	142,014
Coke and refined petroleum products	28,111	17,363	0	0	0
Chemicals, chemical products and man-made fibers; rubber and plastic products; nuclear fuel	25,034	8,322	11,053	12,243	11,184
Other non-metallic mineral products	5,345	2,260	0	8,266	55,634
Basic metals; fabricated metal products, except machinery and equipment	81,264	44,148	20,926	12,982	32,360
Machinery and equipment not elsewhere classified; office machines and computers; electric machines and devices not elsewhere classified; radio, television and communication equipment and apparatus; medical, precision and optical instruments; watches and clocks	1,063	2,370	3,186	305	0
Other goods not elsewhere classified	0	0	1.572	0	762
Grand totals	**450,929**	**427,026**	**326,854**	**424,304**	**332,941**

According to the port services quality indicators shown below and in addition to the available capacities of Luka Vukovar, the port can fully meet the expectations in respect of transshipment and biomass transport.

Table 32: Port services quality indicators

No.	Indicator	Designation	Basis of computation	2016
1.	Annual throughput	Q	Throughput tons in port per month or year	209,665
2.	Ave. turnaround of vessel in port	t	Total value of vessel in port: total no. of vessels	81.43
3.	Throughput per vessel per day/hour	Q/day	Cargo quantity: total dwell time of vessel at berth	2,281.60
4.	Berth utilization	%	Oper. time of vessel at berth *100: no. of berths*360	69.0
5.	Berth occupancy rate	%	Total value of vessel at berth *100: no. of berths*360	17.3
6.	Ave. value of vessel at berth	t-sati	Total time of vessel at berth: total no. of ships	9.50
7.	Berth productivity	Q/berth	Cargo quantity: number of berths at terminal	20,967
8.	Terminal productivity	Q/worker	Cargo quantity: number of workers	78.4
9.	Shift productivity	Q/shift	Cargo quantity: number of shifts*hours	165.30
10.	Transport vehicle productivity	Q/diz	Cargo quantity: trans. vehicle hours of work*no. of trans. vehicles	54.40

No.	Indicator	Designation	Basis of computation	2016
11.	Average time t in port	t	Cargo quantity and dwell time from unloading until departure from port: total cargo quantity	592.88

It has already been mentioned that in the hinterland of Luka Vukovar, there is a port Tranzit in Osijek which is equipped for biomass transshipment and transport but does not participate in these operations for two reasons. The first reason is that there are no optimal quantities that would render the river transport acceptable in terms of prices. The second and perhaps even more significant one is that the port is limited in operation during low water seasons, but only for goods arriving or leaving on IWW. There are no limitations for goods arriving by road and railway.

It is this low water problem that gives Luka Vukovar a great advantage in directing potential quantities of biomass to river transport, as well as indicators on the import of biomass and refined biomass products to the territory of the Republic of Croatia as well as exports from Slavonia and Baranja.

By analyzing the practice which shows that truck transport is the most common type of transport used today to export biomass and biomass products from the region of Slavonia and Baranja, conclusions show that there are two reasons for this. The first reason is that the quantities are too small, while the other reason is of logistic nature. The costs of reloading are avoided because the goods are transported by truck from one yard to another, without reloading.

This circumstance also points to the need to establish a collection and logistics center in Luka Vukovar, which would allow the optimal quantities for transport along the Danube River to be collected.

The yearly navigation is determined by the configuration of the terrain and river water levels during the year depending on the amount of rainfall annually.

Critical sections for navigation are defined by the Joint Expert Group of the Republic of Croatia and the Republic of Serbia[5] for maintenance of the waterway, and recognized a total of 17 sections. On most of the sections such lack is determined by insufficient width of the waterway, and in four sections by a lack of depth.

Those are section of «channel Mohovo», section Sotin, section in the range ppp 1397 «Židovski rukavac» and section Apatin.

Section Sotin and «Židovski rukavac» were primarily insufficient in depth for full draft vessels.

Table 33: Channel section Mohovo and Apatin

			full draft 2,50 m	reduced draft 2,00 m
1.	Channel Mohovo	Vukovar	+70	+20
2.	Section Apatin	Apatin	+50	+/- 0,0

[5] According to the Law on ratification of the agreement between the Government of the Republic of Croatia and the Republic of Serbia on inland navigation and maintenace of inland waterways, Official Gazette NN 01/2010, special Intergovernmental commission between the Republic of Croatia and Republic of Serbia is established. One of the internal bodies of the commission is Joint Expert Group of the Republic of Croatia and the Republic of Serbia. (https://narodne-novine.nn.hr/clanci/medunarodni/full/2010_02_1_3.html)

On the section of the «channel Mohovo» limiting water levels are steady and do not change because the bottom is firm and the disturbance create underwater rocky uplifts.

At the Apatin section, the well is still not considered stable, and the flow direction in low waters is often subject to changes.

The Low Water Levels (LWL) were adopted on the basis of technical documentation for individual waterways based on the recording of water status and hydrological water treatment in a period of 20-30 years (Agency for inland waterways 2017). As it stands and is based on joint results of common work of Joint Expert Group of Republic of Croatia and Republic of Serbia, it is agreed that the common section of Danube Low Water Level(LWL) is determined. On the Danube there is a level of low navigable water level and is adopted by the Intergovernmental Commission between the Republic of Croatia and Republic of Serbia (Agency for inland waterways 2017).

During January 2016[6] very low water levels were recorded creating the limitations for full draft at the Apatina and in the "Mohovo" channel. After February, water levels are favourable over the whole year, and very short limitations of only a few days are present in the fall of the year for a full draft. The limitations for sailing 200 cm unloading are negligible. Under the terms of the AGN contract[7], the characteristic draft should be secured through a minimum of 240 days per year.

From the graphs of the duration of the water level the number (percentage) of days that are favourable to navigate with full and reduced draft in 2016 is determined (Agency for inland waterways 2017).

Table 34: Sections Vuvovar and Apatin on the Danube river

Relevant measuring station	For draft 250 cm			For reduced draft 200 cm		
	% sailing days in 2016.	% LWL days	The difference between 2 - 3	% sailing days in 2016.	% LWL days	The difference between 5 - 6
1	2	3	4	5	6	7
Vukovar (Mohovo)	**92**	94	-2	**98**	94	+4
Apatin	**97**	94	+3	**99**	94	+5

There were short periods in the beginning and at the end of 2016 on the Danube waterway in disturbances to navigation in terms of insufficient depth for full draft of 250 cm, but unloaded navigation of 200 cm was possible almost the whole year.

So far, the largest and limiting obstacle for navigation which was in the Apatin area in previous years is significantly reduced and almost no longer exists.

This section is still the shallowest part on the upstream of the firth from the Drava River to the border with Hungary.

Improvement can be attributed to the newly constructed T-pier by the Republic of Croatia on the right banks as well as the local removal of the silt by the Republic of Serbia. «Mohovo» Channel is a constant hindrance and it would be advisable to keep Danube section navigable throughout the

[6] 2016 is the reference year since it shows realistic staus and conditon of the waterway basin on the latest data.
[7] Decision on promulgation of Law on European Agreement on Main Inland Waterways of International Importance (AGN): https://narodne-novine.nn.hr/clanci/medunarodni/1998_12_16_152.html

year for as long as possible. Furthermore, it is essential to extend the number of days when full navigability is possible (Agency for inland waterways 2017). In addition to these sections there are more frequent disturbances at the site Sotin and on location «Židovski rukavac» on the 1397 km.

6.4. Conclusion and analysis – key findings

Because of different level of development in terms of technological background and networks with the bioenergy sector, ports emphasized various challenges that are slightly connected or dependent.

Straubing, Vienna and Bratislava are all facing with issues related to navigability and water level despite of a lot of efforts to regulate the waterway with dams and locks. However, it is obvious that conditions of navigability are worse in the Hungarian and Croatian sections due to the lack of such physical facilities.

The first issue of transportability causes the second one. Modal shift, mobility of both raw materials and energy utilization, too many trucks on the road instead of distributors using inland waterways were mentioned by all the partners.

To solve this problem, Straubing and Vienna will continue what they have been doing, namely, attracting companies by high-end infrastructure to enter the port and letting them, the port operators to provide new services that divert traders from roads to river. In fact, there are limitations even in these two well-equipped Danube ports, e.g. regarding storage. But due to their efficient policy, they have experiences on transhipping and transporting biomass products on the Danube.

On the other hand, Budapest and Vukovar referred to high volumes of agricultural products transshipped and carried on river partly thanks to their activity and services provided. Building on that, they wish to have significant biomass materials to handle as well, which their port infrastructure and technical capacities are capable of.

Bratislava faces the biggest challenges among the five ports. It does not handle any type of biomass, and low quantity of agricultural products. SPaP has a concession partner port in Komárno handling agricultural products in high volume, which would be hard and useless, maybe economically harmful to divert to the capital's port. Having no biomass carried out yet and no storage available for dry bulk cargo, port of Bratislava plans to develop its wood handling capacities and markets. Although, because of difficulties above and the short section of Danube which is also sometimes hard to navigate, high investments regarding equipment and network development for transshipping and transporting wood are required.

7. Presently available technical background of biomass processing and logistics in the port

7.1. Objectives of the chapter, methodology

Here shall have been presented any type of technology available in the ports that can be used for biomass handling, if currently there is any at all. Any kind of equipment, machine or facility could have been named and briefly introduced here, be it specifically for loading-unloading, handling, storing or manipulating biomass products. Also, technology that is not biomass-specific and so far has been used for agricultural products which are the closest bulk products to solid biomass and could be utilized as biomass handlers.

However, chapter was not strict to how detailed certain data on equipment (cranes, conveyor belts, warehouses, silos, forklifts, big-baggers etc.) and their capacities (ton, m^3, m^2, m etc.) required and especially not about their ownership.

Besides, photo documentation should have been complemented written descriptions on machines and facilities, as well as maps showing their locations in the port area (in case of non-mobile elements such as warehouses, silos and fixed cranes), or the owner location of mobile technology (e.g. forklifts, big-baggers, tugboats etc.).

Source of information

Partner ports, be them the owner or manager authority of their ports or both, completed databases and keep them up-to-dated on every single equipment available in their port area, whether they belong to port operator companies or administrative bodies. In this chapter partners listed and briefly introduced their facilities and machines (regarding type, brand, capacity, what it is used for), providing a big picture of the technological conditions of their ports.

7.2. Summary of the surveys

Partner ports completed this chapter by providing detailed lists, brief descriptions, photo documentation and maps showing the availability and location of their facilities. Due to different levels of experience and development of biomass carrying, certain ports do have equipment and storage capacities for biomass raw materials and products, while others have machines and warehouses for agricultural goods and other bulk cargo handling that can be used for biomass loading and storing too.

Although, supplementary infrastructure and machineries is presented e.g. quay length, Ro-Ro, railway tracks, parking lot, number of basins, terminals.

Straubing is perhaps the newest port among the five partners, and the newest in Germany, in operation since 1996. Therefore, its technology is very modern and the port is already well-equipped to serve the renewable raw material cluster in the region. As they state, the most frequently needed facilities for biomass carrying are available, however there would be options for further modernization and more efficient equipment. Additionally, the port authority itself does not own and provide extensive and versatile storage options for biomass products (no warehouses, silos, covered areas), only limited open space is available with concreted grounds to protect materials, products from humidity and ground from influx. Instead, logistics companies settled have limited storage options in the port.

General infrastructure of the Port of Straubing:

- 1050 m long quay,
- 90*700 m basin,
- 120 m turning basin,
- electric charging and water gas stations.
- 6 km long railway system with links to national network of Deutsche Bahn.

Specific infrastructure of the Port of Straubing:

- 3 jib full gantry seesaw slewing cranes with carrying capacity of maximal 35 tons each or 60 tons in case of twin handling.
- Outreach of maximum 27 meters, 9 meters under quay and 18 meters over quay.
- Specific bulk good and wood grippers any type of biomass can be dealt with

Among the three terminals at the Port of **Vienna**, Albern is and will be serving as the bulk cargo carrier since it is well-surrounded by stakeholders in the energy biomass industry and trade who already handle agricultural products.

General infrastructure of the Port of Vienna:

- mobile crane with various attachments (lifting capacity of 84 tons), multimodal usability (container spreader, scope)
- small mobile crane with various attachments, multimodal usability

Specific infrastructure of the Port of Vienna:

- 3 conveyor belts
- fork-lifter (lifting capacity of 8 tons)
- wheel loader
- e-crane, multimodal usability

Bratislava has the least experience and available technology regarding biomass and agricultural products handling in general. A huge disadvantage is that there are not much storage capacities available, neither dry nor closed. Iron ore has the biggest share among different types of bulk products handled in the port. Even if biomass was stored open space, a very precise cleaning would be required after relocating iron ores from that certain place to put biomass products there afterwards.

General infrastructure of the Port of Bratislava

- cranes and containers are situated next to water basins and trains can be directed underneath the cranes
- road for trucks is also accessible so it provides a complex way to handle products multiple ways

Specific infrastructure of the Port of Bratislava:

- high capacity containers attached to crane with multiple way of use e.g. for agricultural products
- hoppers for containing bulk material such as grain, used for handling agricultural products e.g. corn, rape seed etc.

- multiple crane combined with high capacity container to handle agricultural products
- tugboats to ensure biomass products (wood chips, pellets, fertilizers, agricultural products) dry and covered space while being transported

The port managing authority in the Freeport of **Budapest** could not provide storing and loading capacities by its own. The port authority is responsible only for the maintenance of the basic infrastructure (road, safety etc.). Port operator companies have facilities for cargo handling. They ensure that the Freeport of Budapest offers the most diverse services and carries the most diverse types of products in Hungary, however, in tons, agricultural products are handled the most. There is no typical biomass material or upgraded product handled or stored in the port, but the available equipment can fit for biomass loading as well.

General infrastructure of the Freeport of Budapest:

- two regular basins and a petrol basin
- 18 terminals
- rail tracks

Specific infrastructure of the Freeport of Budapest:

- gantry cranes with 12/16-27.5/5/12.5/16/6/10 ton capacities for bulk cargo loading (80/60/20/30/50 ton/hour)
- fork-lift with less than 3-ton capacity
- other gantry cranes and container moving 'calmar'
- covered loading area, huge grain warehouse, open air workstation

The port of **Vukovar** owns and maintains space and equipment for transshipment of biomass and refined biomass products in concession with Vupik d.o.o.. Vukovar reloads forest biomass and biomass products, while Vupik carries out transshipment of biomass (actually, agricultural products e.g. sunflower, soybean, corn etc.). 81% of all cargo is bulk good: agricultural products and fertilizers. The biggest challenge of the port is the need of grippers, log grapples and wood waste crushers.

General infrastructure of the Port of Vukovar:

- 1700 m long quay with 205 m vertical in, 55 m vertical full-profile quay, 1000 m sloping, 400 m undeveloped
- 7 berths and dispatch of vessels
- internal port road network is 4000 m long
- tugboat pusher, dredgers, barges
- mobile facilities, transport vehicles and devices used for loading, unloading, reloading cargo
- locomotives
- C-hook for lifting coils with 25-ton capacity
- open storage (10.000 m^2)

Specific infrastructure of the Port of Vukovar:

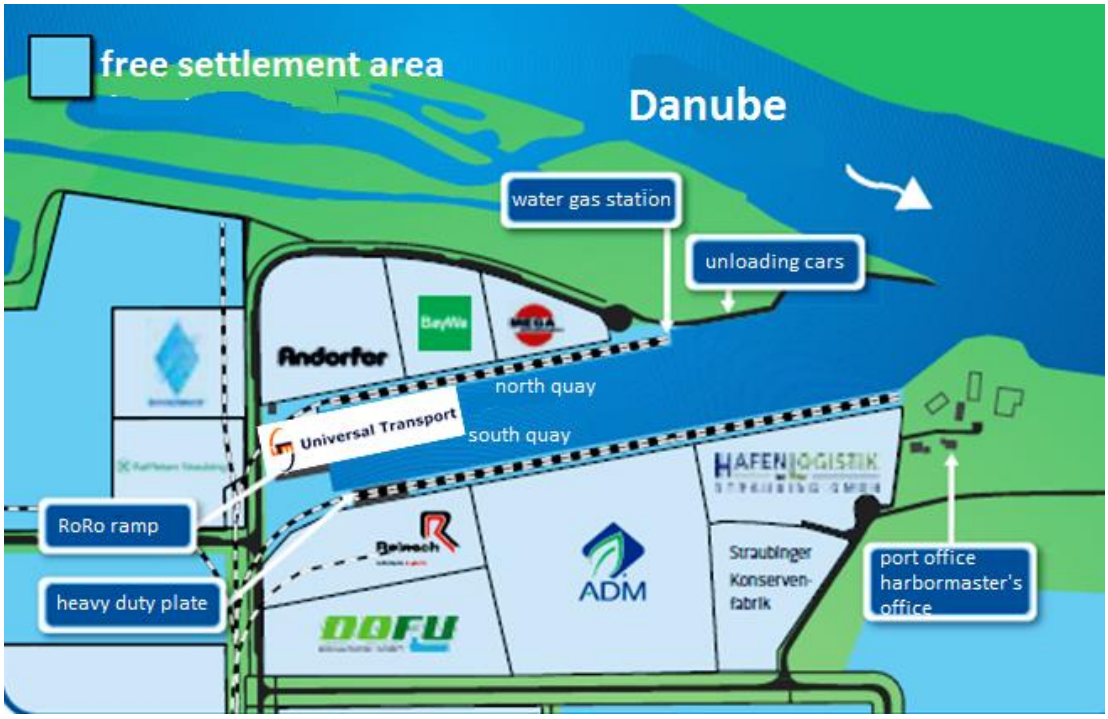
- mobile harbour crane with 63-ton capacity
- gantry cranes with 6/6 and 16/25-ton capacity

- forklift truck with 20 and 2-5 tons
- grabs for bulk cargo
- ULT loaders
- enclosed storage area (3000 m²)

7.3. Chapters from national surveys

7.3.1. Straubing

Straubing is the newest Danube port at the right side of the Danube at km 2313.3 (opened 1996). It has up-to-date technology and a flexible and customer oriented management. The port has three cranes, a special roll-on–roll-of facility and a heavy duty plate for the handling of vehicles as well as project goods and machines. Also the handling of heavy loads, harvesting and building machines can be managed by the equipment. The quay length is 1050 m. The port basin itself is 700 m long and 90 m broad. The turning basin is 120 m. The port offers electric charging stations and a hydrogen station. Efficient handling companies guarantee a reliable transport on the road, via train and by ship.



74. Figure Port area

The railway system in the port area is about 6 km long and has a connection to the railway net of the Deutsche Bahn. All properties next to the quay are developed with two tracks on each side.

Three double jib full gantry seesaw slewing cranes with a maximum carrying capacity of 35 t each are present in the port. Using two cranes for one good in the twin handling, the maximum carrying capacity rises to 60 t individual weight. An outreach of maximal 27 m is possible. The lifting capacity under hook is 18 m over and 9 m under quay. With an extensive range of grippers and lifting tackles, for example two manual spreaders, the port is ready to handle piece goods and grabbable cargo efficiently and product-specific with the given acquirements. There are specific

bulk good and wood grippers available. This is especially relevant for biomass handling. With this equipment, any type of biomass can be dealt with. Due to the high amount of biomass handling, the port is equipped with the most frequently needed facilities - nevertheless, there would be options to upgrade and increase the technical equipment and facilities – especially with regard to modernization and more efficient equipment.

The special installations of the port are the roll-on-roll-off facility and the heavy duty plate with extensive installation and storage surfaces each. The RoRo facility is located as an end-loading ramp at the western quay and has a longitudinal incline of maximal 10%. It is mobile with platform trailers with up to 14 axes and an axle load of up to 30 t. The heavy duty plate consists of reinforced concrete and lies on bored and driven piles. It is 60 m long and 17.45 m bride. The support pressure is 350 t at 1.8 m x 1.2 m or 200 t at 1 m x 1 m.

The port management itself does currently not offer extensive and versatile storage options for biomass products (warehouses, silos, roofed areas) but only a limited open space with concreted grounds to prevent influx to the ground or humidity from the ground. Some settled logistics companies do offer limited storage options.

7.3.2. Vienna

The following technical equipment is located in the Break Bulk area of the port of Vienna:

- three Conveyor belts
- Mobil Crane with various attachments (Lifting capacity 84 tons), multimodal usable
- Small mobile Crane with various attachments, multimodal usable
- Fork-lifter (lifting capacity 8 tons)
- Wheel loader
- E-Crane, multimodal usable
- Mobil Crane: Lifting Capacity 84 tons, Multimodal Usage, Attachments (Container Spreader, Scope)

75. Figure Big-Bag Bottling Plant

76. Figure 8-tons-Forklift truck

77. Figure Wheel loader

79. Figure Excavator

78. Figure E-crane

80. Figure Mobile crane

7.3.3. Bratislava

Presently available technical background of biomass processing and logistic in the ports:

High capacity container: is used when dealing with agricultural products and is attached to a crane. It has multiple way of use. Trucks can unload their trailers straight into the container, for trains we have special position where the container is lowered below the ground level and carriages can be discharged. The full container is then moved by crane above the tugboat and can drop the product straight into cargo space of tugboat.

81. Figure Handling agricultural products in the port of Bratislava, discharging trucks and trains and charging of a barge with covered cargo area

Hoppers: containers for a bulk material such as grain; it has been used for handling agricultural products such as corn, rape seed and similar products. It tapers downward and is able to discharge its contents at the bottom.

82. Figure Hopper for loose bulk materials in Bratislava port

Crane: Multiple crane, are used in combination with high capacity container to handle agricultural products. They are situated next to water basins and trains can be directed underneath the cranes. A road for trucks is also accessible so it provides a complex way to handle products in multiple ways.

83. Figure Cranes ready for charging/discharging of trains/barges

Tugboats: Most of the products within biomass industry require dry and covered space while being moved or stored. Humidity or mechanical damage can lower the quality of products. SPaP dispose with tugboats with covered cargo space. They can be used for transport of goods such as wood chips, wood pellets, fertilizers, agricultural products without danger of damaging the products.

84. Figure Loading of barge, type DE (Dunaj-Europa) with covered cargo area with agricultural products (a)

85. Figure Loading of barge, type DE (Dunaj-Europa) with covered cargo area with agricultural products (b)

7.3.4. Budapest

Biomass will be a new type of product in the Freeport of Budapest, the basic infrastructure exists, but specific storage facilities and equipment are missing.

Services regarding logistics, packing, loading, uploading, storing, warehousing are all provided by port users, not the port governance and authority. Companies own cranes, grabs, warehouses, silos and they have storage capacities (mostly open, but also covered). There is no covered open

storage facility for agro products exists any more within the port area, but either one can be built or an existing one can be converted to store biomass.

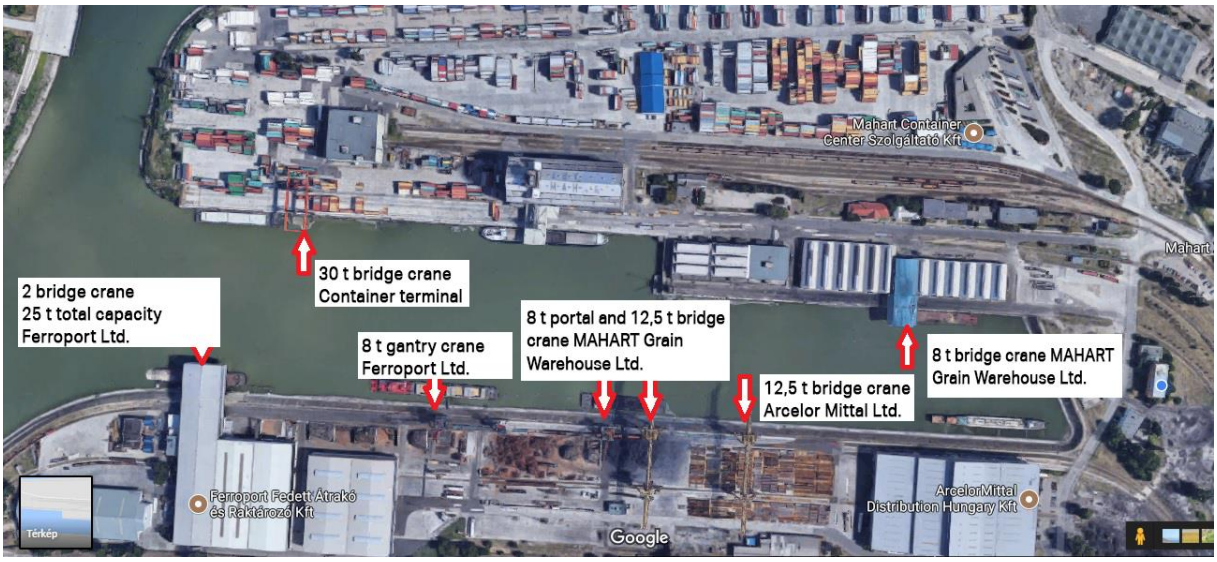
Total covered storage area is 92.800 m², open storage area is 49.120 m² in the Freeport, while other options are silos with 5.000 m² and container terminals with 100.000 m². The port has two basins and 18 terminals, additionally there is a petrol basin for oil products, but it is run by oil companies outside the Freeport area.

Total transshipping capacity is 1000 thousand tons per year which is supported by the equipment named below.

Table 35: Equipment and capacities available in the Freeport of Budapest

Equipment	Capacity			
Number and capacities of gantry cranes	Maximum capacity (ton)	Overhang above the water (metre)	Bulk cargo loading capacity (ton/hour)	Loading TEU (TEU/hour)
	2×12	5-15m depending on the water level	80	
	16/27,5	5-15m depending on the water level	60	
	5	5-15m depending on the water level	20	
	12,5	5-15m depending on the water level	30	
	16	5-15m depending on the water level	30	
	32	10 m		100
Number and capacities of other cranes	Maximum capacity (ton)	Crane type	Bulk cargo loading capacity (ton/hour)	
	3×6 5×10	Gantry cranes in store	50	
Fork lift	Lifting capacity		Quantity (ps)	
	< 3		3	
Other loading and container moving equipment	Type and name of equipment		Quantity	
	Gantry crane			
	Container moving “Calmar”			

Below another view is presented showing what sort of capacities and equipment are available in the Freeport, which are related to biomass loading. Also, companies holding them are mentioned.



86. Figure Biomass related equipment and capacities in the Freeport of Budapest

Source: BSZL – Budapest Dock Budapesti Szabadkikötő Logisztikai Zrt. (Freeport of Budapest Logistics)

One of the most relevant actors in the Freeport, MAHART Gabonatárház Kft. (Grain warehouse Ltd.) operates the covered loading area of Agroterminal. Here, direct transshipping to/from road and ships is possible. A multi-purpose equipment, a 10.5 ton bridge hydraulic gripper spatula and slide, extending over 14 meters above the water, provides fast, reliable and professional transshipment, thus accelerating service for waiting and outgoing ships. With Agroterminal, Gabonatárház usually treats grain handling, and also has experiences on loading coke, break bulk goods and fertilizer.

87. Figure Covered loading site of MAHART Gabonatárház

Source: gabonatarhaz.hu

The so-called open-air workstation is located on the shore of the commercial pool opposite the grain warehouse. Bulk and break-bulk cargo is stored here; both inside and outside storage are possible. Gabonatárház operates the 60-ton road scales, which allow them to weigh as much bulk

carriers arriving to the warehouse as possible, but it serves other companies in the Freeport as well.

New technology soon available

Additionally, in the framework of DTP project Energy Barge, a new forklift that can be used outside and inside will be purchased. The forklift will be equipped with a specific bulk bag filling and handling "big bag" adaptor enabling it to effectively load different biomass products into big bags. Either be pellet or wood chips, incoming biomass arriving in bulk form will be filled into big bags easier to be handled and stored even outside and delivered to its final destination.

Specifications of the forklift and its adaptor being purchased are the followings:

- LPG engine
- loading capacity to lift 1,5 tons up to 5 meters
- can be used both inside and outside
- cabin, rider seat, triplex solution
- big bag filling unit
- big bag handling unit

7.3.5. Vukovar

Technical characteristics of the port system according to the Inland Waterway Navigation and Ports Act: port facilities are operational quays, breakwaters and other hydro-engineering infrastructure facilities in the port, port roads and railways, water supply, sewage and power grid, navigation safety facilities in the port, administrative buildings, warehouses, silos and reservoirs.

Operational quay

The total length of the shore within the port area of the port of Vukovar is approximately 1700, of which 205 meters are constructed as a vertical quay on pilots, 55 meters are vertical full-profile quay, 1000 m are constructed as a sloping quay while approximately 400 m are undeveloped shoreline. On the total length of the operational quay there are 7 berths for reception and dispatch of vessels.

Roads

The internal road system of the port consists of the main port road with a connection to state road D2. The internal port road network is 4,000 meters long. At the entrance to the port there is a further 12,000 m2 of parking space and space for motorized individual traffic for arrival and departure.

Railway tracks

In the area of the existing port, between the buildings and the shoreline, there are three operational railway tracks for handling ship-to-shore and loading/unloading from which it is possible to carry out direct transshipment into/from rail wagons into vessels. Within the area of the Vukovar railway station, there are four operational railway tracks with manually operated parking and trainset switches, which can be used for marshaling of trainsets for all port operators.

Transhipment facilities

Transshipment facilities at the terminal represent mobile facilities, transport vehicles and devices used for:

- loading, unloading, reloading cargo from vessels or to vessels
- cargo handling within the port area including vessels (tugs, dredges, grab dredgers and barges).

Transshipment facilities include:

- Locomotives DHC 400 and DHC 600 KS
- C-hook for lifting coils with lifting capacity of 25 t
- Grabs for bulk cargo from V=5m3 to V=13m3
- Spreader 20" and 40" containers
- Vehicle transporter:
  1) with the load capacity of 3,6 t,L=4m H= 3,4m
  2) with the load capacity of 2,5 t,L= 3m, H= 2,7m
- Tugboat-pusher tug PRILJEVO with 480 HP
- 10000 m2 of fitted out open storage area
- 3000 m2 of enclosed storage area
- 1 x forklift truck with load capacity of 20 t
- 7 x forklift trucks with load capacity of 2 to 5 tons (Linde)
- 2 x ULT loaders
- 1 x mobile harbor crane with lifting capacity of 63 t (Gottwald HMK 170)
- 2 x harbor gantry cranes with lifting capacity of 5/6 t (Ganz)
- 1 x harbor gantry crane with lifting capacity of 16/25 t (Ganz)

88. Figure Cranes within the area of the concessionaire Luka Vukovar d.o.o.

Table 36: Technical equipment of Luka Vukovar d.o.o. and Vupik d.d.

Technical data	Luka Vukovar d.o.o.	Vupik d.d.
Terminal purpose	Reloading of cargo on multipurpose terminal for bulk, palletined, break bulk containers, special cargo	Loading, unloading, reloading, transporting and storing of bulk cargo (grains and oilseeds)
Port position	1334	1336
Operational quay	cca 450 m	206
Number of berths	4	1
Type of quay		vertical
Floating dock length		
Fuel tank capacity		
Equipment		
Cranes	1 x 63 t Gotwald HMK 170	Static reloading tower with a mechanical elevator and transporters, capacity 200t/h (wheat 0.75t/m^3) and automatic vessel shifting system
	1 x 16/27 t Ganz	
	2 x 5/6 t Ganz	
Enclosed storage facilities	cca 3.000 m^2	48.000 t
Open storage area	cca 15.000 m^2	
Working machines	7 forklifts trucks with lifting capacity 2.5-5 t	
	1 forklift truck with lifting capacity 20 t	
	2 loaders with capacity 3 m^3	
	diesel locomotive	
	pusher vessel 480 KS	
Truck parking space	yes	yes – 50 parking spaces
Own industrial railway track	3 tracks of cca 1300 m	2 tracks of 750 m
Maximum annual capacity	1.2-1.5 mil ton	300.000 t

With the above technical equipment the port operated according to the data and quantities given in the table 19 of the previous section. 81% of all cargo is bulk, mainly agricultural products and fertilizers, 4% is liquid cargo such as oil and fuel, 15% is general cargo mainly iron and iron components and construction materials.

As already mentioned, two concessionaires: Luka Vukovar d.o.o. and Vupik d.d. have the space and equipment for the transshipment of biomass and refined biomass products.

Luka Vukovar d.o.o. given the technical equipment and the capacity can reload forest biomass and biomass products, while the concessionaire Vupik d.d. is able to carry out transshipment of biomass based on agricultural products exclusively (e.g. sunflower meal, soybean meal, corn).

However, if the biomass traffic would be developed, both concessionaires would have to strengthen their capacities and acquire additional equipment.

The specific equipment for biomass transshipment on both terminals is necessary to compliment with equipment for transshipment - gripper – log grapples, crusher – wood waste crushers.

89. Figure Silo and transshipment technology of Vupik d.d.

90. Figure Aerial view of port of the area of the concessionaire Luka Vukovar d.o.o.

7.4. Conclusion and analysis – key findings

Major differences in terms of readiness

It turned out that there are major differences among ports concerning readiness for biomass handling and storing. Straubing is well-equipped for biomass handling and thanks to its strategic thinking does not have to worry about further modernization as it will be implemented by interested companies settled in the port.

However, at the beginning of this document Vienna mentioned 5 silos with 90.000 tons capacity settled in the Port of Albern, the greatest agricultural and bulk cargo centre of Eastern Austria, they stated in *chapter 6* that they have no biomass specific silos and machines e.g. forklifts available, meaning that PoVi is semi-prepared for biomass handling. They are equipped and ready for loading and unloading biomass materials and products arriving to the port either on rail, road or river, but they must transfer them just-in-time and are not able to store the goods as their current silos are always full.

Budapest and Vukovar have shown similarities in terms of the large quantity of agricultural products handled and stored in their ports and the fact that both referred to facilities and machines that could be used for biomass loading as well besides other bulk cargos. Nonetheless, Vukovar has more experience in biomass handling.

Bratislava has no biomass in the port, and even agricultural products which are very similar types of goods requiring similar infrastructure are carried out in low quantity compared to other types of cargo handled in the port.

Future challenges

Complex ownership structures (which were not examined in this research) can cause difficulties if each available facility for biomass handling belongs to different companies within the port. Without having all the relevant, specific technology concentrated at one owner per port, availability of different sort of equipment shall be made clear in databases as well as forms of internal processes: when biomass arrives to the port which organization will be responsible for

- loading/unloading it,
- manipulating it,
- packing and/or storing it,
- transferring it further or to end-user.

More machines for manipulation and actual handling are necessary to be installed and developed in every port, as long as they would like to establish and improve logistics hubs with diverse services provided. The five ports have similar ideas on future development, although they start the implementation from different technological levels.

7.5. SWOT analysis per ports based on the first 7 chapters

In this chapter, based on the situation analysis carried out by the ports in Chapters 1-7, a SWOT analysis has been elaborated on each port, gathering the **Strengths, Weaknesses, Opportunities and Threats** in the following four fields:

- **Infrastructural connections of the port** (based on Chapter 1 on geographical location and Chapter 6. on navigability of the Danube);
- **Technological background of the port** (based on Chapter 7. presently available technical background of biomass processing and logistics in the port);
- **Supply side of biomass industry** (based on Chapter 2. hinterland areas of the ports, Chapter 3. regionally available raw materials and Chapter 4. supply and demand side for upgraded products);
- **Demand side of biomass industry** (based on Chapter 4. supply and demand side for upgraded products and Chapter 5. links with the bioenergy sector).

The analyses, below is good summary of the first seven chapters.

Straubing

	Strengths	Weaknesses
Infrastructural connections of the port	- Good road connections: motorways A3, A92, B20 - Airports (own regional airport and Munich international airport reachable in about 1 hour) - Good railway connections (connection to the railway net of the Deutsche Bahn); 5,3 km of own industrial rail tracks - IWW: Danube - Continuous effort to strengthen IWW in comparison to road in the modal split	- On the Danube section Straubing-Vilshofen: low-water periods can negatively affect navigability
Technological background of the port	- Trimodal port (water, road, rail) - Straubing-Sand is the newest inland port in Bavaria (anno 1996), it has up-to-date technology (3 cranes, Ro-Ro, heavy duty plate, 1050 m long quay, basin 90*700 m, turning basin 120 m, - electric charging and water station) - Most common technical background for handling biomass is given (specific bulk good and wood grippers available, conveyor belts) - Companies handle considerable more biomass products (about 80% of the total amount) than non-biomass products since 2006	- The port management itself does currently not offer extensive and versatile storage options for biomass products (warehouses, silos, roofed areas)

Supply side of biomass industry	- Wood for biomass energy utilization available on hundreds of thousands of hectares in the surrounding area (Bavarian forest) -The main wood suppliers are saw mills and forestry - Logging accounts 10.82 m^3/ha/year - 522 km^2 agricultural (so called Gäuboden, an area with one of the best soils in Germany) area with 2700 farms; 10% of the local residents work in the agricultural/forest sector, producing potatoes (252 t/year), sugar beets (473 t/year), maize (303 t/year) and crain as well as respective residue material - Several logistics providers located in the port that can offer logistics and handling services for all kinds of biomass intermediaries and products	- Wood/forest industry is quite heterogeneous due to compartmentalization of ownership (many small forest owners), which complicates trade and supply
Demand side of biomass industry	- Possibilities for processing/upgrading biomass in the port and in its surroundings provide added value and advantages in the market - Comparatively high demand side: Straubing is the region of Renewable Raw Materials with a lot of companies, which are specialised with the processing of biomass, are located in the area - Significant production and R&D capacities, wide network: ADM Spyck GmbH with 900,000 t capacity, BayWa AG, Clariant Produkte (Deutschland) GmbH; DoFu Donaufutter GmbH, Raiffeisen Straubing GmbH and the entire Renewable Raw Materials cluster in the region with all its for-profit and R&D members which are in touch with the port: trading and processing, producer companies, Technical University of Munich, BioCampus Straubing GmbH	

	Opportunities	Threats
Infrastructural connections of the port	- Modal split from road to IWW can be further increased perhaps by eliminating negative effects on navigability of the Danube section Straubing-Vilshofen -Port of Straubing's Westward connection up to the lock of Straubing will improve once the Danube works are being started thanks to a political decision to allow deeper dredging between the lock and the port entrance	- Modal shift can stop or switch back to road - port basin and equipment is currently running at full capacity; further increase of transshipment will require an additional basin which in turn requires long planning and construction periods and might hamper development - current political situation and plans do not suggest an overall satisfying solution for the free-floating Danube stretch between Straubing and Vilshofen
Technological background of the port	- The ports' surrounding trimodal Industrial Park offers completely developed industrial and commercial plots in different sizes - Thanks to the cluster management centre in the port (BioCampus Straubing GmbH)) efficiency of current equipment or further technological improvement needed (if any) can be developed	- Regensburg can be a competitor with its well-equipped port - Availability of free industrial plots is limited; new land acquisition must take place
Supply side of biomass industry	- Opportunities for using bioenergy: there is currently no utility for the usage of biomass for direct generation of energy (heat and/or electricity), but there would be feedstock available that is currently not used for value-creation purposes - Maize slop residues from Hungary: links and networking with foreign companies can be further developed	- In case of increased discussion about "food or fuel" and similar discussions, farmers might not be willing any longer to increase their share of biomass supply for non-food purposes such as bioenergy or the bioeconomy as a whole

Demand side of biomass industry	- Change from an industrial use of fossil fuels to renewable fuels in the previous years can facilitate further improvements and expansion of biomass raw materials demand in the industry and their willingness to invest; not only in the bioenergy sector but especially in the chemical material utilization; growth in demand is expected and can positively affect the development of the port of Straubing which is using this opportunity already as a yardstick for its business development strategy - Shipping energy wood, pellets, chips, round wood to Austrian saw mills from Straubing can become a substantial market in the upcoming years - Increased production capacities for soy crushing at ADM side poses opportunities for higher IWW imports of Danube soy - Plans to build an open access multi purpose demo plant for industrial biotechnology processes to develop new biofuels and biomaterials in the port area might further attract demand side companies to Straubing	- Especially bioenergy demand side might face significant threats due to U-turns in EU and German bioenergy policy, especially ADM might have to stop biodiesel production in total

Vienna

	Strengths	Weaknesses
Infrastructural connections of the port	- Proximity to Schwechat International Airport - Good rail, road, water links - Access to 3 TEN-T corridors: Rhine – Danube corridor, Baltic – Adriatic corridor, Balkans-/Eastern-Med corridor - IWW: connection to ARA ports and Constantia - Competitiveness where inland waterways are involved	- Simmering refers to its biomass from all over Austria and transports it to Vienna, but mainly by road. Such state-owned companies do not use IWW
Technological background of the port	- Trimodal port (water, road, rail) - Largest free port in Austria- modern, large warehousing zone and harbour area in between A23 ring road and A4 east motorway - 3 large cargo terminals: Freudenau (cargo handling), Albern (building materials, agricultural and steel products, 5 grain silos 90.000 ton capacity, most important grain handling location in Eastern Austria), Lobau oil terminal - Break bulk area of the port of Vienna - 3 conveyor belts - Mobile crane with various attachments (lifting capacity 84 tons), multimodal usability (container spreader, scope) - Small mobile crane with various attachments, multimodal usability - Fork-lifter (lifting capacity 8 tons) - Wheel loader - E-crane, multimodal usability	- No silos, no fork-lifter with spec. adapter or equipment - No conveyor belts for loading and unloading the new generation of wagons - port management itself does currently not offer extensive and versatile storage options for biomass products (warehouses, silos, roofed areas)

Supply side of biomass industry	- Port of Albern: one of the biggest round timber suppliers, supplying the biomass power plant in Simmering. - The Alpine regions have high biomass potential forestry areas - Region of Vienna is rich at sugar beets and oil seeds fields and almost a full coverage of grain cereal cultivation,- - agrarian farming regions in Eastern Austria - Viennese Forest covers 135.000 ha, 70.000 ha (52%) is forest - 67.000 ha Biosphere park Wienerwald – one of the largest contiguous beech forest areas in Europe - 25 forestry companies (beach and oak, oak hornbeam, high-yield forests, small-scale meadows and black alder forests, regional specialties: black pine forests, warm-growing downy woodlands, summit ash forests) - Forest ecosystem services: wood production, nature conservation, carbon storage, recreation, habitat certification - Theoretical exploitation of potential of the studied beech and oak denominated stocks is about 12-20% contrast to previous forestry use depending on the age of total biomass. - The values refer to oak and beech forests with an age of more than 80 years and a stock between 400 and 600 m^3 / ha. - Approximately 8-10 (5%) to 16-20 (10%) trees per ha of forest area are to be available as dead wood / old wood as well as old wood contenders depending on the stock (supply 400 to 600m^3 / ha).	
Demand side of biomass industry	- Austria is the 4th largest pellet producer in the Danube region with 1.3 million tons annually - Approx. 50-60.000 households and institutions are provided with biomass based electricity and heat in the region (including Simmering forest biomass power plant)	- Operations are not involved in the supply of the biomass power plants in the vicinity of the port

	Opportunities	Threats
Infrastructural connections of the port	- Modal shift shall be promoted, since 95% of transport takes place by trucks - Building up a Woodworking Industry Cluster in the port of Albern or Freudenau - build multipurpose infrastructure	- Low tides have an influence on the travel time - Closures of freight terminals - Transshipment Speed in the high and heavy cargo area - Bottleneck of Space Shortages
Technological background of the port	- Among the three specified terminals, Lobau serving vessels with oil could be developed as the market share of biofuels increase from the current 8% to the estimated 9% by 2020 and this demand for technologically well-equipped port services occurs - Viennese power plants do not have any limitations in their storage capacities, which means they are not necessarily dependent on regular deliveries	-
Supply side of biomass industry	- Wood supply is the core business in Austria: wood is used by sawmills and the paper industry, opportunity is to have bigger share in the energy biomass industry and less in the paper industry	- According to the existing rules, a power plant is only promoted if the biomass is provided within a radius of 60 kilometres
Demand side of biomass industry	- 3 Viennese biomass power plants will create a huge demand in the future	- The entire market is unpredictable, since the Green Electricity Act in Austria applies only to 2019

Bratislava

	Strengths	Weaknesses
Infrastructural connections of the port	- Closeness of D1 motorway and railway lines, airport - Closeness of port of Komárno specified to handling agricultural products also (owner of the two ports is the same state-owned company)	- Slovakian Danube section is quite short: 172 km and goes on the borderline, while road and rail network cover the whole country
Technological background of the port	- Trimodal port (water, road, rail) - 3 basins - Bulk, break bulk goods, handled - Equipment that can contribute to handle/load biomass: - high capacity container used for agricultural products, attached to crane, multiple way of use - hoppers: container for bulk cargo: grain, corn, rape seed - crane: used in combination with high capacity container to handle agricultural products. Can be situated directly next to water basins and rail tracks. - tugboats: covered cargo space for wood chips, fertilizers, pellets, agricultural products	- Bratislava port does not handle biomass products at all, since it is not fully equipped for handling biomass - Very small amount of agricultural products carried out in the port, while Komárno is specified to handle agricultural goods and fertilizers - No storage capacity (neither dry or closed) - Iron ore is a messy good stored everywhere in the port → difficulties to clean up to store other type of goods
Supply side of biomass industry	- Warmest and driest climate in Slovakia is this region with its fertile soil → major source of agricultural products (wheat, rape seed, barley, corn, sugar beets, vegetables etc.) - Wheat: increased in area and quantity harvested - Corn: increased in quantity - Little Carpathians are densely forested (90%): Smolenice region covers 6 forest administrations. → 184.000 m^3 timber	- Wood harvesting has been reduced by over 50% in the previous years (to save nature) - Barley: decreased in area and quantity - Corn: decreased in area - Sunflower: decreased in area and quantity - Rape seed: decreased in area and quantity

Demand side of biomass industry	- Enviral is the 1st bioethanol producer in Slovakia with own railway lines, rail junction in Leopoldov (65 km far from Bratislava). - Meroco, biodiesel producer with 100.000 ton capacity of FAME and 13.000 tons of glycerine - Polnoservis, oil pressing from rape seed 85.000 tons capacity - Pellet and briquette sellers located in the area of the port: Drevo-Pak, Safira, ENZO TUNING - Vojany power plant, which uses biomass (wood chips)	- Biofuel production is the only relevant activity in the country, it is also a young industry - No clear market in the region or the country, no connections with bioenergy sector - Another big power plant located in Nováky recently stopped using biomass due to decision of the Ministry of Economy of the SR - Enviral delivers bioethanol to customers by rail

	Opportunities	Threats
Infrastructural connections of the port	- Biomass could be handled in port of Komárno and brought to Bratislava in large amounts by ships	- Weather and Gabcikovo water dam (VDG) determine water level in the Danube's Slovak section: too high and too low water levels can obstruct shipping as it can cause damage in barges
Technological background of the port	- Overall area of Port of Bratislava is 205 ha (2 050 000 m^2) from which over 588 000 m^2 is in long term lease of SPaP. Areas in use are: covered areas: 25 790 m^2 and open/non-covered areas 75 335 m^2. Therefore space-wise, Bratislava port has enough land to operate new storage capacities. - Port of Bratislava does have equipment to load and unload biomass products from barges to trains or trucks and other way around	- In case of no huge investments in machinery and equipment for loading and unloading wood, etc, there will be no biomass hub in Bratislava. - Land ownership and leasing conditions are complicated
Supply side of biomass industry	- MERA (methyl of rapeseed oil used as bio-part of motor fuels) → 10% of motor fuels must be from bio-components by 2020 - Spedition Plant manages 40.300 ha of forest land within 73% of economic forest - Trading companies bringing wood from Romania to Bratislava port should be involved in a network	- Import increased, export decreased in terms of rape seed, that otherwise could establish the possibility to produce biofuel
Demand side of biomass industry	- Vojany Power Plant tries to expand → to co-fire biomass up to 20% - Opportunity to establish links with IWW companies like Slovak shipping and port companies towards green logistics - Smaller companies and biogas stations operate on a local basis, they should be involved into a biomass network	-

Budapest

	Strengths	Weaknesses
Infrastructural connections of the port	- Trimodal connections; TEN-T corridors, 3 CNCs: Mediterranean, Orient-East Med railway, Rhine-Danube IWW - Gubacsi bridge – railway, marshalling yards next to Csepel Island - 3 rail tracks divide into 3 directions in the island: to the port, to the petrol basin, to the Csepel Factory (former Csepel Works) - Proximity to M0 ring road, M1, M7, M6, M5, M3 highways	- Gubacsi bridge is currently in a very bad condition - IWW has a very low share (3.3%) among other modes of transport (road ~60%) - Most significant problems on Danube navigation are in Hungary - Corvin node need to be developed in order to avoid road traffic difficulties in Csepel caused by the crossing rail freight transport
Technological background of the port	- There is equipment for handling bulk cargo: - gantry cranes for loading bulk cargo with 20/30/50/60/80 ton/hour capacities - forklift with less than 3 ton capacity - other gantry cranes - container moving 'calmar' - covered loading area - huge grain warehouse - open-air workstation	- No exact equipment available specialized on biomass, only for bulk cargo in general, e.g. agricultural products
Supply side of biomass industry	- Concentration of stakeholders, producers, forestry actors in the hinterland area of the port - Besides agricultural areas and forests, capital has plenty of parks too: 2370 ha - Grassland, forest, reed and uncultivated land areas have expanded recently - Significant size of forests in the hinterland area: - Pilisi Parkerdő 65.000 ha, - HM Budapesti Erdőgazdaság 37.000 ha, - Ipoly Erdő 64.000 ha - Agricultural products: millions of tons of grain, wheat, sunflower and rape - Utilization of rape stalk started to grow with the increase of biodiesel production	- Responsibilities on maintenance are fragmented among forestry actors and public companies in the capital i.e. unclear data and information on exact quantities extracted, grass cut, trees chopped - Budapest had the lowest logging rate (36% more wood planted than how much was extracted) in 2012 - Huge proportion of forests are under NATURA 2000 protection → not exploitable - No exact data of agricultural products processed in biomass industry, not even estimations - Using solid biomass for warming water and heating has been stopped due to political reasons taking traditional gas consuming into a better position

Demand side of biomass industry	- 80% of rape in Hungary is for biodiesel, 1.4 million tons for bioethanol - Rossi Biofuel Zrt. produces 150.000 tons of biodiesel per year - Zöldolaj BB Zrt. processes 90.000-100.000 tons of rapeseed of which 39.000 of refined technical vegetable oil and rapeseed oil are produced and sold for biodiesel production - Pannonia Ethanol produces 10.000 tons of corn oil, 450 million litres of bioethanol, 325.000 tons of DDGS	- No special market for biomass developed around the port, it is a brand-new area to be established and improved
	Opportunities	**Threats**
Infrastructural connections of the port	- Gubacsi bridge is planned to be soon reconstructed generating higher turnovers - Mobile Dam will be constructed protecting the Freeport from flood - There is space available for further investments in the area of the port	- There is still no agreement on the development of navigability of the Danube among the stakeholders in Hungary
Technological background of the port	- In the framework of this project a forklift will be purchased with special adapters and big-bagger feature to load, handle, carry biomass products	- Storage capacity of the grain warehouse will not be enough for storing agricultural products and biomass too

Supply side of biomass industry	- Residues from compost sites will be sold as bulk product. - Energetic use of biomass from parks and public places has recently been spreading - Chopped wood is increasingly used for heating in public institutes (schools, offices etc.) - Herbaceous plants could be grown for biogas production (yet not spread approach) - Pest county had approx. 67-77% more wood planted than how much was extracted - 250.000-300.000 tons of waste from wood extraction or processing could be utilized meaning 90.000 tOE - Forestry in Central-Hungary is higher than the national average, forests are located by or close to the Danube; chance to transport biomass on river - Sawmills and furniture and construction industry generate residues and by-products that could be utilized as biomass. Companies are by or close to the Danube	- Arable land, orchards, vineyards have reduced recently - Biomass compost sites will not let/contribute to biomass energy industry to grow (50.000-60.000 m3 organic waste processed on one of the biggest composting site)

Demand side of biomass industry	- Annual firewood extracted is enough for 500.000 households for heating; by improving extraction and utilization of green waste leftovers, this number could be 700.000-800.000 - 81 active companies in Central-Hungary registered by the Directorate of Agriculture under the National Food Chain Safety Agency: 7 biomass processors, 69 biomass dealers, 4 biofuel distributors - District Heating Co. of the capital will construct and develop 2 biomass plants with 1 MW performance each - Pellet production is a potential area for solid biomass - Hundreds of projects granted across the country to switch from traditional to renewable (biomass-based) energy and heating systems; beneficiaries e.g. local hospitals, ministries and governmental departments, universities, educational institutes, sport centres, town halls could be new clients supplied by the port	

Vukovar

	Strengths	Weaknesses
Infrastructural connections of the port	- TEN-T core network port - Perfect navigability in the port area regardless of water level - River Sava is also international waterway, (but it is only conditionally navigable) - Main trade routes between Croatia and Bosnia, Hungary and Serbia, Romania - Connected by rail and road to the Adriatic Sea - Mediterranean corridor passing by connects Rijeka-Zagreb-Budapest on road and rail - Four A3 highways to Babina Grda, Zupanja, Vrbanja, Lipovac - D2 state road - There is a Tranzit port in Osijek, but due to weak navigability of River Drava, cargos usually end up at Vukovar	- Port is not accessible when it is not allowed to navigate along the Danube - Truck transport to export biomass from the region of Slavonia and Baranja instead of IWW - The Danube stretch passing through Croatia is only 137 long and the Danube is also natural border with Serbia. To handle this situation both countries, Croatia and Serbia established joint expert group with task to detect critical sections alongside common stretch of the Danube in order to provide navigability all year long with as less as possible congestions and delays.
Technological background of the port	- Vukovar has the space and equipment to transship and reload biomass and refined biomass products, especially wood - Direct loading/unloading to/from vessels and rail wagons - Mobile facilities, transport vehicles and devices (tugs, dredges, grab dredgers, barges) - Transshipment facilities include: - locomotives - grabs for bulk cargo - spreader containers - vehicle transporter - tugboat-pusher tug - fitted out open storage area 10.000 m2 - closed storage area: 3.000 m2 - mobile harbour crane (63 t) - 3 harbour gantry cranes (5/6 t and 16/25 t) - 81% of all cargo is bulk: agricultural products and fertilizers	- Biomass capacities must be developed in the port; not enough grippers, wood waste crushers

Supply side of biomass industry	- Hinterland is an agricultural area with the most fertile soil in Croatia: 569.064 ha utilized as agricultural area, 69% of which is used to grown corn and cereals 2.408.300 tons (80%) of annual quantities of biomass from agriculture - Biogas production from livestock (bovine, sheep, goats, pigs, equidae) - Slavonia and Baranja are rich in forests: 425.175 ha estimated available forest biomass: 1.010.244 m3 / year - 10 sawmills generating residues: annual capacity 326.000 m3 - 3 pellet and 4 wood chip manufactures refine products: 121.600 t / year - 52 companies with the right to exploit forests in the region: 311.000 m3 / year - Wood chips, shavings, wood pellets are exported in higher volumes than imported meaning that there are a lot in the country - Wood Cluster of Slavonian oak with 23 companies and several institutions, towns, development agencies and a technology school: dealing with wood bioenergy among other activities. Sisarka Ltd as the largest pellet producer in Croatia is also a member. - Besides the cluster, domestic market has built on private households	- Market for upgraded products of the port hinterland is still not developed enough considering its potentials; more efficient storage is missing
Demand side of biomass industry	- In the region are 49 out of 89 power plants built or under construction use or planning to use biomass and 40 is or will be using biogas for producing electricity and thermal energy (49 biomass plants create 87.832 MW electric power and 96.310 MW thermal power, 40 biogas plants produce 53.688 MW electric and 16.397 MW thermal power) - Hrvatske sume supplies wood biomass for several power plants: 800.000 tons of wood mass for cogeneration plants per year	- Power plants use domestic raw materials available locally, i.e. no need for IWW, therefore Vukovar port has no connection with power plants and distributors

	Opportunities	Threats
Infrastructural connections of the port	- M601 railway line will be improved, partly rebuilt and electrified and there will be further developments	- As part of a railway line development project connecting Vukovar with Vinkovci, an international railway line M601 will be built and it shall pass through the port causing it to lose some parts of its territory
Technological background of the port	- Since the port has lot of experience and facility at handling agricultural products and wood, it is an opportunity to enter the biomass market by becoming a logistics centre - Within the existing port area there is the area of approximate 26 h that is occupied with the prevalent concession agreements so there are three available locations suitable for the establishment of the biomass center - Two concessionaires: Luka Vukovar d.o.o. and Vupik d.d. already have the space and equipment for the transhipment of biomass and refined biomass products	- If the biomass traffic would be developed, both concessionaires (Luka Vukovar d.o.o. and Vupik d.d.) would have to strengthen their capacities and acquire additional equipment - All the three-possible locations would require some establishment of the infrastructure for the biomass center
Supply side of biomass industry	- The market is growing continuously - Demand for plants fuelled by pellets is increasing - Croatia is a large exporter of pellets - Trend of continuous growth of forest biomass trade exchange with neighbouring Danube countries - Further development of Vukovar port to become part of the biomass market	-

Demand side of biomass industry	- 7 biomass, 11 biogas plants concluded power purchase agreements for the national grid by entering into agreements to become eligible electricity producers - Government encourages the use of renewable energy sources, biomass too in family houses, residential buildings, public institutions - Law regulates quotas incentivizing generation of electricity from renewable energy sources - Immediate proximity of urban settlements also opens up the possibility of promoting biomass usage as a cheaper solution	- Since power plants using locally available raw materials do not use IWW, Vukovar port will not improve its connections with power plants and distributors

8. Summary of preliminary development ideas of the ports

8.1. Objectives of the chapter, methodology

There have been several development ideas observed by five partner ports based on the previous chapters of their national surveys. Ports of Straubing-Sand in Germany, Vienna in Austria, Bratislava in Slovakia, Budapest in Hungary and Vukovar in Croatia completed their surveys aiming to map their competencies and opportunities to develop their ports to contribute to a cooperative energy biomass network along the Danube.

Each of the five partner ports has discussed possible future project ideas with its local stakeholders according to a joint methodology including the topics below. Among their possible project drafts each port will choose a main development area that it is going to complete a pre-feasibility study about.

What kind of biomass products can be handled in the port?

It could be logged wood, timber wood, bulk cargo such as pellets, residues and by-products from industrial use, agricultural by-products, or main product but grown for energy purposes, mostly rapeseed for biofuel production.

Does that product exist in the port or a further developed one or a completely new product that is willing to be attracted into the port?

Depending on the product, whether it already exists within the port, what have been so far or will be the target group of the current or future service/product provided by a certain port?

What kind of development is needed to handle these products?

Wood based biomass needs break-bulk cargo handler facilities, e.g. cranes, while the other most common example is bulk cargo which needs silos and dry, covered warehouses to store and forklifts and big-baggers to move it easily.

Service/product description

What activity will be implemented by the development? Is it a demand-pulled or supply-pushed service? How will the target group benefit from this activity? How does this activity contribute to a biomass-based energy system at least in a local and maybe on regional level?

Required technical background – capacities

Among the necessary facilities, infrastructure, equipment for biomass handling, loading, unloading, manipulation listed above, what is really available in the given port. If the necessary machine is not available, will the port purchase it within the framework of project Energy Barge, or finance it by its own, or choose another way of development.

Estimated investment cost

Here should be estimated the volume of investments, public procurement, development within the port.

Involved partners

A list is requested including port owners, port authorities or administration bodies, port operators, potential other stakeholders, companies having biomass related experiences or activities, biomass processors, district heating companies, end-users be them public institutes or private households around the port.

Cooperation possibilities foreseen with partner ports

A list is requested including possible partner ports be them either concessionaries or not, domestic or from abroad (e.g. from other Danube countries) that could contribute to biomass energy market development in the Danube region. What sort of cooperation is foreseen?

8.2. Summary of the surveys

As it clearly turned out from the national surveys, partner ports in Germany and Austria have well-established networks or even clusters on biomass production and supply chains to use it as a renewable form of energy for heat and electricity in their regions. Cooperation of specialized companies with R&D and academic institutes, traders and end-users can be seen and only a few elements are missing these logistic chains to become even more sustainable in terms of modal shifts to IWW and port development.

Building on that, **Straubing** noticed that even if many companies and organizations with biomass handling as a core activity are settled in the port, hard infrastructure, such as storage, bioenergy supply solutions inside the port, dedicated facilities and concepts for a circular economy are missing. Straubing, therefore, is developing its project ideas in this direction.

First of all, the managing authority of the port with cooperation of port operators will be mapping storage options and customers of wooden products and sugar beets as well as successive products. It is important, to have at least 2 suggestions for different covered storage options one can be chosen from based on investment's profitability and running costs. Own storage options and just-in-time delivery shall be in comparison to price sensitivity of customers for different storage options.

Therefore, integrated and sustainable bioenergy supply solutions shall be developed in parallel with the new port designing plan. A new port basin needs to have facilities dedicated to biomass handling. Port buildings and facilities demanding heat and power shall be identified with intensities that could be provided by a biomass-fuelled system (be that within the port by port management authority or third party). Bioenergy generation facilities are necessary for sustainable and more efficient integration and supply concepts for all potential operators and companies.

In the framework of developing a circular economy in the port, bio-based residue materials occurring in the port infrastructure management such as roadside grass and landscaping materials shall all be utilized. These materials are energetic feedstock inputs. Specified engineering firms and R&D&I funding programmes will be sought after.

Port of **Vienna** also has companies in the biomass value chain settled in the region with which it has been cooperating. However, exact strategies and measures are needed to improve the port's suitability and attractiveness to make these companies move into the port. PoVi's 3-pillar objectives, Innovation, Investment and Business Relocation will be completed by facilitating a

modal shift in the region from road to IWW, infrastructural-technological development and establishing a bioenergy cluster including more woodworking industrial enterprises, power plant in Simmering and more. To build up and increase consumer loyalty, biomass goods shall be manipulated in the port. Therefore, PoVi will purchase a forklift to store, handle and big-bag biomass products, and a conveyor belt to unload and transport new generations of wagons.

Meanwhile in Bratislava, Budapest and Vukovar, deviation among the development levels regarding biomass markets is big. None of the other three ports have experiences related to biomass handling or connections to the bioenergy sector in their countries, but each of them state they carry out other bulk products especially agricultural products (Budapest and Vukovar) in huge volumes, which is very similar and needs almost the same infrastructure, facilities and capacities. Bratislava is the least prepared for biomass handling, since its share of agricultural products in the total annual turnover is very low.

SPaP in **Bratislava** – having no dry or closed space in the port area to store even agricultural products – will construct new buildings, warehouses and silos to store solid biomass products. Although there is an intention to enter into the new biomass energy market, it did not turn out from their national survey, which target-groups and potential partners or clients they consider. Additionally, there are difficulties on Danube navigation in the Slovak section due to economic and geographical reasons.

The Freeport of **Budapest** has also no experience on carrying, handling, storing biomass products. Although, there is a historical grain warehouse for agricultural products and several facilities and equipment specialized for bulk cargo as well as many free-to-develop places within the port area where new storage and manipulating capacities can be settled. Based on the potential market of the capital and its agglomeration, the aim is to establish a logistics centre for the biomass market in the region with the purposes of either supplying buildings in the port with biomass energy and heat or delivering biomass for local institutes and the households.

Needless to say, how important in the upcoming phases of designing such projects is to have numerous calculations and communication with the relevant actors. Mapping the current demand of public and private entities for electricity and heat in the district, specifying prices of presently supplied gas are necessary for estimations which need to be included in the prefeasibility studies. Also, stakeholders, such as port operator companies, district heating company, boiler producer companies, partner ports, end-users must be contacted.

Luka **Vukovar** plans to install a biomass processing/manipulating plant and to establish a logistics hub for its region. Since citizens in the region of Slavonia and Baranja already use biomass for heating. There are three potential sites within the port area for implementing such development including warehouse building, covered manipulation facilities, calibrated platform scales and equipment implying mechanization for loading-unloading. Besides, forklifts, trucks, scattered biomass loader, log loader, basic utilities are necessary.

8.3. Chapters from national surveys

8.3.1. Straubing

As described above, a very high percentage of waterside freight handling in the port of Straubing is currently based on biomass, typically belonging to the cargo categories of agricultural and forestry goods. On rail, biomass currently makes up almost 100 per cent of all goods transported

to and from the port area. However, the port's business development strategy to sustainably profit from the bioeconomy development in Europe as described above, is based on two pillars. Firstly, a more diversified product portfolio both regarding transshipment in the port and the processing in plants in the port area itself by companies settled in the port, which, in turn, again need feedstock supply that could be guaranteed via the Danube transport axis. Secondly, the port management itself shall lead by example and include, where economically viable and sustainable, "green" solutions regarding port infra- and superstructure. Therefore, the port of Straubing would like to suggest a business development strategy that builds on two kinds of project pillars to transform the port of Straubing and others into biomass and bioenergy hubs.

The two pillars are:

1) Encouraging and supporting companies processing biomass along the value chain and related value chains **to settle in the port** via active business development strategies and measures to improve the port's suitability and attractiveness regarding these companies' needs.
2) **Install bioenergy appliances** and circular systems in the port itself to demonstrate commitment to economic and ecological sustainability.

For each pillar, at least one suggestion for a project pre-feasibility study is provided that could be conducted during the ENERGY BARGE running time and might be realized by the port itself afterwards. Especially for pillar 1, it has to be mentioned that not all ports, also in the project, have the same preconditions and profile regarding options to settle companies in the port area and/or sell or let land and plots for plants and other settlings in their area. If this is not the case, the alternative is to cover the hinterland area of the ports where the customers might be located with business development activities and to analyze whether these businesses have potential to shift transport on the Danube. One of the projects suggested by the port of Straubing clearly functions also for customers that do not have their production sites directly in the port.

In order to pre-select these project ideas for the pre-feasibility studies that have to precede actual activities, a brief workshop with the port's managing director and the port master was held and the results from the interviews conducted in WP 4 as well as WP 4's field visit were considered. Generally, for all project suggestions to further conduct the pre-feasibility studies, a number of additional stakeholders should be involved.

In the workshop, a number of selection criteria for the project suggestions for final activities were discussed. These are:

- activity must have a realistic economic and technical chance to be realized
- activity must support customers of the port
- activity must enhance environmental performance
- activity must be in line with currently running or foreseeable activities in the port
- activity must incentivise modal shift to inland waterway / use inland waterway as logistics axis
- activity must offer an option to cooperate with/transfer to other ports along the Danube and outside the Danube region

Three ideas for activities whose feasibility could be studied in the context of ENERGY BARGE in the port of Straubing are:

- Storage options for bio-based products and feedstock
- Integrated and sustainable energy supply solutions in the context of the new port development plan
- Concept for energetic and material circular and sustainable utilization of the bio-based residue material occurring in port infrastructure management such as roadside grass and landscaping materials

These shall be described in more detail below.

Storage options for bio-based products and feedstock

Description and technical background:

As laid out above, the port management itself does currently not offer any considerable specific storage areas for different kinds of goods. There is some space available for storage directly at the quays (approx. 300 m^2 in total) with solid, concrete ground, which is in use e.g. for storing bundles of agricultural plastic foil going into recycling downstream, delivered on box ballets. However, there are no storage houses, silos, mobile solutions or other roofed, enclosed options available. Mostly, the cargo is directly transshipped for further transport or directly to the customer processing the goods, as in the case of rape seed and soy. Especially for round wood and all kinds of wooden products, e.g. pellets, storage options, also for longer periods of storage are necessary. Especially for round wood, the space available has to be considerable, roofed options could also be favoured.

Generally, since the port management owns the port area and there are currently around 45 ha available and ready-to-built-on, there is no general lack of capacity for space to realize storage options. At the same time, specific types of bio-based cargo might become more interesting for both processing and trading companies, for example hard wood since it is grown more and more in the Bavarian forest and is an attractive raw material for material use and added value creation in the chemical industry and wooden residues for cascading energetic use or sugar beets and sugar thick juice for both energetic and material use. Also sugar beets or thick juice would require certain specific storage options as they are prone to cold, pests and sun.

Therefore, the goal would be to offer the trading and processing companies, both local and interest in settling, at least partial storage facilitated by the port management itself, which would also mean an extension of the current business portfolio offered by the port and ideally lead to a diversification of the biomass feedstock and products handled in the port.

An additional driver for the assessment of port-owned storage capacities for biomass products is provided by an ongoing project currently planned by the Zweckverband Hafen Straubing-Sand, the so-called open access multipurpose demo plant for biotechnological processes. The goal of this project is to establish an openly accessible infrastructure for companies and research institutes working with industrial biotechnology and the energetic and material conversion of biomass,

funded by the Free-state of Bavaria. In the context of this project, it is expected that – at least in the medium term – bigger amounts of biomass feedstock might be required that also need storage.

In order to determine final viability and demand by companies and the new plant, a study should be conducted.

Points to be covered by the study:

The study should assess the following criteria to support the decision whether to establish port-owned storage facilities for bio-based products:

- types of products in need of storage options and of interest for customers, special focus on wooden products and sugar beets and successive products
- types of products and storage needs additionally required in the vague of the planned demoplant
- suggestions for at least two different covered storage options incl. price calculation based on needs assessment
- financial calculation of investment and profitability as well as running costs
- price sensitivity of customers for different storage options offered by port in comparison to own storage options or just-in-time delivery
- identification of potential suitable location on site
- recommendations for realization

Estimated costs:

The study should ideally be conducted by an engineering and planning company with competences in the field of needs assessment, potentially the study could also be split into a needs assessment and a financial and technical planning to be run congruently.

The contract volume for the study should not exceed 9.000 €. The volume of investment needs to realize storage options, is currently not realistically foreseeable and has to be judged against its potential to be profitable.

Potential partners / stakeholders involved:

As this would be an investment fully targeted at potential and already existing customers of the port, the pre-feasibility study would have to involve all port-located companies trading or processing biomass products as well as former customers (e.g. from the wood branch) and after identification and usage of existing networks, also potential clients.

Moreover, the managing director of the newly-planned multipurpose demo plant should be consulted.

Potential port partners / Transferability:

Firstly, other ENERGY BARGE port partners should be consulted regarding what types of storage options they offer themselves in their ports in general, and which ones are suitable for which specific biomass products. From this, an assessment of how satisfied the partners are with their current solutions and recommendations for a realization in Straubing could be drawn. Moreover,

the ENERGY BARGE port partners with underdeveloped own storage could adapt the outcomes of the Straubing pre-feasibility study to their needs. Another system that could be used would be the upgrading value chain system. Assuming e.g. that sunflowers are harvested in Bulgaria, brought to a port where e.g. storage for the sunflower seeds are needed before transport, or where e.g. the seeds are already hulled and storage for the hulls and the actual seeds is needed. Afterwards, the sunflowers get transported onwards and in an upstream-port, e.g. a conversion facility is nearby and again, the second port could offer storage for the seeds and even potentially for the sunflower oil. For this kind of assessment, at least two port partners would need to emphasize an interest in upgrading storage facilities for bio-based products. Also, other ports outside the project consortium could act as business development partners according to the pattern described above.

Integrated and sustainable bioenergy supply solutions in the context of the new port development plan

Description and technical background:

The practical background of this project suggestion is the internal initiative started by the port of Straubing to instigate a new port development plan that might eventually lead to a second port basin as the existing port as built in the 1990s is laid out for an annual waterside transshipment capacity of 500.000 t. This capacity has been constantly exceeded in the recent years and projections, based on statements from the plant's executive management are that this trend will further increase in coming years. Moreover, the land plots available are getting scarcer and are scattered across the 220 ha area. The port management has therefore already started the process to draft suggestion for port development. In this context, there would be a significant window of opportunity to increase the utilization of sustainable bioenergy options to fuel needed superstructure buildings and facilities in the port itself and to equip the new port basin with biomass-handling dedicated facilities.

In order to integrate these sustainable aspects into the port development plan in the light of the Danube strategy and the objectives of ENERGY BARGE, a pre-feasibility study could assess which new port-owned buildings and facilities could be sustainably fuelled by a bio-based energy generation system in an integrated manner, and what kind of system this could be (e.g. a CHP plant based on biogas or wood chips or co-firing).

The benefits of activities that could be realized would be the port operating authorities as well as clients in the sense of a clear statement regarding sustainable and innovative energy supply systems which could be a decisive argument for e.g. companies trading with bioenergy feedstock to settle in the port.

Activities to be initiated/points to be covered by the study:

The study should enable the decision bodies in charge – provided its result is encouraging an integrated bioenergy solution –to swiftly integrate such solutions into the overall port development plan and to furthermore initiate the instalment of such solutions, e.g. a biomass heat and power station to supply surrounding buildings and facilities, in such a way that specific technical questions regarding best suited technical devices are already covered.

The most important points to be assessed would be:

- Identification of newly planned and existing port-owned buildings and facilities in need of heat and power in an intensity that could be provided by a biomass-fuelled system
- Identification of further buildings in the port area owned by companies in need of heat and power in an intensity that could be provided by a biomass-fuelled system and assessment of interest
- Assessment of most suitable technology based on needs assessment above
- Technical layout of bioenergy generation facility incl. identification of ideal location
- Design of sustainable and most efficient integration and supply concept for all potential users
- Calculation of investment costs, running costs, prices and profitability
- Recommendations for realization

Estimated costs:

In case this pre-feasibility study is realized, the costs will potentially be higher than those for project suggestion 1. The offer should however not exceed 10.000 € (already above budget; re-allocation from other WP possible).

In case the pre-feasibility study suggests initiating the investment, this will be considerably higher than the one suggested under idea 1. Therefore, additional financing partners need to be involved, especially in the final decision making.

The study itself could be financed by the Zweckverband itself via the ENERGY BARGE project budget.

Potential partners / stakeholders involved:

As described above, for this project, especially when being realized but also when assessing feasibility, more partners need to be involved.

Clearly, the project manager in charge of the port development plan needs to be consulted. Moreover, companies located in the port have to be interviewed regarding their needs and interest to be part of the project. Also, they need to be questioned regarding their readiness to pay for the energy to be generated. Most important however are technical partners from the local energy supplying companies as well as the authorities in charge of approving such projects, e.g. the Government of Lower Bavaria, which is an ENERGY BARGE ASP.

Further supporting and counselling partners could be regional network partners of the BioCampus Straubing GmbH from the bioenergy and biomass realm, most importantly CARMEN e.V. and the Technology- and Support Centre (TFZ), both part of the Kompetenzzentrum Straubing, which are equipped with experts regarding decentral renewable energy supply solutions.

Potential port partners / Transferability:

Generally, biomass-fuelled renewable energy solutions, potentially combined with other renewable solutions, can offer attractive decentral local heating and power solutions for

accumulations of buildings with medium power demand (potentially no energy-intensive production plants) as can be found in ports. Therefore, all ports interested in energy efficiency, independence and sustainable solutions should be committed to looking into options on the market and potential benefits that could be generated from these solutions.

There are a number of best case examples already known that could be contacted for experience, advice and cooperation, for example the port of Aschaffenburg that in a consortial manner motivated the construction of a biomass power station on their premises. Also the big seaports of Rotterdam and Hamburg have bio-based energy solutions installed. Port of Rotterdam in its bioport strategy aims at having 20-30 % of its fuel mix for its own power plants to be co-fired with biomass.

In case other ENERGY BARGE port partners are interested in similar solutions, cooperative assessment could be an option. This would mean for example that only one external expert would need to be contracted or joint data could be used.

Concept for energetic and material circular and sustainable utilization of the bio-based residue material occurring in port infrastructure management such as roadside grass and landscaping materials

Description and technical background:

This suggestion is indirectly connected to suggestion 2, as it could also provide energetic feedstock input into a to-be-developed integrated energy supply system. Generally, however, it mainly addresses the practical challenge faced by the port of Straubing regarding a lack of value-adding utilization of high volumes of plant material occurring during port infrastructure management. Currently, the port management is in charge of landscaping the port area, meaning that especially in summer and autumn, mowing and tree-and bush-prunning and cutting results in high quantities of biowaste materials that have to be disposed of and currently needs to be paid for. Considering this situation and the claim the port of Straubing to become a hub for bio-based economy and bioenergy, it would be highly welcome if a value-adding and sustainability enhancing valorization method could be found – either directly in the port or somewhere in direct vicinity.

This valorization could be based both on material or energetic utilization options, ideally both could be covered via a circular/cascading technology (thermocatalytical reforming, power-to-X, other conversion/pyrolysis technologies). These technologies are available; most of them however are not finally market-ready yet. Therefore, supporting such a technology could also contribute to the innovation landscape in the bio-based economy.

As the biomass occurrence peaks seasonally, it would be positive to also assess in a pre-feasibility study whether other problematic/unused waste/residue materials in the vicinity (and if viable also in greater distance, to be transported via IWW) could be integrated to back up the production process and allow for continuous production/generation.

Activities to be initiated/points to be covered in the study:

The most important points to be assessed in a pre-feasibility study for valorization of biomass waste products from the port area itself would be:

- Exact assessment of occurring volumes and quality of the biomass residues occurring directly in the port
- screening for suitable conversion technologies incl. their technology-readiness-level, potential engineering firms offering these technologies, and technical requirements of these technologies and selection of at least 2 options
- Assessment of biomass requirements (quality, quantity, etc.) for these options and check for suitability with available biomass
- Assessment of necessity and options for back-up biomass residue supply and logistics ways (economic viability) to provide these
- First technical design/layout
- Calculation of investment costs, running costs, prices and profitability
- Assessment of potential research & innovation funding programmes to cover the research part of such an investment

Estimated costs:

The study contracting volume should not exceed 10.000 €.

In case of realization, due to the innovative character, acquiring innovation funds for additional financing would be essential.

Potential partners / stakeholders involved:

For this more innovation-oriented project idea, the partners to be selected should come from the research realm, preferably from the existing network of the BCG as mentioned above. Also, other biomass residue feedstock providers could be included.

Potential port partners / Transferability:

Clearly, all other ENERGY BARGE port partners should be interviewed regarding their own situation with biomass residue occurrence on their premises and how they are currently dealing with it. In case the pre-feasibility study suggests viability and a project is realized, there is – depending on the technology selected – an option for mobile demo/pilot facilities. It would be an option to install a follow-up funding project that allows for transporting and running the technology in different ports with different feedstock.

8.3.2. Vienna

Our goal is the implementation of innovation, by conveying small & medium enterprises and start-ups, drive-forward cooperation and benefit from implementing internal innovation. The strategy is based on three pillars, the Logistics Lab, business relocations and city logistics. The Logistics Lab relies on knowledge development, research and close cooperation with start-ups. For business relocations the settlement of innovative companies at the Port of Vienna is encouraged, who could benefit from the location and network. The aim of the Port of Vienna in the field of City

Logistics is to act as a business accelerator, contributing to efficient and sustainable land use and to support the sectors e-mobility as well as urban logistics.

The port of Vienna itself shall run by a role model and include, where economically viable and sustainable, "green" solutions regarding port infra- and superstructure. Therefore, the port of Vienna would like to suggest development ideas that build on three kinds of project pillars to transform the port of Vienna into a biomass friendly City Hub.

Three Pillars:

- Innovation
- Investment
- Business Relocations

Development 1 – Innovations / Investments

Encouraging and supporting companies processing biomass along the value chain and related value chains to settle in the port via active business development strategies and measures to improve the port's suitability and to become more attractive for companies, it is necessary to create a feasibility study and develop project ideas like the Rumplmayr project. Port of Vienna takes possible calls for proposals into account in the future for such feasibility studies.

Possible Project implementation 2018

Port of Vienna in cooperation with the Port of Enns and the private entity Donausäge Rumplmayr. The Business Case is a Transport Chain which is:

- Esterhazy Wood from Eisenstadt to Vienna by truck
- Transshipment on Barge
- Transport to port of Enns on the Danube

The main Issue of the Business Case is that paired transport operations are not possible, the trucks will leave empty for Eisenstadt, which increases the price of the haulage. The Challenges we are facing is about to find a truck trailer that is suitable for several types of goods. This project would be an opportunity for the Vienna region to reduce truck transports.

Investment

In order to be able to manipulate these goods optimally, additionally a suitable forklift truck is needed. Therefore, a specialized biomass fork lifter to be able to handle these goods should be bought.

• 12 tons' forklift truck with a timber gripper: E-crane and mobile crane have a limited range; therefore, a lifting device is needed to transport the round wood to the storage location

• Forklift handling is used as a handling aid for bulk material (wheat, grain, forestry material, old wood), for example, a forklift truck is lifted into a barge to support the crane during the loading process

• 12 tons' forklift Truck with the right component to fill big bags e.g. with pellets

• Since the ports business cases do not require permanent acquisitions, the port would like to build up an all-rounder in the area which guarantees a flexible use.

Estimated costs = 80.000€

Development 2 – Business Relocations / Investments

Installing a bioenergy Cluster in the port of Vienna would close the circle with more woodworking industrial enterprises. The Bundesforste Austria is directly located in the port of Albern and the biomass power plant in Simmering, is in the Hinterland of the port of Albern. In between is enough space to settle down woodworking enterprises.

The long term strategy of the port of Vienna is to settle down companies and create a strategic cluster of consumer goods, for example biomass products. Customer loyalty is to be increased by manipulating the goods for our customers. Therefore, the port wants to change the planned small scale investments (timber grabber, etc.), into a conveyor belt, which is produced to unload and transport the new generation of wagons.

Project Development Old wood chips

Port of Vienna plans to develop services on old and deadwood handling with a new processing branch in the port. The port could develop a conveyer infrastructure for faster transshipment operations. Old wood chips are a good basic raw material for the processing industry.

Investment

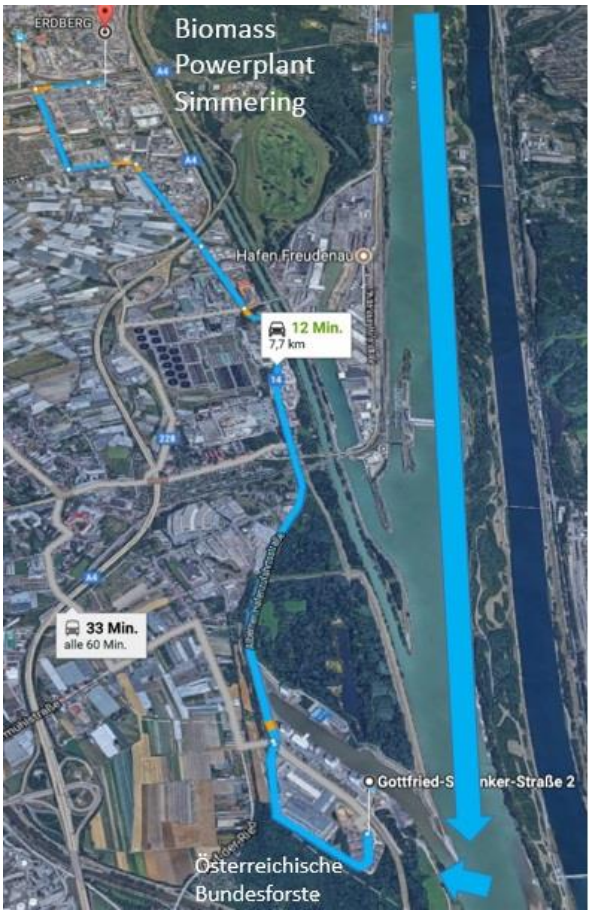
Conveyor systems are necessary to be able to unload and load modern/next generation wagons.

- Mobile unit with power supply generator
- Moving along the stationary train
- Designed for approx. one complete train per day
- Radio remote control
- Estimated costs = 90.000€

91. Figure Wood chips are transferred to a truck via conveyor belt

Assuming that the green electricity law is not extended, a more efficient supply for power plants must be ensured. This could be an opportunity for the port of Vienna to develop a more favourable transport concept by means of inland shipping.

One of the biggest round timber suppliers of Austria is located at the port of Albern. It also supplies the biomass power plant in Simmering. It refers to its biomass from all over Austria and transports it to Vienna, mainly by road. Both are state owned companies. Unfortunately, they do not use the inland waterways. In the Vienna Region are 3 biomass power plants located. The company mainly uses road transport. The reason for this is that freight stations are gradually closed. The fact that the company is settled down at the port of Albern, creates a good basis for a possible partnership or the development of a sustainable logistics concept.



92. Figure Location of the biomass power plant Simmering

Involved Partners:

- Inland Ports for example the Port of Enns
- Biomass Power plants and its Suppliers – for Example the Biomass Power Plant Simmering and the Österreichischen Bundesforste
- Biomass processing Industry
- Logistic Service Providers specialized in agricultural and forestry products
- Shipping companies

Regional Case Study

ENERGY BARGE will compile a set of regional case studies assessing the cases potential for integrated biomass and bioenergy production. Special attention will be given to the incorporation of Danube logistics and port locations. The interviews in WP4, conducted in the field of biomass helped the port to find suitable and possible ideas for a study. The port will organize a meeting and discuss what would be most helpful in terms of sustainable establishment or more efficiency in transporting biomass. Estimated Costs = 30.000€

8.3.3. Bratislava

The port of Bratislava already has a range of technical background to handle several types of biomass products. Cranes, covered push-tags, rails network and loading/unloading positions are available. More kinds of loose cargo can be handled, agricultural products and fertilizers in form of granules. Although above mentioned kinds of products are mostly handled in out port of Komárno, this port is excluded at this point of the study because it has no relevant potential to become an international biomass hub.

The Port of Bratislava does have equipment to load and unload biomass products from barges to trains or trucks and other way around, but what the port does miss are the storage capacities to store biomass products. Agricultural products, fertilizers, wood chips or pellets need to be stored in dry and closed storages. Having appropriate storage capacities would bring new business opportunities for the port and also for potential partners.

In a first step it would be needed to sort out property relations. The Port of Bratislava works on a basis where the infrastructure, machinery equipment, barges and buildings are in ownership of Slovak shipping and ports, while land is in ownership of another company, the state owned Verejné prístavy a.s. (Public ports a.s.). Slovak shipping and ports as a company is located at the port in long-term lease. The port is divided to several areas and lease conditions (length etc.) for each area might differ. More details of lease deals are a matter of internal corporate information and the author has no access to them. This is and would be the first, most important and major step in case of any kind of possible investments in the port. Negotiations with Public port a.s. would need to be held and in case of agreement, SPaP could move on to make further steps.

SPaP needs to analyse the land plan of the port and find the best possible area to build potential storage capacities or best possible buildings to turn or refurbish into adequate storage locations. The overall area of the Port of Bratislava is 205 ha (2 050 000 m^2) from which over 588 000 m^2 is in long term lease of SPaP. Areas in use are: 25 790 m^2 (covered areas) and 75 335 m^2 (open/non covered areas). Therefore, Bratislava port has enough space to operate new storage capacities. There are at least 2 other companies leasing land or property in the area of the port and they need to be involved in process of investments and negotiations as well. Other companies that need to be involved in a process of planning investments regarding a biomass hub are partners from the project Energy Barge. It is necessary to share ideas, experiences and different points of view in order to prepare high quality studies and to avoid duplicating ideas and steps.

SPaP needs to approach potential clients and clients from past that have already cooperated with the port in order to transport bio-based products. The main meeting agenda would be:

- what kind of bio-based products would be to transshipped, loaded, unloaded and stored

- average volumes of cargo per month or year, depending on further agreements

- expected technical requirements of future storage capacities (air conditioning, cooling, etc.)

- possible average charges for storing, charging and discharging services

Companies SPaP have already worked with in terms of transshipment, charging and discharging bio-based products are Mahart, DDSG and Duslo.

If everything goes well, SPaP needs to find a contractor to take over the project. To find a contractor to build new storage capacities, SPaP needs to cooperate with involved stakeholders, mainly with the companies that agreed on further cooperation and business activities in the port of Bratislava. When every involved side takes its part in preparing the study of the project, the study should meet all of expected requirements. Estimated costs of the project may vary depending on what kind of investments are described in the study.

A Slovak company named Wolf system (http://www.wolfsystem.sk) offers all kinds of storage capacities for a wide range of products, including liquid fertilizers, wood residues, biomass, wood pellets, wood chips and all kinds of agricultural products.

93. Figure Silo for wood residues from Wolfsystem

Source: http://www.wolfsystem.sk/Zelezobetonove-nadrze/Sila/PEVNE-A-SPOLAHLIVE-WOLF-SILA-ZO-ZELEZOBETONU

Biomass silos from monolithic reinforced concrete can be supplied including integrated explosives flaps, fire doors, inspection holes, and technical backgrounds. Long term experience and constant development ensure optimal performance and guarantee safety standards. Exit ladders, landings, railings and fire extinguishers complement the offer.

94. Figure Silo for agricultural products from Wolfsystem

The strength of concrete is high resistance, fast availability, versatility as well simple production and processing. This gives the best conditions for using it. Mounting holes, exit ladders, landings and rails belong to the WOLF System option.

Every silo from Wolfsystem can be built in 3 types:

Type 7 (diameter 4,50 m - 10,00 m)

Type 12 (diameter 6,00 m - 20,00 m)

Type 24 (diameter 10,00 m - 50,00 m)

Prices and costs: on demand after filling up a form with necessary information

8.3.4. Budapest

Solid biomass handling is a possible but not yet existing activity within the port, that could mean either an in-house utilization or processing and distribution. The port has storage, loading and unloading capacities in terms of agricultural by-products and wood materials (biomass handling requires similar technological background) and there are potential suppliers (forests companies, farmers) and consumers (public institutes, companies) are in a relevant distance. However, to establish possible developments in the port, technological background should be improved – as a first step procuring a forklift with a big bag adaptor specifically for biomass handling in the framework of ENERGY BARGE project.

During the designing period of the project ideas, the port cooperated with Budapest Dock – Freeport of Budapest Logistics Ltd (BSZL), Ferroport Ltd., Danube Port Ltd., National Food Chain Safety Agency, Urban Development Ltd of the 3rd District of Budapest, Plimsoll Ltd and FŐTÁV Zrt.

Budapest Dock – Freeport of Budapest Logistics Ltd. (BSZL) is a private company responsible for port management, supporting the state owned MAHART Freeport Ltd. but with a for-profit point of view. BSZL coordinates among companies in the freeport and consults potential new economic actors. Also, BSZL collects data and provides statistics about loading and unloading different types of goods from port operator companies that is sent to ministries.

Plimsoll Ltd. is a private trading company and expert on logistics services on road and IWW as well. Regarding the further development of project ideas they will provide exact calculations whether depending on distances, fix and variable costs transhipping biomass raw materials on the river Danube is feasible, profitable and efficient.

FŐTÁV Zrt. has been and will later be mentioned in other chapters of this document. The District Heating Company of the capital is recently searching for innovative and environmentally sustainable ways of providing public services. As such, later it can be a serious partner of PPs of project Energy Barge, especially, if its plans to settle biomass based heating plants into different locations around the capital will be implemented. If so, a possible biomass focused logistics hub in the Freeport of Budapest could provide services to FŐTÁV Zrt.

Description of the development ideas

Project ideas focusing on solid biomass could basically be identified as a need of a logistic centre on one hand and for satisfying own heat demand within the port area on the other. Both ideas need free space within the port that is 100.000 m^2 (mainly storage and partly offices) currently, and there are further developments in progress or during project desingning period:

- settling LNG fuel station for vessels, trucks and trains
- general infrastructure development
- railway connection development

In later sections of DTP project Energy Barge, we treat these two parts of the project idea as one organic whole development.

Project part no. 1 – new service description with required technical background, capacities, partners

To serve own energy demand means heating the offices and halls by switching from gas to biomass boilers. Currently, 214 m^3/h of natural gas is the bound gas quota for the port, this volume shall be triggered by biomass heating. Although, present boilers and heating technology had been modernized between 2000 and 2017, switching to biomass based heating would fit into such a programme. Especially in the upcoming period, due to the construction of a new hall, called C2, which will have offices on 800 m^2 out of 2000 m^2 in total. Offices are supposed to be heated up to 20° Celsius, while cooling halls down to 10° C has recently caused problems due to infrastructure bottlenecks. For a new construction like this, purchasing raw materials is important but not complicated, since

- Forests, wood industry plants, agricultural by-product handlers can be found in the agglomeration

- There are companies within the port area dealing with drying semi-finished wood products, and others selling timber, lumber
- Suppliers of MAHART Gabonatárház Kft. (Grain warehouse Ltd.) are traders of agricultural products (barley, rye, maize, wheat) that can be waste and by-product suppliers to
- Port governance owns the infrastructure concerning boilers and channels inside the buildings, which means, companies renting the buildings, are only renters of the inside infrastructure as well. Port authority is the local distributor of gas purchased from FŐTÁV (District Heating Co. of the Capital)
- Actual condition of energy infrastructure in the port and tendencies and data (quantity and prices) coming from consuming energy, gas, heat shall be collected to estimate benefits of switching to a biomass based energy supply

In the next phase of the project idea all the mentioned factors have to be included. Further planning is also necessary in terms of storage, drying, manipulation, heat supply and logistics.

All in all, implementing a project that makes heating environmentally more sustainable than with traditional gas, is manageable within the port area with a cooperation of capacity and equipment owners, authorities, port users and related companies and suppliers. It is worth the calculations to change the current gas based system.

Project part no. 2 – new service description with required technical background, capacities, partners

Another part of the improvement for the Freeport is the development of a logistic hub to become a biomass handler and distributor. According to the conditions of the privatization in 2007 (the agreement is a classified document) 75% of the port area must be used for logistic services. Wood handling and drying facilities are missing at the port, however below the key factors are provided that comply with the project idea:

- There is equipment available to pack chips into big bags
- Currently, returns logistics need to be improved to reduce the number of empty barges going up and down the river either home or abroad. These barges could ship wood as well.
- Suppliers, related organizations (boiler developer companies, heat plant, etc.) are in available distances, as mentioned above
- FŐTÁV plans to implement 2 projects related to biomass based district heating system
- Budapest Central Wastewater Treatment Plant is located on the Csepel Island, near to the Freeport, moreover its channels go under the ground in the area of the port.

For the further development of these ideas, a pre-feasibility study should be elaborated in the next phase of ENERGY BARGE project implementation.

Proposed content of further examinations (pre-feasibility study)

The following content needs to be elaborated in the pre-feasibility study:

Analysis on the current situation

- Detailed analysis of the supply and demand side in the agglomeration of the port (including consumers, such as public institutions and private households in a 10km radius of the Freeport
- Examination of existing supply chains
- Mapping and involving of all relevant stakeholders.

Development issues - Analysis of future requirements and demand

- Examination of potential supply chains regarding solid biomass with a special focus on wooden products.
- Examination of types of products in need of storage, handling and processing (drying) options and of interest by customers, special focus on wooden products.
- Mapping waste heat source for drying opportunities
- Calculations whether using waste heat for drying wood is possible or not
- Recommendations for realization

Detailed description of the planned activities

- Definition of development needs
- Suggestions for the potential location of covered storage options and drying facilities within the port incl. price calculation based on needs assessment.
- Technical parameters/capacities
- Technology and equipment
- Financial calculation of investment and profitability as well as operating costs
- Information on design and permissions
- Suggestions for partners to be involved
- Recommended implementation schedule
- Conditions of feasibility, risks and barriers

Although, the aforementioned project ideas are implementable due to current technical background and interests of stakeholders, costs and benefits are still just to be estimated as long as the feasibility studies of listed activities are not done. Furthermore, concrete services and certain partners to be involved have to be specified and till then, organizations named under chapter 9 shall be contacted to.

Description of project ideas to be elaborated in the frame of the pre-feasibility study

Developments to satisfy the port's own heating energy needs

Service/product description

The provision of biomass based heating, domestic and technological hot water (or steam) for tenants and owners of production, storage and office facilities located in the port.

Preliminary development estimates – technical background

For the implementation of the new services the following technological developments are foreseen in the port:

- Construction of open and roofed warehousing areas for the handling and storage of biomass raw materials and to ensure necessary buffer stocks
- Construction of a boiler room
- Biomass boiler, with feeder and control systems
- Insulated heat supply pipelines
- Front loader

Forklift with a big bag adaptor will be purchased in the framework of ENERGY BARGE and will part of the technological process.

Preliminary cost estimates

The preliminary estimated investment cost is 120 000 – 160 000 EUR, depending mainly on final pipeline lengths and boiler capacity.

Involved partners

- Biomass suppliers: forestry companies, major wood manufacturing plants
- Heat purchasers: tenants, owners of production, office and storage facilities located in the port, and its neighbourhood

Cooperation with partner ports

Depending on actual energy biomass prices partner ports may serve as biomass supply hubs.

Overview

In the frame of the pre-feasibility study a detailed analysis of gas consumption of each port owned building will be elaborated based on energy bills and service provider data, taking into consideration state and age of gas boilers and optimal locations for the installation of biomass boilers.

Based on the energy needs calculations and investment cost estimations, cost effectiveness of a biomass based heat supply will be examined. In case of positive results further analysis will be carried out to define optimal energy biomass supply, taking into consideration different types of biomass (firewood, logs, chips, agricultural by-products, pellets etc.). Ideal solutions for logistic solutions and possibilities for further processing within the port area will be examined as well.

In the frame of the pre-feasibility study the following possible handling and further manufacturing processes will be analysed from cost efficiency and investment point of view: chopping of solid biomass, pelleting, drying and storage.

For the drying of energy biomass possibilities of using waste heat available in the port and in the neighbourhood will be investigated.

Developments to set up a biomass handling and distributing centre in the Port

Service/product description

The woodchip and firewood processing to quality biomass and the distribution of solid biomass to end users.

Preliminary development estimates – technical background

For the implementation of the new services the following technological developments are foreseen in the port:

- Construction of open and roofed warehousing areas for processing and storage of energy biomass
- Chopping and splitting machines
- Drying equipment and additional (heater, manipulating) equipment (or waste heat utilisation system)
- Loading and manipulating machinery
- Quality control equipment
- IT system for commercial and logistic activities

Forklift with a big bag adaptor will be purchased in the framework of ENERGY BARGE and will part of the technological process.

Preliminary cost estimates

- The preliminary estimated investment cost is 200 000 – 250 000 EUR, depending mainly on storage and machinery capacities

Involved partners

- Biomass suppliers: forestry companies, major wood manufacturing plants
- Potential waste heat suppliers
- End users: institutions with biomass based heating system, households with biomass based heating system, district heating company

Cooperation with partner ports

- Depending on actual energy biomass prices, partner ports may serve as biomass supply hubs.

Overview

In ideal case the infrastructure created to provide good quality energy biomass for the port's own heat energy consumption can serve as technological background for the activities of the biomass handling and distribution centre. During the engineering planning capacities of technologies have to be adjusted to satisfy both needs in case efficiency calculations prove both activities viable.

The key element of the biomass distribution centre function is the organisation of a reliable demand side which generates large enough energy biomass flow through the Port. A precondition is a detailed needs analysis which provides information on consumer needs including quantities, optimal price level, quality requirements, delivery conditions and safety inventory obligation.

Based on the consumer needs assessment, the sources of supply, the ideal transport modes and the most economically feasible processing capacities can be analysed and designed. In order to increase added value besides logistic services within the port, possibilities of chopping, pelleting, briquetting have to be analysed. Depending on the quantities of solid biomass, distributed via the port roofed storage facilities, economic value with better quality products by reducing moisture content of the biomass can be created. Using waste heat sources available in the port and the neighbouring industrial sites, possibilities and technological solutions for drying the distributed biomass will also be examined.

For increasing consumer satisfaction, the introduction of a quality control system monitoring for moisture content, ash content, clarity and size parameters may be advantageous for the long-term success of the biomass distribution.

In order to be able to supply consumers with different technical parameters a logistic system has to be designed which is able to transport different types of energy biomass for diverse boiler feeding systems (silo, bulk, big bag etc.).

8.3.5. Vukovar

According to the referred data, the area of Slavonia and Baranja is the richest biomass area in Croatia with not even one biomass trade and logistic center (hereinafter: biomass center). The traffic position of the Vukovar Port enables it to be an excellent choice for the establishment of the center.

The main goals of the biomass center would be:

- the establishment of the regional biomass center that includes the area of the five counties of Slavonia and Baranja,
- center would provide the woody biomass fuel, wood chips, and other biomass fuels,
- preservation of the supplying safety, as the provider of all kinds of the biomass
- providing the service of transshipment while using the inland waterway transport of the biomass
- strengthening of the consistent quality standards (fuel quality, service providence)

After the establishment, the center would provide an offer which would include energy wood, wood chips and split logs. In further development, the product range of the port could be supplemented with pellets and other alternative products of agricultural origin.

Within the existing port area there is the area of approximate 26 ha that is occupied with the prevalent concession agreements, so there are three available locations suitable for the establishment of the biomass center. A project called *'Upgrading and Electrifying the Existing Railway Lines of Importance for the International Traffic M601 between Vinkovci and Vukovar'* (hrzinfra.hr) is conducted by Croatian national company for railway infrastructure development

HŽI. One of the main prerequisites of this project is to exlude a rail corridor out of the port area. Thanks to this development, PoVu will lose approx. 5 ha from its territory.

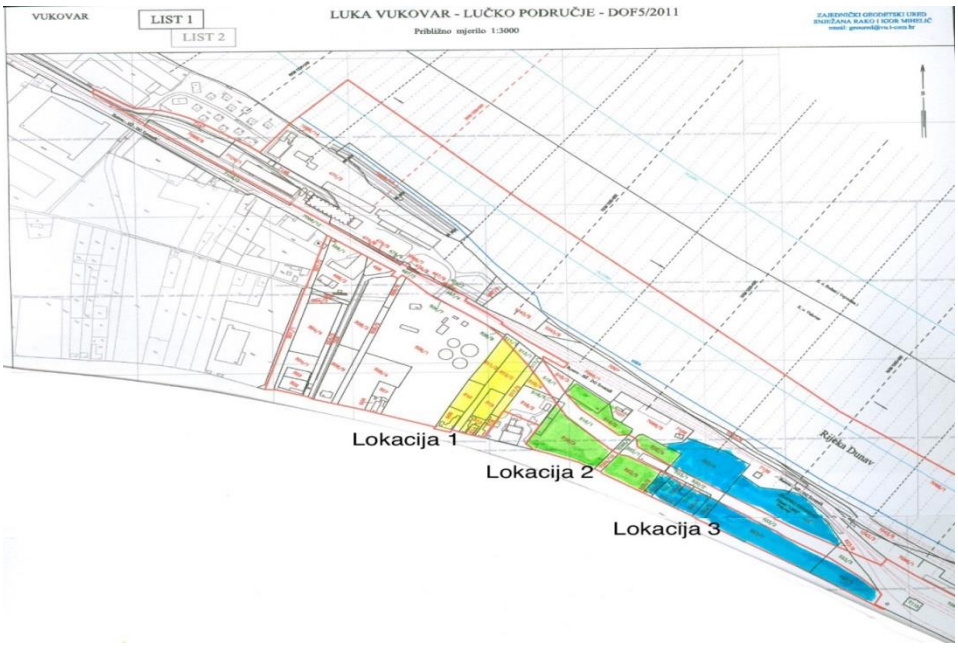
With the railway passing through and dividing the port area into two, the part next to Priljevo Street is connected with the operable quay only through two level crossings.

Three potential locations are charted on the following graphic display in order to choose the most convenient location according to the needs of the future center and minding the size and the position within the port area.

When comparing the possible biomass center locations, it is noticed that the first location (yellow) is the smallest area of 9.126,62 $m^{2,}$ the second location (green) is bigger - 11.127,09 $m^{2,}$, and the third possible location (blue) is the biggest with 22.682,01 m^2.

An overview of the parcels which are within the port area is given for all the three locations.

In its background, the first suggested location is not directly connected to the operable quay which is situated in a parallel direction with the stated areas. The only possible way of connecting with the operable quay is through the two-level crossings.



95. Figure Display of the possible location of the biomass centre in the port of Vukovar

Source: Geodetic study of port area Vukovar, September 2017 – Zajednički geodetski ured Snježana Rako i Igor Mihelić

Table 37: The area of the first possible biomass centre location

Cadastral parcels belonging to the port area - 2017.						
no.	**Land parcels that are partly within port area**	**Cadastral parcel no.**	**Land register folio**	**Parcel area according to land register folio**	**Owner**	**Area of the whole or part of the parcel within port area**
1.		513	1752	442	RH - port authority	434,98
2.		514	1752	136	RH - port authority	141,52

3.		515	1752	919	RH - port authority	945,33
4.		516	2120	421	RH - port authority	430,04
5.		509	2675	779	RH - port authority	777,76
6.		510	2675	1069	RH - port authority	1.064,30
7.		512/2	4572	2425	RH - port authority	2.426,95
8.		511/2	5885	1483	RH - port authority	1.483,32
9.		517/2	9858	981	RH - port authority	982,18
10.		518/4	11561	440	RH - port authority	440,24
						9.126,62

The second possible location includes the areas whose direct connection to the undeveloped part of the coast (180 m of the coast) could be enabled by the means of the existing road. Suggested areas are not situated next to each other. They are separated by the railway route, but the mutual connection is insured through the level crossing.

Table 38: The area of the second possible biomass centre location

Cadastral parcels belonging to the port area - 2017.						
no.	**Land parcels that are partly within port area**	**Cadastral parcel no.**	**Land register folio**	**Parcel area according to land register folio**	**Owner**	**Area of the whole or part of the parcel within port area**
1.		522/4	3072	1198	RH - port authority	1.199,35
2.		522/5	3072	2384	RH - port authority	2.385,55
3.		519/2	9366	2459	RH - port authority	2.465,03
4.		519/3	9366	5073	RH - port authority	5.077,16
						11.127,09

The third possible location would be within one part of the port area whose existing concessionaire the Vukovar Port d.o.o. would be granted to perform the work of the biomass center on the part of the area it has the access to, according to the concession agreement. At the moment, the concessionaire does not perform transshipment and warehousing activities on the area. The river bank on the sight is partially regulated but to provide the safe mooring additional terminal would have to be built.

Table 39: The area of the third possible bio mass centre location

Cadastral parcels belonging to the port area - 2017.						
no.	**Land parcels that are partly within port area**	**Cadastral parcel no.**	**Land register folio**	**Parcel area according to land register folio**	**Owner**	**Area of the whole or part of the parcel within port area**

1.		520/4	1762	961	RH - port authority	961,81
2.		522/6	1762	1052	RH - port authority	1.053,15
3.		521/2	3546	450	RH - port authority	449,98
4.		523/4	6590	4633	RH - port authority	4.636,39
5.		523/5	6590	492	RH - port authority	492,13
6.		523/6	6590	6284	RH - port authority	6.288,85
7.		523/7	6590	5881	RH - port authority	5.885,44
8.		523/8	6707	81	RH - port authority	80,93
9.		523/9	6707	2632	RH - port authority	2.634,03
10.		520/3	11554	147	RH - port authority	146,78
11.		522/2	11554	51	RH - port authority	52,52
						22.682,01

All the three-possible location would require the establishment of the infrastructure for the biomass center: warehouse building, paved manipulation area and calibrated platform scales.

It is expected for the port to participate in the river transport of the biomass in the future, so the third location has significant advantages due to the availability of the river bank, which should be brought to port purpose in order to perform the transshipment of the biomass. It is possible to organize the unregulated river bank as the vertical coast or the leaning coast. Also, the position of the crane moving on the crane track or the mobile crane has to be foreseen.

The biomass center equipment implies the gadgets and transshipment mechanization intended for the biomass loading and unloading: fork-lift trucks, scattered biomass loader, log loader. It is necessary to provide the basic utilities (gas, electricity, water, sewerage, and telecommunications).

The advantage of the third location presented in this paper is that it has been run by the concessionaire Vukovar Port d.o.o. that already owns the harbor equipment: cranes, fork-lift trucks and the 3000 m^2 closed warehouse nearby. Port concessionaire can start the transhipment even now, but collecting, handling and potential processing are to be subjects of extending the area and establishing the biomass center.

At the same time, we find that the size of the third location enables the existence of the biomass center and the biomass storage which will be transported or transshipped. Its size also enables the establishment of the pellets production which is the next phase in the biomass center development.

Regardless of the biomass center location choice, a future concessionaire should:

- build closed and opened warehouse buildings,
- paved manipulation area,
- provide moisture measurement in warehouse buildings to ensure product quality,
- provide calibrated platform scale,
- provide one mobile crane,
- fork-lift trucks and loader trucks,
- provide tuck access,
- provide suitable office-sales space as well as access to future customers of the Center

In order to ensure the suitable biomass and refined products port transport services requirement, it is necessary to regulate the unregulated part of the river bank on the third location.

As already stated, the second phase of the biomass center development foresees the establishment of a pellet production plant.

With the second phase of the project the feasibility study will be made and it will be necessary to analyze location mentioned above to choose the most appropriate and optimal solution that would enable long-term Center development, together with enabling the biomass and refined products transport port capacity development.

Each possible location is different in its development opportunities. Therefore, the detailed estimate of the required investment will be possible by choosing a location for the establishment of the Center.That choice will depend on the result of cost-benefit analysis for each of the proposed locations as components of the Pre-feasibility Study.

Table 40: Rough estimation of investment costs

		Unit of measure €	Quantity	Total €
1.	Costal structure and foundation			
	Bound meter vertical coast	26.667 €/m	100 m	2,666.700
	Bound meter leaning coast	6.667 €/m	100 m	666.700
2.	Transport and open storage area			
	Location 1	133 €/m²	5000 m²	665.000
	Location 2		7000 m²	931.000
	Location 3		10000 m²	1.330.000
3.	Railway line	1.333 €/m	350 m	466.550
4.	Water and sewage works			149.940
5.	Electrical installations			199.920
6.	Closed warehouse	400 €/m²	1500 m²	600.000
7.	Weighbridge	30.000	1	30.000
8.	Forklift 2,5%3 t	30.000	1	30.000
9.	V Forklift 20 t	80.000	1	80.000
10.	Crane adapters – gripper - log grapples	15.000		15.000
11.	Crane	2.000.000	1	2.000.000

According to Croatian Chamber of Civil Engineers guidelines[8] on prices, cost of main project is 5% of total investment cost and cost of supervision is 2 % of total investment cost. That combined represents 7% of overall investment cost.

However, it should be stressed again that both the future Center and the Port have reason to believe that quantities of biomass located in the hinterland of the Port and the fact that even today most of the rural areas of Slavonia and Baranja use biomass for the production of energy, either thermal or electrical are good arguments for development of this project. The immediate proximity of urban settlements also opens up the possibility of promoting biomass usage as a cheaper solution, and all indicators show that this area is developing in Croatia as well as the relevant market.

[8] https://www.arhitekti-hka.hr/hr/komora/akti-komore/pravilnici/pravilnik-o-cijenama-usluga/

Overall volumes of cargo in ports need to be increased to make inland navigation more attractive in comparison with other transport modes. According to some interviews with stakeholders conducted in WP 4 and collected results, it is obvious that biomass itself and final products made of biomass are not suitable for too many transshipment operations (loading/unloading) because it raises overall transportation costs.

One of the measures to move biomass from road transport would be to find a model of reducing overall expenditures (transshipment fee, port due, storage fee) giving the potential customers the opportunity to use ports as centers where they could store higher quantities of biomass that could later be transported with vessels to the final destination.

Since the data presented shows that most of the forest biomass is exported, this opens up possible cooperation with the ports on the Danube which is not present now since without consolidation of quantities the road transport is more competitive. It is also evident that the Danube countries, such as Hungary and Austria, are one of the most prominent in the biomass trade balance.

Another positive effect in rehabilitation of inland navigation could be the installation of new capacities of biogas and biomass powered plants near ports and in close vicinity of agricultural and forests areas that could be a mutual source for plants and of raw material for the market.

In Croatia, improvements on the plan of rehabilitation of inland navigation and the biomass sector are only possible with common effort and joint approach to this issue, involving all interested parties from the Ministry of Sea, Traffic and Transportation – the Directorate for Inland Navigation, the Croatian Chamber of Economy, the Ministry of Economy, Entrepreneurship and Crafts, the Ministry of Environment and Energy, policy makers but also all stakeholders who carry out policies and activities.

8.4. Conclusion and analysis – key findings

8.4.1. Possible duplications and competitions of planned activities

Because of different levels of development as far as their technological backgrounds, diverse networks including port operators with diverse profiles and activities with the biomass energy sector are concerned, the ports of Straubing, Vienna, Bratislava, Budapest and Vukovar face with various challenges that they are planning to manage differently. Nonetheless, the most conspicuous element occurring in every project idea is that all of them feature hard and soft development to be implemented. In fact, all five ports realized that in order to build up and improve level of trust among partners and consumers' loyalty, biomass goods should be handled and manipulated in the port, the added value is crucial. However, proportion of the hard and soft parts depends rather on the objectives than on actual technical conditions of the ports.

Duplications, main similarities in the project ideas

There are two kinds of similar ideas. One of them designed by two partner ports is related to cluster development, while the other one designed by the other three is focusing on ports to become logistics hubs of their regions, as detailed below.

Common approach at designing cluster development

Straubing-Sand and PoVi have cluster development related ideas based on their current infrastructure and existing excellent networks of raw material suppliers, bioenergy producers,

distributors and the academic, science and research pillars of the sector. Common elements of this type of project idea are:

- According to their approach, a strategy is needed to be set up attracting biomass related companies into and around the port.
- Straubing and Vienna lack capacities to store and examine biomass products. Only just-in-time system works, in case cargos go through other modes of transportation to the customer, but for both ports, this is a challenge future port operators will face, not the port administrators.

Common approach at designing logistics hubs

The other project idea that the ports of Bratislava, Budapest and Vukovar developed is to become biomass logistics hubs of their regions based on already being key actors of their hinterlands' industry and the fact, that supply and demand sides of the biomass energy sector in Slovakia, Hungary and Croatia need to be more accurately connected. Since the biomass sector represents sustainable processes and environment friendly modes of energy and heat supply in these countries more or less successfully, modes of transporting renewable sources and upgraded products could also be sustainable.

The biggest part of these project ideas are infrastructure developments planned to be completed by the port management authorities. They are planning to procure either forklifts, big-baggers or other machineries, or install warehouses and or plants where biomass can be stored and/or manipulated. Indeed, manipulating the product inside the port area is important for having value added within the services provided to customers in cases of every port.

Common soft elements of developing energy biomass logistics hubs in Smolenice, Central-Hungary and Slavonia and Baranja regions are the followings. They all need to map well-defined but ever-growing target groups including companies, power plants, distributors, district heating corporates, public and private end-users (whom Straubing and Vienna have already identified in their hinterlands, moreover, been working with for a long time).

No competing activities planned

First of all, construction and building of new capacities within the port and in its hinterland area are the core activities of each planned investments and none of the partners planned to invest in shipping and forming a biomass energy specialized fleet.

Second of all, networks of potential biomass suppliers, processors and end-users are different in every country. Since markets are different or do not exist in the five regions, actors are different to with various needs and aims.

Thirdly, there is no direct competition based on national surveys (ports analysed mostly national data, statistics, stakeholders etc) provided by the five ports. This can have geographical reasons as ports are rather far away from each other - except Vienna and Bratislava. These 2 ports are quite close to each other however they (and also the other 3 ports) want to serve national markets and local (national) buyers so competition is not foreseen.

There is no direct competition visible

Different levels of development of current technological background and markets lead to different needs and purposes. What Straubing and Vienna plan to implement is a *market pulled* cluster-building where less, but important links are missing in the chain: facilitating new dimensions of renewable energy clusters by high-end service provision and by diverting road transport to river in higher volumes. On the other hand, what port of Bratislava, Budapest and Vukavar are planning to do is known as the *technology pushed* approach of forming logistics hubs into the centres of non-existing biomass markets. Certainly, they are taking bigger economic risks, but it is very important to have such key actors in the Danube region pushing stakeholders – not just in the business sphere, but on political and social levels – to be tending into a sustainable regime of energy supply.

8.4.2. Interlinkage and cooperation possibilities between project ideas

Above we presented how the ports of Straubing, Vienna, Bratislava, Budapest and Vukovar planned their possible development projects. Due to different levels of development they are facing with various challenges and have different type of opportunities. Therefore, all of them concentrate on regional issue-handling. None of the five ports indicated that – and if so, then how – they could cooperate with each other or with other members of the Energy Barge partnership during the implementation at transnational level.

Instead, they mapped the opportunities and possible solutions matching their regions. During designing possible future services, they were counting on the available data from their statistical regions in the national surveys, despite of cooperating and asking for support from the neighbouring partner countries that the certain *'100 km radius'* covers. This approach would have made national surveys more insightful especially in cases of Bratislava and Vukovar that are on the borders of their countries and half of that radius is in the territory of another state. As a next step, being familiar with partner countries' needs and supply opportunities, ports could have designed their project ideas involving wider ranges of stakeholders building true international partnerships. However, it does not mean, that project partners cannot cooperate in a more sophisticated way in the future.

Additionally, only PoVi and Straubing mentioned that by the developments planned to be implemented, new services will contribute to the reduction of truck transport in favour of IWW in the Viennese Region and Bavaria. At first sight, many of the ports are unsatisfied with Danube navigability on their sections, but did not count on international connections that Danube could possibly provide.

Instead, separate development actions have been designed that might have interlinkages but lack of cooperation as far as previous activities, research works, service improvements are concerned. Even though, we can notice best practices among the five ports for other Energy Barge partners to apply.

First, what Straubing port has so far achieved, established in the field of biomass energy specialization with its knowledge and R&D centres, traders, related companies could be defined as a positive example that the other ports should seek after. These results are defined as

- continuous searching for newer, more environmentally sustainable and more unique solutions;

- tools and services that can attract companies into the port to do business together with the port management authority's efficient coordination from the background.

Secondly, not only what Straubing has implemented so far, but what it plans to create by developing circular and sustainable utilization of biomass based residue materials occurring in port infrastructure management is entirely exemplary.

8.4.3. Possible further services for joint implementation

One of the objectives of the Energy Barge project is to create the bases of a cooperative energy biomass network of Danube ports in order to exploit advantages of waterway shipment of raw materials and biofuels and to increase the role of sustainable biomass based energy production in the Danube region.

Future investments planned in the frame of the project are mainly focusing on developments in individual ports. However there are opportunities and market potential for possible further services for joint implementation as well. These possible cooperation and joint developments may increase the turnover of participating ports from energy biomass shipment and handling considerably.

The suggested further services for joint implementation are preliminary ideas to be discussed by participating ports during project meetings in order to define directions of further co-operations. The detailed elaboration of these possible services is not the aim of the Energy Barge Project but project activities are providing good opportunity to define active co-operation directions for the long run as it is defined in the objectives of the AF.

Objectives and driving forces of possible future services

Based on the experiences of the situation analysis waterway shipment of biomass have to compete with road and rail transport. Presently, the majority of green energy raw materials is transported on road as it is more flexible both for producers and end users. The shipment usually does not require transfer and most of the production and end user sites has no direct connection with the river. Waterway shipment, however, is also able to gain extra benefits for market players like lower shipment costs, larger quantities and the opportunity of value added services and further processing in the ports.

For end users the key decision-making criteria are

- good price (delivered at place);
- reliable, permanent quality (where key factors are clarity and caloric value) and
- security of supply.

Possible future services of ports for joint implementation have be selected and designed in line with the above key criteria in order to satisfy potential consumers' needs.

Types of possible joint services

Possible main directions of further services for joint implementation may cover different elements of information and logistic services as well as direct assistance of commercial activities of the energy biomass market. The complexity of provided services may differ very much and the introduction of more complex activities will most probably require a step by step approach.

There are different levels of services which can be provided by the ports in the form of joint implementation:

Information services for traders and end users

With the collection of market information on energy biomass raw material prices and available stocks in the hinterland of the port, individual ports may become essential player of local biomass trade and the opportunity to provide further services is increasing. Based on the experiences of the Energy Barge project, ports already have a basic database on potential suppliers and buyers in their hinterland which provides a very good basis for setting up a market database. Via the active connection with the members of the biomass industry, ports will have further opportunities to sell services like logistic related activities, processing or storage of biomass as well.

As a supplementary service, information on waterway shipment costs can be valuable data for end users. By using port areas as buffer storage sites for solid biomass, the security of supply can be maintained with flexible shipment arrangements as well which gives the opportunity to select the most economical timing and mode of transport. This way for example suitable returning empty vessels can be involved in biomass shipment with more economic shipment prices and seasonality effects can be reduced as buffer storage capacities are able to maintain security of supply.

With the information available on stocks, prices and shipment costs, ports are able to optimise the raw material supply of neighbouring end users and traders. A cooperation between Danube ports in the fields of information sharing and a jointly operated database brings them a competitive advantage as energy biomass supply can be optimised from anywhere along the Danube taking into consideration local prices and shipment costs.

Quality control

To further develop the level of services it is essential to set up a standard quality assurance system in each participating port in order to standardise quality (e.g. clarity, average unit size, homogeneity, calorific value, humidity content) and make buyers sure that they receive the expected raw material for their energy production even if it is shipped from a distant location, via waterway.

In order to ensure standardised quality, ports have to set up control units with the necessary equipment and protocols which are used uniformly in each port. The reliability of the quality certification system is one of the key success factors of an international biomass market assisted by Danube ports.

Biomass "stock exchange"

With a well-functioning database on prices, up to date information on optimal shipment costs and a reliable quality assurance system Danube ports may become key players of energy biomass trade in their region. Also with developments in processing and handling (e.g. shredding, drying, storing etc.) they may become active part of the value chain as well.

To further extend the services of Danube ports an electronic solid biomass "stock exchange" could be developed in order to give the opportunity to end users and traders to buy their raw material on an optimal price (including shipment cost) independently of its production site using the Danube as shipment route. The system could provide up-to-date information for potential buyers,

suppliers and forwarding companies and create an electronic platform to manage transactions as well.

The system requires a standardised quality system based on well-functioning quality control procedures which guarantees that buyers will receive the required product quality.

With the assistance of the electronic system raw material prices and shipment costs are competing on a daily basis giving the industry a new momentum.

Other joint activities in order to increase the role of waterway transport and Danube ports in the utilisation of energy biomass

Extending cluster and cooperation activities

Based on the findings of the survey clusters may have a very positive effect in the development of energy biomass market by bringing together standpoints of industrial, academic and other players. Any extension of these already existing clusters to other countries could help the internationalisation of bioenergy supply and increase the role and efficiency of energy biomass utilisation. These initiatives would probably increase the role of waterway transport and the possible services of Danube ports as well.

Cooperation in technical innovation

In many cases the main reason of energy raw material producers for choosing road transport is that no port is available in the neighbourhood of their production site. Most cases the need for transport is season connected to harvesting time or forestry activities. With the development of mobile temporary loading pontoon and attached loading devices for forestry companies and agricultural residues the quantities of waterway transport of energy biomass could be increased. In order to develop the most suitable equipment and use its capacities the most effective way cooperation between participating ports would be advantageous.

A further topic for possible cooperation in technical, technological innovation could be the drying of solid biomass (mainly woodchips) with environment friendly technical solutions. Ports could become a very valuable part of the value chain of energy biomass if solutions for the reduction of humidity would be available during biomass handling and processing. Best practices for the effective utilisation of waste heat, heat pumps, solar thermal or other technologies could help the development of new services.

Policy level cooperation

Danube could be an economic and more environment friendly transportation route for the shipment of solid energy biomass especially if major raw material producers and end users (energy producers) would have direct access to port facilities. An initiative could be supported by Danube ports towards decision makers and key players of the green energy production industry to increase number of biomass based combined heat and power plants (CHP) and district heating power plants with direct access to ports. This way energy biomass end users and producers of biomass located close to the Danube (agricultural producers, forestry companies) could be connected directly via the Danube.

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Contact

MAHART-Freeport Co. Ltd
1211 Budapest
Weiss Manfréd út 5-7

E-mail: sztilkovics.szavo@mahart.hu

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