Interreg
Danube Transnational Programme
ENERGY BARGE

ENERGY BARGE

Building a Green Energy and Logistics Belt

Project Code: DTP1-175-3.2

Deliverable 5.1.3

Port of Vukovar – Pre-feasibility Pilot Study

June 2018

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.

I. 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 facilitates the market uptake of biomass, supports better-connected transport systems for green logistics, and provides practical solutions and policy guidelines. The Agency for Renewable Resources (FNR) coordinates the ENERGY BARGE project consortium with fourteen partners from Austria, Bulgaria, Croatia, Germany, Hungary, Slovakia and Romania.

II. About this document

This report corresponds to D 5.1.3. Pre-feasibility study - developing the Port Vukovar as a biomass hub. It has been prepared by:

Due date of deliverable	2018-04-15
Actual submission date	2018-06-25
Start date of project	2017-01-01
Duration	30 months

Work package	WP5
Task	D 5.1.3
Lead contractor for this deliverable	Port Authority Vukovar
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Version	Date	Author(s)	Reason for modification	Status
1.1	2018-05-07	Port Authority Vukovar	Comments from the LP and MAHART	First draft
1.2	2018-06-22	Port Authority Vukovar	Comments from the LP and MAHART	Second draft
2.	2018-06-25	Port Authority Vukovar	Comment from the LP and MAHART	Finalised
3.	2018-06-28	Port Authority Vukovar	Review by QAM	Finalised

III. Background

This deliverable "D 5.1.3 Pre-feasibility pilot studies to prepare large-scale investments to transfer ports into biomass hubs" is based on the task as described in the latest approved version of the Application Form (AF) of the project ENERGY BARGE (Project Code: DTP1-175-3.2).

- Activity 5.1. *Pre-feasibility pilot studies to prepare large-scale investments to transfer ports into biomass hubs* (Lead: MAHART)

The port partners of the project elaborated pre-feasibility pilot studies (including investment plans) in order to define development plans and investment needs required to strengthen ports as logistics hubs for the bioenergy sector, where biomass is handled, stored and manipulated in the most appropriate way.

Individual pre-feasibility pilot studies were prepared following a common methodology (D.5.1.2) which helped the port partners to develop their pre-feasibility studies following a unified approach and it will also support the preparation of the synthesis report (D 5.3.2). Each individual pre-feasibility study defined development plans and investment needs - to prepare large scale investments beyond the project duration - of participating Danube ports in bioenergy logistics alongside the Danube River. Studies investigated existing value chains, industrial and logistics capacities and identified technological solutions and related investment projects with a budget, cost-benefit analysis and timeframe. Each of the 5 studies are interlinked in a way that the investment plans were coordinated to avoid competition and overlap.

Coordinator: MAHART (HU)

Involved Danube Ports: BCG (DE), PoVi (AT), SPAP (SK), MAHART (HU), PoVu (HR)

They all prepared their own pre-feasibility pilot study following the D 5.1.2 common methodology and were also responsible for the involvement of policy makers and at least 5 industry stakeholders to derive industry knowledge and experience.

The key focus of the pre-feasibility study structure was to provide a guideline for the elaboration of feasible and economically sound investments to strengthen ports as logistics hubs for the bioenergy sector alongside the Danube. The study structure was elaborated based on previous experience gained in the preparation of infrastructure development projects funded by the EU and also guides issued by various development organizations including the European Commission (*eg. Guide to Cost-Benefit Analysis of Investment Projects Economic appraisal tool for Cohesion Policy 2014-2020 (European Commission 2014 - http://ec.europa.eu/regional_policy/sources/docgener/studies/pdf/cba_guide.pdf).* Previous ENERGY BARGE activities and deliverables, including experiences gained during the preparation of D5.1.1 surveys, impressions gathered during the port exchange workshop and results and deliverables of T2 WP4, also contributed to the development of the structure and finally the pre-feasibility studies. Objectives set by the AF were taken into account, too.

Local biomass markets are at a various development stage in each involved Danube Port area. It is also reflected in the subject and results of the pre-feasibility studies:

- Port of Straubing (PP1 – BioCampus Straubing) is an operational logistics hub for biomass handling with a main focus on bioenergy utilization. The focus of its study is to put on a preliminary analysis of options to develop additional storage space for biobased feedstock and products serving the needs of current and future potential customers of services offered in the port by both port management itself and the private logistics companies operating based on the port's infra- and superstructure.
- Port of Vukovar (PP11 - Public Institution Port Authority Vukovar): several analysis on biomass market prices in the wider environment indicated the possibility of inclusion of the port in the production chain, and thus in the value chain via the establishment of a major biomass trade center primarily for pellets and wood chips provided by the hinterland area of the Port of Vukovar.
- Port of Bratislava (PP7- Slovak Shipping and Ports JSC): responding to the needs of a growing market and building upon the country's large forest areas on the supply side the subject of the study is to develop the transshipment and storage facility in Port of Bratislava suitable for the handling of wood pellets and wood chips in bulk.
- Port of Budapest (PP9 - MAHART-Freeport Co. Ltd) is located at an ideal site for the implementation of a biomass-based energy production project. The necessary raw materials can be supplied through a waterway-based logistics network. With the planned Galvani bridge nearby the Freeport a key district heating pipe network will be built very close to the planned place of implementation. For the feed in of green electricity transformers are available on the site as potential connection points. Preliminary calculations show that a profitable biomass-based power plant could be set up in the port.
- Port of Vienna (PP4 – Port of Vienna): is already the largest port and trimodal logistics centre on the Danube in Austria. The study investigates the potentials of log wood/roundwood and waste wood / wood residues in the Danube Region east of Austria up to the coast of the Black Sea in order to disclose relevant insights into price structures and trends to justify business cases and/or logistical value chains. As a conclusion a conveyor belt system is to be installed which will also serve the new generation of the wagon fleets carrying biomass to the port.

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1. Executive Summary

This pre-feasibility study was prepared based on the project task and the Transnational Implementation Plan made under the Energy Barge project, which provides a description of the situation and operations of the Port Authority of Vukovar as a beneficiary of the project.

The Transnational Implementation Plan described the supply and demand of biomass and processed products in the hinterland of the Vukovar port. The data on export and import of biomass and processed products from the Republic of Croatia are also analysed. Looking at the conducted analysis it can be stated that in Croatia, and even in the hinterland of the Vukovar port, the market of biomass and processed products is in continuous development. The specialty of the forest biomass market arises from the fact that the Hrvatske šume d.o.o. (Croatian Forests Ltd) is the largest supplier with a monopoly position. This market position gives Hrvatske šume d.o.o. the position of a strategic partner in this project. Such position was undoubtedly recognized through the development of this pilot study, their available official reports were used for the study including official contact with their management. At the same time, data on biomass market prices in the wider environment indicate the possibility of inclusion in the production chain, and thus in the value chain, by the establishment of a biomass trade centre primarily for pellets and wood chips in the area of the Vukovar port. Currently the largest quantities of biomass and refined biomass products are transported by trucks from the forest to the door of the customer or from door to door.

The existing infrastructure and technical conditions at the Vukovar port were also analysed and it is estimated that the present concessionaires can carry out the transshipment and storage of biomass and biomass products, but there is no interest in it because local transport is carried out by trucks and import volumes that could be exported using shipping are currently too small. By setting up a biomass trade centre there would be an increase in the amount that would benefit the cheaper shipping and at the same time would stimulate further development of a biomass market in the hinterland and beyond of the port. The need for the establishment of the biomass trade centre is shown by the increasing number of power plants and cogeneration plants that use or plan to use biomass or biogas. By setting up a biomass centre, a free biomass market would emerge as an additional incentive for the use of renewable energy sources. Through the SWOT analysis, strengths and weaknesses, opportunities and threats regarding the infrastructure connectivity and technical equipment of the Vukovar port, as well as the supply and demand of biomass and processed biomass products have been evaluated. And this analysis points to the many strengths and opportunities for development of the Vukovar port, which should be the basis for the project for the establishment of a biomass hub in the Vukovar port, but with previous investment in infrastructure of the Vukovar port.

In the description of the pre-feasibility study, the arguments for the establishment a biomass trade centre in the port area are shown. The biomass trade centre would have two functions, the first one is a terminal port specializing in the transshipment and storage of biomass and processed products, and the second one is a place of sale for customers from the wider hinterland of the port.

The centre would provide a supply that would include energy wood (wood chips and logs). In the further development of the port area, the production range could be supplemented with wood pellets and other alternative products of agricultural origin. It should be noted that the centre would have a significant impact on the market, and in particular the monopoly position of Hrvatske šume d.o.o. as the main supplier. As potential stakeholders interested in the establishment of the centre, this document specifies suppliers of biomass Hrvatske šume d.o.o. and Spačva d.o.o., the leading company of road transport Ricardo d.o.o., and Luka Vukovar d.o.o. as an existing concessionaire in Port.

For the realization of the project or the establishment of the biomass trade centre, three locations in the port were initially considered, with location 'one' being eliminated because there is no direct access to the operational coast, so that the remaining two locations are included in further consideration. The important difference between the remaining two locations lies in the fact that location 'two' is not under concession while location 'three' is under the concession of Luka Vukovar d.o.o. until 2026. At both locations, it would be necessary to invest in port infrastructure. However, considering the possibility of establishing a biomass trade centre, then location 'two' is more favourable because immediately after the construction of the port infrastructure it is possible to have a concession tender. The establishment of a biomass trade centre would require the same investment on both considered sites, meaning that the future concessionaire would have to make all the necessary investments in establishing such a centre. Partners that could contribute to the establishment of a biomass trade centre in the port area can be grouped according to the type of their contribution to policy makers at the state, regional and local level, biomass suppliers, logistic service providers and biomass associations.

The project of the restructuring of the Vukovar port at a biomass hub is a project that should be realized in three phases:

- the first phase is the construction of a coastal structure that covers the design and construction of the coast as well as the establishment of the necessary infrastructure,
- the second phase is the issuance of a concession for the establishment of a biomass trade centre and the selection of concessionaires,
- the third phase is the establishment of a biomass trade centre which is the investment of the future concessionaire.

According to the proposed plan, an estimate of the required investment by the Port Authority of Vukovar is presented, as a prerequisite for granting a concession for the establishment of a biomass trade centre, as well as an estimate of investment for the future concessionaire. The total planned investment is 7,158,660 €. The investment includes construction and upgrade of an infrastructure of the Vukovar port. The new infrastructure makes 65.1% of the investment, while the equipment purchase makes the remaining 34.9% of the investment. This also implies the granting of a concession for the establishment of a biomass trade centre in the same period of time. The investment is planned for the period of 2019 - 2021. The total time horizon is 30 years, which is common for infrastructure projects of this kind. This also implies a granting of a concession for the establishment of a biomass trade centre in the same period of time. The commercial investment period (business operation period) is 27 years. Expected amounts of forest biomass in the future biomass trade centre are estimated at 126,000 tonnes per year. Of this total, 66% are pellets and the remaining 34% is wood chips. Investment for the construction

of a biomass trade centre is the obligation of a potential concessionaire. Cost-effectiveness of a biomass trade centre is not explicitly the subject of this study, although data output in the study implies significant cost-effectiveness of a biomass trade centre for a potential concessionaire.

Implementation of the project of the development of the Vukovar port in a biomass hub is analysed solely from the point of view of the Port Authority as the project holder and beneficiaries. Thus, the costs of operation and maintenance of the port infrastructure were analysed through two scenarios: business as usual and implementation of the project in order to assess the actual impact of the project on the future business of the Vukovar port.

Through the financial analysis, the project's profitability was considered, project sustainability as well as its feasibility was verified, and a projected cash flow that supports socio-economic costs and benefits. Investments required are analysed. Furthermore, a possible source of funding according to co-financing from EU funds for the investments is considered. This necessity arises from the results of the financial analysis according to which the financial net present value (FNPV (C)) and the financial return rate (FIRR (C)) indicate the project's non-profitability when the total invested amount of the project is observed. The net present value of financial assets (FNPV (C)) is -5,292,163 €, while the financial return on investment (FIRR (C)) is -4.03%. The net present value of the national equity (FNPV (K)) is -788,899 €, while the financial return on investment (FIRR (K)) is 1.03%.

In the economic analysis, socio-economic benefits were considered, such as: the value of the general contribution of a biomass trade centre (ecological-economic-social context) and the effect of transport costs on waterways in relation to road transport. Given the economic analysis elements, the economic net present value of the investment (ENPV) is presented below as the difference between the discounted total benefits and costs for the company and the economic return rate (ERR), which is equal to the rate generating the value of ENPV = 0. The economic net present value is positive and amounts to 5,353,090 €. The economic return rate is positive and is 13.31%. The ratio of benefits and costs (B/C ratio) is also calculated as the ratio between discounted economic benefits and is 1.92.

In the analysis of implementation, special consideration was given to the possibility of cooperation with other Danube ports. Considering the existing biomass resources in the wider environment of the Vukovar port (a narrow gravity area of 300 km is observed), the cooperation with ports in Hungary (Baja and Mohacs), Serbia (Pančevo, Novi Sad and Belgrade) and the wider gravitational the cooperation area with the Constanza ports in Romania and the Vidin port in Bulgaria at the bottom of the Danube and the Krems arch from the Upper Danube area.

In the last chapter of the study the risks and obstacles to the implementation of the project and risks and obstacles after project implementation, i.e. during the operation of the port as a biomass hub are considered. Critical variables were defined by sensitivity analysis, parametrization of pessimistic and optimistic scenarios, and a risk management matrix that may occur in project implementation and after implementation in a biomass trade centre.

2. Introduction of the implementing organisation

2.1. Organizational structure and activities

Vukovar port is located on 1,335 km of the downstream flow of Danube River, on its right coast. 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.

The port's mission is to effectively carry out port transshipment and warehousing operations for various cargoes from Croatia and abroad, providing the best quality of service to the port users they will be satisfied with and thus becoming the leading river port in this part of Europe. In order to become the status of the leading inland waterway Croatian port, it is necessary to modernize and reconstruct the port.

Port authority Vukovar was established in 2001 by the Republic of Croatia, Ministry of maritime affairs, transport and infrastructure. Port authority Vukovar is a non-profit legal organisation.

Port Authority Vukovar performs following activities:

1. organization and supervision of vessels docking and manoeuvring in port,
2. control of port traffic and incoming/outgoing vehicles,
3. maintenance of common structures of the port in the port area,
4. maintaining order in the port, a high degree of safety and environmental protection in the port,
5. construction and modernization of port structures on behalf of Republic of Croatia,
6. property management in the port area where port authority has a right to build,
7. management of free zone in the port area, which was established by the Croatian Government in accordance with the rules governing free trade zones,
8. conducting of procedures related to granting concession,
9. supervision of port operators work and port users who perform port activities, in accordance with the commitments,
10. marketing and promotion of the port on the transport market,
11. ensuring the provision of services of general interest or for which there is no economic interest of other economic subjects,
12. preparation of a draft planning documents for the development of the port system in the inland navigation,
13. technical assistance to local and territorial (regional) governments in the development of ports and harbours,
14. other activities determined by law.

In the Port Authority of Vukovar four departments with 22 employees are organized.

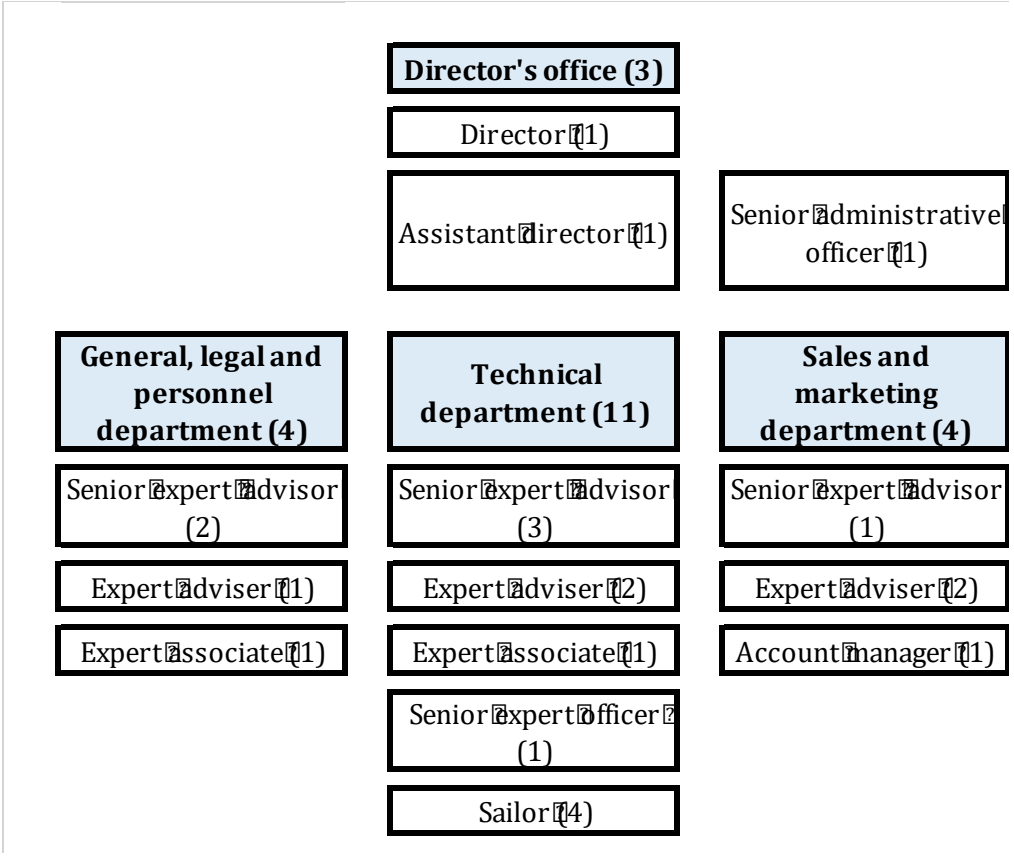

Figure 1 – Organigram Port Authority of Vukovar.

Source: Rulebook on internal organization of Port Authority of Vukovar

2.2. Description of technical, financial and legal capacity

The superstructure in the Vukovar port includes port facilities and handling capacities for cargo shipment, warehousing and other specific port activities. Port superstructures are fixed facilities built on the port area (warehouses, silos, administrative buildings) as well as port transshipment facilities (cranes).

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

Luka Vukovar d.o.o. is located on the right bank of the Danube River which, with its class Vc in this section, enables the availability of sailing for 365 days a year. It has the largest length of the operational bank making it the largest concessionaire in the port area.

Nautica Vukovar d.o.o. has been operating in port since 1999. This company recognized the potential of the Vukovar port in an economic and traffic sense. Target market Nautica Vukovar d.o.o. as a supply station with diesel fuel is the complete Danube area from Slovakia to Romania.

Lukoil Croatia d.o.o. for the transfer, storage and transport of oil and petroleum products was registered in Vukovar in 2005 in order to import and distribute petroleum products to the Republic of Croatia market, which was granted concession at the end of September 2005.

Vupik d.d. operates within the Agrokor Group and is involved in investments in the silos plant with a gravel ramp on the Danube Silos. The state-of-the-art equipment with a capacity of 200 t/h is utilized at the Danube silo, thus tripling the capacity of transshipment.

Table 1 - Technical specifications of the port and its concessionaires.

Source: Port Authority Vukovar

TECHNICAL DANA	LUKA VUKOVAR d.o.o.	VUPIK d.d.	LUKOIL CROATIA d.o.o.	NAUTICA VUKOVAR d.o.o.
Terminal purpose	Reloading of cargo on multi-purpose terminal for bulk, palletised, 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 +000	1335 +800	1335 +500
Operational quay	cca 450m	206	cca 75 m	cca 100 m
Number of berths	4	1	1	1
Type of quay		vertical quay	sloping quay + pontoon	sloping quay + pontoon
Floating dock length			75 m	PO-9-VK 76,50 m
				PO-1-VK 82,40 m
Fuel tank capacity			R-1 V=3000 m3 R-2 V=1000 m3	PO-9-VK - 3047 m3
			R-2 V=2000 m3 R-2 V=2000 m3	PO-1-VK - 1334 m3
Equipment			Pumps, measuring instruments	Pumps, measuring instruments, weighbridge scale
Cranes	1 x 63 t Gotwtwald HMK 170	Static reloading tower with a mechanical elevator and transporters, capacity 200t/h (wheat 0.75t/m3) and automatic vessel shifting system		
	1 x 16/27 t Ganz			
	2 x 5/6 t Ganz			
Enclosed storage facilities	cca 3000 m2	48.000 t	8.000 m3	
Open storage area	cca 15000 m2			
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 m3			
	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 1300m	2 tracks of 750 m	218 m	390 m
Maximum annual capacity	1.2-1.5 mil tona	300.000 t	100.000 m3	

While analysing the quantities of transhipped cargo of the Vukovar port in 2017, the total cargo volume is 319,467 tonnes of various types of goods. Most of the cargo is artificial fertiliser, followed by oilseeds and grains.

The financial aspect of the Port authority Vukovar considers funds provided by the state budget and revenues from its own activities. Ensured funds from the state budget are intended for projects of construction and modernization of port facilities and maintenance of port facilities, while current operations are ensured from their own activities, consisting of concession fees, port fees, rents and other revenues.

The Port Authority's action is in line with the legal acts: the Law on Navigation and inland ports, the Law on Concessions, the Strategy for the Development of River Transports in the Republic of

Croatia (2008-2018), the Transport Development Strategy of the Republic of Croatia 2014-2030 and aligned with the spatial plans of Vukovar-Srijem and Osijek-Baranja Counties.

2.3. Previous investments

In the past three years, the Port Authority of Vukovar has not had significant investments in the improvement of the infrastructure and capacity since the capacity of the port are 2,000,000 tonnes, while in 2015 424,304 tonnes are implanted, in 2016 slightly less – 332,941 tonnes, and in 2017 only 319,467 tonnes.

Figure 2 - Port Vukovar (copyright: Port Authority Vukovar).

3. Analysis of the current situation

3.1. Supply of bioenergy raw materials

The project includes the hinterlands of Vukovar port in a radius of 100 km (Croatian territory), in further analysis as Vukovar port hinterland the area of five counties was analysed:

- 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
- Virovitica - Podravina County with the seat in Virovitica.

Figure 3 - The area of five counties as the hinterland of Vukovar port.

Source: http://www.hzz.hr/print.aspx?id=11397

The listed area is the region of Slavonia and Baranja, the economically most underdeveloped Croatian area. This fertile area, which is significant for agriculture and forestry, is bordered by the Drava River from the North, the Sava River from the South and with Danube from the East. According to data from 2012, there are 806,998 inhabitants in this area. The area is rich in forests, with over 80% owned by the Republic of Croatia, and managed by Hrvatske šume d.o.o.. The total area of forests in the hinterland of the Vukovar port is 425,174 hectares, which is 15.41% of the total forest area in the Republic of Croatia. Of the above total forest area the 46,090.76 hectare is privately owned forests. The estimated available biomass level at the five counties was calculated (by the authors of the study) using data at the level of the Republic of Croatia, taking into account the share of forest areas in the mentioned counties, and is given in the following table.

Table 2 - Estimated available biomass at county level.

COUNTY	ESTIMATED FORREST BIOMASS m³/ year
Vukovarsko-srijemska	162,642
Brodsko-posavska	134,649
Osječko-baranjska	291,011
Požeško-slavonska	266,160
Virovitičko-podravska	155,782
TOTAL	**1,010,244**

As already mentioned in the project documentation, the main supplier of forest biomass in the hinterland of the Vukovar port in the area of all counties is the Hrvatske šume d.o.o.. In order to be more efficient in the use of forest biomass and to create economic benefits for Hrvatske šume d.o.o., a company called Šumska biomasa d.o.o. (Forest Biomass Ltd.), was formed with the primary task of organizing the market of forest biomass, i.e. for organized collection and sales of wood chips and wood splinter. However, according to available information, the Šumska biomasa d.o.o. is in the process of shot down as a separate daughter company and will meagre into organization structure of Hrvatske šume d.o.o. . (E.g. list of smaller suppliers of wood in Annex A.1 of this document).

Private forest owners are smaller suppliers and cannot compete with Hrvatske šume d.o.o.. In addition, the Hrvatske šume d.o.o. has to license them in order to collect wood from the forest. Businesses and crafts that have a license are limited based on annual quantities (on average 8,000 m^3).

According to the study of the Faculty of Electrical Engineering Osijek, the J. J. Strossmayer University of Osijek (Ivanović, M., Glavaš, H., 2013), the largest source of biomass in agriculture in the Slavonia and Baranja region, is the cultivation of corn and grain, which accounts for more than 80% of the annual quantities of biomass, while the rest is from vineyard and fruit growing. Agriculture biomass is a product of small agriculture households and as such is used largely within these households where it is generated.

The basic prerequisite for the collection of biomass produced by agricultural production is the commasification (Land Management) of agricultural land which has not yet been carried in Croatia.

According to 2010 data, approximately 3.5% of total primary energy is obtained from firewood. However, this is estimated total consumption at the national level because reliable statistical data for the regional and local level do not exist and are estimated based on available data from the Central Bureau of Statistics. These data contain the number and size of households using wood as the primary source of heat energy. For Slavonia and Baranja the annual consumption is estimated at 1-2 m^3 per capita, which is about 1,5 million m^3 per year.

In the project area, 10 sawmills are active and the residues from the wood processing are estimated at maximum year capacity of 326,000 m^3.

In the production of processed products, there are three producers of pellets and four producers of wood chips with a maximum capacity of 121,600 tonnes per year.

According to the annual energy review "Energija u Hrvatskoj (Energy in Croatia)" of the Ministry of Economy, the capacity utilization in the Republic of Croatia of pallets production is about 65% and the total production in 2013 amounted to 181,568 tonnes in Croatia. Estimated data for the pellets production in the Vukovar hinterland amounts to 79,040 tonnes per year. According to the same data, 88% of the total pellet production was exported to the foreign markets and the rest was used on the domestic market. There are 52 companies with the right to exploit forests in Slavonia and Baranja with a total capacity of 311,000 m^3/year.

At the level of Croatia, according to EIHP (Energy Institute Hrvoje Požar) data, in the period from 2008 to the present year, a steady increase in biomass exports has been recorded with an annual

rate of 25%. Of the total energy exports of the Republic of Croatia, biomass accounts for more than 10%, almost in the total amount of forest biomass. According to the same source of data, the trend of biomass imports increased by 32% in the observed period, mainly wood pellets (Raguzin I., 2011).

Consequently, in a very cautious estimation, from the available forest biomass in the hinterland of the Vukovar port, 50% would be utilized, and 1/3 would reach a biomass trade centre in the Vukovar port, thus the estimated forest biomass amount in Biomass trade centre would be approx. 170,000 m^3 per year.

3.2. Demand for raw materials

Demand for processed products in Croatia is largely made up of households, although most household biomass is used in old and non-economical facilities, and demand for such facilities primarily on pellets is increasing. This increase is largely due to a program of co-financing of the procurement of small heating and hot water installations for households and public institutions. This, however, indicates a generally weak awareness of the use of energy-renewable sources, but it should be mentioned that this is an area that is still influenced by war damage. Official data on demand for raw materials at the hinterland of the Vukovar port are not available.

The Wood Cluster 'Slavonski hrast' (Slavonian oak), which is made up of wood processing companies (23 companies) and institutions including Vukovar-Srijem County, Vinkovci and Otok towns, Andrijaševci and Privlaka municipalities, two development agencies, and Vinkovci technical school for wood processing, point to the potential of a biomass market in the hinterland of the Vukovar port (Ivanović, M., Glavaš, H., 2013). This wood cluster is aimed at encouraging sustainable development, environmental protection and increasing the competitiveness of forestry and wood industry with the efficient use of valuable Slavonian oak and other wood species. Among the most important products of the cluster are the veneer, parquet of all kinds, furniture and construction carpentry, barrels, wooden houses and wood bio fuels. The cluster gathers all important stakeholders in the field of forestry and wood processing and is linked to the 'Spačva' area - the largest common oak (*Quercus robur* L.) forest in Europe. The members of the cluster are Spačva d.o.o. the largest Croatian manufacturer of veneers, and Šišarka d.o.o. the largest Croatian pellet producer. Cluster members are also Alpi Aviation from Italy, who uses wood for making light aircraft.

According to the Catalogue of Wood Industry in Croatia, there are 46 manufacturers of furniture and 24 woodworking companies in construction sector.

Since imports and exports data for the Slavonia and Baranja area are unavailable, an overview of imports and exports is available at the level of the Republic of Croatia (e.g. tables with data about export and import of processed products in Annex 8.2).

It can be estimated that considering the potentials, the market for processed biomass products in the hinterland of the Vukovar port is still not sufficiently developed. However, the data from recent years evidence that the market is experiencing steady growth. A steady growth in domestic product demand every year (mainly due to the financing programs) to encourage renewable energy sources, as well as the increase in exports (mainly pellets), is a clear indicator

of future production and market development. The growth of indicators would follow the consolidation of the amount of the raw materials and the possibility of more efficient storage in appropriate warehouse spaces with quantities that will ensure the continuity of supply. Therefore, realistic expectations that a biomass product market, as well as a biomass market, will continue to grow with all its potential.

3.3. Existing value chains, industrial and logistics capacities for energy biomass

Energy-wood is derived from the rest of the wood raw material and classified according to the appropriate origin. Round wood is a kind of raw wood from the forest. It refers to waste wood that cannot be sold as saw wood and therefore is the by-product or product that remains unused due to the utilization of the round wood. This includes, for example, stump, parts of logs, torn pieces of wood, industrial minced waste and pulpwood as well as very soft wood (fine-grained parts) and so-called secondary wood.

Cultivation of tree species that is rapidly growing for the production of energy is mainly possible on agricultural land and at the edges of forests and meadows. These tree species grow rapidly and their rotation cycle is 10 to 15 years. For such cultivation, poplar and willow are preferred. At the end of the rotation period, the technology that it is used is either fully automated or machine-friendly. In the case of automatic exploitation technology, rotational periods are maintained in the range of approx. 3 to 5 years since this process uses a waste utilization system that is energy-efficient and in one work step and processes wood into wood chips.

In the hinterland of the port of Vukovar dominates the pedunculated oak forests with the association of Genisto elatae-Quercetum roboris with species of broom (Genista ssp) on the habitats of higher or lesser depression and occasionally flooded around the rivers Dunav and Drava, while on the area of Spačva dominates the association Carpino betuli-Quercetum roboris with species of hornbeam (Carpinus betulus).

Firewood is a fuel based on wood in which the original composition was retained, without changing the original shape. Hrvatske šume d.o.o. has officially announced that the production plan in 2016 has been fully realized. In this year 5,144,154 m^3 of wood assortments was produced, i.e. 1.3% more than planned. There is a noticeable increase in the production of space wood compared to the planned 10.5% which can be related to the increase in demand for energy wood. It should be noted that Hrvatske šume d.o.o. with its transport capacities transported 9.6% of total production, while the share of transport to external contractors increased by 3.5%, i.e. it is now 85.1%. Hrvatske šume d.o.o. in 2016 sold 5,291,364 m^3 of wood assortments. From this, the energy wood amounted to 587,856 m^3; the firewood amounted to 2,358,423 m^3. If the raw material for energy wood and biomass within space wood for processing and firewood is considered, then at the level of the Republic of Croatia there is an amount of 2,946,279 m^3. Regarding this, it can be estimated that a third of the values naturally belongs to the hinterland of the Vukovar port, i.e. 988,093 m^3. The estimation of one third is based on the distribution of the quantities and values that Hrvatske šume d.o.o. make by dividing the area of activity into three main pools, namely Slavonia, central Croatia and mountain Croatia. It is clear that these amounts can add a certain value on behalf of the other participants in the chain but at the same

time be taken away because it is to be assumed that some of them will not use the Vukovar port and potential biomass trade centre. However, these estimated data confirm previous data on available biomass in the hinterland of Vukovar port which is 1,010,000 m^3.

The usual declarations of the product of a biomass trade centre are:

- Forest logs from forest residues (softwood and/or hardwood),
- The wood of soft / hardwood timber,
- Wood, birch, ready to use in a fireplace,
- Firewood, beech, ready to use in a fireplace,
- Firewood, mixed hardwood, ready to use in the fireplace.

In the hinterland of the Vukovar Port there are 89 power plants out of which 49 utilize or will use biomass and are in operation or under the construction, and 40 power plants use or will use biogas for the production of electricity and heat as a cogeneration plant. A large number of biomass power plants have signed long-term contracts with Hrvatske šume d.o.o. for supplying forest biomass. Hrvatske šume d.o.o. on an annual basis provides about 800,000 tonnes of wood for cogeneration plants in the Republic of Croatia.

For the time being, the Vukovar Port does not have business connections with these plants operating in Slavonia and Baranja, as they mostly supply them from domestic biomass sources, which are guaranteed on the basis of long-term raw material insurance contracts.

Within the framework of the Cohesion Competitiveness Operational Program, the Government of the Republic of Croatia has launched several incentive programs in the area of energy efficiency and renewable energy sources, which encourage the use of renewable energy sources and thus the use of biomass products. The program includes family houses, residential buildings, and public sector buildings. A special program that is currently being conducted focuses on educational institutions. The Government of the Republic of Croatia in October 2017 co-financed from EU funds the transition to renewable energy sources for 60 educational institutions in Croatia. As this program continues, it is to be expected, that both Slavonia and Baranja will have a significant increase in consumption, i.e. increase demand, especially due to the availability of biomass and biomass products in this area. Data on the effects of the program are not yet fully known since it is still in the process of being implemented. However, it can certainly already be expected as a result of the program, increase in demand for biomass products by the potential buyers and citizens, as well as companies and institutions from the public sector as potential partners.

3.4. Currently available infrastructure at the port Vukovar, technical conditions

As recognized and listed in ENERGY BARGE D5.1.1. Transnational Implementation Plan (p. 152-155) the transshipment equipment in Vukovar port represents the mobile transport equipment and devices that serve 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 tonnes
- Grabs for bulk cargo from V=5m^3 to V=13m^3
- 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 tonnes
- 7 x forklift trucks with load capacity of 2 to 5 tonnes (Linde)
- 2 x loaders
- 1 x mobile harbour crane with lifting capacity of 63 tonnes (Gottwald HMK 170)
- 2 x harbour gantry cranes with lifting capacity of 5/6 tonnes (Ganz)
- 1 x harbour gantry crane with lifting capacity of 16/25 tonnes (Ganz)

Table 3 - Technical equipment of concessionaire Luka Vukovar d.o.o. and Vupik d.d.

Source: Port Authority Vukovar

TECHNICAL DANA	LUKA VUKOVAR d.o.o.	VUPIK d.d.
Terminal purpose	Reloading of cargo on multi-purpose terminal for bulk, palletised, break bulk containers, special cargo	Loading, unloading, reloading, transporting and storing of bulk cargo (grains and oilseeds)
Port position	1334	1336 +000
Operational quay	cca 450m	206
Number of berths	4	1
Type of quay		vertical quay
Cranes	1 x 63 t Gotwtwald HMK 170	Static reloading tower with a mechanical elevator and transporters, capacity 200t/h (wheat 0.75t/m3) and automatic vessel shifting system
	1 x 16/27 t Ganz	
	2 x 5/6 t Ganz	
Enclosed storage facilities	cca 3000 m2	48.000 t
Open storage area	cca 15000 m2	
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 m3	
	diesel locomotive	
	pusher vessel 480 KS	
Truck parking space	yes	yes - 50 parking spaces
Own industrial railway track	3 tracks of cca 1300m	2 tracks of 750 m
Maximum annual capacity	1.2-1.5 mil tona	300.000 t

Two concessionaires: Luka Vukovar d.o.o. and Vupik d.d. already have space and basic equipment for biomass and biomass-enhanced products. Luka Vukovar d.o.o. is technically equipped and has the available capacity so it can overload forest biomass and processed

products while the concessionaire Vupik d.d. has the technical equipment and the possibility of transshipment exclusively of biomass-based agricultural products (e.g. Sunflower biomass, Soybean biomass, corn). However, if a biomass centre project would develop, both concessionaires would have to strengthen their capacities and acquire additional equipment. Existing equipment on both terminals needs to be supplemented with specific equipment for biomass transshipment - gripper - grate/gravel, crusher - wood waste crushers.

The available handling capacities are sufficient to handle the current cargo volumes, but the expected increase of biomass cargo generates the need for investment in port handling capacities. Investing in a port crane is needed and justified by expected biomass cargo traffic in the Vukovar port.

4. Development issues

4.1. Analysis of future requirements and demand

According to the annual report of the Croatian Energy Market Operator (HROTE) for the year 2016 in Slavonia and Baranja, seven biomass power plants and eleven biogas power plants concluded contracts and become eligible electricity producers and have concluded electricity purchase contracts for the national grid. Further the number of energy producers from renewable sources increases and thus their connection to the national grid will also increase.

Such a development of the situation has so far been stimulated through the energy regulation of the Republic of Croatia. On January 1, 2016, the Law on Renewable Energy Sources and Highly Effective Cogeneration (OG 100/15) (here and after the OIEiVUK Act) came into force on the basis of which the earlier regulations for the incentive system were abolished. With the entry into force of the OIEiVUK Act, the new methodology for dealing with HROTE is foreseen. This means that for the conclusion of a contract for the purchase of electricity from the renewable sources it is necessary to conduct a public tender for the award of a market premium and conclusion of contracts with a guaranteed purchase price, all based on the decision on the selection of the most favourable bidder. Since the necessary subordinate legislation, provided for under the provisions of the OIEiVUK Act (OIEiVUK Electricity Generation Quotas Order, OIEiVUK Rule book, and State Aid Program) have not yet been adopted, HROTE has not entered into new electricity purchase contracts from OIEiK. However, such a trend of development and the fact that biomass power plants conclude long-term contracts with Hrvatske šume d.o.o. on biomass supply will in the future have a significant impact on the available quantities of biomass for export or further processing, but also on the importation of biomass.

For the time being, Vukovar port does not have business connections with these plants operating in Slavonia and Baranja, as they mostly supply them from domestic biomass sources, which are guaranteed on the basis of long-term raw material insurance contracts.

The Government of the Republic of Croatia has launched several incentive programs in the area of energy efficiency and renewable energy sources under which it encourages the use of renewable energy sources and thus the use of biomass products as part of the Operational Programme Competitiveness and Cohesion 2014 – 2020. The program includes family houses,

higher residential buildings, and public sector buildings. A special program that is currently being conducted focuses on educational institutions, and in October 2017, the Government concluded contracts with EU co-financing for the transition to renewable energy sources in 60 educational institutions in the Republic of Croatia. As this program continues, it is to be expected that both Slavonia and Baranja will see a significant increase in consumption, i.e. increased demand, especially due to the availability of biomass and biomass products in this area. Data on the effects of the program are not yet fully known since it is still in the process of being implemented. However, it can certainly already be expected as a result of the program, increase of the demand for biomass products, and thus, citizens, businesses and institutions from the public sector can become potential partners.

4.2. New technological solutions foreseen

By applying new technologies, forest biomass of small branches and bushes are transported in form of bio-bundles to the cogeneration plant or to a biomass trade centres.

The pyrolysis of wood biomass in the production of electricity is a very interesting technology with many benefits. There are many benefits of the pyrolysis of wood biomass: easier and better power regulation in thermopower plants, basic carbon utilization technology with environmentally friendly emissions, increased energy efficiency of thermoelectric blocks on solid fuels, a very good degree of manoeuvrability, and great economic benefits in areas where wood biomass is available at relatively low prices.

In addition to the great advantages of wood biomass pyrolysis, there is some disadvantage in pyrolysis technology: pyrolysis is a fairly complex and sensitive process, wood biomass is fairly bulky and for constant operation of the system it is often necessary to fill the fuel tank, the inability to use dry wood biomass, a rather unpleasant ash cleaning tar condensate, despite easier gas acquisition, the use of pyrolysis technology is not so easy. In addition to all the advantages and disadvantages, the production of electricity by the pyrolysis of wood biomass, along with other renewable energy sources, represents the future of energy. Because of the growing awareness of humanity towards the environment and its preservation, the economic viability of such plants is less important.

At this moment, it is not realistic to look at the pyrolysis technology in the Vukovar port vicinity. From all the new technologies, biofuels and biogas should be highlighted especially in the context of the potential of hinterland agricultural biomass. In Slavonia and Baranja (five counties), the total of agricultural biomass amounts to 2,43 million tonnes per year, which is equivalent to 854,770 tonnes of fuel oil (Ivanović, M., Glavaš, H., 2013).

However, 30% of biomass can be used because other 70% of biomass is required to be left on agricultural surfaces due to the natural renewal of organic matter in the soil. Accordingly, the available amount of agricultural biomass in the hinterland of the Vukovar port is 810,000 tonnes equivalent to 285,000 tonnes of fuel oil, which is a very significant potential and should also be taken into account (Krička, T., 2012).

4.3. SWOT analyses on biomass logistics

Table 4 – SWOT analysis.

	Strengths	Weaknesses
Infrastructural connections of the port	- VII transport corridor - 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 and Hercegovina, Hungary and Serbia, Romania - Connection 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 Greda, Županja, Vrbanja, Lipovac - D2 state road - There is a Transit port in Osijek, but due to weak navigability of River Drava, cargos usually gravitate to Vukovar	- The dominance of truck transport for exporting biomass from the region of Slavonija and Baranja instead of inland waterway transport
Technological background of the port	-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 - equipped open storage area 10.000 m^2 - closed storage area: 3.000 m^2 - mobile harbour crane (63 tonnes) - 3 harbour gantry cranes (5/6 tonnes and 16/25 tonnes) - 81% of all cargo is bulk: agricultural products and fertilizers	- Biomass handling capacities must be developed in the port; not enough grippers, waste wood crushers - All the three possible locations would require some establishment of the infrastructure for a biomass trade centre

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 tonnes (80%) of annual quantities of biomass from agriculture - Biogas production from manure - Slavonija and Baranja are rich in forests: 425.175 ha, estimated available forest biomass: 1.010.244 m^3 / year - 10 sawmills generating residues: annual capacity 326.000 m^3 - 3 pellet and 4 wood chip manufactures refine products: 121.600 tonnes / year - 52 companies with the right to exploit forests in the region: 311.000 m^3 / year - Wood chips, shavings, wood pellets are exported in higher volumes than imported - 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. Šišarka 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 - Private forest owners are smaller suppliers and cannot compete with Hrvatske šume d.o.o. In addition because the Hrvatske šume d.o.o. actually gives to private forest owners a license to collect wood from the forest. Businesses and crafts that have a license limited based on annual quantities (on average 8,000 m^3).
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 šume d.o.o. supplies wood biomass for several power plants: 800.000 tonnes of wood mass for cogeneration plants per year	- Currently power plants use domestic raw materials available locally, i.e. no need for inland waterway transport, therefore Vukovar port has no connection with power plants and distributors
	Opportunities	**Threats**
Infrastructural connections of the port	- M 601 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 a biomass market by becoming a logistics centre - 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 a biomass trade centre - Two concessionaires: Luka Vukovar d.o.o. and Vupik d.d. already have the space and equipment for the transshipment of biomass and processed biomass products	- If a biomass traffic would increase, both concessionaires (Luka Vukovar d.o.o. and Vupik d.d.) would have to strengthen their capacities and acquire additional equipment
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 (produces 1 percent of the world's total pellet production and exports 85 percent of its total pellet production) - Trend of continuous growth of forest biomass trade exchange with neighbouring Danube countries - Further development of Vukovar port to become part of a 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

5. Project description

5.1. Aims of the development

The Slavonia and Baranja area is the richest biomass area in the Republic of Croatia. Currently, there is no biomass trade centre operating in this area. The position of the Vukovar port is located in a very favourable traffic position, and this represents a good choice for the establishment of such a centre.

The potential specialization of the Vukovar port for handling biomass, considering transshipment and storage in biomass trade centre, is defined as one of the outputs of this project. Specialization of Vukovar port is needed to balance temporal differences of supply and demand over time in the supply chain. In biomass logistics, the need for a terminal is the highest during the seasons of heating and during of the harvest, which are non-simultaneous.

If the demand for energy from forest residues increases, new logistics solutions are needed. According to expectations, the greatest increase in use is expected in heat and power plants, which set specific supply requirements such as supply quantities and transportation distances increase. A biomass terminal extends the spectrum of available supply options by providing an economical scope for storing large quantities of biomass and biomass supply options in all conditions.

A specialized biomass terminal in Vukovar port is considered as important node between the origin and destination points in a biomass supply chain. Terminal capacities can be separated so that at least one logistical operation precedes (e.g. road or river transportation) or follows (storage and processing) other terminal activities within the supply chain. Biomass terminal in combination with a biomass trade centre in Vukovar port terminals are required because of a lack of sufficient space to store or handle a biomass in the area. An advantage of a biomass terminal in the Vukovar port would offer the potential for boosting the transportation performance by intermodality or by levelling the unstable need for transport capacity.

The specialized biomass terminal at Vukovar port, with planned infrastructure and superstructure capacities and accompanied future biomass trade centre, 'will generate additional costs in supply chain of biomass as manipulation costs, but this will certainly generate positive environmental organizational and financial effects and enable integrated management of biomass resources'. These effects will be directly visible in the hinterland of the port i.e. five counties in the gravitational area of the Vukovar port within 100 km.

The planning of the developing needs of a specialized terminal for biomass in the Vukovar port consider the following factors that are significant for the biomass supply:

- balance factors: direct supply of biomass fluctuates significantly and is incapable of meeting the more regular demand at the same time
- resource/capacity factors: the supply chain can perform with less resources (e.g. vehicles, machines, workforce) needed to achieve the same desired output than a supply chain without a terminal

- quality factors: the terminal improves the quality of supply chain of biomass from the level of a supply chain based on direct deliveries
- synergetic factors: the terminal can be used for other business purposes during the low-season of biomass storages or for other cargoes handling
- legislative factors: e.g. storing at roadside is periodically prohibited due to environmental reasons or availability and functioning of the specialized terminal for biomass is prerequisite for obtaining permission to build a new energetic plant (e.g. in urban area).

As biomass supply is existing and significant, more efficient logistical methods of specialization of a terminal for biomass handling with sufficient capacity are needed. Specialization of the Vukovar port for biomass handling offers security of supply for biomass users and all others parts of the biomass supply chain.

The main goals of the collection and logistics centre for biomass would be:

- establishment of a regional biomass-collecting and logistic centre that would cover the area of five counties that make up Slavonia and Baranja,
- the centre would offer fuel energy, forest wood chips, other biomass fuels,
- continuity of supply, as well as suppliers of biomass of all kinds,
- transshipment service for the use of river transports biomass,
- ensure consistent quality standards (fuel quality, service delivery).

5.2. Definition of development needs

Biomass supply and demand on a daily or weekly basis is often imbalanced because biomass collection depends on harvesting seasons and weather conditions. With regards to forest fuels, wood harvesting takes place all year round but the schedule of logging operations determines what kind of wood is directly available. Balancing is to be managed by storages as end-users need a steadier raw material flow for their processes.

There are three types of biomass handling functions at the terminal: transshipment, transportation and transfer, storage.

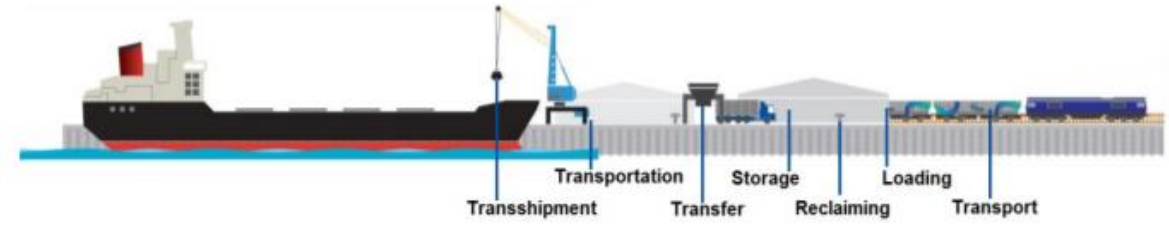

Figure 4 - Terminal activities.
Source: Lanphen L.S.J.C., Biomass handling equipment in European ports; an overview of current designs and required design improvements, TUDelft, 2014)

Transshipment - the first step when handling the solid biomass at a port of Vukovar is to tranship the solid biomass from the delivering transportation vessel, which can be a ship/barge, truck or train. This can be done via multiple options, a grab, vertical conveyor, pneumatic systems, bucket elevators or a self-unloader.

There is no specific type of grab for biomass, but existing types for grabbing which are also suitable for biomass. When using a grab to unload the solid biomass one of the things that requires extra attention is the reduction of (wood) pellet degradation. Several grabs are taken into consideration for port of Vukovar: company Nemag (Figure 5) states that, by experience, breaking is reduced by 50% when using a closed clam-shell grab for wood pellets instead of pneumatic, continuous unloading devices. Also, some companies offer the closed clam-shell design as their grab for handling. The closed clam-shell design reduces dust emission and breaking.

Figure 5 – Grapple types.

Source: Lanphen L.S.J.C., (Biomass handling equipment in European ports; an overview of current designs and required design improvements, TUDelft, 2014)

A vacuum unloader is also recommended to be used in Vukovar port (figure 6). Ship vacuum unloaders can reach a high throughput with its flexible design.

While planning storage capacity at a specialized terminal in Vukovar port, it should be emphasized that the capacity is determined in line with expected quantities of biomass and according to the stochastic parameters: arrivals / departures and flows of biomass, the size of the floating / land transport composition, and the impact of the seasonal supply which makes it more difficult to calculate.

Figure 6: Pneumatic transshipment of biomass.

Source: Lanphen L.S.J.C. (Biomass handling equipment in European ports; an overview of current designs and required design improvements, TUDelft, 2014)

The following recommendations apply to all storage options:

- measures against dry matter loss and material degradation, such as a good ventilation system and pre-drying before storage, should be applied
- measures against self-heating should be applied. Such measures consider handling with homogeneous storage piles (in terms of material particle size distribution), taking the

geometry of storage piles into account, avoiding compacted storage piles etc.

- the storage time of solid biomass should be controlled. Depending on the moisture content of the material, the recommended storage time varies from three weeks (for fresh wood chips) to three months (wood pellets).
- both storage capacity and storage time are sensitive to arrival and departure patterns, meaning that good logistic control is required.

It is expected that wood pallets and wood chips will be major biomass cargo types. Two types of wood biomass materials are selected as the potential cargos for the Vukovar port. Their basic properties (i.e. energy content, density, and moisture content) are described as follows:

Wood pellets - Lower Heating Value: 16-18 GJ/tonne, density: 600-750 kg/m^3, moisture content: 10%. Currently most of the wood pellets are made from saw dust. It can be expected in the future to be significant volumes of available sawdust, which represents a large opportunity for wood pellets in the future. The wood pellets also have other applications than energy use, such as in fireboard or particle board industries. Since wood pellets are the most compact form of solid biomass, the wood pellet trade is an already existing large-scale international trade flow.

Wood chips - Lower Heating Value: 14-17 GJ/tonne, density: 150-400 kg/m^3, moisture content: 30- 45%. Compared to wood pellets, wood chips have a lower energy content, lower density and higher moisture content. Nevertheless, wood chips are widely used in paper industry. Demand for wood chips in energy sector is increasing, since they can be used for electricity producing. Wood chips are mostly made from forest residues thus the available amounts are affluent.

When considering potential volume measurements in future biomass at terminal in the Vukovar port, which will be supplied to the terminal and shipped from the terminal practical measurement unit, is based on the annual fuel output. Based on current available data on available biomass it is considered to be small and medium terminal in the beginning and large one in the future. Small terminal is classified as one producing 0.1 TWh/a, medium-sized terminals considers 0.3 TWh/a and the large terminal considers 0.7-1.0 TWh/a.

In small terminals (0.1 TWh/a) weighing is done during material handling by using timber scales and loader scales. A weighbridge is not used. Estimation and prediction of moisture is done based on drying models.

In medium-sized terminals (0.3 TWh/a) weighing is done likewise during material handling by using timber scales, loader scales and material handlers. A weighbridge is not used. Weighing of forest chip and measuring of the frame volume can be done in the conveyor belt after chipping (applied also for mobile chippers) or alternatively the frame volume can be measured in the truck. At the medium size terminals stock accounting is also used.

In large terminals (0.7-1.0 TWh/a), weighing of incoming and outcoming material is performed with a weighbridge. Weighing and measuring of the frame volume of forest chips is performed in the conveyor belt or measuring of frame volume of the forest chips in the truck. A stock

management system takes care of the amounts of coming and delivered biomass and of the moisture variation of the storages.

While planning the Vukovar port capacities as biomass node handling it is crucial that a biomass is not degraded and that quality is maintained throughout the entire logistic chain (from the point of view of biomass producers, biomass end-users, and traders).

While planning of the storage capacities of the Vukovar port and the capacity of a biomass trade centre, particular consideration should be given to the security aspect. Transfer points and towers are key locations in terms of dust emissions and need to be avoided to protect the health of workers from the inhalation hazards of dust and spores, and to prevent explosions, that can occur if a small fire or localized dust explosion brings down a residue of settled dust. Stored dry biomass is sensitive for problems, like material degradation, self-heating (and fires) and unwanted chemical reactions.

5.3. Definition of planned products/services

Biomass trade centres can sell all kinds of biomass fuels. The main products are fuel from wood biomass: logs and wood chips. In addition, the offer can be supplemented by wooden pellets. Other types of biomass fuel such as pellets of plants or grasses that are pelletized either directly in the field or in a biomass trade centre could also be included in the sales assortment.

As alternative activities of regional biomass trade centres are the possibility of providing energy services wherever possible as well as including in contract sales of wood biomass for heat and biomass heating plants.

Strict quality criteria must be adhered to in order to guarantee the quality of products and services provided. A biomass trade centre is responsible for working in accordance with the high standards of national and European (CEN TC 335) quality standards.

However, apart from investments in construction, organization, and equipment of a biomass trade centres the annual concessionaire should provide 6,835,976 € for the purchase of biomass. This amount is estimated very carefully on the basis that from the total estimated available biomass in the hinterland of the port, 50% will be utilized, and one third will reach a biomass trade centre in Vukovar port - which will then amount to 168,374 m^3. By converting this amount into the space meters, and multiplying by the coefficient 1.45, the result is 244,142 scm, after which by multiplying at a cost of 28 €/scm is the value of biomass on the forest road in the amount of 6,835,976 €. When added to transport costs to the port in the total amount of 2,148,450 €/year (provided the average distance between the transport is 20 km and the unit price of transport is 8.8 €/scm), the manipulative costs are estimated at 110,000 € and material costs 21,300 €/year. The labour cost was calculated separately, with an estimate that 5-10 employees would work in the biomass trade centre. The total cost of raw materials and operations is 9,115,726 €/year (excluding labour force). These are the result of calculations based on the EU Biomass Trade Centre Project models and the estimated amount of biomass in the hinterland of the port.

The total annual income of the future biomass centre can be estimated or calculated in several ways.

If the average price of biomass and processed products in Croatia is to be 136 € (according to data from chapter 6.6) in relation to estimated product quantities (wood chips and processed products) in tonnes of 126,000 tonnes, the total revenue is of 17,136,000 €, before loading. The same means that the difference between the total income and cost of raw materials and operations is 8,020,274 €. However, this amount does not include staff costs, river transport, and further manipulation, as well as drafting of project documentation. As the price of biomass processed products is the lowest in Croatia, and if prices are rising for a part not covered, competitiveness is still achieved in comparison to other areas within and outside the project scope.

If the total annual income of the biomass trade centre is calculated according to the patterns of the EU Biomass Trade Centre. Project in such a way that all available biomass raw materials in the Centre are mostly sold as a wood chips (732,426 packs per unit price of 17.5 €), the results if the amount of 12,817,455 € per year, and, to a lesser extent, as a firewood (37,500 packs per unit price of 50 €) it is an amount of 1,875,000 €. Then, by summing these two values, a somewhat lower total income of 14,692,455 € would be available, and that is understandable because calculations do not include processed products (pellets) that have a higher price.

The third option to calculate the total annual revenue of the centre is based on the fact that 66% of the total exports of biomass from the Republic of Croatia are pellets. So the import was not taken into account. This means that compared to the total turnover of 126,000 t, the total revenue of the pellet based on the pellet and the prices in chapter 6.6 is 10,710,000 €, while the wood chips has a total revenue of 4,677,750 €. Overall, on both bases, the total annual income of the centre would be to 15,387,750 €.

The demand for energy from the end of the year should be considered, since the official data from the Hrvatske šume d.o.o. for 2016 state that 10.5% more energy wood was sold than planned. This growth could be assumed for the medium term period because, due to resource constraints, this percentage increase is not really the same for each year. The issue of limiting natural resources for biomass is partly offset by the establishment of a short-term forestry cultures (KKO) for biomass. At the level of Croatia, according to Energy Institute Hrvoje Požar (EIHP) data, in the period from 2008 to the present year, a steady increase in biomass exports has been recorded with an annual rate of 25%. Of the total export of energy, biomass represents more than 10%, almost in the total amount of forest biomass. According to the same source of data, the trend of biomass imports increased by 32% in the observed period.

The costs of managing and maintaining the future biomass trade centre are estimated at 110,000 €/year and this refers to manipulative costs and biomass handling at the centre. The cost is calculated in the calculation tables of the EU Biomass Trading Centre and refers to the costs of transforming energy wood frame into wood chips (85,000 €) and all other handling (25,000 €). In the calculation sheet, this is called Biomass processing and handling - Chipping and Handling subgroup. This amount can be as high as 537,112 €/year on the same tables and depends on the product structure. However, in this case it is estimated at 110,000 €/year, for example, for

pellets the difference is obtained at a higher price of the product (pellets in the Republic of Croatia - 250 €/tonne).

Hrvatske šume d.o.o. as the largest supplier of forest biomass, in the official price list of the main forest products determines the price depending on the place of picking up the raw material: in the stump, by the stump overturned, by the stump made, on forest road, in wagon, on the Croatian border. Following, these are three most interesting cost locations; on the forest road, in wagon and on the Croatian border. At the very beginning, in 2008, the average price of forest chopping logs of 30-35% loaded on a forklift truck amounted to 35 €/tonne. To this price, it is also necessary to add the transport costs that can be estimated at approximately 0.1 €/tonne/km.

5.4. Target group/stakeholders

In line with the activity plan envisaged in the Application Form, five key target groups or interest groups are identified. At this stage of planning a specialized biomass terminal in the Vukovar port and a biomass trade centre within port of Vukovar area, the identified target groups have not recognized interest nor had interest to be actively involved in handling capacity planning and the expected biomass supply planning. In the future, active cooperation and participation of these target groups in a biomass trade centre business activities are expected and recognized as very important and contacted during the study preparation.

Target groups are biomass suppliers, biomass processors and biomass associations. These target groups could potentially initiate business in the Vukovar port. Among these target groups, there are four stakeholders which have a dominant market position and have already shown interest in biomass business.

Hrvatske šume d.o.o. (supplier and trader)- manage more than 80% of forest and forest land in Croatia. Therefore, owners of private forests are smaller suppliers which cannot compete with Hrvatske šume d.o.o.. Hrvatske šume d.o.o. also gives license to collect wood from the forest. Companies and crafts that have that license are limited by the annual amount (on average 8.000 m^3). Hrvatske šume d.o.o. has a state monopoly for delivery of biomass raw materials.

Spačva d.o.o. (processor and end user) – consists of 5 factories: sawmill, parquet factory, final wood products, furnace factory and bioenergy factory. It employs 740 workers, making it one of the leading employers, both in Vinkovci and in the county. Most of the company is exporting to European markets, with the aim of stepping up exports of final products, primarily parquet, peasant flooring and doors, and bioenergy production, which has recently invested considerable investment funds. Spačva d.o.o. is the most important and largest company in the hinterland of the Vukovar port for suppling the processed biomass products.

Ricardo d.o.o. (logistics)- The leading road transport company in the Republic of Croatia that provides the complete logistic solutions tailored to each individual requirement, in line with international quality standards for safety and security. The fleet of the company amounts to a total of 280 vehicles equipped with top-of-the-line equipment to transport all kinds of goods in

all required conditions. There are real expectations that Ricardo d.o.o will have an important share in biomass transport to Vukovar port.

Luka Vukovar d.o.o. (logistics) - is located on the right bank of the Danube River which, with its class Vc in this section, enables navigation to be available 365 days a year. It has the largest length of the port riverbank that makes it the largest licensed concessionaire in the Vukovar port area and is also the only one dealing with the transshipment of general and bulk cargo. The mission of Luka Vukovar d.o.o. is to efficiently carry out port transshipment and warehouse operations on goods for various businesses from Croatia and abroad, and to provide the highest quality services to partners. In addition to the transshipment-storage section, Luka Vukovar d.o.o. also develop agency services, both for merchant ships and cruise ships, which have significantly increased their presence in this part of the Danube in recent years. Luka Vukovar d.o.o. is an existing concessionaire who expressed interest in establishing a biomass trade centre.

The main reason why these four enterprises are taken into consideration is mostly because of good position on the market of mentioned services and previous experience with biomass. Certainly, it does not mean that other companies are not welcome and could not express their intention to obtain concession for port activities, but it only shows which type of companies are most preferred and according to the law are allowed to do business within the port area. Potentially interested stakeholders could be companies whose activities are related to the trade and processing of forest biomass, as outlined in section 5.9.of this document as Biomass supplier.

Pre-feasibility study is the fundamental document at the early stage of documentation preparation for the investment, and it will provide to Port Authority the crucial financial and economic details which will be elaborated in forthcoming documents such is Feasibility study. So far, potential target group/stakeholders that were interviewed in previous project phases, still have not definitely confirmed their determination to invest in setting up the biomass trade centre but they expressed their readiness to reconsider all the benefits such centre could provide. From the Port Authority Vukovar point of view, Pre-feasibility study will bring good starting point in preparation of all necessary documents that are prerequisite for the biomass trade centre construction. According to the legislation, Port Authorities are responsible for preparation and implementation of projects which main goal is the construction and maintenance of port infrastructure. Once the port infrastructure is built, including river bank with terminals, railway tracks, roads and all other communal infrastructure, Port Authority may begin process of granting concession for port activities. Since the potential sites (‘two’ and ‘three’) do not include any infrastructure that is required for biomass trade centre, before the concession is granted, Port Authority needs to prepare Feasibility study on concession granting, that has to provide all inputs which will determine the procurement procedure and define all expenditures including fees for the concession after the biomass trade centre is built. According to this, it is also not excluded that a few companies express joint intention to set up the biomass trade centre if they find it profitable, since the preliminary expenditure is quite high. To summarize, target group of potential investors in biomass centre is mostly oriented on existing companies or cluster of companies from this part of country, and definitely on companies that

already possess experience in biomass or at least on companies that have any experience in dealing with production, trading transporting similar types of commodities.

5.5. Location, site

Based on the spatial-technological features of the Vukovar port, three locations for the specialized biomass terminal have been identified. The document ENERGY BARGE D.5.1.1. "The Transnational Implementation Plan" (Chapter 8.3.5, p. 197-201) defines these three locations without a detailed analysis of each of them. The analysis of these locations is given below.

Within the existing port area, there are three free locations for the establishment of a biomass trade centre given the fact that the area of approximately 26 ha is occupied by existing concession agreements. The area of the Vukovar port with the passing of the international train line M601 within the project "Upgrading and electrification of existing railway lines of importance for international traffic M601 Vinkovci -Vukovar" remains deprived of part of the existing space that is excluded from the port area. Within the port area that is divided into two parts by the crossing of the railway lines, part of the port area near Priljevo Street has access to the operational coastline only over two railroad crossings.

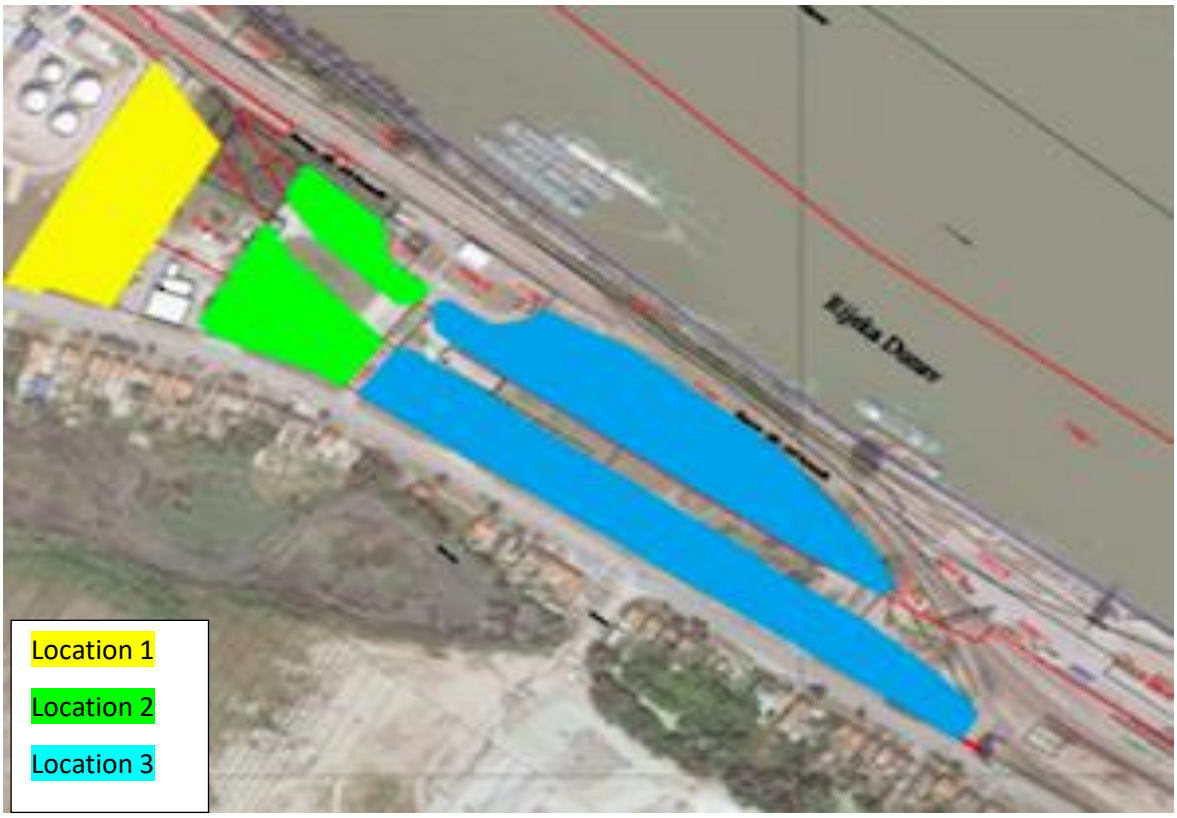

Figure 7: View of the possible locations of a biomass trade centre in the area of Vukovar port.

Source: Geodetic study of the port area of the Port Authority of Vukovar

All three potential locations are shown in the graph and in accordance with the needs of the future centre, the most suitable location is chosen, given the size and position of the port area.

When comparing the possible biomass trade centre locations, it is noticed that the first location (yellow) is the smallest area of 9,126.62 m^2, the second location (green) comprises – 11,127.09 m^2, and the third possible location (blue) is the biggest with 22,682.01 m^2.

The proposed first location in the hinterland does not have direct access to the port riverbank, which runs parallel to the above-mentioned parts, whereby the connection to the port riverbank can only be realized over two railway-road crossings. Accordingly, the first site was evaluated as inadequate and is not considered in the further analysis.

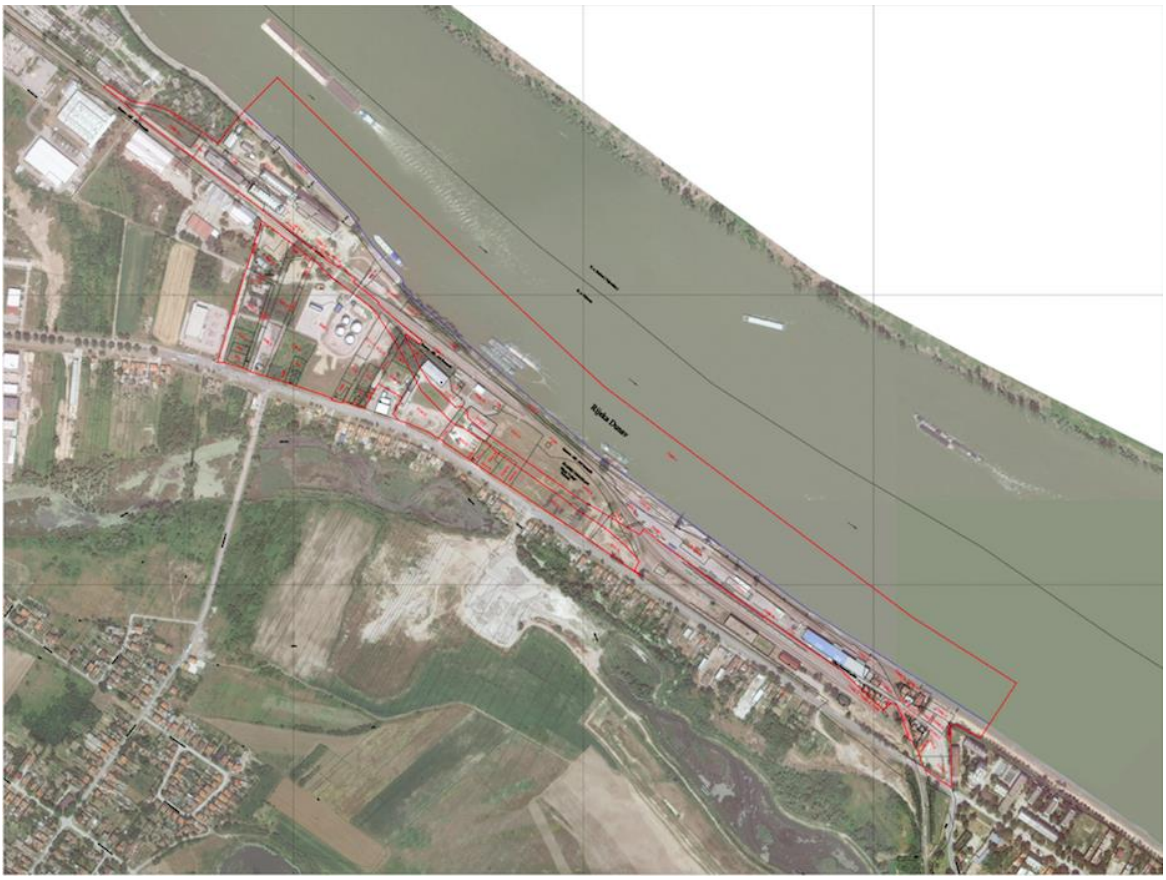

Figure 8: Vukovar port area.

Source: Geodetic study of the port area of the Port Authority of Vukovar

The second possible location includes land parcels that could provide direct access to the unbuilt part of the riverbank (riverbank approximately 180m long) through the existing road. The proposed location are located next to each other but are divided by the rail line, the mutual access is secured via rail-road crossing.

The third possible location is within the port area of the existing concessionaire Luka Vukovar d.o.o. so that the existing concessionaire would also perform the tasks of a collection-logistic centre on the part of the area under the concession contract. The concessionaire currently does

not carry out transshipment and storage activities. At this location, the riverbank was partially regulated, and additional terminal for safe mooring would have to be built.

For further consideration of possible two locations, a minimum infrastructure for a biomass trade centre should be established. The minimum infrastructure is made up of:

- equipped warehouse
- paved area for manipulation
- weighbridge

As it is expected, the Vukovar port will be intensively involved in river transport biomass in the future, the third proposed site has significant advantages over the availability of the riverbank, which should be brought to port use in order to carry out biomass transshipment. Where there is no riverbank, a vertical riverbank should be built. In the part of the newly built riverbank, a place should be made for the position of a crane that moves on a crane track or for a mobile crane.

The equipment of a biomass trade centre implies devices and transshipment mechanisms for biomass loading/unloading: forklifts, bulk biomass loaders, logs loaders. The terminal needs to provide basic communal infrastructure (gas, electricity, water, sewage, and telecommunications).

5.6. Technical parameters/capacities

The capacity of the port is up to 2,000,000 tonnes per year, which is above current demand. Consequently, the capacity is sufficient for the future transshipment of biomass loads. Restrictions are present for the inadequate performance of the riverbank and the operational area.

Vukovar port plays a significant role in the transit of goods for the Croatian industry as well as a potentially important role as an intermodal node for the Danube Region countries. It is expected to serve all industrial sectors in Croatia as well as surrounding areas after the implementation of the project for transshipment mechanization for biomass and biomass trade centre construction.

When defining the technical parameters and the transshipment capacities of the Vukovar port, the expected amount of biomass that will enter the port and take part in manipulation by loading, unloading or storing at open stock or in a biomass trade centre, is taken into account. As current biomass does not exist as a cargo in Vukovar port, according to an optimistic scenario forecasts for future cargo volume annually 126,000 tonnes are expected.

When defining technical parameters and capacities it should be kept in mind that:

- 1 m^3 of wood chips corresponds to a 2.70 space meter,
- 1 m^3 of forest residues corresponds to a 2.50 space meter,
- 1 m^3 of stumps corresponds to a 2.22 space meter,
- 1 m^3 of firewood corresponds to a 1.45 space meter,
- 1 m^3 of cuttings corresponds to a 1.82 space meter.

5.7. Technology and equipment

A detailed description of the investment assessment of the first stage of investment to be carried out by the Port Authority of Vukovar is described in 5.11.

The minimum equipment for a biomass trade centre is the following: warehouse, minimum energy wood storage area, paved area for manipulation, regular moisture measurement equipment for quality assurance, roadside billboards, and info boards. A weighbridge should be available to calculate the available fuel quantity. The weighbridge is also important for determining the energy value (e.g. water content) of the fuel.

The size of the third site enables simultaneously the existence of a collection-logistic centre as well as the storage of biomass to be transported or transhipped. At the same time, this location enables the pellet production to be set up as the next phase of the development of a biomass trade centre.

Regardless of the choice of a possible location for a biomass trade centre, the future concessionaire should provide:

- build closed and open storage facilities,
- paved area for manipulation,
- moisture measurement in the storage areas to ensure quality,
- weighbridge,
- 2 forklifts and loaders,
- access to trucks,
- appropriate office-sales space as well as access to future customers of the centre.

In order to ensure the conditions for biomass, biomass transport services, and processed biomass products it is necessary to arrange the currently unregulated riverbank.

5.8. Design and permissions

Of the three available sites for the establishment of a biomass trade centre in the port area, the first location has been eliminated because there is no direct access to the port riverbank, and the remaining two possible locations for further consideration are:

- location ‘two’ that is not under concession and,
- location ‘three’ that is under the concession of Luka Vukovar d.o.o. until 2026.

Both of the considered locations have direct access to the Danube riverbank, and they can also provide road access to Priljevo Street. Ensuring this approach is of utmost importance in order to allow access to future customers in a biomass trade centre, and not to enter the port area which is a closed unit for security and customs regulations.

At both locations, it is necessary to build a riverbank structure of a 100-meter vertical bank along with the railway system, water supply and sewerage, electrical installations, and to obtain a crane with grabs and grapples. For this construction according to the regulations, it is

necessary to draw up the execution projects and get all the necessary permits for construction and operation.

Advantages and disadvantages of Location 'two'

Although location 'two' currently does not have a concessionaire, it is necessary to initially carry out works on the infrastructure of the riverbank in order to create all the necessary preconditions for the work of the future concessionaire. It is to be assumed that for the infrastructure of the riverbank at this location, it would take at least three years (length of vertical riverbank: 100 meters).

Advantages and Disadvantages of Location 'three'

As already mentioned at location 'three', the concessionaire is Luka Vukovar d.o.o will be present until year 2026. The regulations of the Republic of Croatia do not allow changes to the rights and obligations of the concessionaire during the concession, which means that the regular tender could take place in 2026. Luka Vukovar d.o.o. today operates with 30% of its capacity and is extremely interested in working with new cargo, as well as with biomass. The concessionaire also has the basic equipment needed for the transfer and storage of biomass, but there is no basis for the existing concession to establish a biomass trade centre.

As it has already been stated that the construction of a vertical riverbank (length of approx.100 meters) would have to be built at this location, this would potentially disrupt the work of the concessionaire during construction period.

Both locations will be considered as sites for the establishment of a biomass trade centre.

5.9. Partners to be involved

It would be very important to include Hrvatske šume d.o.o. in the process of preparation and operational implementation as a partner, because they are the largest supplier of biomass in the Republic of Croatia, and in addition to the private forest owners, they are licensed to obtain wood from the forest. Businesses and crafts that have a license are limited based on annual quantities (on average 8.000 m^3).

Biomass suppliers:

- Hrvatske šume d.o.o. Zagreb
- Hrvatske šume d.o.o., Offices: Osijek, Vinkovci, Nova Gradiška, Požega and Naši
- Spačva d.o.o. Vinkovci
- Agro Tovarnik d.o.o. Tovarnik
- Arator d.o.o. Lovas
- Čepin oil factory
- Žito grupa Osijek
- A.M.S. Biomasa d.o.o. Darda
- Progresys d.o.o. Nova Gradiška

Policy makers:

- City of Vukovar

- Vukovar-Srijem County
- Ministry of Finance Customs Office of Vukovar
- Ministry of the Sea, Transport, and Infrastructure
- Department of Agriculture
- Ministry of Environmental Protection and Energy
- The Environmental Protection and Energy Efficiency Fund

Ports authority and Ports:

- Port Vukovar d.o.o.
- Port Tranzit in Osijek
- Port Authority Osijek

Other Logistic Service Providers:

- HEP - Distribution System Operator d.o.o. Vukovar
- Vupik d.d. Vukovar
- PIK Vinkovci d.d. Vinkovci
- Dunavski Lloyd Sisak
- Belje d.d. Darda
- Ricardo d.o.o. Vukovar

Biomass Associations:

- A-pellet d.o.o. Oprisavci
- Euro-tim d.o.o. Trviž, Pazin
- Uni Viridas d.o.o. Babina Greda

Other partners:

- Croatian Radio Vukovar (marketing partner and dissemination of the project)

5.10. Recommended implementation schedule

Creating conditions for the restructuring of the Vukovar port in to a biomass hub is a project that should be realized in phases, namely:

- The first phase is the construction of a riverbank structure (at site 'two' or 'three') which includes the design and construction of the riverbank as well as the establishment of the necessary infrastructure.
- The second phase is the issuance of a concession for the establishment of a biomass trade centre and the selection of concessionaires.
- The third phase is the establishment of a biomass trade centre.

Table 5 - Recommended implementation schedule.

	2019				2020				2021				2022				2023			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1 phase																				
Design of the main project and necessary technical documentation																				
Construction of port infrastructure (50% of planned works)																				
Completion of works on port infrastructure																				
2 phase																				
The issuance of a concession for the establishment of a biomass trade center																				
3 phase																				
The establishment of a biomass trade center																				

In the first and second phase, the Port Authority of Vukovar would be the beneficiary of all activities, while in the third stage the activity holder would be a future concessionaire under the supervision of the Port Authority of Vukovar according to the concessionaire.

5.11. Investment costs and financing

Investments should be considered in two separate ways, the ones that the Port Authority of Vukovar should do and on those that are the obligation of the future concessionaire. Therefore, an overview of the investments that will be undertaken by the Port Authority of Vukovar in order to achieve the conditions for business and development at a biomass hub will be provided below. This document also provides an estimation of the minimum investment that will, in accordance with the concession, have to be investment of the future concessionaire, taking into account proposed locations.

Port Authority of Vukovar investments

Table 6 – Estimation of investment costs for the Port Authority of Vukovar.

		Unit of measure €	Quantity	Total €
1.	Cost of the Master Project (5%) and Supervision (2%)			304,772
2.	Costal structure and foundation			
	Bound meter vertical coast	33,334 €/m	100 m	3,333,375
3.	Railway line	1,666 €/m	350 m	583,188
4.	Water supply network and wastewater system			187,425
5.	Electrical installations			249,900
6.	Crane	2,500,000	1	2,500,000
	TOTAL			**7,158,660**

In accordance with the cost guidelines of the Croatian Association of Civil Engineers on total investment amount 5% of the costs for the main project and 2% of the costs of supervision should be added. This represents the overall percentage of 7% for the main project and construction supervision - shown in the table.

The mentioned investments relate to location ‘two’ or ‘three’ (they are approximately the same for both locations), and further investment for construction and operation of a biomass trade centre will be carried out by the concessionaire.

Future concessionaire investments at location 'two'

Table 7 - Estimate of investment costs for the future concessionaire at location 'two'.

		Unit of measure €	Quantity	Total €
1.	Transport and open storage area Location 2	133 €/m²	7,000 m²	931,000
2.	Closed warehouse	400 €/m²	1,500 m²	600,000
3.	Weighbridge	30,000	1	30,000
4.	Forklift 2,5-3 t	30,000	1	30,000
5.	Drying plant	22,000	1	22,000
6.	Other equipment (picker etc.)	10,000		10,000
7.	Crane adapters – gripper - log grapples	15,000		15,000
	TOTAL			**1,638,000**

At location 'two' one of the problems is the intersection of the future railway line with the possibility of communication between the railway-road crossings.

Future concessionaire investments at location 'three'

Table 8 - Estimate of investment costs for the future concessionaire at location 'three'.

		Unit of measure €	Quantity	Total €
1.	Transport and open storage area Location 3	133 €/m²	10,000 m²	1,330,000
2.	Closed warehouse	400 €/m²	1,500 m²	600,000
3.	Weighbridge	30,000	1	30,000
4.	Forklift 2,5-3 t	30,000	1	30,000
5.	Drying plant	22,000	1	22,000
6.	Other equipment (picker etc.)	10,000		10,000
7.	Crane adapters – gripper - log grapples	15,000		15,000
	TOTAL			**2,037,000**

The third presented location also has the advantage of being managed by the existing concessionaire Luka Vukovar d.o.o. which owns harbour equipment: cranes, forklifts, as well as a closed warehouse of 3,000 m², and can start shipping operations before arranging the site and setting up a biomass trade centre.

6. Operation

6.1. Project Management Organisation, human resources

The Port Authority of Vukovar has sufficient human resources to implement the project. The existing organization and management capacity are also sufficient for the implementation of the project.

Part of the project related to the establishment and operation of a biomass trade centre will depend on the interest of the future concessionaire, or the interest of the concession itself.

6.2. Operation and maintenance costs

Projection of concession contract management costs

The management of a concession contract, which includes legal and administrative concession-management activities such as the concession feasibility study, contract preparation, billing procedure, collection and similar, is under the jurisdiction of the Port Authority of Vukovar, which itself carries out the above mentioned activities. Given that these activities are covered by the existing operational costs of the Port Authority of Vukovar (legal and economic service), the incremental costs of managing the concession contract are considered negligible or are not considered as the relevant project costs because the implementation of the project does not generate additional cash outflows for managing the concession contract.

Projection of infrastructure maintenance costs

The maintenance cost is related to the amount of initial investment. Maintenance activities begin in the first year of the (commercialization) of the project (the year in which the collection of concessions is initiated), i.e. in 2022 with different cost dynamics taking into account the age of long-term assets.

Calculation of maintenance costs is shown in the following table.

Table 9 - Infrastructure and equipment maintenance costs.

Item	Purchasing value (EUR)
Investment in infrastructure	4.658.660
Investment in equipment	2.500.000
Total	**7.158.660**

Item	Annual maintenance expenses in period 2022-2031 (% of purchasing value)	Annual maintenance expenses (EUR)
Costs of infrastructure maintenance	1,0%	46.587
Costs of equipment maintenance	0,5%	12.500
Total		**59.087**

Item	Annual maintenance expenses in period 2032-2041 (% of purchasing value)	Annual maintenance expenses (EUR)
Costs of infrastructure maintenance	1,5%	69.880
Costs of equipment maintenance	1,0%	25.000
Total		**94.880**

Item	Annual maintenance expenses in period 2042-2048 (% of purchasing value)	Annual maintenance expenses (EUR)
Costs of infrastructure maintenance	2,0%	93.173
Costs of equipment maintenance (reinvested)	0,5%	12.500
Total		**105.673**

6.3. Pricing

Prerequisite of the denomination and the price factor of production factors and output of the project

The input and output prices included in the calculations for the financial analysis of denominations are in € and based on the price level in 2018 with the applied rate of HRK 7.60 for 1.00 €.

Level of price changes (assumptions about inflation/deflation for the duration of the project)

Financial analysis is conducted in constant (realistic) prices, meaning that the sum of all estimated items does not include an adjustment to the inflation rate (therefore a realistic discount rate for financial analysis was used). All financial projections are expressed in €. Since loan financing is not used for financing the project, correction of the nominal interest rate on real interest rates is not necessary.

Impact of profit and value added tax (VAT) on financial analysis of the project

In general, the impacts of profit and value added tax (VAT) implications on total investment costs, operating costs, operating income, and also the cost-effectiveness of individual projects may be significant, depending on the tax environment in which the investor acts and his tax status. Below is a summary of the tax status of the subject - Port Authority of Vukovar.

The port fees that port administrations charge according to the Maritime Law and Sea Ports (Official Gazette 158/03, 100/04, 141/06 and 38/09) are not subject to taxation as they fall under the authority or scope of work of the port authorities in accordance with special regulations. The Port Authority of Vukovar can be a taxpayer only in the part related to performing the so-called economic activity which it carries out or can perform and only for that part of the supply may use the right to the deduct input tax. In all other cases, the input VAT for the Port Authority of Vukovar is a non-refundable expense for which no right to deduct is allowed.

Forming of concession price

Any (economic and other) activity in the port area is usually regulated by the provisions that each country determines in accordance with its objectives. The concession model for ports and inland waterways in the Republic of Croatia is regulated by the Ordinance on criteria for

determining the concessions for concessions in ports and inland waterway ports of June 15th 2015 (OG 72/2015).

Prior to the formation of a concession fee, the Port Authority of Vukovar is obliged to make a feasibility study for granting the concession. The current concessionaires in the area of Port Authority of Vukovar pay the average variable concession in the amount of 0.5% of annual revenues, or 2.0% if this is related to the manipulation of oil and oil derivatives in the area of the Port Authority of Vukovar.

Therefore, prior to the call for tenders for a concession contract, a feasibility study should accurately determine the level of concession for the construction and management of a biomass trade centre. Based on the experience and common practice of the Port Authority of Vukovar, the concession fee should consist of two components - a fixed fee of 10,000 € per year and a variable fee of 1.0% of the income of the future concessionaire. Revenues from concession fees are explained in the Income and Cost Analysis section.

6.4. Preliminary cash flow estimates

Financial plan (overview of cash flow by years)

One of the fundamental criteria for the acceptability of an investment project is the criterion of financial sustainability. The criterion defines a positive cumulative cash flow as a project sustainability indicator, i.e. the project is financially viable when it is not exposed to the risk of the future financial losses. In this project this criterion is fulfilled. Although negative cash flow may occur in certain years, the cumulative cash flow is always positive. Sustainability of the project is presented in the following table.

Table 10 - Total cash flow.

Year	0 2018	1 2019	2 2020	3 2021	27 2045	28 2046	29 2047	30 2048
Sources of financing	-	**217.694**	**2.220.483**	**4.720.483**	-	-	-	-
Revenues	**901.000**	**901.000**	**901.000**	**901.000**	**1.087.225**	**1.087.225**	**1.087.225**	**1.087.225**
Concession fees	91.000	91.000	91.000	91.000	247.925	247.925	247.925	247.925
Revenue by special regulations (except concessions)	200.000	200.000	200.000	200.000	229.300	229.300	229.300	229.300
Transfers from Government budget	500.000	500.000	500.000	500.000	500.000	500.000	500.000	500.000
Assets revenues	60.000	60.000	60.000	60.000	60.000	60.000	60.000	60.000
Other revenues	50.000	50.000	50.000	50.000	50.000	50.000	50.000	50.000
TOTAL INFLOWS	**901.000**	**1.118.694**	**3.121.483**	**5.621.483**	**1.087.225**	**1.087.225**	**1.087.225**	**1.087.225**
Initial investment (infrastructure & equipment)	-	**217.694**	**2.220.483**	**4.720.483**	-	-	-	-
Reinvestment (replacement costs)	-	-	-	-	-	-	-	-
Principal repayment	-	-	-	-	-	-	-	-
Financial expenses	**2.500**	**2.500**	**2.500**	**2.500**	**2.500**	**2.500**	**2.500**	**2.500**
Operating outflows	**755.000**	**755.000**	**755.000**	**755.000**	**860.673**	**860.673**	**860.673**	**860.673**
Emplyees expenses	142.000	142.000	142.000	142.000	142.000	142.000	142.000	142.000
Material expenses	598.000	598.000	598.000	598.000	703.673	703.673	703.673	703.673
Other expenses	15.000	15.000	15.000	15.000	15.000	15.000	15.000	15.000
TOTAL OUTFLOWS	**757.500**	**975.194**	**2.977.983**	**5.477.983**	**863.173**	**863.173**	**863.173**	**863.173**
NET CASH FLOW	**143.500**	**143.500**	**143.500**	**143.500**	**224.052**	**224.052**	**224.052**	**224.052**
Cash and cash equivalent at the beginning of year	449.946							
Cumulative of cash and cash equivalents	**593.446**	**736.946**	**880.446**	**1.023.946**	**3.943.127**	**4.167.179**	**4.391.231**	**4.615.282**

Throughout the project implementation period, financial sustainability problems of the project, i.e. cash flows problems, from the point of Port Authority of Vukovar are not expected. Cumulated net cash flow is positive in all years of the project time horizon.

6.5. Cost-benefit analysis

Financial analysis

The financial analysis must be included in the cost-benefit analysis (CBA) in order to calculate the financial performance indicators of the project. The financial analysis is carried out for the following purposes:

- project profitability estimates from the point of view of investors;
- project profitability assessment for the project owner;
- verification of the financial viability of the project, a key prerequisite for feasibility for any type of project;
- a cash flow chart that supports the calculation of socioeconomic costs and benefits.

Methodology and assumptions of the financial analysis

The applied methodology in the analysis is based on the Guide to Cost-Benefit Analysis of Investment Projects Economic Assessment Tool for Cohesion Policy 2014-2020 issued by the European Commission (hereinafter referred to as the Guide).

Financial analysis includes quantification and description of project costs (investment costs, financial costs, and operating costs), project revenue, sources of funding, and financial outcome of the project presented to the relevant indicators of financial and economic feasibility. The applied indicators are the financial net present value of investment FNPV (C), financial return on investment (FRR (C)), the financial net present value on invested equity (FNPV (K), financial profitability ratio of invested equity FRR (K). The calculation of the indicator applies the discount cash flow technique. Only cash receipts (cash inflows) and expenditures (cash outflows) are considered for the purposes of assessing the financial viability of the project.

The elements of financial analysis depend on the model of management of a biomass trade centre in the area of the Vukovar port. Given the existing legal framework regulating the right of ownership of the infrastructure in the port areas, it is considered that the most acceptable option is the financing of the port infrastructure upgrade by the Port Authority of Vukovar, while the construction and management of a biomass trade centre according to the concession model will be entrusted to the concessionaire. The concessionaire will pay the concession to the Port Authority of Vukovar, according to a predetermined concession model. Specifically, the projected investment in port infrastructure (which is merely a precondition for building and managing a biomass trade centre) is estimated to be too high for a private investor (a concessionaire) who would not have the right to acquire ownership of the infrastructure that he would potentially finance. Consequently, this model of the Port Authority's partnership with Vukovar as a concession provider for the construction and management of a biomass trade centre and future concessionaires that will build, equip and manage a biomass trade centre is considered acceptable in relation to other alternative models where the concessionaire itself would have to bear the costs of financing investment in infrastructure the Vukovar port.

The basic assumptions of the financial analysis are as follows:

- financial analysis includes only cash inflows and outflows; non-cash accounting items such as depreciation, provisions, contingency provisions and other non-cash items that have been accounted for are neglected;
- the recommended realistic discount rate for the financial analysis of 4% was applied;
- the financial analysis was carried out at constant prices (base prices since 2018), meaning that projections of the sum of all estimated items do not include a correction for the inflation rate, i.e. a real discount rate is used;
- all amounts in the financial analysis are expressed in €; the applied rate of HRK 7.60 for 1.00 €; it is assumed that the exchange rate will remain unchanged throughout the project period;
- the value-added tax is entirely excluded from the financial analysis unless it is a non-recoverable item for the investor;
- profit tax and profit tax effects are excluded from the financial analysis.

Beneficiary / Project Sponsor Identification

The beneficiary of the Project is the Port Authority of Vukovar which performs the management of the ports in the status of a public institution "Public Institution Port Authority Vukovar", with headquarters in Vukovar - for the area of local authority of the Harbourmaster' office of Vukovar.

Project scope

The pre-feasibility study encompasses investment in port infrastructure from the perspective of a beneficiary/project sponsor as a basic precondition for the construction and management of a biomass trade centre in the area of the Vukovar port. This study does not consider explicitly the viability of investing in the Centre by private investors (concessionaires), although it implies that its construction and management (and hence the cost of construction and management) will be in the direct interest of the future operator of such a centre (concessionaire - at the time of making this study is not known). However in this study, there are numerous parameters that point to the cost-effectiveness of building and managing such a biomass trade centre. Also, this study does not in any way prejudge the identity and legal status of the future concessionaire who will manage a biomass trade centre according to the proposed model from this study.

Realistic financial discount rate

The financial discount rate represents the opportunity cost of capital, and is defined as the expected return on potential best alternative missed investment activities. For the programming period 2014-2020, the European Commission is in Article 19 (Discounting of Cash Flows) of the Delegated Commission Regulation (EU) no. 480/2014 recommended using a realistic discount rate of 4% as an indicator of the opportunity cost of capital. Given this provision, the financial analysis applies a recommended rate of 4%.

Incremental approach

The project is being considered in the context of the existing infrastructure managed by the Port Authority of Vukovar. Financial analysis, or determination of relevant cash flows, is based on an incremental approach, considering the difference between cash flows in the scenario that

encompasses the business scenario with the project and the scenario of the continuation of the present state without the proposed project (business as usual). Therefore, the financial analysis involves a differential analysis of cash flows. The projected incremental cash flows are discounted at the appropriate discount rate to calculate the present value of future cash flows. Discounting does not include the effect of possible price change in the future.

Definition of financial sustainability

Financial sustainability of this project is defined as the capability of the Port Authority of Vukovar to cover all investment expenditures, financial expenditures and operational costs of the project with financial resources that include own operating revenues (including state budget funds transferred in accordance with legal provisions) and other appropriate (by structure and amount) sources of financing.

Project time horizon

For the purposes of financial analysis and projection of future benefits, revenues and project costs, it is necessary to select the project time horizon, which includes the period of preparation (investment) and the period of project implementation

The project horizon of 30 years has been selected for this project. Therefore, the financial analysis covered the period from 2019 to 2048.

In 2018, financial expenditures were not anticipated as a result of the adoption of this project. It is assumed that investment expenditures will start in 2019 and that the dynamics of investment before commercialization will last for a total of three years in the period 2019-2021. After the investment period, the investment effect will begin at the beginning of 2022 with a forecast period of 27 years, covering a total of 30 years. At the end of the explicit time horizon, the value of the asset that originated from the initial investment including long-term fixed assets, equipment and possible investments in the permanent working capital is included in the residual value at the end of the observable time horizon.

A summary of economic assumptions is given in the following table.

Table 11 - Economic variables of the project.

Economic parameters	Value of parameters
Time horizon (years)	30
Real discount rate	4,00%
Economic discount rate	5,00%
Exchange rate EUR/HRK	7,60

The initial investment, reinvestment and residual value of the investment

For the purposes of the financial analysis of this project, a model for the construction, management, and operation of biomass trade centre has been defined according to which:

1. Port Authority Vukovar as a concession provider provides investment in the entire port infrastructure and partly in equipment (crane),

2. A potential concessionaire shall bear all other investment required for the construction and equipping of biomass trade centre and the operating costs incurred for the Centre management. The concessionaire entrusts the management of a biomass concessionaire to the concessionaire who pays the concession fee on a predefined concession model.

In Chapter 5.11 the project options also considered the three current potential locations for a biomass trade centre's within the port area of Vukovar. Leading the current port infrastructure, the required investments for each of the three options, and the traffic link of the location, it was concluded that locations no. 'two' and location no. 'three' provide the best conditions for building a biomass trade centre. Therefore, the cost and benefit analysis will start from the required investment in these two locations. The amount of investment is considered to be the same for both considered locations.

An individual or combinations of investment funding sources that are considered are:

- own resources, i.e. non-return funds from the state budget of the Republic of Croatia intended for maintenance of infrastructure;
- grants from the European Union funds.

The total investment is divided into three stages:

- Stage I: design of the main project and necessary technical documentation (billing, permits etc.);
- Sage II: construction of port infrastructure (50% of planned works);
- Stage III: completion of works on port infrastructure (50% of planned works).

The project scope includes obtaining the supporting project and technical documentation required for construction interventions of the infrastructure of the Vukovar port.

Total Initial Investment and Investment Phases

Initial investment other than infrastructure investment (including project and technical documentation) includes partial investments in equipment needed for the functioning of a biomass trade centre. As mentioned above, the entire investment is carried out in three phases, in the period of 2019-2021; however project implementation is also possible in any forthcoming period.

Therefore, total investments in fixed assets amount to 7,158,660 €. A detailed overview of investment with the associated time frame of each investment is shown in the following table.

Table 12 - Overview of the amount and dynamics of the investment.

		Unit measure	Number of units	Price per unit (€)	2018	2019	2020	2021	Total (€)
1.	**Investment in port**				**-**	**217.694**	**2.220.483**	**2.220.483**	**4.658.660**
1.1.	Cost of the master project (5%) and supervision (2%)				-	217.694	43.539	43.539	304.772
1.2.	Costal structure and foundation vertical coast	m	100	33.334	-	-	1.666.688	1.666.688	3.333.375
1.4.	Railway line	m	350	1.666	-	-	291.594	291.594	583.188
1.5.	Water supply network and				-	-	93.713	93.713	187.425
1.6.	Electrical installations				-	-	124.950	124.950	249.900
2.	**Equipment**				**-**	**-**	**-**	**2.500.000**	**2.500.000**
2.1.	Crane	kom.	1	2.500.000	-	-	-	2.500.000	2.500.000
	TOTAL INITAL INVESTMENT (€)				**-**	**217.694**	**2.220.483**	**4.720.483**	**7.158.660**

Operating Revenues and Expenses

After identifying initial investment, analysis of operating income and costs is the second step of financial analysis and includes the project's operating life-cycle. Below are explanations of income and expense items. It is assumed that all revenues are also cash receipts, that is, all expenses (except amortization) are cash expenditures.

The Port Authority of Vukovar, according to Croatian legislation, has defined revenue forms defined by law. From the standpoint of the Port Authority of Vukovar, revenues are defined in Art. 132 and Art. 140 of the Law on Navigation and Inland Waterways (Official Gazette 109/07, 132/07, 51A / 13, 152/14), according to which port services and ports for port administrations pay harbour fees constituting port fees and concession fees.

Overview of Revenues and Expenditures of the Port Authority of Vukovar

As previously pointed out, the Port Authority of Vukovar, according to Croatian legislation, has defined revenue forms defined by law.

Fees are calculated on the basis of the gross amount of the cargo to be manipulated at the port. Passenger traffic is calculated and charged by the vessel according to the number of passengers. The Port Authority of Vukovar charges berthage for inoperative ship for boats that use the harbour for other purposes or stay longer than the standard time of loading/unloading.

Port charges for port taxes of different types of cargo and for passenger traffic are prescribed by the Port Authority of Vukovar by the Decision on the amount of port fees in ports and docks, from 09. 12. 2015. and the Decision on Amendments to the Decision on the amount of port fees in ports and docks from 03. 03. 2017. In table below is outline of the Port authority fees from various sources for period 2015 - 2017.

Table 13 - Overview of Port Authority Fees for Port Authority Vukovar.

Euro	2015	2016	2017
Quay charges	204,812	157,689	174,407
Port fee	10,263	10,430	10,382
Berth charges	11,895	3,816	2,743
Other incomes	1,627	20,940	11,597
Total	**228,597**	**192,875**	**199,130**

Fees from concessions

Currently, Port Authority Vukovar charges a concession of four concessionaires. The concession fee consists of a fixed and variable part. The fixed portion of the fee is payable for the use of the port area as a one-time annual fee. It is charged on the basis of the formula that takes into account the type and number of services for which the concessionaire has the authority in a given port area.

The variable part of the concession fee - port fees are paid according to the realized business activities of the concessionaire - the port user during the year. The variable part is calculated as a percentage of realized annual revenue from the performance of port activities assigned to the concessionaire user. The following table gives an overview of the concession fees paid to the Port Authority of Vukovar with regard to the concessionaire (legal person).

Table 14 - Overview of the concessions of the Port Authority of Vukovar for 2006 – 2018.

	Concession fees (kn)							Concession fees (€)		
god.	fixed fees	variable fees	Total	LUKA VUKOVAR	NAUTICA VUKOVAR	LUKOIL	VUPIK	fixed fees	variable fees	Total
2006	184.489	109.725	294.214	10.840	27.873	0	0	24.275	14.438	38.712
2007	345.687	97.651	443.338	25.557	19.860	10.954	1.962	45.485	12.849	58.334
2008	587.937	152.378	740.315	58.754	20.496	13.227	4.932	77.360	20.050	97.410
2009	586.224	159.073	745.297	61.596	15.453	15.954	5.063	77.135	20.931	98.065
2010	585.475	242.847	828.321	62.299	25.738	16.007	4.945	77.036	31.953	108.990
2011	592.605	259.522	852.127	66.203	25.094	15.966	4.858	77.974	34.148	112.122
2012	604.539	283.829	888.368	69.684	24.983	17.149	5.075	79.545	37.346	116.890
2013	605.835	183.916	789.751	68.658	10.948	16.772	7.537	79.715	24.200	103.915
2014	613.825	190.403	804.228	68.720	13.716	16.839	6.544	80.766	25.053	105.819
2015	622.407	202.459	824.865	69.022	9.483	19.504	7.302	81.896	26.639	108.535
2016	611.607	150.538	762.145	66.346	9.405	17.170	6.021	80.475	19.808	100.282
2017	596.718	80.749	677.467	65.558	9.235	5.691	6.056	78.515	10.625	89.140
2018	559.525	0	559.525	59.561	9.173	4.888	0	73.622	0	73.622
Total	**7.096.871**	**2.113.090**	**9.209.961**	**752.799**	**221.457**	**170.122**	**60.296**	**933.799**	**278.038**	**1.211.837**

As it can be seen from Table 14 - Overview of the concessions of the Port Authority of Vukovar for the period 2006 – 2018, currently there are four concessionaires in Port of Vukovar. From 2015 onward, concession fees have declining trend, reaching total of 73,622 € concessions fees in 2017 (including fixed and variable concession fees).

Table 15 - Overview of total revenue of the Port Authority of Vukovar.

Euro	2015	2016	2017
Concession fees	108,535	100,282	89,140
Fixed concession fees	81,896	80,475	78,515
Variable concession fees	26,639	19,808	10,625
Revenue by special regulations (excluding concessions)	228,597	192,875	199,130
Revenues from the State and County budget	395,162	537,379	453,253
Assets revenues	48,408	68,099	33,586
Other revenues	40,882	51,264	81,718
Total	**821,584**	**949,898**	**856,827**

Projection of revenue from concession fees and port fees in the project

The calculation of the concession fees and the expected revenues of the future concessionaire are shown in the following table. The concession fee, as it is to date, will be composed of two components - a fixed fee of 10,000 € per year and a variable fee that will, as planned, be 1.0% of the income of the future concessionaire.

As shown, in the first four years of a biomass business, revenues from concessions are lower than the maximum expected due to the capacity of the centre (business start-up). In 2026, the full capacity of a biomass trade centre will be realized. A fixed concession fee is planned in the amount of 10,000 € per year and a variable concession fee at the level of 1% of a biomass trade centre operator's (concessionaire) revenues.

In addition to the proceeds from the concession, as a result of the project's implementation, revenue from port fees will also be increased. Given the annual capacity of the 126,000 t biomass trade centre, it is estimated that at least 40% will be transported on waterways (50,400 t). Considering that under the present conditions of utilization of the capacity of the Vukovar port of about 300,000 t in 2017, revenues for the use of a port or a dock amount to 174,407 € (which, considering historical developments, can be regarded as representative for a starting point) it is envisaged that the project will increase the revenue from these fees to 50,400 t (from the project)/300,000 t (the current actual utilization rate). This means that in the year of realization of the full capacity of a biomass trade centre (2026) of 126,000 t, additional fees will be realized in the amount of 16.8% of 174,407 €, which is 29,300 €. By 2026, port charges would be proportional to the utilization of a biomass trading centre capacity as indicated in the table.

Table 16 - Projection of revenues from concessions and port fees.

		0	1	2	3	4	27	28	29	30
		2018	2019	2020	2021	2022	2045	2046	2047	2048
1.	Revenues from biomass centre	-	-	-	-	4.407.737	14.692.455	14.692.455	14.692.455	14.692.455
	Coeficient of full revenue capacity					*30%*	*100%*	*100%*	*100%*	*100%*
2.	Fixed concession fees	-	-	-	-	10.000	10.000	10.000	10.000	10.000
3.	Varaible concession fees	-	-	-	-	44.077	146.925	146.925	146.925	146.925
4.	Port fees	-	-	-	-	8.790	29.300	29.300	29.300	29.300
	Total	**-**	**-**	**-**	**-**	**54.077**	**156.925**	**156.925**	**156.925**	**156.925**

Projection of reinvestment and residual (terminal) value of the project

Given the relatively high long-term investments and the time horizon of the investment, the project also foresees the residual value of the investment occurring at the end of 2048 (the last year of the project horizon). For long-term assets acquired through the project, the following depreciation periods have been estimated for which it is estimated to reflect the actual economic cost of the resource, and thus the reinvestment of long-term assets is also conditioned:

- coastal structures and foundations = 50 years;
- railway installations = 40 years;
- water supply and sewage = 30 years;
- electrical installations = 20 years;
- crane = 20 years.

Therefore, for all long-term assets whose depreciation period is more than 30 years, there will be no reinvestment in the observed time horizon of the project, but the costs of maintaining such long-term assets for the entire duration of the project will be calculated.

Sources of financing

In addition to their own resources, i.e. funds transferred to the Port Authority of Vukovar from the state budget, another source of funding for the project is funds from EU funds. The table shows all sources of funding for the years of the project.

For the purpose of identifying the amount of co-financing from the EU funds, the amount of the co-financing required by the calculation procedure set out in the EC, Article 55 of Council Regulation (EC) No 1083/2006: Revenue-generating Projects (COCOF 07/0074/04-EN).

The structure of the sources of funding for the total investment is shown below.

Table 17 - Structure of funding sources.

		2018	2019	2020	2021	Total (€)	Structure of financing sources
1	Private equity	-	217.694	226.168	1.729.010	2.172.872	30,4%
2	European Union Assistance	-	-	1.994.315	2.991.472	4.985.787	69,6%
3	Credit and loans	-	-	-	-	-	0,0%
	TOTAL INITIAL INVESTMENT (€)	**-**	**217.694**	**2.220.483**	**4.720.483**	**7.158.660**	**100,0%**

Private equity amount is investment of own funding of Port of Vukovar Authority. Regarding the European Union Assistance, it is foreseen that invitation for EU funding for such infrastructure projects will be opened during 2019 or earlier. It is expected that EU assistance should amount to 4,985,787 €.

Financial viability of the project - Investment yield (FNPC (C) and FIRR (C))

The net cash flow of the project is based on an incremental analysis of the cash flow differences in the situation with the project with respect to the project-free situation.

Table 18 - Table of net (incremental) cash flows of the project.

Year	0 2018	1 2019	2 2020	3 2021	4 2022	27 2045	28 2046	29 2047	30 2048
OPERATING INFLOWS									
Concession fees i port fees (Project	-	-	-	-	62.867	186.225	186.225	186.225	186.225
Concession fees (Project generated)	-	-	-	-	54.077	156.925	156.925	156.925	156.925
Port fees (Project generated)	-	-	-	-	8.790	29.300	29.300	29.300	29.300
Prihodi po posebnim propisima (except concessions)	-	-	-	-	-	-	-	-	-
Revenues from Government transfers	-	-	-	-	-	-	-	-	-
Assets revenues	-	-	-	-	-	-	-	-	-
Other revenues	-	-	-	-	-	-	-	-	-
Total inflows	-	-	-	-	62.867	186.225	186.225	186.225	186.225
INVESTMENT AND OPERATING EXPENSES									
Investment in port infrastructure	-	217.694	2.220.483	2.220.483	-	-	-	-	-
Equipment	-	-	-	2.500.000	-	-	-	-	-
Residual value of investment	-	-	-	-	-	-	-	-	2.966.384
Reinvestment (replacement costs)	-	-	-	-	-	-	-	-	-
Employees expenses	-	-	-	-	-	-	-	-	-
Material expenses	-	-	-	-	59.087	105.673	105.673	105.673	105.673
Wages and salaries	-	-	-	-	-	-	-	-	-
Investment maintenances	-	-	-	-	59.087	105.673	105.673	105.673	105.673
Materials and energy	-	-	-	-	-	-	-	-	-
Other material expenses	-	-	-	-	-	-	-	-	-
Other expenses	-	-	-	-	-	-	-	-	-
Total investment and operating outflows	-	217.694	2.220.483	4.720.483	59.087	105.673	105.673	105.673	-2.860.710
Net cash flows	-	-217.694	-2.220.483	-4.720.483	3.781	80.552	80.552	80.552	3.046.935
Cumulativ net cash flow	-	-217.694	-2.438.177	-7.158.660	-7.154.879	-7.683.478	-7.602.927	-7.522.375	-4.475.439

Based on afore-mentioned parametres, following result is given.

Total present value of operating inflows	2,470,375
Total present value of investment and operating outflows	1,303,764
Discount net revenues (DNR)	**1,166,611**
Discount investment costs (DIC)	**6,458,774**
Maximum eligible expenditures (Max EE)	**5,292,163**
FNPV(C) (financial net present value of investment)	-5,292,163 €
FIRR(C) (financial internal rate of return on investment)	**-4.03%**

Economic analysis

This chapter of the feasibility study provides an analysis of economic arguments for the implementation of this project. The main objective of the economic analysis is to determine whether the contribution of the proposed project to future improvements in community social and economic well-being is greater than the cost of resources generated in the national economy. The project's financial costs are converted into economic costs through appropriate conversion factors (CF). The economic analysis, among other things, quantifies effects such as the impact of the project on the environment, health, noise, congestion, social and wider

economic benefits. While the project is analysed in the financial analysis from the point of view of the Port Authority of Vukovar, the economic analysis of the project looks at the project from the standpoint of the society, i.e. through the prism of the socio-economic development of the Vukovar region and the society point of view.

Discount rate

According to the recommendation of the European Commission, given that there is no officially recommended discount rate in Croatia, in the socio-economic analysis for the 2014-2020 programming period a discount rate of 5% is used.

Socio-economic costs

In the analysis of socio-economic costs, attention is devoted to the explanations that are related to:

- Fiscal adjustments involving the elimination of the effect of the value-added tax, and all other direct and indirect taxes and subsidies,
- possible price deviation differences in relation to actual market prices prevailing in the absence of monopoly market structure, trade restraints and market imperfections, in particular the differences in employee salaries and inputs with respect to labour market prices in other sectors for the same qualifications and inputs (shadow prices);
- External costs for other social groups (the impact of positive and/or negative externalities) and/or factors that involve potential environmental impact.

Fiscal corrections

In accordance with the Guidebook, the following principles were applied in the preparation of the economic analysis:

- VAT and other indirect taxes are excluded in input and output prices since VAT and other indirect taxes are re-transferred to consumers at the company level;
- salaries are calculated with the exclusion of the associated taxes and surtaxes by applying (approximated) average tax rates;
- In revenue, budget transfers are not planned in the form of grants or subsidies other than those related to the legal obligation to fund port infrastructure maintenance from the state budget.

Price differences

For the purpose of economic analysis, the VAT rates and other indirect taxes are excluded in the input prices, while the collection of the concession is done without VAT calculation. All project input prices (in the investment period) are planned based on the free market and the absence of trade restraints. Planned input prices in the project are market-based, that is, prices that are freely formed in a competitive market. Therefore, the project's financial costs were used as a basis for estimating economic costs. The calculation of the conversion factors from the financial to the economic cost of inputs during the investment phase was done by excluding value added tax (factor 0.80) without other conversion elements (except for low skilled labour costs)

because the project inputs will be delivered to an open, competitive tender (given the high degree of integration and degree of openness of the Republic of Croatia with other EU markets).

1. Calculation of "Shadow Wage"

"Shadow wages" measure the opportunity work cost. Usually in economies with a high unemployment rate, they can be lower than real (observed) wages. The projected work cost for the project construction period (three years) are formed within the prices that prevail in private companies for qualification levels. For a highly qualified workforce, it can be approximated that "wages in the shadows" are equal or very close to market wages. For low skilled labour, it can be assumed that "wages in the shadow" are equal to unemployment benefits (if workers are engaged in a group of unemployed) or equal to the values of missed outcomes from informal activities (if workers are redirected to the project from these activities).

The cost of the unskilled labour force (for the investment phase) was corrected by applying a conversion factor (given the relatively high current unemployment rate in the Republic of Croatia) in order to apply the concept of "shadow wages". The following formula has been applied:

SW = W (t-1) * (1-u)

The tags stand for:

SW - shadow wages

W - pay is observed in the market

t - rate of payroll tax

u- regional unemployment (factor for the Republic of Croatia)

Therefore, the conversion factor for low-skilled and highly qualified workforce is estimated at:

$CF\ l_{\text{low-skilled workforce}} = (1 - t)*(1 - u) = (1 - 0.20)*(1-0.1125) = 0.71$

$CF_{\text{high-skilled workforce}} = (1 - t)*(1 - u) = (1 - 0.30)*(1-0.0000) = 0.70$

2. Application of conversion factors to investment period inputs

It is assumed that the costs of low skilled workforce during the project construction account for approximately 1/5 (20.00%) of the total infrastructure construction costs (conversion factor 0.71). It is assumed that the same share in the investment period has a highly qualified labour force (for which conversion factor CF = 0.70 applies). For other construction costs (construction materials, equipment, material costs of energy generators), as well as conversion factor equipment, is 0,80. It is assumed that the VAT rate of 25%. Input VAT (prepayment on incoming invoices) is irrefutable to Vukovar Port Authority and therefore enters investment cost and financial analysis.

Conversion factors by input type are listed in the following table.

Table 19 - Conversion factor overview.

Item	Conversion factors (CF)	Remark
Construction materials and services in construction period	0.80	Purchased through open, competitive, international tenders, adequately priced on the market. No correction required. Correction only for VAT.
Costs of highly qualified workers for engineering services and operations in period of construction	0.70	A competitive market is assumed for skilled labour which can be thus assumed to be adequately priced on the market. No correction require, except for direct taxes and surtaxes.
Costs of low qualified workers in period of construction	0.71	High regional unemployment, hence, correction required for unemployment rates and direct taxes and surtaxes.
Equipment	0.80	Purchased through open, competitive, international tenders, adequately priced on the market. No correction required. Correction only for VAT.

The total conversion factor for infrastructure investment costs is calculated as the average weighing centre of conversion factors where the weights applied are the share of unskilled and qualified workforce in total investment costs (20% each) and the share of all other investment costs (60%), respectively:

$CF_{\text{construction of infrastructure}} = 0.20 \times 0.71 + 0.20 \times 0.70 + 0.60 \times 0.80 = 0.7620$

A conversion factor of 0.80 is applied to the equipment.

$CF_{\text{equipment}} = 0.80$

Socio-economic benefits

The project's social benefit analysis is estimated in accordance with the methodological guidelines of the Guide. Socio-economic benefits consist of energy, ecological and other benefits that contribute to the economic development of society. The socio-economic benefits of the project are described below.

1. **The value of the overall useful contribution of a biomass trade centre (ecological-economic-social context)**

The EU ETS is the world's first and largest emission trading system under the Kyoto Protocol and is the most comprehensive and most significant measure that the EU is trying to achieve regarding the goals signed by the Kyoto Protocol. Although the term trading of emissions is common practice, it is not actually trading of emissions, but by of broadcasting permits. The emission permit is equal to permit for emission of one tonne of CO2 equivalent, i.e. or tCO2-eq. The EU ETS includes more than 11,000 energy and industrial facilities and facilities in 28 EU Member States, including Iceland, Liechtenstein and Norway, and air traffic within and between most of these countries, covering around 45% of total EU emissions.

The wood chips are pieces of wood biomass of various shapes and dimensions. They are made by lumbering and cutting woody raw materials such as branches, bark and other residues in the forestry and wood processing industry, where chippings are used. It is most often used in heaters with more MW. The length of the chopping piece is 1-10 cm. Category of so called 'fine wood chips' has a diameter of up to 3 cm, a medium wood chips up to 5 cm and a large wood chips up to 10 cm. It is important for the appliance of the wood chips in the fireplaces to have as little moisture content as possible and to make the pieces as uniform as possible, as this is the only way to ensure the operation of automated fireplaces without any interference. After the purchase and the supply it is necessary to dry it for several weeks, since the purchasing chalk has a moisture content of about 40% and the drying achieves an optimal of 20%. There should be no residues of paint and similar chemical substances on the raw material for the production of the wood chips. If this condition is met, combustion will be without the occurrence of harmful emissions and with an ash content of less than 0.5%. Pellets are geometrically equal pieces of pressed chopped raw wood. Generally, they are cylindrical or shaped like tablets. They are produced by pressing sawdust and shavings of dried wood of high calorific value (such as oak, beech, poplar and ash wood) under a pressure of 1,000 bar. In this case, from 6 to 8 m^3 of raw material a 1m^3 of pellets is made. They are used in heating boilers with a thermal output of up to 50 kW for central heating and hot water preparation in family houses, residential and business buildings, and boilers of industrial and thermal power plants. The pellet length usually ranges from 5 to 45 mm, and the diameter of 10 to 12 mm for the heating systems of larger buildings and for energy plants. Density usually amounts to more than 650 kg/m^3.

In the production of pellets wood, natural binders such as corn starch are added to raw materials which facilitate the process of pressing and bonding of wood particles, but also improve the utilization and energy features of the finished product. The proportion of binders must not exceed 2%. The basic advantages of pellet application are high calorific value, as well as their shape and dimensions, which are reasonably easy to transport and store, and can be transported to the furnace in fully automated process, enabling the same simple application as for example gas. The most important energy feature of forest or wood biomass is the calorific value, which is usually expressed as the lower calorific value (Hd, MJ/kg). This is the amount of heat that is generated by the complete combustion of the unitary amount of fuel, whereby the flue gas is cooled to 25°C and the moisture remains in steam, and the heat of condensation of water vapour remains unused. The greatest impact on the fuel value of forest biomass has the share of moisture, chemical composition, density and wood health. The type of wood is also important for this, i.e. whether it is leaf or coniferous wood, soft or hardwood. The wood burning value decreases with increasing moisture in wood. During drying, a reduction of 10% in moisture causes an increase of about 2.16 MJ/kg in energy value. The chemical composition implies the share of certain basic wood materials and most of the basic elements: carbon, hydrogen, oxygen, sulphur and water, while the share of nitrogen, phosphorus and various alkali and other metals can be neglected. Wood density is also an important factor in its fuel value, and the moisture content of wood is also to be considered. Spatial Meter is a unit that denotes the volume of space in which forest biomass is placed relatively proportionately (pieces of wood, logs, briquettes). Bulb meter is a unit that denotes the volume of space in which the biodegraded forest biomass or wood raw material (sawdust, chips, and pellets) is located.

By strictly observing, forest biomass is not much different in the case of combustion emissions from fossil fuels because in both cases large amounts of carbon dioxide and numerous other harmful substances are produced. The unique CO2 abyss represents the remaining and newly planted trees that it uses for its growth and development, and that is why the energy exploitation of forest biomass is considered CO2 - neutral. It can be said that by using forest biomass instead of fossil fuels, carbon actually returns to the ground and does not go into an atmosphere where as CO2 increases the natural greenhouse effect. CO2 - neutrality of forest biomass is only valid with the assumption of re-growing the same quantity of wood used for its harvest.

Emissions generated by combustion of forest or wood biomass can be divided into two groups:

- emissions at full combustion,
- incomplete combustion emissions.

Emissions at full combustion of forest mass mainly include carbon dioxide, nitric oxides, sulphur oxides, hydrogen halides and particles. Emissions from incomplete combustion of forest biomass in the main include: carbon monoxide, particles, dioxins and furans and various gases such as methane, ammonia, volatile organic compounds etc.

Calculation of the cost of CO2 emissions in one year is carried out according to the following formula:

$$\text{Cost} = (\text{Amount of } CO2 \text{ emissions} - \text{number of free units}) * \text{price } EUA$$

The Government of the Republic of Croatia encourages the use of biomass as combustion fuel in industrial plants by co-financing in the amount of 40% of the cost of biomass boilers. Taking this into account, the cost of investing in new boilers on wood biomass is reduced from 463,493 € to 278,096 €. By comparing the savings achieved by excess emissions from wood biomass and the cost of investing in new biomass boilers, investments can be paid off in the first 5-6 years after boiler installation, and sometimes only three years after the boiler commissioning.

Assuming that the plants will use a hardwood dry wood chips of 30% moisture content and a lower heating value of 12.2 MJ/kg or 3.4 kWh/kg, and that boilers operating on wood biomass work with a yield of η of 80% based on the quantity of wood chips of 126,000 tonnes per year in a biomass trade centre, the produced energy corresponds to 342,720 MWh. The assumption taken into account when calculating that the wood chips used (30% moisture content) has an ash content of 1.0% per dry matter. The total annual cost of ash disposal, assuming that the cost of disposal per ash tune is 300 €/tonne, is 264,600 €/year.

The comparison can be made with natural gas, and considering the average price of natural gas for the industry of 300 HRK/MWh and wood chips (moisture 30 - 35%) of the average 160 HRK/MWh, the conclusion is that the difference in favour of biomass is 140 HRK/MWh. In this respect, the calculation shows that based on the price difference in favour of biomass, and after the deduction of the cost of ash disposal (264,600 €), savings is 6,132,840 €/year. At the beginning of the 3rd trading period (2014), the EU ETS covered about half (50%) of all EU emissions.

Wood biomass due to its great potential and the fact that it is considered neutral with respect to CO2, its emission factor is zero when applying emission units from the plant. With this the plant

that replaced natural gas with biomass saves the total amount of emissions costs due to natural gas combustion.

On the other hand, the natural gas emission factor is 56.10 tCO2/TJ of thermal energy, or 0.202 kg CO2/kWh according to the National Inventory of Greenhouse Gases (NIR-2014). The 2015 emission prices ranged from 7.55 €/EUA (January 15th) to 8.10 €/EUA (September 4th). Pricing is therefore strictly indicative. The lower scenario envisages 5 €/EUA in 2015, 12 €/EUA in 2020, and 50 €/EUA in 2030. The higher scenario envisages 8 €/EUA in 2015, 21 €/EUA in 2020, and even 59 €/EUA in 2030. Given the actual movements in the EUA's price in 2015, the higher the scenario nowadays is relatively accurate for the EUA price (average 8 €/EUA).

Based on the mentioned parameters, with the assumption that the EU ETS covers 50% of emissions, the same amount for a biomass of the Centre 34,614 t/y, and with the price of 8 €/EUA, the savings on the emissions is 276,912 €/year (as it can be seen the amount roughly abolishes the cost of the ash disposal). In conclusion, the total savings related to the difference in a biomass price versus gas, and the cost savings of greenhouse gas emissions generated by a biomass trade centre, amount to 6,409,752 €/year.

Given that the relevant economic benefits for the project are only those of the product of the project (incremental effect), it is estimated that 10% of the calculated amount of economic energy benefits of 6,409,752 € is the result of the project (easier availability of biomass and higher available volumes on one place) or 640,975 € per year.

2. Effect of transport costs on waterways in relation to road transport

By building a biomass trade centre, one part of biomass is expected to be transported by waterways instead of road transport. It is estimated that about 40% of biomass in the future biomass trade centre in Vukovar port will be transported on waterways instead of road transport. The total annual quantity of wood chips in the biomass trade centre is estimated at 126,000 tonnes/year, of which about 40% will be diverted to waterways (50,400 tonnes/year). In order to calculate the effect of alternative water transport biomass in relation to road transport now prevalent, in the context of socio-economic analysis, it is necessary to compare the costs of transport by biomass toll on road transport in relation to waterways in the context of which are the focus of two relations: Vukovar - Constanta and Vukovar - Vienna.

The cost comparison per tonne is displayed in Table 20.

Table 20 - Cost comparison Vukovar - Constanta and Vukovar - Vienna given the modalities of transport.

Total external costs (€/t)			
Origin-destination	Cost category	Road	IWW
Vukovar - Constanta	Air pollution	4.08	4.71
	Noise	1.10	0.00
	Climate change high scenario	5.97	3.14
	Climate change low scenario	1.04	0.52
	Total external costs high scenario	**11.15**	**7.85**
	Total external costs low scenario	**6.21**	**5.23**

Total external costs (€/t)			
Origin-destination	Cost category	Road	IWW
Vukovar - Vienna	Air pollution	3.04	2.48
	Noise	0.82	0.00
	Climate change high scenario	4.44	1.65
	Climate change low scenario	0.77	0.28
	Total external costs high scenario	**8.30**	**4.13**
	Total external costs low scenario	**4.62**	**2.75**

For these two destinations, the transport of domestic business travel in relation to road transport produces on average less costs in the amount of 1.43 €/tonne. With the establishment of a biomass trade centre, it is predicted that 50,400 tonnes of biomass will be transported annually to waterways in relation to road transport (40% of a biomass trade centre capacity - 126,000 tonnes), which produces annually less external transport costs in the amount of 71,820 €/year (economic benefit).

The economic net present value, the economic rate of profitability and the ratio of benefits and costs

Given the economic analysis elements, the economic net present value of the investment (ENPV) is presented below as the difference between the discounted total benefits and costs for the company and the economic return rate (ERR), which is equal to the rate generating the value of ENPV = 0. The economic net present value is positive and amounts to 5,353,090 €.

The economic return rate is positive, it is 13.31%. The ratio of benefits and costs (B/C ratio) is also calculated as the ratio between discounted economic benefits and costs, and it is 1.92.

6.6. Market analysis and marketing concept

A market analysis will help decision-makers to create favourable conditions for using the Danube's waterway and provide financial incentives for investment in biomass handling, storage, and delivery.

At the same time, this market analysis will be the starting point for meetings with the stakeholders of a biomass trade centre organized by the project team to effectively validate the analysed potential and identify the partners to realize the real change in intermodal transport.

Proactive discussions with the logistics sector will encourage mutual learning between public and private decision-makers and provide solid arguments for public support for the sectoral modal shift. The study identifies new promising market segments and sets the foundation for regional co-operation between stakeholders from the Danube Logistics Sector with the aim of covering the entire Danube Corridor.

Characteristics and market potential:

At the level of Croatia according to the data of the Energy Institute Hrvoje Požar, in the period from 2008 till today, there has been a steady increase in the export of biomass with an annual rate of 25%; of the total energy export, biomass represents more than 10% almost in the total amount as forest biomass; according to the same source of data, the trend of biomass imports increased by 32% in the observed period. In the hinterland of Vukovar Port, or in the area of the observed five counties, 89 power plants are in operation or in the process of construction, out of which 49 utilize or will use biomass and 40 power plants uses or will use biogas for the production of electricity and heat as a cogeneration plants (see chapter 5).

The areas of Slavonia and Baranja according to the mentioned data in this study are the richest biomass area in the Republic of Croatia, and currently there is no collecting and logistic centre in this area. The Vukovar port is located in a very favourable traffic position thus is a good choice for establishing such a centre. Current research and studies in the area of Europe (outside the Republic of Croatia) show that higher impacts are realized in the country from which biomass is exported, but certain impacts also occur in the country where biomass is imported due to increased economic activity due to equipment, plant, maintenance plants etc.

Specifically, for Croatia, it is estimated that the effects are greater when the larger biomass is processing, e.g. when it is converted into electricity or generally in goods with a higher value. For this reason, future plans for utilization of biomass in Croatia should also include the export of processed biomass.

This analysis is, therefore, an important step towards establishing a comprehensive market monitoring tool for the establishment of a biomass trade centre in Vukovar.

Structure and methodology

From the results of the research mentioned in this study, it can be concluded that the market analysis itself integrates the evaluation of the specific requirements of the transported cargo, the place of production and the processing site and the direction of the transport flows and the existing infrastructure conditions depending on the availability of data.

It is evident that the classification of potentials is based on production volumes, in general, trade activities and trade relations with especially the Danube coastal countries.

Data used in market research originate from heterogeneous sources due to the large scope of study subjects and broad geographical coverage. The quantitative review of cargo groups is primarily based on official national and international statistical databases such as UN Comtrade, FAOSTAT, Eurostat, etc.

The scope of the data, as well as the accuracy and degree of detail, vary from country to country.

In addition to using statistical databases and annuals, sectoral reports by national and international associations, the selected reports have provided valuable product information.

By identifying and analysing the target market, the basis for developing a marketing concept has been created.

Development and design of marketing concept elements:

It is necessary for the implementation to develop, shape and adapt the marketing concept in order to achieve the desired reaction of the user and to realize the plan of the established business goals.

The purpose will be fulfilled if the marketing concept is a combination that meets the expectations, needs, and desires of the chosen market segment of users.

Below are some arguments, decisions, and activities related to each of the variables of the marketing concept.

Production variables - Decisions and activities related to the production variables are important because they involve the creation of products that will meet the needs and wants of buyers. The area of biomass sources in the Republic of Croatia is mainly Slavonia and Baranja region, which is economically ⅓ of EU average, economically least developed Croatian area, but very rich in forest areas. Serbia is also an interesting source of biomass with regard to raw material prices of biomass.

Furthermore, it is important to emphasize that private forest owners are smaller suppliers and cannot compete with Hrvatske šume d.o.o.; in addition to the fact that the Hrvatske šume d.o.o. grant a license to collect wood from the forest; companies and crafts that have a license are limited based on annual quantities (on average 8,000 m^3). It is necessary to know that there are also balancing factors because direct biomass supply significantly oscillates and is not able to meet all of the regular demand at the same time.

Price variable - refers to the activities of determining the pricing policy and determining the price of the product. Price is a particularly critical component of a marketing concept because buyers are taking care of the value they get by exchanging. Biomass raw materials are cheaper in Croatia and Serbia than in Western countries (Austria, Germany), so it is logical to move from countries with cheaper biomass to more expensive biomass countries. Hrvatske šume d.o.o. has almost a monopoly position and is the main supplier of the market.

Distribution variable - When deciding on a distribution variable, it is aspired that the product will be available to as many customers as possible in the desired quantities and that inventory, transportation and storage costs will be maintained at the lowest possible level. In its function as

the transport axis, the Danube connects key production and sales markets that have significant European importance. The waterway contributes significantly to the strengthening of the transport network within the Danube Region, as well as the merging of the macroeconomic area through the North Sea and Black Sea ports to the rest of the world. The Danube's waterway is of special importance as a cost-effective way of transport for industrial areas along the Danube Corridor. So, the lower costs of transporting waterway biomass and navigation on the Danube are possible all year round. Other advantages of these distribution variables are:

- The fragmentation and lack of transport of biomass from Croatia, which now is mainly carried out with smaller quantities.
- The specialized biomass terminal at Vukovar port is considered an important node between the starting and end points in the supply chain of biomass.
- The possibility of transporting larger quantities of biomass at a time when it comes to water transport.
- The concentration of larger ports along the Danube.

Promotional Communication Variable - refers to activities that are used to inform one or more groups of people in the organization about its products.

The aim is to familiarize consumers with product features, encourage people to take a specific view on ecological acceptance of water transport in relation to road transport, as well as a high degree of organizational and financial performance that enables integrated management of biomass resources.

Therefore, by choosing the most environmentally friendly and safest way of transportation can also be an economic factor of success, not just another marketing measure. The introduction of a transport solution that causes lower external costs and ensuring a higher level of security for transported goods can be a decisive factor in procurement and price negotiation processes. Inland navigation also has the lowest specific energy consumption of all modes of transport on land, enabling cost reductions in many market segments. Danube river cruising is possible 24 hours a day/7 days a week.

Compared to road transport which is limited by weekend and night driving bans implemented in various European countries, inland waterways transport has a competitive advantage because it is not subject to any administrative regulations that interfere with the steady flow of goods.

The specialized biomass terminal in Vukovar port, with planned infrastructure and suprastructural capacities and a future biomass trade centre, will generate additional supply chain costs if additional cargo manipulation is observed in a biomass supply chain, but this will certainly generate positive ecological values.

6.7. Partners to be involved

As has already been mentioned in the operational implementation process as a partner, Hrvatske Šume d.o.o. should be involved, because they are the largest supplier of biomass in the Republic of Croatia, and in addition to the private forest owners, they are licensed to obtain

wood from the forest. Businesses and crafts that have a license are limited based on annual quantities (on average 8,000 m^3).

The following implementing partners have been defined:

Policy makers:

- City of Vukovar
- Vukovar-Srijem County
- Ministry of Finance Customs Office of Vukovar
- Ministry of the Sea, Transport, and Infrastructure
- Department of Agriculture
- Ministry of Environmental Protection and Energy
- The Environmental Protection and Energy Efficiency Fund

Ports authority and Ports:

- Port Vukovar d.o.o.
- Port Tranzit in Osijek
- Port Authority Osijek

Other Logistic Service Providers:

- HEP - Distribution System Operator d.o.o. Vukovar
- Vupik d.d. Vukovar
- PIK Vinkovci d.d. Vinkovci
- Dunavski Lloyd Sisak
- Belje d.d. Darda
- Ricardo d.o.o. Darda

Biomass Associations:

- A-pellet d.o.o. Oprisavci
- Euro-tim d.o.o. Trviž, Pazin
- Uni Viridas d.o.o. Babina Greda

Biomass suppliers:

- Hrvatske šume d.o.o. Zagreb
- Hrvatske šume d.o.o. Offices: Osijek, Vinkovci, Nova Gradiška, Požega and Naši
- Spačva d.o.o. Vinkovci
- Agro Tovarnik d.o.o. Tovarnik
- Arator d.o.o. Lovas
- Čepin oil factory
- Žito grupa Osijek
- A.M.S. Biomass d.o.o. Darda
- Progresys d.o.o. Nova Gradiška

Other partners:

- Croatian Radio Vukovar

6.8. Co-operation possibilities with other ports

The Danube strategy is aiming to increase the attractiveness and competitiveness of Danube region in line with the traditions and living standard of the population in the macro-region. Therefore, co-operation possibilities of Vukovar port with other ports are to be envisages.

Vukovar port is recognized as multimodal connecting point dealing with biomass to other ports in Danube region. The economic development and participation in a biomass circulation within Vukovar port and other targeted ports in the area. Cooperation should be enhanced through the optimal utilisation of port development in the frame of enhancing waterway transport of biomass on the Danube in a transnational context.

According to the project outputs of SEE Programme DaHar project (*www.dahar.eu)* there are large differences in overall economic growth perspectives in the Danube countries, inland waterway transport use and its future potentials on the Danube vary from country to country as it is influenced by the general economic development of these countries and of the micro regions of the ports.

While planning cooperation of the Vukovar port with other Danube ports following outcome of the assessments of Danube Region Biomass Action Plan are important:

- There is lack of available biomass related data in the Danube Region;
- Biomass has the greatest significance among renewable energy sources in the Danube Region;
- Forestry sector is the main biomass supplier and going to keep its dominance until 2020;
- Biomass supply is continuously increasing.

With regard to the resources in the targeted the Vukovar port surrounding area of 100 km and in a wider range beyond the above-mentioned 100 km, the importance of the future biomass trade centre in the Vukovar port is emphasized as a collecting point in this part of the Danube region. Particular attention should be given to the fact that downstream of the Vukovar port there are large timber resources that cannot be expected to be attracted by Hungarian, Slovakian, Austrian and German ports. According to the same source, the technical quantities of biomass in Serbia are estimated at 2.7-3.3 million tonnes, and that amount is currently being exploited by 1.1 million tonnes. Also, the estimation considers that the total volumes of 1.7 million tonnes are agricultural biomass, and forest biomass considers 1 million tonnes. According to available sources from Serbia (Serbian Energy Portal), the current available amount of forest biomass in Serbia is estimated at 1.53 million tonnes. According to the results of other projects of the Danube Transnational Program, it is assessed the exceptional cooperation of the Vukovar port with ports in the Danube region. Considering the existing biomass resources in the wider surrounding area of the Vukovar port (300 km) it is proposed to develop cooperation with ports in Hungary (Baja and Mohacs), Serbia (Novi Sad and Belgrade) and wider with ports Constanta in Romania and Vidin in Bulgaria and Krems in Austria.

Particularly worthy of note is Constanza, which is the largest Black Sea port connecting Europe through the Danube with the Black Sea and the rest of the world. It has 155 berths, 23,000

employees and has 57 million tonnes of traffic per year, and this year it has already had 9 million tonnes of traffic.

Although it is estimated that Romania has biomass potentially of 10 mil. m^3 per year, large deficit of firewood to supply the population needs makes very little resources available for the use as primary forest biomass. Firewood prices of 50-60 €/tonne on the forest road are very high and discourage investment in industrial biomass projects. Moreover, current legislation discourages the mobilization of forest biomass from shredders and branches because there is no possibility of storing for subsequent drying and chopping and is not even part of the assessment of the wood biomass.

Forest wood is one of the main biomass resources in Bulgaria. The entire surface of wood adds up to 3,866,372 ha. The reserves of wood are over 591 mil. m^3 and the natural growth is over 14 mil.m^3 per year. The exploitation out of pinewood is 325,000 tonnes and out of hardwood 567,000 tonnes. With this the annual wood-biomass potential adds up to 892,000 tonnes. Bulgaria has a high theoretical agricultural and forestry potential for both energetic and material purposes. Also, there are quite a number of actors in a biomass and bioenergy market, but market performance and subsequent numbers for bioenergy deployment, especially for new technologies, is low. In sum, it can be concluded that the industry of energy out of biomass did not get sufficient support in the last years, leading to a high penial not being exploited and options for value added unused.

7. Risks and barriers

7.1. Risks and barriers during the project implementation

Defining critical variables by sensitivity analysis

The sensitivity analysis enables the identification of critical variables of the project. Those variables that may have positive and negative deviations from the expected values are those that have the greatest impact on the financial and/or economic performance of the project. The analysis is carried out with only one variables change, while the other variables are kept constant (condition ceteris paribus), which measures the effect on the net present value of the project. As a guideline for determining critical project variables, it is recommended that critical variables are considered those variables that, with a variation of +/- 1% in relation to the baseline scenario, affect the net present value by more than 1%.

The following table presents an overview of critical and non-critical variables.

All variables whose 1% change causes a change in FNPV (C) and ENPV by more than 1% are defined as critical variables. With this criteria, from the point of financial analysis, the only critical variable is are initial investment costs. From the point of economic analysis, the critical variables are calculated energetic and ecological benefits, and economic costs of using waterway transport versus road transport.

As a critical variable of the project, the amount of investment is considered. Therefore, the performance of the project will be tested with a pessimistic and optimistic scenario, besides changing the amount of investment (including the residual value of the investment) within the range of realistic values, will include the range of changes in the value of concession fees, port fees, maintenance costs and the amount of reinvestment. Parameters of scenarios and results are outlined in the following table.

Table 21 - Parametrization of a pessimistic and optimistic scenario.

Variables	Pesimistic scenario - deviation from base scenario	Base scenario	Optimistic scenario - deviation from base scenario
Investment amount	20.00%	0.00%	-20.00%
Revenues from concession fees	-20.00%	0.00%	20.00%
Income from port fees	-20.00%	0.00%	20.00%
Maintenance costs	20.00%	0.00%	-20.00%
Reinvestment costs	20.00%	0.00%	-20.00%
FNPV(C)	*-7,704,582*	*-5,292,163*	*-2,879,744*
FIRR(C)	*-8.41%*	*-4.03%*	*-0.44%*
ENPV	*3,554,367*	*5,353,090*	*7,151,813*
ERR	*10.04%*	*13.31%*	*17.64%*

Prevention and Risk Management Measures

The risk prevention measure is quantified in the risk prevention and risk management table.

For the key risks, the likelihood of negative outcomes has been identified and down to the following classification:

(A) Low probability (0-33% probability)

(B) Medium probability (33-66% probability)

(C) High probability (66-100% probability)

For each of the relevant risks, the seriousness of the consequences a result of the risk has been identified.

The seriousness of the risk is indicated by the Roman numbers from (I) to (III) where the least number (I) indicates the least consequences, and the largest number (III) indicates very serious consequences for the success of the project.

Based on the likelihood of occurrence and the consequence of occurrence, it is possible to qualitatively classify the significance of risks from the lowest to the highest according to the following table:

The risk level tags are listed in the following table:

Seriousness / Probability	**I**	**II**	**III**
A	**low**	**low**	**moderation**
B	**low**	**moderation**	**high**
C	**moderation**	**high**	**high**

The risk level tags are listed in the following table:

Risk level	**Colour**
Low	
Moderation	
High	

Table 22 – Risks during the project implementation.

	Adverse event	Probability of occurrence	Severity	Risk level	Prevention and/or mitigation measures
1	Lack of funds in the state budget for investment and maintenance	B	III		Investment in maintenance from its own income
2	Investment costs of construction higher than projected or delay in works	B	III		Preparation of a detailed investment plan, drafting of a project office for overseeing project implementation; Surveillance and timely reporting of overspending during project implementation
3	Operating costs of infrastructure maintenance higher than planned	B	II		Establishment of timely inspection and servicing to reduce maintenance costs

7.2. Risks and barriers during operation

From the aspect of the Port Authority of Vukovar, there is a risk of the potential lack of interest of the target groups for the port concession, opportunities of biomass related work and the establishment of a biomass trade centre. The fundamental risk for the potential concessionaire is the unregulated and unsettled market and the supply chain of biomass that can directly affect the profitability of the engagement and investment of the concessionaire.

Potential obstacles are the inefficiency of contracting the concession, which leads to the prolongation of the planned business of the concessionaire and a biomass trade centre.

Improvements and rehabilitation of land navigation and biomass sector in Croatia are possible only with joint efforts, including all stakeholders. From the aspect of the Port Authority of Vukovar and the potential concessionaire, there is a risk of oscillation in supply and demand for biomass on the market, the uninterrupted flow and not profitable investment.

Potential obstacles from the Port Authority's and the future concessionaire point of view are the extension of the timing of mechanization and construction of a biomass trade centre as well as the existence of a monopoly of the Hrvatske šume d.o.o. on biomass raw materials.

The risk level tags are listed in the following table:

Risk level	Colour
Low	
Moderation	
High	

Table 23 – Risks during the operation.

	Adverse event	Probability of occurrence	Severity	Risk level	Prevention and/or mitigation measures
1	Lack of interest of potential concessionaires to build and manage a biomass trade centre	A	III		Making a biomass trade centre feasibility study before publishing a tender for a concessionaire
2	Delays of concession contracting	B	II		Timely submission of a tender for concessionaires and definition of partnership conditions
3	The delay in building a biomass trade centre	B	II		Timely submission of a tender for concessionaires and definition of partnership conditions
4	Oscillations in supply and demand for biomass	C	III		Concluding annual supply contracts with biomass and biomass products
5	Negative attitude of Hrvatske šume d.o.o. for biomass supply	B	III		Establishment of long-term cooperation with Hrvatske šume d.o.o. with respect for mutual interest

8. Recommendation

Starting from the project task and the Transnational Implementation Plan made under the Energy Barge Project, the starting point is that the Port Authority of Vukovar is a beneficiary of the project.

Due to the trend of continuous annual growth in trade in forest biomass with neighbouring countries, most notably in the Danubian countries (Austria, Slovenia, Bulgaria, Germany and Serbia), available quantities and potential forest biomass in the hinterland of the Vukovar port and domestic market demand as raw materials in production processed products, it is determined the logical development of the Vukovar port to be seen also through further development of a biomass trade centre.

Current concessionaires can carry out transshipment and storage of biomass and biomass products, but there is no interest in it because local transport is carried out by trucks, and the import volumes that could be used by sea transport are currently too small. By setting up a biomass trade centre, there would be an increase in the amount that would benefit the less expensive shipping, and at the same time would stimulate further development of a biomass market in the wider area around the port.

The analysis points to the numerous strengths and opportunities for the development of the Vukovar port, which should be the basis for the realization of the project for the establishment of a biomass hub in Vukovar, but with the previous investment in infrastructure to eliminate the observed weaknesses and reduce the threats.

The arguments for establishing a biomass trade centre in the port area were presented, which would have a dual function, as a terminal port specializing in the transshipment and storage of biomass and processed products, as well as a place of sale for customers from the wider hinterland of the port.

For the realization of the project, or the establishment of a biomass trade centre, two locations in the port were initially considered. The important difference between the remaining two locations lies in the fact that location ‘two’ is free and for it a concession tender can be launched once the port infrastructure is established, while location ‘three’ is under the concession of Luka Vukovar d.o.o. until 2026. At both locations, it is necessary to invest in port infrastructure, although considering the possibility of transshipment and storage of biomass, the existing concessionaire already has the conditions for doing this job. However, if we look at the possibility of establishing a biomass trade centre, then location ‘two’ is more convenient because immediately after the arrangement of the port infrastructure it is possible to launch a concession tender.

Financial net present value of the investment (FNPV (C)) and financial return rate of return of the investment (FIRR (C)) indicate the project's non-profitability in the case of total project funds being considered. When the economic analysis, socio-economic benefits were considered, such as the value of the general contribution of a biomass trade centre (ecological-economic-social context) and the effect of transport costs on waterways in relation to road transport.

Economic Rate of Return (ERR) is equal to the rate that produces the value of ENPV = 0. The economic net present value is positive and amounts to 5,353,090 €. The economic return rate is positive and is 13.31%. The ratio between discounted economic benefits and costs is 1.92.

Considering the existing biomass resources in the wider environment of the Vukovar port (a narrow gravity area of 300 km is observed), the cooperation with ports in Hungary (Baja and Mohacs), Serbia (Pančevo, Novi Sad and Belgrade) and the wider gravitational the cooperation area with the Constanza ports in Romania and the Vidin port in Bulgaria at the bottom Danube area and the Krems harbour from the upper Danube area.

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Annexes

A1. List of mostly smaller suppliers of wood in the respective counties

Number of mostly smaller suppliers of wood that operate:

Vukovar-Srijem County - 9

- 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 - 11

- 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 - 6

- 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 - 7

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

Virovitica-Podravina County - 17

- Aero-tec Ltd., Virovitica;
- Drvomercant d.o.o., Slatina;
- Drvopromet, Čačinci;
- Craft Božičković, Voćin;
- Cutting and production of firewood, Nova Bukovica;
- 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.

A2. Tables with data about export and import of processed products

Table 24 - Export of processed products from the Republic of Croatia in 2016.

Source: Bureau of Statistics, https://www.dzs.hr/hrv/publication/StatisticsInLine.htm (Accessed 25.09.2017)

NAME / COUNTRY	EXPORT (t)	EXPORT (€)
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

Table 25 - Export of processed products from the Republic of Croatia in 2016.

Source: Bureau of Statistics, https://www.dzs.hr/hrv/publication/StatisticsInLine.htm (Accessed 25.09.2017)

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
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 26 -Import of processed products in the Republic of Croatia in 2016.

Source: Bureau of Statistics, https://www.dzs.hr/hrv/publication/StatisticsInLine.htm (Accessed 25.09.2017)

NAME / COUNTRY	IMPORT (t)	IMPORT (€)
Conifers in form of wood chips, shavings	**17,107**	**849,599**
Austria	73	34,018
Bosnia and Herzegovina	136	13,967

Table 27 -Import of processed products in the Republic of Croatia in 2016.

Source: Bureau of Statistics, https://www.dzs.hr/hrv/publication/StatisticsInLine.htm (Accessed 25.09.2017)

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
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

Table 28 -Import of processed products in the Republic of Croatia in 2016.

Source: Bureau of Statistics, https://www.dzs.hr/hrv/publication/StatisticsInLine.htm (Accessed 25.09.2017)

Romania	0	47
Slovenia	609	102,439
Serbia	256	39,680

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http://www.interreg-danube.eu/energy-barge