Interreg
Danube Transnational Programme
ENERGY BARGE

ENERGY BARGE

Building a Green Energy and Logistics Belt

Project Code: DTP1-175-3.2

Deliverable 3.2.3

Regional case studies

for biomass and bioenergy production –

Case Study Hungary 1:

Utilisation of biomass in the district heating service of Bioenergy-Duna Ltd. in Mohács

29 June 2018

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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.

Project coordinator

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

Project partners

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

II. About this document

This report corresponds to "D.3.2.3. Regional case studies for biomass and bioenergy production" of the ENERGY BARGE project. It has been prepared by:

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Background

ENERGY BARGE aims at exploiting the Danube macroregion's bioenergy potential to increase energy security and diversification of energy sources by establishing secure, efficient and sustainable bioenergy supply chains along the river. To this end, a holistic view on the bioenergy market and underlying value and supply chains is needed. Given national and regional disparities in theoretical, geographical and market potential for bioenergy, deployment, public support, and also cooperation between private and public actors, it is necessary to identify levers for tapping potential and options for market actor cooperation, business development and market uptake.

A theoretical model designed to increase the market uptake of bio-based feedstock for both material and energetic (ideally cascading) use in the Danube region and thus to address the objectives also set out in the EU Strategy for the Danube Region (EUSDR) is a concept called "Green Energy and Chemistry Belt" (see Figure 1). It was developed by the BioCampus Straubing GmbH (Project Partner 1) and aims at using the Danube River as a natural biomass corridor and sustainable transport axis for biomass. The underlying principle follows the logic of "local harvesting – decentral processing into more transport-worthy states (e.g. oils, pellets, liquids) – central refinement or end use", so that added value creation can mainly stay in rural areas along the Danube. This concept forms the basic idea of the ENERGY BARGE project.

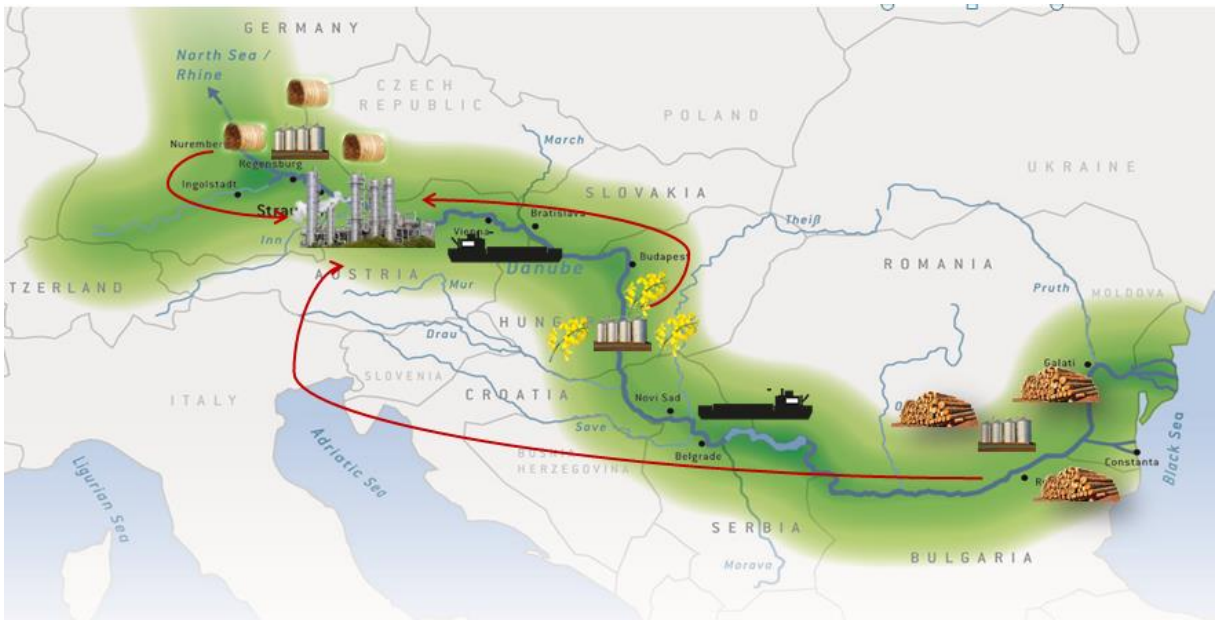

Figure 1: Green Energy and Chemistry Belt (Source: BioCampus Straubing GmbH, own visualization).

In order to reach the targets outlined above, Work Package 3 provides market-oriented mapping of the Danube region's value chains from biomass feedstock production and residues to energy generation from an integrated, transnational perspective, giving regional and transnational guidance for market development along the river (green bioenergy belt) and setting the stage for increased use of Danube logistics in the bioenergy sector. This will be achieved through a transnational market study compendium including biomass flows and sustainability aspects

(macro-perspective, Activity 3.1), business landscape mapping, case studies and identification of best practice locations for bioenergy value chain integration (micro-perspective, Activity 3.2).

Objective of the regional case studies

This deliverable "D 3.2.3 Regional case studies for biomass and bioenergy production" is based on the task as described in the latest approved version of the Application Form of the project ENERGY BARGE (Project Code: DTP1-175-3.2).

- *A3.2- Providing a systematic insight into the integrated bioenergy landscape along the Danube (lead: BCG)*

Activity 3.2 focusses on the biomass and bioenergy business sector, with the aim of mapping the state of the business landscape working along the bioenergy value and supply chain in the Danube region. This will mainly be achieved, in connection with a company inventory and a demand scenario analysis, via a set of regional case studies, focusing on exemplifying cases with already established (or currently being established) biomass and/or bioenergy markets/businesses, their future integration potential, and also covering their already existing as well as potential logistics connections with a focus on connections with nearby inland port terminals and inland waterway transport (IWT).

With D 3.2.3, the aim is to identify cases, i.e. specific real-life situations (businessdictionary, 2018), in each of the partner countries in which biomass production and/or utilisation in the bioenergy sector (as well as other utilisation sectors, e.g. chemical-material use) plays a dominant role in comparison to other cases. After identification via a standardized matrix, the objective is to coherently analyse these cases in case study reports. The focus here shall be on describing the status quo of these cases with respect to a set of characteristics and on subsequently analyzing the success factors (enablers & inhibitors) influencing this status quo. In addition to this qualitative analysis, each case shall be accompanied by a GIS-based (geographical information system) map depicting land use, as well as options for regional supply and logistics chains (roads, ports, business partners). Through the direct contact to responsible managers and other important people in charge at the cases, the project can be further disseminated. Moreover, discussions and considerations about challenges and chances of the bioenergy sector in the Danube region are spurred, contacts made and options for future integration of inland waterways and ports can be presented and discussed.

In the following project steps, the aim is to use these case studies for Output 3.2. as a basis to identify good practice examples on how and in what ways biomass and bioenergy production and utilisation can be regionally and locally integrated, how supply chains can be improved or established and – ideally - how inland ports can contribute to this integration via their logistics services as biomass and bioenergy hubs.

Executive summary

The present case study analyses the present and future biomass-based energy production activities of the Hungarian district heating sector on two levels. One level is based on a nationwide survey among members of the Association of Hungarian District Heating Enterprises (MaTáSzSz), the second is the local level, which is based on expert interviews with the management of Bioenergy-Duna Ltd., a biomass-based energy producer located in the vicinity of River Danube (estimated distance to the nearest port – Mohács - is 2.6 km) in the town of Mohács.

The intention of MaTáSzSz is to help the harmonization of energy biomass supply of the existing and planned heat and combined heat and power plants operated by district heating companies in Hungary.

In case of the Bioenergy-Duna Ltd in the town of Mohács - the supply chain is currently very simple: energy biomass raw materials are transported on road directly from the forests, in most cases without any transshipment. In the future however when new port capacities will be available in Mohács (see more details in Chapter 4.8), waterway transport will probably gain a more prominent role in biomass transport. Seeing as part of the woodchips used in the plant is coming completely ready to use from Croatia, further supply possibilities may open from abroad. Moreover, as the area of the neighbouring Gemenc forests in Hungary is partly located on an island on the Danube not far from Mohács, the new port can open alternative transport channels for the utilization of those biomass stocks.

Based on the findings of the case study, harmonization of raw material supply of major energy biomass end users such as district heating companies is inevitable in order to avoid cost increase and risking security of supply. New investments in solid biomass-based energy production on regulated circumstances can change raw material market conditions considerably, which may make operational cost and profitability difficult to forecast. Long term strategy and identification of possible alternative solutions of raw material supply are inevitable in the preparatory phase of these new biomass-based district heating projects.

Currently, road transport has a nearly monopolistic role in energy biomass transport with district heating companies in Hungary, however for future biomass-based heat power plant developments the optimisation of waterway connections could simplify raw material supply using the potentials of the Danube as a transport route.

1. Description of case study methodology

Overall, six partner countries present case studies: Austria, Germany, Hungary (2 studies), Croatia, Slovakia, and Romania. Each country's case study report is designed as additional information to the interactive ENERGY BARGE platform. A summarizing case study report is made available in order to get an overview to the whole case study area and the sites chosen.

In Figure 2, an overview of the Danube region and all cases covered (red dots) is presented. The map is an extract from the ENERGY BARGE modal shift platform (www.energy-barge.eu) and also depicts an abstracted level of bioenergy company locations in the macro region (green dots).

The case study is based on the intention of the Association of Hungarian District Heating Enterprises (Magyar Távhőszolgáltatók Szakmai Szövetsége, MaTáSzSz) to harmonize the energy biomass supply of the existing and planned heat and combined heat and power plants. In the framework of the case study, the Fuel Supply Management Committee of the Association initiated a survey among member companies to collect data on their raw material needs and quality requirements regarding energy biomass (MaTáSzSz, 2018),

As a concrete example this case study examines the case of company **Bioenergy-Duna Ltd,** which operates both biomass and natural gas-based heat production units and is located close to the Danube waterway (app. 2.5 km), but energy biomass is presently transported on road. Bioenergy-Duna Ltd. is a member of MaTáSzSz.

The nationwide survey was based on a questionnaire that collected information from biomass-based energy producer members on: number of end users and actual heat output of the system; the annual sales volume of heat; qualitative requirements towards purchased raw material; the annual raw material consumption; mode of transport and average price. Also, the average transportation distance and the distance from Danube ports were included in the questionnaire.

Regarding planned future biomass-based energy production investments, information was collected as part of the questionnaire, also based on data of district heating company projects that received co-financing from EU Structural and Cohesion Fund sources. For the estimation of future raw material demands of these planned investments, data on built-in heat capacity and planned annual energy biomass need was collected from MaTáSzSz member companies.

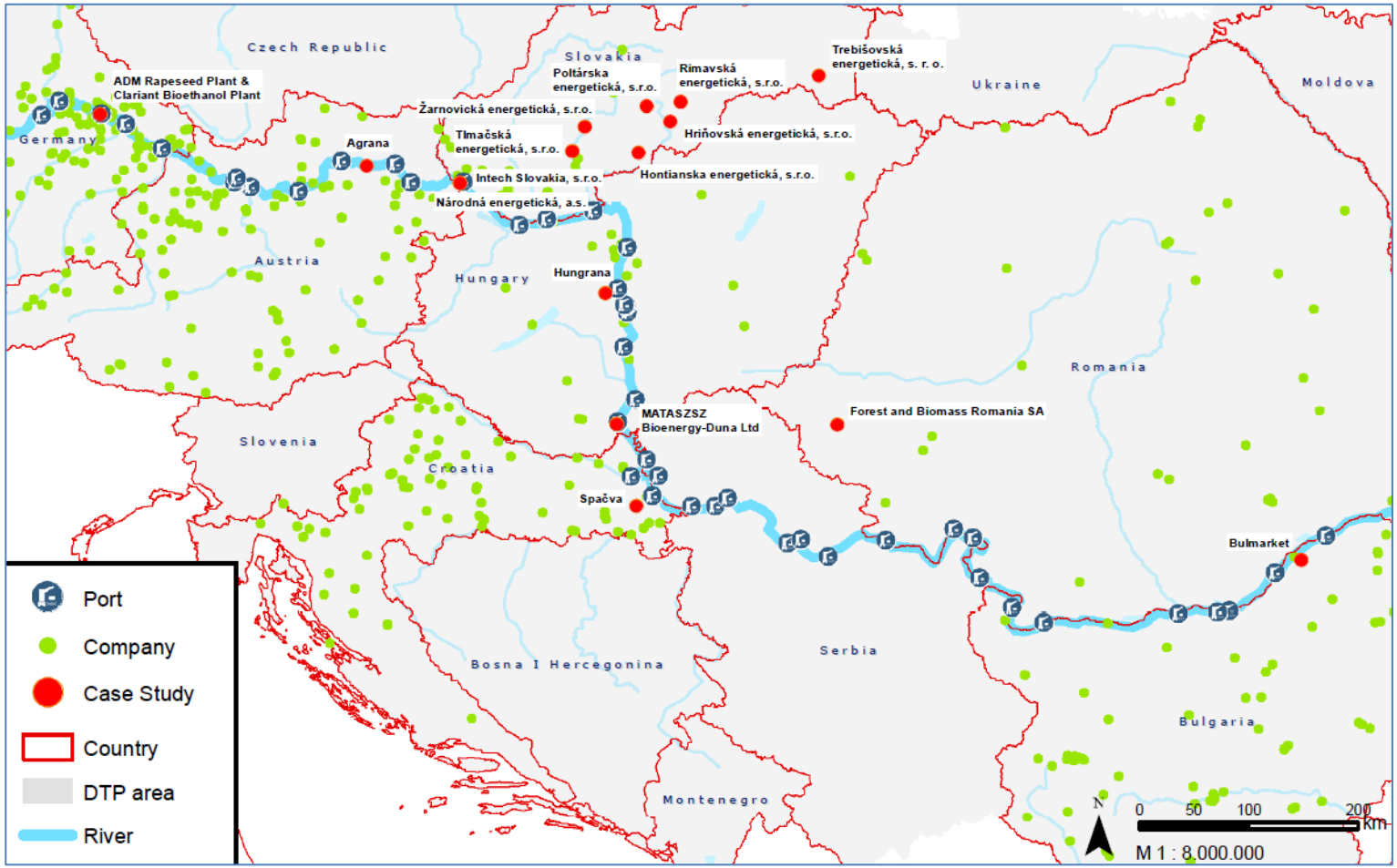

Figure 2: Overview of the location of the selected cases in the Danube region (DIT, 2018 source: open street map)

Within the framework of a site visit, local practical and operational information was collected at Mohács-Hő Heat Production Company, which is the 100% owner of Bioenergy-Duna Ltd. to summarize management opinions on biomass supply and trends.

In order to gain information on the potential supply side, availability and market trends of solid biomass expert interviews were conducted with representatives of the Ministry of Agriculture responsible for the operation of the forestry sector and local county level data was collected for the Mohács case. Also, logistic experts were interviewed to discuss possibilities of biomass transport via waterway from state forestry companies.

Findings of the survey will be summarized for all involved MaTáSzSz member companies and will form the basis of future activities in the field of energy biomass supply. Planned activities include harmonization of the organisation of raw material supply of district heating companies and elaboration of a long-term action plan in cooperation with policy makers in order to secure sustainable bio fuel supply.

During the elaboration of the case study, the following experts were interviewed:

Table 1: Interviews executed during case study

Name	Organisation	Date
Zsuzsanna Uitz	MaTáSzSz	26.02.2018.
Tibor Orban	MaTáSzSz	20.04.2018.
Andras Kiss	Plimsoll Ltd.	20.04.2018.
Imre Matancsi	Ministry of Agriculture	23.04.2018.
Józsefné Szekó	Mohács-Hő Heat Production Company	13.03.2018.

The data collection and most part of the analysis covered the entire country, with special focus on South-West Hungary and the town of Mohács, where the Bionergy-Duna Ltd. is located.

2. Case description

Scope of the case study

The aim of this study is to analyse the utilization of biomass in the district heating service, through a concrete example at a MaTáSzSz's member, the Bioenergy-Duna Ltd., in Mohács, Hungary.

The ENERGY BARGE project focuses on the transportation of biomass for bioenergy purposes on inland waterways, which is not an existing practice in Hungary, yet, however this option has also been analysed during the elaboration of the case study.

Among MaTáSzSz's partners (over 60 service providers) there are only six companies dealing with biomass-based heat generation at present, although there are some who are planning to develop a biomass-based heat service system, such as Budapest-Főtáv (The District Heating Company of the Capital) and Csepel. With regard to the location of these service providers (Figure 3) Mohács (Bioenergy-Duna Ltd.) is the only operating district heating service provider using biomass where the biomass transportation can be taken into consideration by inland waterway. The town of Mohács is located just on the banks of the Danube, which makes waterway transport a real opportunity for the company. Transportation on the Danube has big potential for the future because it connects the renewable energy usage with a more environmentally friendly way of transport. Mohács has another advantage compared to the others, i.e. it is located in the border area of three countries, Hungary, Croatia and Serbia, which could be an advantage for future raw material import.

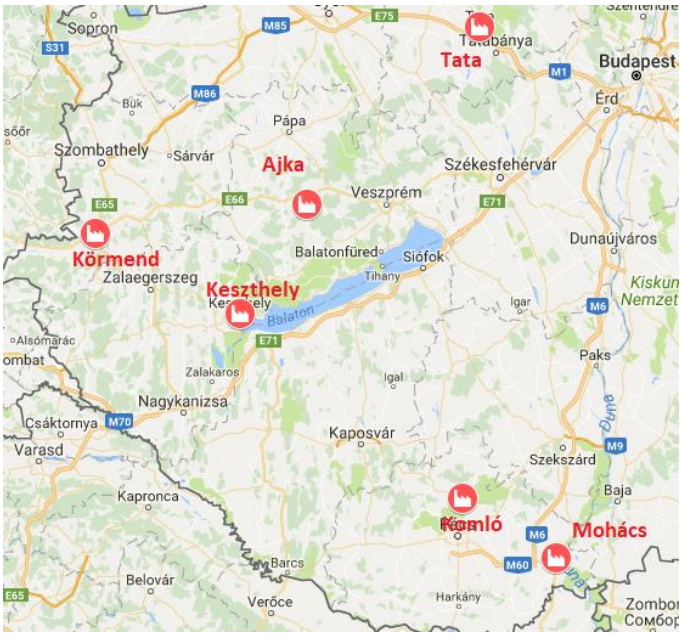

Figure 3: Association partners who are dealing with biomass in the western part of Hungary

(source: own editing based on Google Maps)

Introduction of the company

Bioenergy-Duna Ltd. operates a 4.5 MW biomass (woodchips) power plant in Mohács. The whole plant – part of which is the biomass block - is owned by Mohács-Hő Heat Service Provider Ltd and has a total capacity of 14.4 MW. The Mohács-Hő Heat Service Provider Ltd. was founded in 1993 and now it is in the 100% ownership of the Local Government of Mohács (Figure 4) (Mohács-Hő Hőszolgáltató Kft. 2018).

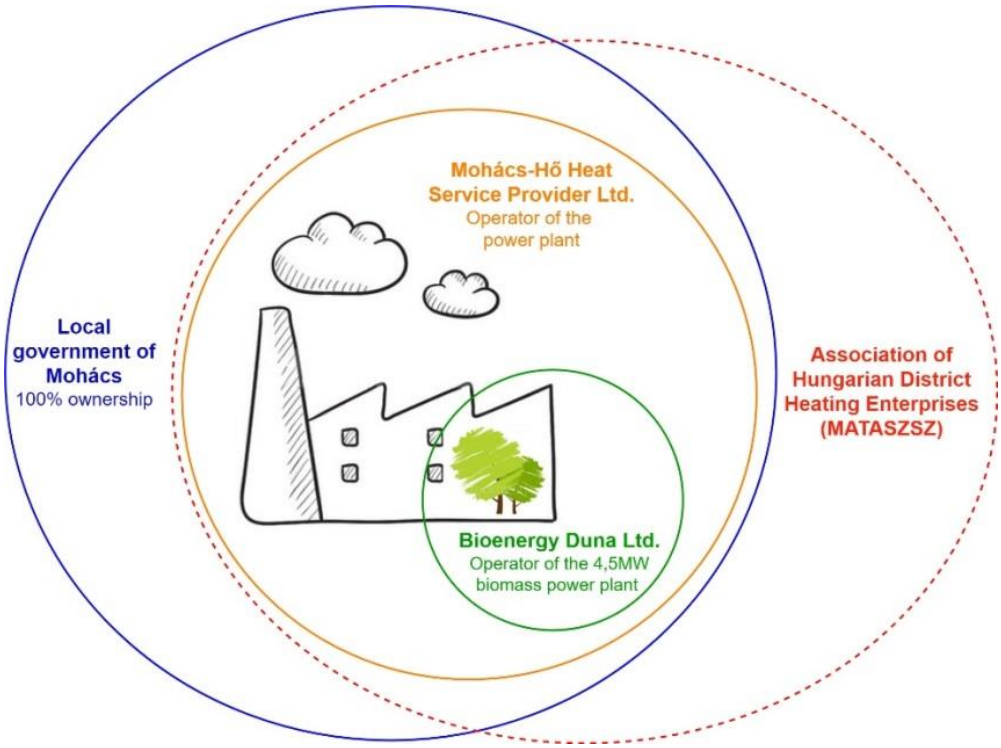

Figure 4: Organisation structure of the operators of the power plant in Mohács

(source: own editing)

Its main task is to ensure the quality of district heating and hot water services in the city of Mohács. Currently, the whole power station – including the biomass block - provides services for 2,015 apartments and 42 other institutional consumers (kindergartens, schools, shops). The company's district heating supply system is constantly being developed and its comprehensive energy modernization was completed in 2013. The company has installed three hot-water boilers with a capacity of 4.5 MW and equipped with natural gas for modernization of the heat exchangers. Remote monitoring system assists in its economical and safe operation. In order to reduce dependence on natural gas, a 4.5 MW biomass (woodchips) power plant utilizing renewable energy has been established (as part of the 14.4 MW), operated by Bioenergy-Duna Ltd. The company contributes to the reduction of carbon dioxide emissions, a cleaner air and thus sustainable development through the use of environmentally-friendly technology. In the future they plan to upgrade the boiler section of the heating plant and other eco- friendly biomass projects with the help of 'KEHOP' grant calls[1].

[1] Environmental and Energy Efficiency Operational Program, see description in Chapter 4.5.

Figure 5: The plant of the company in Mohács ***(source: Mohács-Hő Hőszolgáltató Kft, 2018)***

Their annual heat quantity is now 70,000 GJ/year (the amount that the biomass-based plant sells to Mohács-Hő Heating Company) and they are operating with a 4,5 MW biomass power plant. For that the demand from biomass raw material is 7,700 t (lutro[2]), which is in the form of woodchips. At the moment, the deliveries are mainly coming on trucks from nearby forests, for example from the Gemenc Forestry (it is maximum 50 km away from the plant) and from Croatia. The aim is to expand this amount and range as a result of this case study to be more efficient and environmental friendly. The Mohács-Hő Ltd has a 600 t raw material buffer capacity, which is a self-sufficient hangar. The quality requirements of the woodchips are G100, <40%, clear (free of dust, leaves and foreign matter). Their average purchase cost is 1.62 Ft / MJ and the estimated distance to the nearest port at the Danube is 2.6 km. At present the methodology is that the biomass transportation is the sole responsibility of the supplier, the company does not deal with it. For them, only the purchase price is important, which already includes transportation costs. Therefore, it would be worth considering the purchase of biomass from other areas, which would allow other ways of transport e.g. waterway transport.

Table 2: Important data about the power plant

SOURCE: OWN EDITING BASED ON THE WEBPAGE OF MOHÁCS-HŐ HŐSZOLGÁLTATÓ KFT

Annual heat quantity	70,000 GJ/year
Biomass-based power plant performance	4,5 MW
Raw material demand	7,700 t (lutro)
Raw material buffer capacity	600 t
The quality requirements of the woodchips	G100, <40%, clear
Their average purchase cost	1.62 Ft / MJ

[2] Lutro weight means 15-20% humidity after storage for 0,5-2 years

Central actors and their roles

The most important groups of stakeholders in this case are the following:

1) District heating service providers using (or planning to use) biomass – MaTáSzSz members
2) Public actors, authorities, government organisations relevant in the field
3) Raw material (biomass) suppliers in the region
4) Relevant logistical actors
5) Research and development (R&D) organisations
6) District heating consumers (personal/household and industrial consumption)

1. District heating service providers using (or planning to use) biomass – MaTáSzSz members

After the examination of the partners (a total of 129 members) of MaTáSzSz one can divide them into 3 groups. Those that are already dealing with biomass are in the first group (6 partners, see Table 3). Their location, production technologies and installed thermal capacity can be found in the table below.

Table 3: Partners of the Association who are dealing with biomass *(source: MAGYAR ENERGETIKAI ÉS KÖZMŰ-SZABÁLYOZÁSI HIVATAL, 2016)*

DISTRICT HEAT PRODUCER LICENSEE COMPANIES	LOCATION OF THE HEAT PRODUCING FACILITY (SETTLEMENT)	FUELS	PRODUCTION TECHNOLOGIES	INSTALLED THERMAL CAPACITY [MW]
Bakonyi Erőmű Zrt.	Ajka	Natural gas, Biomass, Coal	K, EnyT	216,0
BIOENERGY-Duna Ltd.	Mohács	Biomass	K	4,5
Komlói Fűtőerőmű Zrt.	Komló	Natural gas, Biomass, Fuel oil	K, GázM, FT	76,5
RÉGIÓHŐ Ltd.	Körmend	Natural gas, Biomass	K	15,8
TATA ENERGIA Ltd.	Tata	Natural gas, Biomass	K	14,0
VÜZ Nonprofit Ltd.	Keszthely	Natural gas, Biomass	K, GázM	14,9

LEGEND:

K	Energy production (EP) only for direct heat supply by boiler
GázM	EP by solar thermal collector
FT	EP by only hot water supplier back pressure steam turbine generator set
EnyT	EP by back-pressure steam turbine generator set

The second group contains those companies that are planning to use biomass technology in the future and in order to accomplish it they have submitted various applications for KEHOP[3]. This includes 7 companies:

DISTRICT HEAT PRODUCER LICENSEE COMPANIES	LOCATION OF THE HEAT PRODUCING FACILITY (SETTLEMENT)	INSTALLED THERMAL CAPACITY [MW]
Budapesti Erőmű Zrt.	Budapest	20
Cothec Energetikai Üzemeltető Kft.	Sátoraljaújhely	1,2
FŐTÁV Zrt.	Budapest	20
Kaposvári Önkormányzati Vagyonkezelő és Szolg. Zrt.	Kaposvár	15
Kecskeméti Termostar Hőszolgáltató Kft.	Kecskemét	20
KISVÁRDAI KÖZMŰ Szolgáltató Kft.	Kisvárda	3
Ózdi Távhőtermelő és Szolgáltató Kft.	Ózd	3

If these planned investments are implemented in the next years, 82,2 MW extra heat production capacity will be created which would increase the demand side of biomass with approximately 133,000 lutro t.

Other members are not using biomass for heating and they do not plan to introduce it in the near future, either.

2. Public actors, authorities, government organisations relevant in the field

Ministry of National Development: The Minister is responsible for drafting laws and regulations related to climate policy, the promotion of biofuels and other renewable energy sources for transport, the use of renewable sources for generating electricity and heat and increasing energy efficiency and energy saving.

Ministry of the Interior: The Ministry of the Interior is the body responsible for authorization in spatial planning. In collaboration with other authorities, it oversees tasks related to settlement development, planning and the functioning of settlements, which also include construction affairs and the supervision of public space.

Ministry of Agriculture: The Ministry of Agriculture formulates government measures that relate to agricultural development, and supervises food retail chains, environmental protection, and agricultural economy.

Hungarian Energy and Public Utility Regulatory Authority (HEA): It is the regulatory body of the energy and public utility market, supervising the national economy's sectors of strategic importance. The Authority's responsibility covers licensing, supervision, price regulation, tariff- and fee preparatory tasks in the fields of electricity, natural gas, district heating as well as in water utility supply. HEA's responsibility covers licensing, supervision, price regulation, tariff-and fee preparatory tasks in the fields of electricity, natural gas, district heating as well as in water utility supply, besides pricing of public waste management services. HEA has numerous regulatory, supervisory, energy-statistics and related communication tasks. It is responsible for defining the

[3] Environmental and Energy Efficiency Operational Program, see description in Chapter 4.5.

methodology for the assessment of expenditures and revenues related to the power plants' use of waste heat and that of cogeneration as well as the requirements for the preparation of cost-benefit analysis. HEA enhances the reduction of energy consumption costs and the conservation of environmental resources for future generations (HUNGARIAN ENERGY AND PUBLIC UTILITY REGULATORY AUTHORITY, 2015).

National Transport Authority (now part of Ministry of National Development): The National Transport Authority ("Shipping Authority") was eliminated and its legal successor is the Ministry of National Development, Office of the Minister of State for Transport Policy. The primary shipping authorities of Hungary act with national competence for water transport administrative affairs. The task of the shipping authorities in general is to ensure with administrative means the safety, the lawful and professional participation in water transport of persons, assets, facilities, organisations and companies acting there as well as water areas serving for water transport (tracks), briefly the establishment and maintaining the safety guarantees of shipping. From 1st January 2017 the Government Office of the Capital City Budapest is responsible as shipping authority for waterway freight transportation issues.

3. Raw material (biomass) suppliers in the region

The next actors' group is the biomass suppliers which contains the forestries in the four counties (Baranya, Somogy, Tolna and Bács-Kiskun, see more in Chapter 4.7) in the Southern part of Hungary around the town of Mohács and other suppliers dealing with agricultural by-products.

In the 80 km radius of Mohács, the largest forestry is SEFAG Erdészeti és Faipari Zrt. (operating on 80,000 ha area), and 4 other forestries are also important (Mecsekerdő Zrt. – 55,000 ha, Gemenci Erdő- és Vadgazdálkodási Zrt. – 38,000 ha, Gyulaj Erdészeti és Vadászati Zrt. – 23,000 ha, Kaszó Zrt. – 18,000 ha, see more information in Chapter 4.7.)

4. Relevant logistics actors

The logistics side contains road, rail and waterway transportation companies and other logistic actors that provide complex (intermodal) logistic services.

One of the main logistic actors is Plimsoll Zrt. It was founded in 1992, and its primary activity is the transportation of international bulk goods. They offer a system of combinations of rail, road, river and sea transport connected with logistics systems and services. Plimsoll is an important partner for major subcontractors: domestic and neighboring railways, shipping companies, ports and road haulage companies (PLIMSOLL Ltd., 2018).

5. Research and development (R&D) organisations

The following group includes institutional actors and the Research and Development sector relevant in the area of biomass utilization.

One of them is Szent István University in Gödöllő. It has several bachelor and master programs in the field of environment, agriculture and wildlife management. In addition, they undertake intensive applied research and development activities. The Faculty of Agricultural and Environmental Services has good relations and runs research and development programs with

Hungarian and foreign research institutes, universities and agricultural companies. The main goals of the Faculty are the following:

- Environmental management and environment friendly industry
- Quality of life, production of healthy food and food consumption with special emphasis on animal nutrition, livestock breeding and husbandry, as well as the production of foods of animal origin
- Management of climate change with special emphasis on ecosystems and nature conservation, adaptive cultivation and livestock management systems
- Conservation and use of natural resources (wildlife management, forest, and natural ecosytems)
- Biotechnology

(Szent István University's website, 2018)

The other relevant actor in the field is the University of Sopron and its Institute of Forestry and Wood Research. The laboratory complex offers unique professional opportunities. This allows research in new disciplines to serve the professional needs of the region and the whole country. In addition to the traditional topics in forestry, wood and paper industries, research in a wide range of fields like robotics, mechatronics, polymers, energetics and nanotechnology is also possible now.

One of the Hungarian partners in Energy Barge project, National Agricultural Research and Innovation Center (NARIC) also carries out R&D activities. They have accredited laboratories for energetic equipment and technologies as well as on the field of analyses of raw materials. They can estimate the appropriate biomass potential, in the selection, adaptation and investigation of the technologies as well as economic calculations. NARIC is an R&D institution under government control, supervised and funded by the Ministry of Agriculture. Their aim is to promote dialogue with the Ministry and jointly develop robust and sustainable support mechanisms for RES-produced energy and technology (NARIC, 2014).

6. District heating consumers (civil and industrial consumption)

Lastly, there are the users of the district heating services such as institutions and industrial consumers. Mohács-Hő Heat Service Provider Ltd already supplies 2,015 flats and 42 institutional consumers in Mohács but this number can be expanded by further developments.

3. Socio-economic indicators

Main social indicators in the town of Mohács

The subject of the analysis is Bioenergy-Duna Ltd., which is located and provides its district heating services in Mohács. The town of Mohács is located in the Southern part of Hungary, it is the third largest town in Baranya County and the eighth most densely populated. Its total population was 17,278 on 1. January 2017. The population density is 154,64 people/km^2 and the whole area is 112,23 km^2 in 2016 according to the statistics from National Statistical Office. The Gross Domestic Product (GDP) was 806,808 Million HUF in the County of Baranya in 2015.

The population of the settlement continues to decline due to the high rate of natural deaths and emigration. The town has an aging population and the aging index exceeds the country average based on their Integrated Urban Development Strategy (MOHÁCS, Integrated Urban Development Strategy, 2016).

In 2011 the unemployment rate of the total population was 8% (within the economically active 17%). The employment rate is below 40%. The remainder belong to the group out of children, pensioner, temporary worker, inhabitants who are unable to work and passive unemployed who do not use state aid to find a job. Mohács's economy is performing better compared to surrounding regions based on the strategy of Mohács.

The service sector dominates in the town's economy, but industry also plays a significant role, especially the processing industry. The industrial park, which also has significant development potential in addition to existing business, is of paramount importance in the town's economic life.

With regard to all sectors it is important to emphasize the location of Mohács, meaning it is located in the border area of three countries, which provides the opportunity to strengthen cross-border economic relations.

Only 8.5% of Mohács's external area is covered by forests, which is substantially lower than the national and county averages. 1,006 ha forest belongs to the settlement area where the whole wood bulk (growing stock) is 227,302 m^3.

Public utilities

Regarding the energy utilities, the town's electricity supply covers 100% of the settlement. Gas supply in the city is also at 100%. The large-medium pressure gas network through the urban gas transmitter can serve the town's needs for a long time.

The number of flats connected to the district heating system was 2,011 in 2016, which is only 24% of all flats in the town. The amount of heat used for district heat supply to the general public was 68,115 GJ.

The following table shows the share of the different sectors among the registered companies in Mohács. Thereof, 51% are related to the service sector, 24% to the industrial and 25% to the agricultural sector.

Table 4: Number of registered companies by sectors in Mohács in 2013 and 2016 *(source: KSH – Hungarian Central Statistical Office, 2018)*

Number of registered companies	2013		2016	
	2590	100%	2,656	100%
Agriculture, forestry, fisheries sections	641	25%	674	25%
Manufacturing industry	147	6%	149	6%
Electricity, gas, steam and air conditioning industry	2	0%	24	1%
Construction industry	183	7%	166	6%
Trade, vehicle repair industry	321	12%	291	11%
Transport and storage industries	50	2%	51	2%
Accommodation and hospitality services	85	3%	78	3%
Information and communication sections	42	2%	48	2%
Financial and insurance services	64	2%	54	2%
Property transaction services	369	14%	381	14%
Professional, scientific and technical activity section	225	9%	255	10%
Section for administrative and service-support activities	95	4%	96	4%
Education	68	3%	88	3%
Human health and social services section	63	2%	61	2%
Arts, entertainment and free time services	121	5%	122	5%
Other service industries	114	4%	112	4%

Regarding the trends of the last years, the total number of registered companies has slightly increased (by 2,5%) in Mohács, while the number of companies in the agriculture sector has been grown by 5%. The most significant decrease in the number of registered firms took place in the construction industry, in the trade, vehicle repair industry and in tourism (accommodation and hospitality services). The largest increase happened in the electricity, gas, steam and air conditioning industry, where there were only 2 registered companies in 2013, but 24 in 2016. At the same time, the share of the 3 sectors (agriculture, industry, services) remained the same (25%-25%-50%).

District heating characteristics in Hungary and in Mohács

In 2016, based on the document of Hungarian Central Statistical Office (KSH, 2018), 649,129 apartments in 95 settlements of Hungary - about 15% of the housing stock - received district heating. 1.27 million people lived in this type of housing estate in 2015. 82 % of the total amount was produced by biomass-based plants.

A significant rate (37%) of the apartments connected to the district heating system is located in Budapest, 26% of the capital's apartments use this service. Their share is also significant in county seats (due to the Hungarian industrialization and housing policy in the '70-s), the only towns

without ditrict heating are Békéscsaba and Zalaegerszeg. The share of connected homes in Almásfüzitő is the highest (90%), followed by the former socialist industrial cities, respectively: Dunaújváros (83%), Tiszaújváros (76%), Tatabánya (74%), Kazincbarcika (64%), Oroszlány (63%), Ajka (56%) and Százhalombatta (55%) (Statisztikai tükör, 2017).

In the map below, the proportion of flats connected to district heating and their consumption amount can be seen (Mohács has less than 100 TJ consumption) according to the publication of MaTáSzSz in 2016. Modern district heating plants produce more than 50 percent of residential district heat as 'waste heat' so the half of this amount is produced by the processing of biomass with an electricity-linked system.

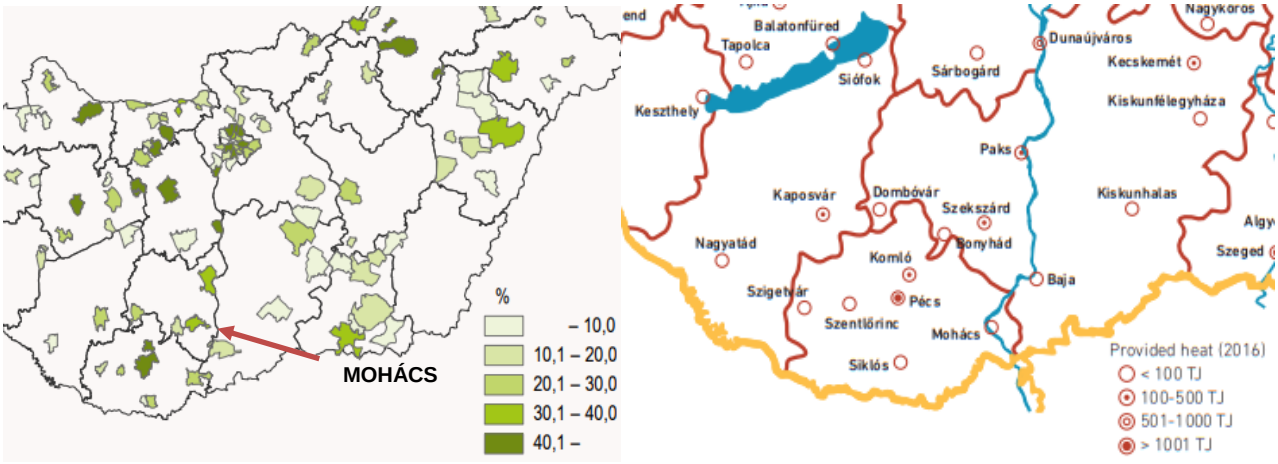

Figure 6: The proportion of flats connected to district heating and their consumption amount in 2016 (source: MaTáSzSz, 2018)

heat energy, 72% of which was used by the inhabitants, while the centralized heat supply structure would make it possible to switch to alternative energy sources: biogas, biomass, geothermal and solar energy.

In Mohács the amount of heat used for district heating by the population is constantly increasing. It was 63,483 GJ in 2015 and in the next year it reached 68,115 GJ.

From the KSH statistics it can be seen that in Baranya County 61% of the provided district heating was used by the inhabitants in 2015.

In international comparison, according to a study called “Renewable Based District Heating in Europe - Policy Assessment of Selected Member States” published in 2015, in district heating represents high shares in the residential sector in Denmark, Estonia, Sweden and Poland, all above 40%, while in Hungary, Germany and Austria DH is limited to the range of 12-15%. Amongst the sectors residential consumption is dominant in all countries, generally above 50%. Industrial use is less significant, only in Hungary it reaches 31%, while in the rest of the countries it is below 20%.

4. Biomass availability and utilization

In Hungary the amount and the proportion of used biomass is increasing every year. In 2016 10,024 TJ biomass energy was used for district heating. According to the statistics from the Hungarian Energetic and Public Regulatory Office, the proportion of the used biomass was 10.63% in 2014 and in 2016 it almost reached 16%. It is because the number of the biomass power plants increases every year thanks to EU fundings.

The nominal district heating capacity of biomass-based heat producing facilities is 817.73 MW and is using 10,024 TJ (this is equivalent to 239,419.1 t of oil) biomass every year for heat production which is 15.79% of total consumption).

Raw materials for biomass processing are coming from forestries and agriculture. The Mohács Power Plant uses woodchips as feedstock for the production of heat. Therefore, this study analyses the possible occurrences of this kind of biomass type material.

The analysis includes the counties of Baranya, Somogy, Tolna and Bács-Kiskun, which are located in the 80 km radius of Mohács.

Table 5 shows the territorial breakdowns for each county. No big changes have occurred concerning the size of areas in the last decade.

Table 5: Land areas by land-use in the four examined counties (source: TEIR, 2018)

(thousand ha)	BÁCS-KISKUN	BARANYA	SOMOGY	TOLNA
Arable land	41,4%	51,4%	44,8%	62,8%
Orchards	1,2%	0,3%	0,5%	0,5%
Vineyards	2,6%	1,0%	0,6%	1,5%
Forest	20,9%	25,5%	31,3%	19,4%
Uncultivated land area	18,1%	16,1%	15,0%	8,9%
Agricultural area, total	59,8%	57,8%	52,2%	70,7%
Land area, total	843,8	438,5	571,2	342,1

The most forested county is Somogy (31,3%). The total amount of forests is 533,2 thousand ha in these four counties which can be the target area for Mohács as a potential supply area.

The following map shows National land use categories around Mohács, including forestry, agricultural, mixed and water management areas.

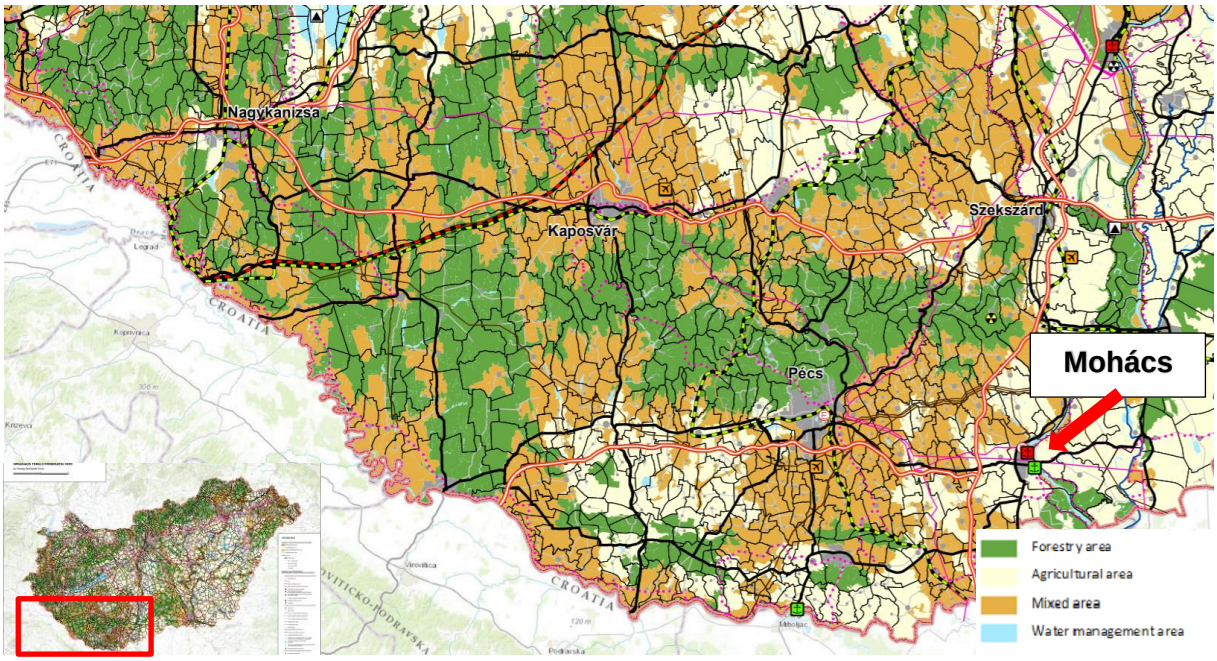

Figure 7: National land use categories in South-West Hungary (source: National Spatial Planning Plan of Hungary, Annex II. 2014)

Forests and green zones in this area, which are shown in Figure 7, are maintained by these companies:

- SEFAG Erdészeti és Faipari Zrt. 79,973 ha
- Mecsekerdő Zrt. 55,000 ha
- Gemenci Erdő- és Vadgazdálkodási Zrt. 38,000 ha
- Gyulaj Erdészeti és Vadászati Zrt. 23,000 ha
- Kaszó Zrt. 18,000 ha

It means that in this region there are 119,973 ha forests and green zones that can potentially contribute to biomass production. In 2012, 7.7 million m^3 of wood was extracted in Hungary, mostly from Zala, Somogy and Pest counties. Increment, meaning the average annual expansion of total extraction expected in the upcoming 10 years, has not changed much, it was 13 million m^3 in 2012. As only a small proportion of this amount of wood transported on IWW transport, this resources presently are not available for energy consumption in larger context or international level.

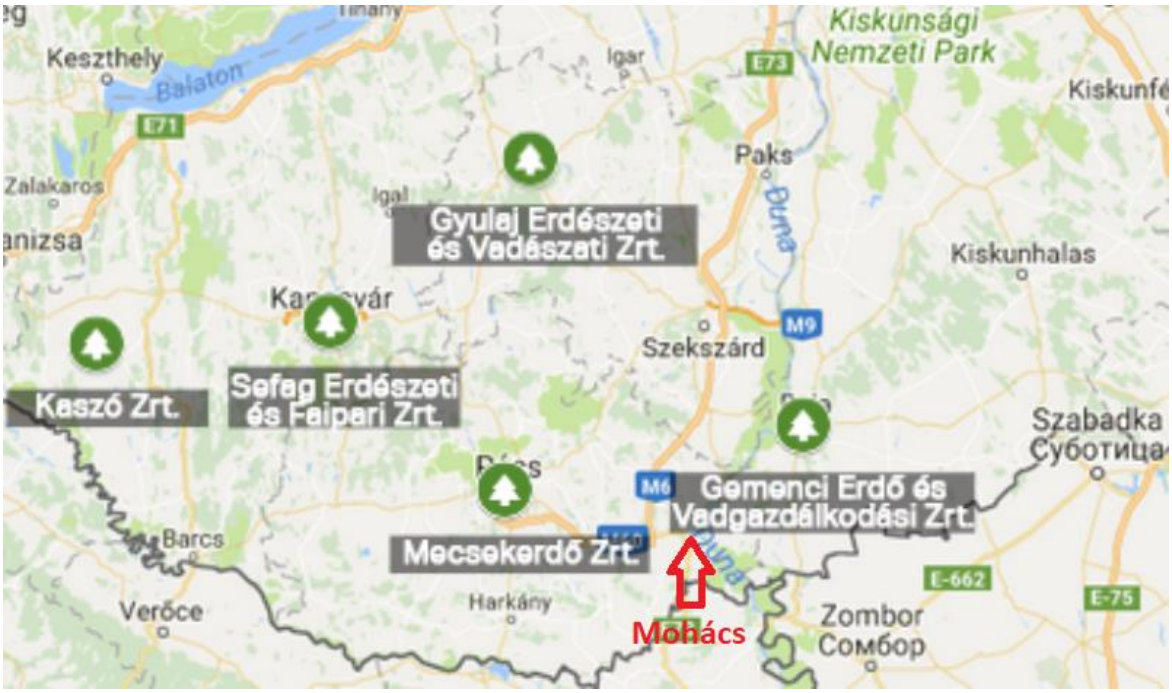

Figure 8: Forestries in the region of Mohács (source: own editing based on Google Maps)

The core activity of SEFAG Erdészeti és Faipari Zrt. is the continuous management of state owned land in Somogy County. Their specialty is forestry and wildlife management. Accordingly, their main productive assets are the forests and the related cultivated land (SEFAG Erdészeti és Faipari Zrt., 2018).

For Mohács, the forest of Gemenci Erdő is the more easily assessible taking into consideration the shipping routes.

Mecsekerdő Zrt. is a significant unit of Hungarian forestry. The company's responsibilities include the management of state-owned forests in Baranya County located on the plain of the River Dráva and in the Mecsek Hills. The forestry is conscientious of managing the stands of silver linden-trees associated with beeches in the Zselic region, the stock of peduncular oaks in the Ormánság region and the beech forests of the Mecsek Hills. The company sells 230,000 m^3 of timber of per year (Mecsekerdő Zrt., 2018).

Gemenci Erdő- és Vadgazdálkodási Zrt. operates from July 1, 1993 on 37,839 ha of state-owned forests and 55,700 ha of hunting area. The floodplain areas form the Danube section of the Danube-Drava National Park (approximately 20,000 ha). The forest stock of 10,200 hs of sand and 5,400 has of hillsides is connected to the floodplain from the east or west. The property is located south of the Szekszárd - Kalocsa line, going right up to the border on the left and right banks of the Danube (Gemenci Erdő- és Vadgazdálkodási Zrt., 2018).

Gyulaj Erdészeti és Vadászati Zrt. manages the state lands and estates on more than 23 ha in the South- West Hungarian Tolna County. They run 3 different forestries on this state property as well as forestry offices. All of these have different and unique natural features (Gyulaj Erdészeti és Vadászati Zrt., 2018).

Kaszó Zrt.'s lands sprawl across the inner area of Somogy County on the forestry of the Somogy Hills. The 14,680 acres form a continuous forest block, even though they border on 14 villages.

To sum up, in Hungary there are 7-7.5 million m^3 of wood extracted per year out of 9 million m^3 wood grown. Currently, annual firewood extracted is enough for the heating of 500,000 households. By improving extraction and utilization of green waste leftover in forests, even 700,000-800,000 households could be supplied (Kaszó Zrt., 2018).

In Mohács, due to large neighbouring biomass-based energy production sites (Pannonpower Zrt. in Pécs and Komlói Fűtőerőmű Zrt. in Komló) there is a competitive market for suppliers.

However, Mohács is close to the Serbian and Croatian borders which provides the possibility to use imported raw materials as well. The only factors that can obstruct the competitiveness of this option are the administrative and time factors during border crossings.

However, it is important to emphasize that not only wood but also by-products of agriculture (such as grain depositories, raw materials found in different reservoirs in ports) would be suitable as biomass feedstocks for power plants. With these solutions the perspective of potential purchasing locations can be further broadened, while the storage and recovery costs could be modified as well.

By-products of agriculture can be maize, rape, grain, straw, wheat and sunflower.

5. Bioenergy production and utilization

The Mohács Bioenergy-Duna Ltd started its operations 15 years ago and their main challenge at the moment is to maintain production costs in a strictly regulated operational environment. The company intends to provide heat for its end users on a price level which is competitive with natural gas-based production that makes their operation cost sensitive.

Suppliers of the company transport energy biomass (wood chips) from an area of appr. 50-60 km radius. Deliveries come from nearby forestry companies such as Gemenc and from Croatia as well. Longer transport distances would increase their cost considerably. Their suppliers use only road transport and no railway or waterway transportation. As transportation costs are included in the contracted price, decision on mode of transport is made by their suppliers. In the opinion of biomass producers, loading and transhipment have relatively high costs and they are not interested in changing to a different way of transport since biomass from the forests has to be moved by trucks anyway.

According to the company's plans a new private railway line will be established as it would be more cost effective. A previously completed line is already available in the neighbourhood; it is missing only an industrial track to connect their premises to the network.

Presently they do not use waterway for raw material transportation although the plant is only 2,6 km from the Danube. However, Town of Mohács is planning to build a commercial port on the

Danube River, as Municipality has been awarded a HUF 4.75 billion European Union and state grant for the investment. The new port will have a public road and railway connection and a modern crane system. With the opening of the new port most economical ways of transport has to be reconsidered based on cost calculations.

The company uses a common heating pipe system for gas and biomass firing, which can be operated in shared use as well. The annual heat production is around 70,000 GJ/year and they are operating with the 4.5 MW biomass power plant only during the winter. The reason for that is that the heat production with biomass whole year round would not be competitive in price. As maintenance and operating costs are higher than for a natural gas-based plant, biomass production is only economical if the energy price is 10 percent cheaper than natural gas.

The biomass plant's demand of biomass raw material is 7,700 (lutro) t per year. The company is not using other agriculture by-products, only woodchips. The safety buffer capacity lasts for one week, which means that max. 600 t can be stored. To increase buffer storage capacities purchase of further land is necessary.

A key obstacle to further development is the regulation that allowed only a part of their budget to be used for developments while these investments could be realized from EU or government subsidies or investments of the owner municipality.

Purchase price of biomass raw material is set in HUF/MJ including shipment to the powerplant. The company fixes annual prices and quality requirement in shipment contracts with four or five suppliers in order to get the lowest possible price. Suppliers are selected based on competitive bidding annually.

Heat prices are regulated towards residential end users which forces the company to operate a very cost-effective system. The production information is presented in Table below.

Table 6: Data in connection with bioenergy production in Mohács (source: survey elaborated by MaTáSzSz)

Company		**Bioenergy-Duna Ltd.**
City		**Mohács**
Consumers:	Inhabitants (flats):	**2,015**
	Associations:	**42**
	Other users (e.g. industry):	**-**
Term heat output (MW)		**4,5**
Provided annual heat amount (GJ/year)		**70,000**
HMV sales (m3/year)		**40,294**
Related electric power generation(yes/no) Performance (MW)		**no**
Currently operating biomass-based energy production:	Built-in heat power (MW)	**4,5**
	Built-in electrical power (MW)	**-**

	Demand on biomass material ((lutro) t)	**7,700**
	Type of biomass material used (Logs, Wood chips, Agricultural by-products etc.)	**Wood chips**
	Delivered by/on	**Trucks**
	Average transport distance	**-**
	Material buffer capacity/expected	**600 T (Own covered hangar)**
	Quality expectations (size, moisture content, calorific value, purity etc.)	**G100, <40%, clean (powder, leaves and extraneous matter free)**
	Average raw material acquisition cost (Forint/MJ)	**1.62**
	Estimated location distance from the nearest Danube port	**2,6 km**

Over the past period, more and more biomass facilities have been built within a 60 km radius, which have become key players in this sector. As a consequence, a serious competitive situation for biomass has also emerged, resulting in a drastic increase in the price of woodchips.

The region's dominant biomass-based district heating companies are Pannongreen Ltd. (49,9 MW), Pannon-Hő Ltd. (35 MW) in Pécs and Komlói Fűtőerőmű Zrt. (18 MW). The first two belong to the Pannonpower power plant and the third to the Komló power plant.

In the summer of 2004, the largest biomass-fired power generation unit in Central Europe started to operate (connected to Pannonpower), providing the entire city of Pécs with green district heating supply. Pannonpower is also addressing other alternatives to expand the existing fuel base for biomass energy production.

The entire logistics process of the two plants in Pécs is carried out by Pannon Biomass Ltd., which processes and trades biomass energy. Based on the interview with Pannon Biomass, the plants are using logs and woodchips from forests, straw-based raw materials in 0.5-t standard bales and bulk timber residue. The total annual demand for smooth operation is 900,000 t of biomass.

The Komló power plant has a maximum of 18 MW biomass-based heat production capacity used in district heating systems. The plant's demand is 21,000 lutro t of raw material annually in the form of mixed woodchips. The average delivery distance is 30 km for the biomass transported mainly on roads (eg. Gemenc forests). The buffer storage capacity of the plant is 5,000 t.

6. Infrastructure, logistics & integration of supply chain and logistics

Accessibility of Mohács

The following chapter summarizes the accessibility of Mohács in connection with the road, rail- and waterway networks. The city is located in the south part of Hungary in Baranya County, on the right and left banks of the Danube, near the Croatian border. Mohács is in a special position for transportation on waterway. The city was built on the bank of the Danube. An international terminal operates in Mohács, the county's water-traffic facilities are excellent. At present, preparations for the construction of a new public port are in progress with the co-financing of the European Union, which can strengthen the county's economic potential by its logistic function.

One of the most important international corridors (TEN-T corridors) is passing through the city, which is part of the Rhine-Danube Inland Waterway Corridor (RHD IWW).

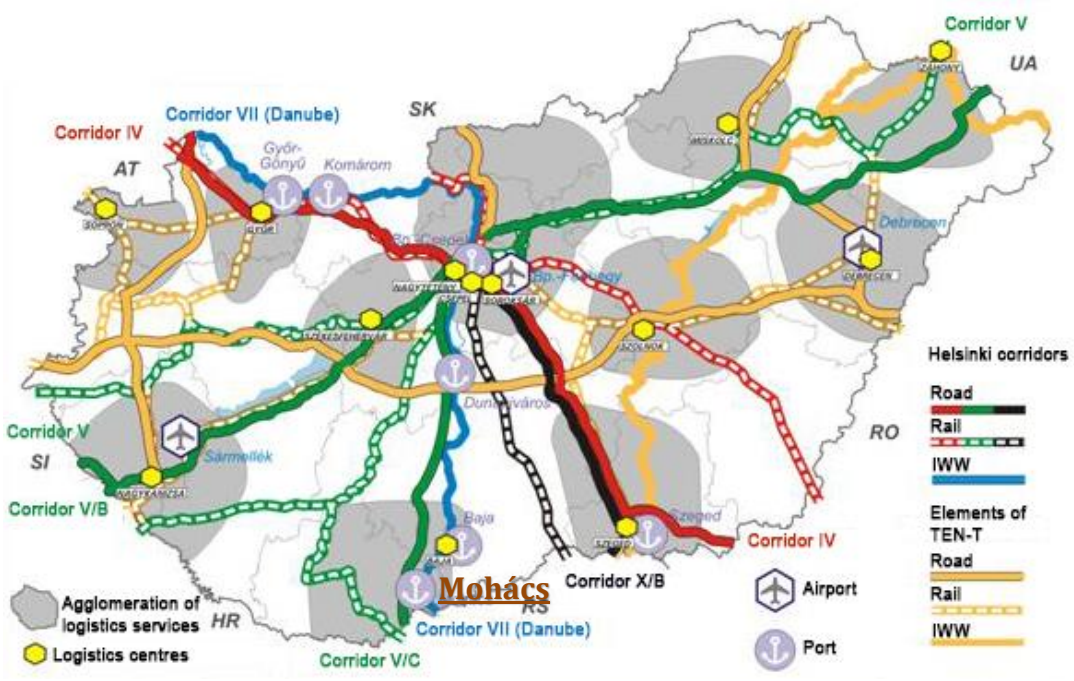

Figure 9: Highways and railways crossing Hungary (source: Institute for Transport Sciences Nonprofit Ltd., 2018)

Mohács is the last port in Hungary before crossing the Southern border. The largest transhipment volume of Danube ports was 730 496 tonnes and the lowest volume was 1 668 tonnes in 2017. Based on these data, the neighbourhood ports (Paks with 260 578 tonnes and Baja with 342 874 tonnes) can be classified into the category of middle sized.

Next to inland waterway transport the road connections play an important role in the city's commercial traffic. The proximity of motorways gives the city a good accessibility. Further construction of the motorway up to the border will be finished in the near future which further increases the possibilities of local enterprises.

The planned Danube bridge in Mohács could be an important element for the development of East-West relations.

The shortest route from the city to the motorway is 17 km. The city's railway transport is not in competition with any other ways of transport as there is no direct connection with the main railway line only in the direction of Pécs. Probably this is the main reason why most of the traffic of the city is through the road network – and in smaller part on waterway.

Biomass supply chain in the region

Presently, the supply chain is very simple in case of the Mohács biomass power plant. Energy raw materials are transported on road directly from the forests, in most cases without any transhipment. In practice trucks are loaded with chips at the forest loading point and they transport raw materials to the buffer storage in Mohács. The average shipment distance is 50 to 60 km. As the Mohács biomass power plant can use only homogenous woodchip quality no other energy raw material is applicable in the plant.

Probably after 2020 when new port capacities will be available in Mohács, waterway transport will probably gain more role in biomass transport. As part of the woodchips used in the plant comes from Croatia ready to use, probably further supply possibilities will open from abroad. Also, as the area of the neighbouring Gemenc forests is partly located on an island on the Danube, the new port opens new transport channels for the utilization of those biomass stocks.

In case of the Pannonpower plants in Pécs where the quantities are much larger supply chains are more complex. The supply and logistic activities are organised by Pannon Biomass Ltd. which collects different types of raw materials and shipment distances are considerable longer. The plants use logs, chips and agricultural by-products as well. In some cases, raw materials (even straw) arrive from over 200 kms. In Pécs the most part of transportation is arranged on road even from longer distances. Waterway is not used; railway is only a small proportion of the total transported quantities.

There is an already existing competition in the Baranya region for energy biomass raw materials which increases the role of cost effective supply systems. Probably a 'commodity exchange type' purchase system could balance raw material and shipment process as well. Cooperation of major players of the energy biomass sector provides the opportunity to harmonize their supply without risking the negative effects of further competition.

7. GIS-map

For the case study, a map visualizing geographical conditions and context based on a geo-information system (GIS) was designed. It is a set of aspects defining the case and its surrounding area with a particular focus on the proximity to the Danube and relevant ports. For the case, a catchment area with a radius of 50 km has been defined in order to allow for theoretically economically viable pre- and post-haulage logistics. Within this area, also the companies along the

biomass and bioenergy value chain as well as the port locations as identified in the course of the ENERGY BARGE project are depicted via icons.

The following information is provided on the map:

- Location of the case
- Land cover categories on NUTS 3 level (CORINE land cover data, Eurostat, 2012)
- Land use data on NUTS 2 level for selected biomass feedstock (Eurostat, 2017)
- Market actors in the biomass and bioenergy sector in the region (ENERGY BARGE D3.2.1 Transnational inventory of biomass and bioenergy companies in the Danube corridor)
- Danube port locations with equipment for biomass handling (ENERGY BARGE D4.1.3 Analysis of logistics requirements for the bioenergy industry)

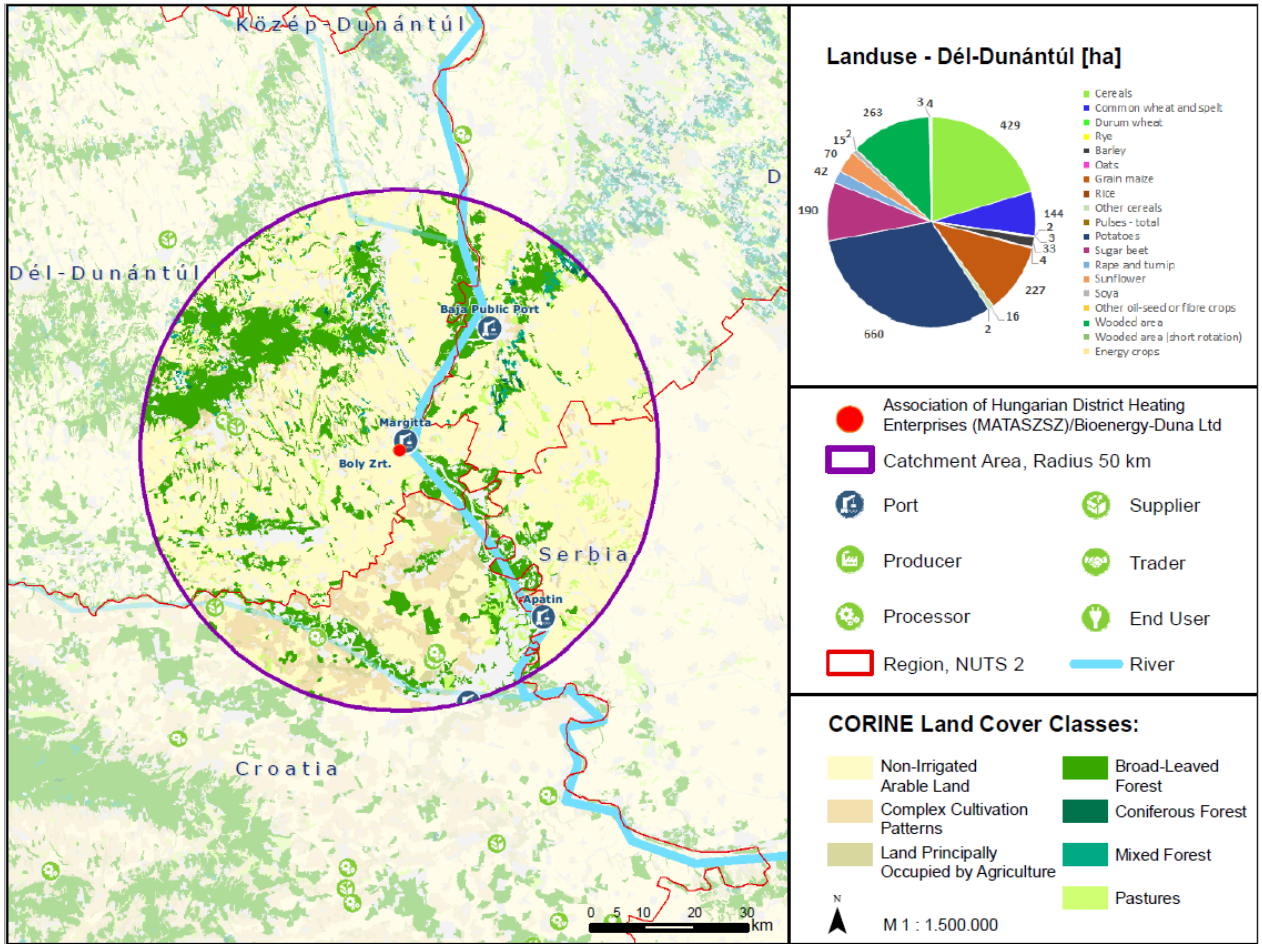

Figure 10: GIS analysis of the case location (visualization: DIT for ENERGY BARGE project; sources: ENERGY BARGE, 2017/2018; EUROSTAT land use data, 2017; CORINE landcover data, EUROSTAT, 2012).

8. Analysis of success factors & lessons to be learnt: enablers and barriers

In the following Table 7, a brief indication is given of the success factors of the case, of the lessons to be learnt:

Table 7: Success factors Mohacs case

	Enablers	Barriers	Learning and degree of transferability
Biomass availability	There are plans and possibilities for further forestations and plantation of energy crops. Mohács is close to the Serbian and Croatian border which gives the possibility to use imported raw material as well.	Based on forestry authority interview presently availability of solid energy biomass limited due to social firewood programme and power plant investments. In Mohács, because of large neighbouring biomass-based energy production sites (Pécs, Komló) there is a competitive market for suppliers.	Long term plans and strategic cooperation is necessary with biomass suppliers and policy level decision makers.
Biomass utilization/valorization	Efficient technologies and operational experiences are available for biomass utilisation at district heating companies; utilization of agricultural residues is an option and has to be scrutinized more carefully	Location of thermal power plants can be a barrier for biomass utilisation (limited space; distance from residential area).	Strategy should be elaborated to select ideal sites for biomass-based heat production at district heating companies located at biomass reach regions. In case of agriculturally strong regions, considering energetic use of residue material is suggested
Bioenergy production / utilization	Subsidized feed in tariffs for green electric energy production areadvantageous for residential end users.	Heat prices are regulated by the Hungarian Energy and Public Utility Regulatory Authority whichreduces profitability and investment potential of the sector.	Regulations, raw material availability and development strategies have to be harmonised for long term stability of the sector.
Existence of a strategy or concept	There is an initiative from MaTáSzSz to co-ordinate energy biomass supply. In Mohács there are plans for the extension of port capacities in the city towards this end.	No detailed development plan on biomass-based heat production at district heating companies. No national level strategy on long term biomass supply of future powerplants with biomass.	Elaboration of a national level biomass supply strategy is necessary by district heating companies to stabilize raw material supply for the long run. Having engaged private actors such as MaTáSzSz can give important impulses for business development and optimization of procedures

	Enablers	Barriers	Learning and degree of transferability
Role of stakeholders	District heating companies are open to launch new biomass based thermal power plants.	Investment capacities are limited for new developments, most new projects are co-financed with EU subsidies. Most companies (like in Mohács) are owned by local municipalities who has limited resources for necessary investments. Transport of biomass to heat production plant is financed by the supplier, they focus mainly on cost effectiveness and less interested in environmental effects.	Suppliers have to be motivated to select more environmentally friendly transport modes. Engaged actors such as MaTáSzSz are important for the viability of developing sectors such as the district heating sector.
Role of socio-economic factors	District heating is considered to be a cheap and comfortable system by end users.	District heating is mainly used at block houses and users are price sensitive.	Connecting new end users can be an effective way of reducing energy costs of low income population.
Integration of supply chains	In most cases district heating companies purchase energy biomass based on competitive bidding. Price usually includes shipment cost as well. Annual prices are fixed.	There is no system to optimise transportation, taking into consideration environment friendly solutions.	Coordinated supply and transport chains is a future option for district heating companies to increase security of supply and optimise purchase prices.
Role of logistics infrastructure	There are major forestry companies along the Danube.	Majority of biomass is transferred on road mainly because of transfer costs. Location of ports and port infrastructure is not ideal for the shipment of solid biomass from forests. In Mohács neither rail, nor waterway is used although both infrastructure is available in the neighbourhood.	Ports located close to major forestry companies should be surveyed and refurbished in order to provide alternative of road transport of energy biomass.

9. Recommendations & suggestions for future development

1) Recommendations for the future successful development of the case, especially in further utilizing the case's biomass and bioenergy potential

1.1 A permanent committee and/or dedicated staff of MaTáSzSz could help optimizing solid biomass supply via data collection, negotiations with key raw material producers, policy makers of forestry authorities and logistics companies.

1.2 Elaboration of a long-term supply agreement with raw material producers (state and private forestry companies, agricultural enterprises) in order to generate new plantations for energy biomass purposes, taking into consideration optimal transport costs and modes as well.

1.3 Creation of a joint energy biomass 'commodity exchange' for district heating companies in order to optimise raw material prices and transport costs. This type of operation requires the standardisation of raw material quality requirements for all participating

2) Recommendations for the future options / potential to integrate Danube ports into the success of the case

2.1 For future biomass-based heat power plant developments optimisation for waterway connection could simplify raw material supply using the potentials of the Danube as a transport route.

2.2 Ports located close to major forestry companies should be surveyed and refurbished in order to provide alternative of road transport of solid energy biomass.

2.3 Purchasing or renting mobile loading equipment and dedicated vessels to make waterway transport of solid biomass for district heating power plants more economical.

2.4 Suggestion: compare the overall transport and storage costs of the two logistics scenarios (e.g. 7,700 t wood chips annually as for the Duna case): 1) hundreds of truck loads as compared to 7-8 vessels and enlarged storage options

3) The three most valuable "lessons learnt" from the case that could give guidance to other regions

3.1 Major investments in solid biomass-based energy production can change raw material market conditions considerably which may make operational cost and profitability difficult to forecast. Long term strategy and identification of possible alternative solutions of raw material supply is inevitable in the preparatory phase of these new projects.

3.2 Transhipment of biomass is a considerable proportion of transport costs (especially in case of relatively low shipment distances eg. ≤ 50 kms) which makes waterway transport presently uncompetitive in many cases. Optimisation of manufacturing (e.g. shredding) and logistic capacity installations at forestry companies close to the Danube can create better set up for waterway transport.

3.3 Harmonization of raw material supply of major energy biomass end users like district heating companies is inevitable in order to avoid cost increase and safety of supply risks.

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