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 –

Synthesis Report

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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1. 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 potentials 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 remain in rural areas along the Danube. This concept forms the basic idea of the ENERGY BARGE project.

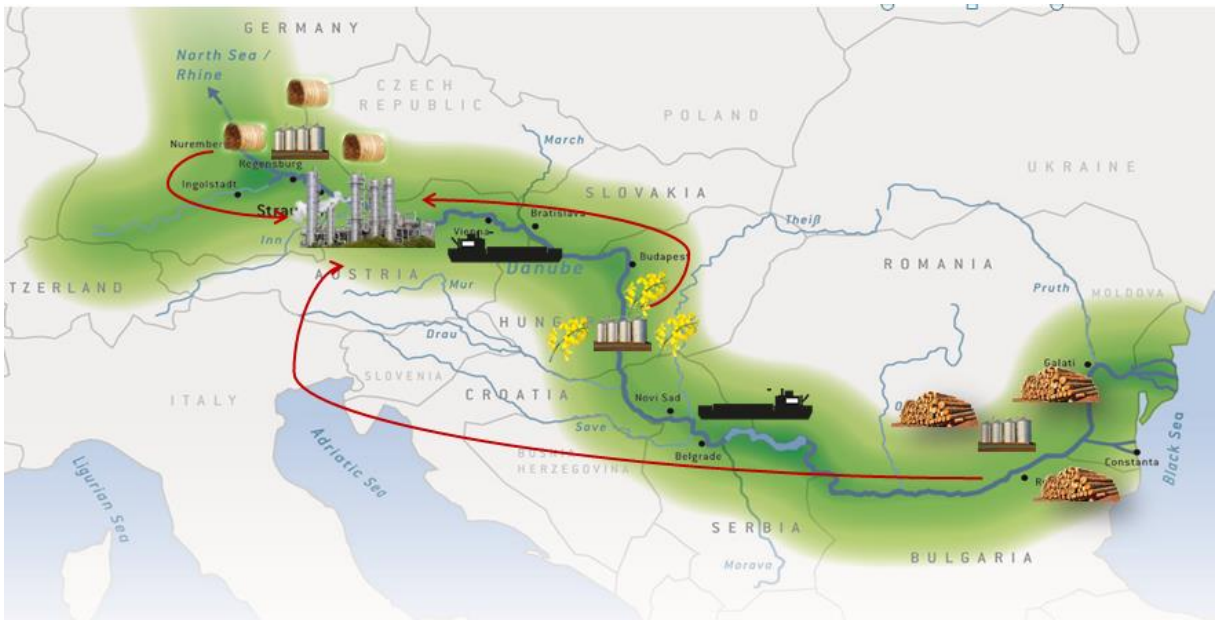

Figure 1: Green Energy and Chemistry Belt (Source: BioCampus Straubing GmbH, own visualization).

In order to reach the targets as 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).

2. Objective of the regional case studies

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 logistic 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. In the following, a brief synthesis report is provided. The case studies are available in separate report documents.

3. Methodology

The core of this deliverable is a set of regional case study reports. For each case study, an own report document was compiled. Each report is qualitative in nature and based on a common structure in order to safeguard comparability and coherence. This common structure is laid out below in the form of the chapters covered by all case studies:

- *Executive summary;*
- *Case study methodology;*
- *Case description;*
- *Socio-economic indicators;*
- *Biomass availability and utilisation;*
- *Bioenergy production and utilisation;*
- *Infrastructure, logistics & integration of supply chain and logistics;*
- *GIS-map;*
- *Analysis of success factors & lessons to be learnt: enablers and barriers;*
- *Recommendations & suggestions for future development.*

For the case studies, maps visualizing geographical conditions and contexts based on a geo-information system (GIS) have been designed. The aim is to visualize 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 are provided on the maps:

- 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 project, company landscape, 2017);
- Danube port locations with equipment for biomass handling (ENERGY BARGE project, inventory of logistics service providers, 2018).

This synthesis report gives an overview over the set-up of the case studies, joint methodology and overarching case comparison.

3.1 Definitions and scope

This report provides a set of qualitative regional case studies. A *case study*, in this context, is defined as a documented study on a specific real-life situation (Businessdictionary, 2018). Such a study provides in-depth examination of the respective case at a certain point in time (for this

deliverable, at the present time), and gives an analysis of the contextual conditions shaping the case. *Regional,* in this context, indicates a spatial limitation, meaning that the observed real-life situation, thus the case, can only be observed in a certain location.

The case study is a classic qualitative research instrument. Therefore, the content of the case study reports clearly relies on the authors' ability to gather in-depth information on the case and/or to utilise already existing knowledge and qualitative information in a structured manner.

In order to integrate the bioenergy and inland waterway logistics pillars of the project, all bioenergy partners were requested to cooperate with their national matching port partner regarding their existing relations and knowledge about the selected case and whether their current and/or future service portfolio is or could be beneficial for the case.

Overall, this results in a list of options for defining the scope of the cases under review.

These are:

- an administrative or otherwise regulatory or thematically confined region, for example a cluster region (i.e. a cluster structure committed to developing and managing a specialized region in a certain business sector);
- a single company, and possibly, regionally and transregionally connected corporate partners (logistics, traders, suppliers, customers, etc.);
- a mixture of the above.

A further guiding prerequisite for defining the case selection is the consideration of Danube port proximity.

Thematically, the cases are defined by a comparatively strong emphasis on the production and/or utilisation of biomass and/or bioenergy either explicitly via e.g. a regional bioenergy strategy or a business strategy of a certain company, or implicitly, e.g. since historically, a comparatively high density of biomass-related companies are clustered in a location. Examples are:

- An explicit strategic focus is being set on the production and/or utilisation of biomass (as defined in ENERGY BARGE) for bioenergy purposes, primarily, but also on other paths of utilisation, e.g. chemical-material use, including establishing suitable supply chains and actor networks.
- The production and/or utilisation of biomass for energy purposes as well as bioenergy utilisation have been comparatively high historically in comparison to other regions.

The focus of the single case studies is on this commitment and the comparatively strong role that the production and utilisation of biomass and bioenergy plays for the case, not primarily on calling this example 'good practice' or 'best practice', even, in the sense that these cases are superior to other alternatives. Rather, the studies analyse and evaluate the performance and situation of these cases. As the cases were selected on the basis of a joint matrix of criteria and thus were pre-assessed as suitable, the respective cases also exhibit mainly "good practice characteristics" that serve as a basis for learning interactions and transfer of knowledge. However, as is shown in each

case study and Chapter 6, each case is also characterized by inhibiting factors that are likewise identified and discussed.

3.2 Case selection criteria

In addition to the definition as indicated in chapter 3 and 3.1, the basis for the identification of the case to be studied was a set of case selection criteria.

All partners checked the potential regional cases known to them as experts in their fields and countries on the basis of these selection criteria, by filling in the template (Figure 2) for at least one, maximum three, potential cases.

The main categories given are:

- Thematic criteria;
- Geographical criteria;
- Performance criteria;
- Organisational criteria.

The selection criteria are depicted in Figure 2.

Annex: Case selection criteria D.3.2.3

Country:				
Name of Case:				
Name of project partner:				
Name of person in charge of case selection:				
	indicate with an "X"			
Thematic criteria	**full match**	**partial match**	**no match**	**internal notes/comments**
1) Comparatively important role of biomass and/or bioenergy in regional and/or business strategy				
2) Easy to define as a "case" according to task description				
3) Existence of (at least partial) biomass supply chains on regional level				
4) Existence/utilization of biomass logistics (road, rail, water)				
Geographical criteria				
1) Proximity to Danube port < 100 km				
2) Case can be regionally limited				
Performance criteria				
1) Case can be considered as comparatively "high-performing" in comparison with other companies or regions with respect to well-functioning business and/or biomass utilization				
2) The case is in a sense using innovative approaches in it's regional and/or business strategy with respect to increasing the sustainable utilization of biomass				
3) The case could also be described as "good pratice" example, meaning it's example can be used as a guiding example for other cases				
Organizational criteria				
1) Availability of reliable and easy-to-reach contact person(s) at the case				
2) Availability of access to reliable data and information on the case				
3) Willingness/consent of case-representatives to be covered in ENERGY BARGE				
SUM of "X":				

Figure 2: Case selection criteria.

The aim of the criteria matrix was threefold. Firstly, it served as thematic orientation for the first scan of the potential set of cases in each country. Secondly, it ensured the cases selected cover the topics with importance to the overall objective, namely to study examples of the Danube

bioenergy landscape that already integrate biomass and bioenergy supply chains as well as inland waterway logistics and have a potential for it (inclusion of port and logistics project partners in case study execution). And thirdly, it served as a common framework, ensuring thematic comparability of the cases. An important aspect for the case selection on organizational level was to only conduct studies on cases where direct contact and approval from the company's or region's representatives was possible.

Each potential case was to be rated for each category, based on the following qualitative scale and on expert discretion:

- Full match;
- Partial match;
- No match.

In case one partner had more than one case study subject in mind, a template for each case was filled in and the one with the highest overall 'full match' ranking shall be selected for the in-depth study. In case only one case was assessed by means of the matrix, at least four 'full match' or two 'full match' and three 'partial match' ratings were mandatory.

4. Selected case studies

The geographical coverage aimed for a set of case studies, which comprises the seven Danube-adjacent project partner countries: Austria, Bulgaria, Croatia, Hungary, Germany, Slovakia and Romania. For each of these countries, one case study location was identified. The Bulgarian study on the biodiesel plant of Bulmarket in Ruse however has not been conducted until today due to administrative challenges. As a back-up, the Hungarian port partner MAHART conducted an own case study about a biomass plant case in Mohács.

Table 1 lists the case titles as well as an overview of the type of case (company or region, central, decentral, small-, medium-, large-scale) and their role in the biomass and bioenergy supply chain on the basis of the feedstock (supplier, processor, trader, or end user of biomass feedstock).

Table 1: The cases selected (including a description of the case type and the role in the supply chain).

Country	Case	Type	Role in supply chain	Location
Austria	**Agrana**	Company; Bioethanol plant; large-scale	Processor, Trader	Pischelsdorf
Bulgaria	**Bulmarket**	Company; Biodiesel plant; large-scale	Processor, Trader	Ruse
Croatia	**Spačva**	Company; Integrated wood-manufacturing plant incl. wood pellet & wood chips production; decentral/medium-scale	Processor, Trader, End user	Vukovar
Hungary 1	**Association of Hungarian District Heating Enterprises (MATASZSZ), example Bioenergy-Duna Ltd**	Company; Biomass powerplant for district heating, based on wood chips; decentral/small-scale	End User	Mohács
Hungary 2	**Hungrana Starch and Isosugar Manufacturing and Trading Co. Ltd**	Company; Bioethanol plant; large-scale	Processor, Trader	Szabadegyháza
Germany	**Region of renewable raw materials, ADM Rapeseed Plant & Clariant Bioethanol Plant**	Cluster region; corporate examples: Oil mill (large-scale) & bioethanol plant (demo-scale)	Processor, Trader (ADM), Processor (Clariant)	Straubing
Slovakia	**Intech Energo / Narodna energeticka**	Company; Organizational roof for set of decentral biomass powerplants (small-scale)	Trader, End user	nationwide
Romania	**FOREST AND BIOMASS ROMANIA SA**	Company; plantations for oilseed, wood & short rotation coppice for energy purposes (decentral)	Supplier, Trader	Petris/ Timisoara

In the map on page 14 (Figure 3), all cases selected and studied are visualized on a GIS-map which also includes the Danube ports (low zoom level). A dynamic version of the map will be included in the ENERGY BARGE online modal shift platform. Regarding the Slovakian case, which consists of a central company with headquarters in Bratislava and satellite locations all over Slovakia, the headquarters as well as the satellites are indicated on the map.

It can be recognized from the map, that all cases selected are located in direct or at least close vicinity (< 100 km, except for the Romanian case) to the Danube and/or a Danube port.

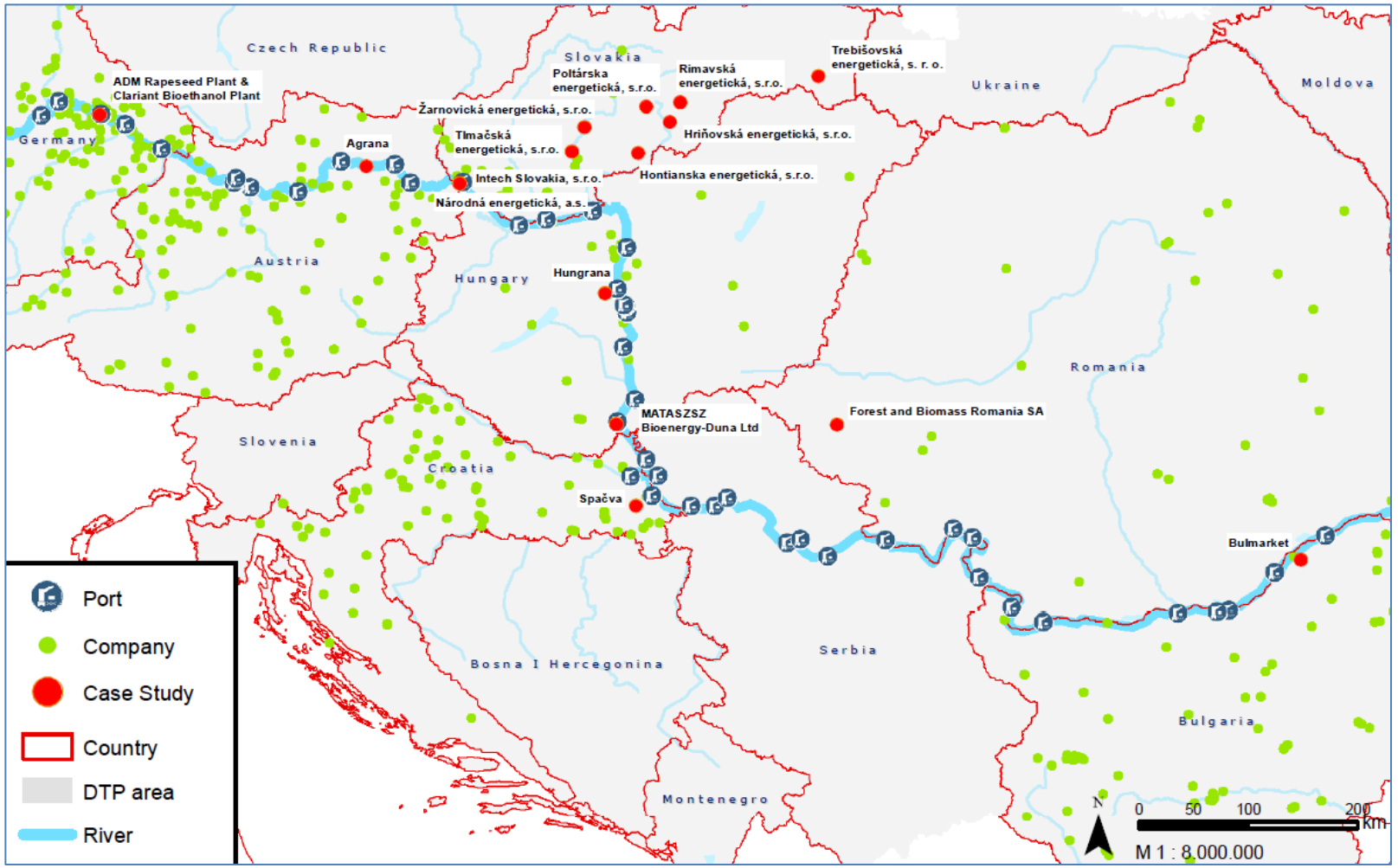

Figure 3: Overview of the location of the selected cases in the Danube region (DIT, source: open street map)

5. Case study fact sheets

The full case studies are provided in separate documents. For each case, a separate fact sheet comprising the most relevant aspects of the cases has been compiled, which are listed below.

5.1 Factsheet Austria

Country:	Austria
Case title:	AGRANA Stärke GmbH - Bioethanol production in Pischelsdorf
Region/City:	3435 Pischelsdorf, Austria
Geographical coordinates:	48.33663, 15.95529
Case type:	Company
Bioenergy segment addressed:	Bioethanol
Feedstock:	Sugar, starch and fruit
Production capacity:	240,000 m^3 of bioethanol (further: 100,000 t of wheat starch, 23,500 t of wheat protein, 120,000 t of biogenic CO2, 190,000 t of the protein-rich animal feed ActiProt®-DDGS - Distillers´ Dried Grains with Solubles and 55,000 t of bran)
Actors involved in logistics/supply chain:	Depending on the market situation and availabilities of storage facilities alongside the supply chain (farmer, warehouse, silos at the loadings stations, etc.) the supply chain, number of actors along these chains as well as transport modes used can vary. To give some examples: • Biomass producer → trader with warehouse/silo | truck| → processing unit |truck/railway/vessel| → client |truck/railway/vessels| • Biomass producer with warehouse/silo → trader → processing unit |truck/railway/vessel| → client |truck/railway/vessels| • Biomass producer → trader with warehouse/silo | truck| → warehouse |railway| → processing unit |truck/railway/vessel| → client |truck/railway/vessels|
Modes used in logistics/supply chain:	Railway, vessels, trucks Regarding the past years the range of cargos transported by vessels was 20% - 40%, by railway 5% - 20% and by trucks 50% - 75%.
Proximity to next Danube port:	The company uses the transhipment point in Pischelsdorf. The next Danube port is less than 50 km away (Port of Krems, Port of Korneuburg).

Potential for future integration of port infrastructure and/or Danube logistics	The potential is high. Especially regarding inbound logistics, the waterway plays a decisive role, given the fact that around 65%-70% of the raw material processed is being imported from outside Austria, making the waterway an attractive carrier.
Barriers for integration of Danube logistics:	AGRANA is an internationally oriented Austrian industrial company, which adds value to agricultural commodities to create industrial products for downstream industries. Large-scale production as their business model does not allow regional procurement solely.
Most important lessons learnt:	What is important regarding the integration of Danube ports: • To guarantee a certain loading rate (performance of loading quantity per day) for the biomass; • Transparency (first come - first serve) in terms of loadings; • To guarantee product safety (in terms of vermins, bugs, rattles, using grids to sieve biomass in case of loading truck cargos into vessels); • The port has a possibility for a intermediate storage; • The port is also able to load truck cargos quick and efficient (adequate weighing bridges, loading ramps, grids, etc.).

5.2 Factsheet Croatia

Country:	Croatia
Case title:	SPAČVA d.d. , Vukovar/Spacva
Region/City:	Vukovar-Srijem County, city of Vinkovci
Geographical coordinates:	45.29520, 18.78288
Case type:	Company
Bioenergy segment addressed:	Bioenergy products: pellets and briquettes (further: flooring, oak doors, oak staircases) The company also uses biomass residues from the processes to fire two large furnaces producing the heat for the company needs on site.
Feedstock:	Wood
Production capacity:	The company is the second largest producer of bioenergy products in Croatia (around 38,000 t per year). Bioenergy product production capacity is 55,000 t/a. The three boilers produce a total of 17.5 MW of heat which is used for own purposes. The boilers burn over 15,000 t of biomass (residues from the other processes) and the total need for heat is 400,00 MWh per year.
Actors involved in logistics/supply chain:	The feedstock is mostly obtained by the methods of public procurement or auction from the nationally owned company Hrvatske šume (Croatian Woods), or in small scale from private forestries. The raw material is hauled by the company's trucks to the company grounds where it is processed in the sawmill and other factory's facilities producing flooring, solid oak doors (interior/exterior), oak staircases and bioenergy products (pellets and briquettes). All products are then shipped to the end users using a contracted logistics company regardless on the final destination (local or international).
Modes used in logistics/supply chain:	The logistics the company uses to deliver the final products and to supply the required raw materials is entirely road based. From the interview with the managers at the company, information has been acquired that there have been some attempts to re-utilize the availability of the currently unused rail infrastructure, but it has proven to be less than satisfactory in terms of the final price and the efficiency of transport (speed, mostly). The nearby waterways (Danube) have not been taken into consideration yet.
Proximity to next Danube port:	Within 20 kilometers to the port of Vukovar.

Potential for future integration of port infrastructure and/or Danube logistics	Traditionally strongly dependent on the road traffic, the area shows great potential of switching the transport modes to alternative ones (mainly waterways).
Barriers for integration of Danube logistics:	Low level of information available to the potential users of the alternative transport modes prevents these for being used to a higher extent. Also, economic viability is not entirely ensured; road transport solutions are oftentimes in terms of prices without competition.
Most important lessons learnt:	An increased amount of information to producers on using waterways might open new possibilities both for more efficient transport and opening to new markets. This would also benefit the local infrastructure which would be forced to upgrade (e.g. new technologies for loading cargo at ports, accessibility of different transport modes, etc.).

5.3 Factsheet Germany

Country:	Germany
Case title:	Straubing – Region of Renewable Raw Materials
Region/City:	Lower Bavaria, Straubing
Geographical coordinates:	48.89459, 12.65816
Case type:	Regional cluster "Renewable Raw Materials", managed by the BioCampus Straubing GmbH
Bioenergy segment addressed:	Biofuels: production of lignocellulosic ethanol (demonstration plant) by Clariant; Production of rape oil for the biodiesel industry and soy oil by the ADM Spyck GmbH
Feedstock:	Agricultural residue material, mainly wheat straw; Oil seeds (rape seed and soy beans)
Production capacity:	Product output approx. 1,500 t/a, feedstock input approx. 5,000 t/a; ADM: capacity >500,000 t/a
Actors involved in logistics/supply chain:	Farmers supplying agricultural residue material; warehouses; Clariant demonstration plant; customers providing test feedstock material; customers utilizing the lignocellulosic ethanol or the residues (idealized, not in demo-plant) Logistics service providers (transport, handling, storage) on road, water and rail; agricultural trading facilities; ADM-owned and other customer refinery sites processing the vegetable oil; customers of the residue materials
Modes used in logistics/supply chain:	Clariant: feedstock supply primarily on regional level (radius max. 100 km), residue materials also mainly utilized in proximity to the plant, the entire logistics are currently facilitated via road transport; ADM: multimodal; feedstock primarily transported on water, products and side streams via rail, road and water.
Proximity to next Danube port:	Both companies are located in the Port of Straubing-Sand
Potential for future integration of port infrastructure and/or Danube logistics	Clariant: not using Danube logistics for their sunliquid® process at the moment due to the following reasons: • no large-scale feedstock supply needed for the demonstration plant; • goal to develop a regional feedstock supply network independent of imports; • lack of suitable permissions and equipment at the port to handle liquid bulk goods / dangerous goods such as bioethanol or vinasse.

	For their industrial-scale plant in Craiova, Romania, 70 km distance to the next port, the company expressed general interest in looking into options of waterway transport for their logistics. almost 75% of all agricultural cargo handled on waterside in the Port of Straubing-Sand are already attributable to the ADM plant
Barriers for integration of Danube logistics:	• Potential threat of feedstock and product contamination due to open-air transhipment from/to vessel (e.g. birds, etc.) • Lacking economic viability of long-distance transport of comparatively light-weight feedstock such as straw • Lacking permission and infrastructure for waterside handling of liquid bulk cargo including hazardous goods in most ports; • Fluctuations in reliability due to weather and water level conditions
Most important lessons learnt:	1) Increased proactive marketing of the potentials and advantages of inland waterway transport for biomass feedstock and certain types of bioenergy products to the biomass and bioenergy sector by means of easily understandable information material is advisable. 2) Integration of inland waterway logistics for the biomass sector and procurement and supply chain management for biobased industry and bioenergy industry into the study programmes and syllabus of the TUM CS Campus University in Straubing. 3) Assessment of unmet demand with regards to logistics services along the biomass supply chain offered in the port among current and potential port customers (forwarding and receiving companies). 4) Creation of supplier and logistics networks and strategic feedstock alliances along the Danube in order to secure sustainable feedstock supply chains and technology and knowledge transfer for potential future industrial-scale applications of a biobased economy along the Danube countries.

5.4 Factsheet Hungary 1

Country:	Hungary
Case title:	Utilisation of biomass in the district heating service of Bioenergy-Duna Ltd. in Mohács
Region/City:	Baranya County, Mohács
Geographical coordinates:	45.99258, 18.66774
Case type:	Company, Group of companies
Bioenergy segment addressed:	Biomass and natural gas-based heat production
Feedstock:	Woodchips
Production capacity:	Total capacity of 14.4 MW (the demand from biomass raw material is 7,700 t woodchips)
Actors involved in logistics/supply chain:	The biomass transportation is the sole responsibility of the supplier
Modes used in logistics/supply chain:	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.
Proximity to next Danube port:	2.6 km
Potential for future integration of port infrastructure and/or Danube logistics	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. In the future, when new port capacities will be available in Mohács, waterway transport will probably gain a more important role in biomass transport. As a part of the woodchips used in the plant comes from Croatia, 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.
Barriers for integration of Danube logistics:	Majority of biomass is transported 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 types are available in close proximity.
Most important lessons learnt:	1) Major investments in solid biomass-based energy production can change raw material market conditions. Long term strategy and identification of possible alternative solutions of raw material supply is inevitable in the preparatory phase of new projects. 2) Transhipment of biomass is a considerable proportion of transport costs (especially in case of relatively low shipment distances eg. ≤ 50 km) which makes waterway transport presently uncompetitive in many cases. Optimalisation 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) 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.

5.5 Factsheet Hungary 2

Country:	Hungary
Case title:	Hungrana Starch and Isosugar Manufacturing and Trading Co. Ltd.
Region/City:	Fejér County/Szabadegyháza
Geographical coordinates:	47.07845, 18.69228
Case type:	Company, processor of corn and maize
Bioenergy segment addressed:	Production of bioethanol; biomass power plant to generate steam and thermal energy
Feedstock:	Corn for bioethanol production; Biomass power plant fired by wheat and barley straw, sunflower husk pellets
Production capacity:	Approx. 900 Mio l/a bioethanol (nominal, theoretical capacity); biomass power plant fires approx. 70,000 t biomass per year (covers two thirds of the company's requirements)
Actors involved in logistics/supply chain:	Feed corn suppliers, raw material/biomass suppliers, public actors, logistical actors, research and development organisations, customers, certification organisations
Modes used in logistics/supply chain:	Supply of raw materials one third by rail and two thirds by road transport; export is carried by road, rail and water transport in equal parts
Proximity to next Danube port:	Port of Adony (17 km), Port of Dunaújváros (22 km)
Potential for future integration of port infrastructure and/or Danube logistics	Change of energy prices could be a periodic influencing factor to increase the share of inland waterway transport; Danube logistics are an option only for large transport volumes
Barriers for integration of Danube logistics:	Reliability and predictability of inland waterway transport can be a barrier (e.g. fluctuating water levels); distribution of goods to/from fragmented areas for raw material production and final products use; adequate port infrastructure not always available; limited number of partners requiring and using water transport
Most important lessons learnt:	• major investments in solid biomass-based energy production can change raw material market conditions • bioethanol plants generating renewable energy cannot only benefit from energy production, but also from by-products produced during the process • stable political framework conditions are essential for reliable conditions for investments in renewable energy market

5.6 Factsheet Romania

Country:	Romania
Case title:	Forest and Biomass Romania SRL
Region/City:	Timis County (Western Romania), close to Timisoara
Geographical coordinates:	45.7318, 21.2666
Case type:	Company, managing 4,200 ha agricultural land 5,000 ha forest area
Bioenergy segment addressed:	Wood chips for a cogeneration plant; raw material for rape oil
Feedstock:	Wood chips from short rotation coppice (poplar); firewood; rapeseed
Production capacity:	4,050 t/a wood chips from short rotation coppice; rapeseed is cultivated on approx. 840 ha/a
Actors involved in logistics/supply chain:	Road and rail transport services are provided by specialized companies; customers of rapeseed from Timis; Holzindustrie Schweighofer (customer of wood chips)
Modes used in logistics/supply chain:	Wood chips transported by trucks from the place of harvesting to the customer at a distance of up to 200 km;
Proximity to next Danube port:	100 km (Moldova Noua)
Potential for future integration of port infrastructure and/or Danube logistics	Suitable ports for the transhipment of biomass cargo would need to be identified via a study; at the moment the potential to integrate transports via the Danube is considered rather low
Barriers for integration of Danube logistics:	The distance to the Danube reduces the profitability to transport the cargo via inland waterways transport; the port in Moldova Noua does not have handling equipment for biomass cargo; lack of political incentives to foster the integration of Danube logistics
Most important lessons learnt:	The demand for biomass for the generation of energy needs to be better directed by the legal framework (e.g. support schemes); short rotation coppice has the potential to defuse the use of wooden biomass from forests

5.7 Factsheet Slovakia

Country:	Slovakia
Case title:	INTECH Slovakia – Národná Energetická
Region/City:	851 01 Bratislava, Slovakia
Geographical coordinates:	48.1244277, 17.09606699
Case type:	Group of companies
Bioenergy segment addressed:	The company Narodna energeticka is operating as a holding company with shareholders position in eight operating companies, owning and providing services of industrial and municipal heating supply. The Company is fully cooperating with its "sister" company Intech Slovakia, s.r.o., which is responsible for the supply of biomass, including partial production, preparation, handling, warehousing for each site of the Company. Intech Slovakia is very active in the field of bioenergy, where responsible for supply of VESKO boilers (boilers running on biomass – both dendromass as well as straw and hay) in Slovakia.
Feedstock:	Wood, straw, hay
Production capacity:	Intech Slovakia is currently able to arrange and handle 60,000 t of biomass feedstock from dendro-mass per annum and additional 6,000 t from agriculture biomass in the form of straw and hay.
Actors involved in logistics/supply chain:	Based on regional sites and based on current availability of dendro-biomass feedstock, supply is based usually on local sources and due to transportation costs. However, the major part of suppliers and supply sites is located in Mid-Slovakia region (area of Zvolen), where the sources of biomass are generally available at affordable prices. This supply region can serve as much as 6 sites of Narodna energeticka with transport radius maximum 50 km (average of 35 km). Supply of straw and hay for Trebisov site is managed solely locally due to transport constrains of the material.
Modes used in logistics/supply chain:	100% of biomass logistics is facilitated by road transport. Except of straw, which is packed and transported as breakbulk cargo in straw packages, other types of biomass feedstock the company is using is transported in the form of dry bulk cargo.
Proximity to next Danube port:	The closest Danube port is located in Komarno and is approximately 60 km from the nearest operations of the Company in Tlmače.
Potential for future integration of port infrastructure and/or Danube logistics	As in many other sectors, logistics infrastructure plays significant role in business decisions and success of project implementations. Biomass is still considered to be more local / regional product with certain limits for longer transport. Road network remains the key. However, availability of railways and water transportation might

	play more significant role in future in case if larger volumes of biomass are processed / utilized.
Barriers for integration of Danube logistics:	Only significant underdevelopment of road network might represent potential important barriers from logistics point of view. Biomass handling requires also proper warehousing facilities, as availability of biomass is more seasonal and storage plays important role in proper overall distribution. Availability (in terms of technology and price) of special equipment suitable for biomass handling might also represent certain barriers.
Most important lessons learnt:	The three most valuable lessons learnt from the case are: 1) A proper biomass utilization, using its main unique "selling" points, such as relatively high efficiency of heat production, low final price of heat, environmentally friendly approach and close regional approach, can serve as a long-term sustainable business model 2) Proper regulation and legislation framework represents key success factors for wider spread of biomass utilization for energy, especially heat production. 3) Combination of several local / regional applications can build a big enough operations in order to utilize economy of scale effects, such as central group purchasing process (better prices of feedstock can be handled), know-how transfer from operations in order to increase operational efficiency and overall professional management based on rational business principles.

6. Case study comparison and discussion

By means of compiling a set of regional case studies on examples of corporate and/or public activities along the bioenergy value chain in the Danube region, the aim is to give insight into currently existing integration of regional and transregional supply chains of biomass and bioenergy production. Based on this systematic insight into specific cases, the studies assessed requirements regarding biomass types, availability, bioenergy potential, actual bioenergy production, closed loops, influence of socio-economic factors and logistics infrastructure, including the integration of Danube logistics and the role of ports.

Looking at the cases, it can be seen that the set of studies covers the entire biomass supply chain for bioenergy purposes (supply, trade, processing/production, end use) as well as all bioenergy sectors (heating & cooling, electricity, transport). Moreover, the cases cover both central, large-scale bioenergy actors as well as small- to medium-scale actors with a more regional and decentralized radius of action. Supporting factors and barriers for the cases' successful performance are also part of the assessment. A summary of the assessment is depicted in Table 2.

Table 2: Comparison of success factors for the two identified case typologies.

Criteria	Central, large-scale cases	Decentral, small to medium scale cases
Strategies or concepts	• No dependence on regional-level strategies for bioenergy development or actors such as clusters • Partial relevance of corporate strategies • Strong regional stakeholders with interest in bioenergy not primarily important	• Private and/or municipal initiatives and strategies are important for investment and business model creation • Association and cluster existence support the case • Single persons with specific interest in bioenergy development of importance
Biomass availability and utilisation	• Dependence on imports; only partial cover through regional/national feedstock supplies; • Starch- and oilbased biomass feedstock • Mainly non-residue material	• Dependence on regional supply • Partially restricted regional supply markets for feedstock • Woody and lignocellulosic biomass feedstock • Residue material
Bioenergy production and utilisation	• Production and sales of bioenergy products for international markets (biofuels) • Partial utilisation of bioenergy for internal process energy system to establish closed loops and enhance environmental performance	• Production, sales and utilisation bioenergy products and heat/electric bioenergy to regional • Decentral markets

Integration of supply chains	• Transregional and transnational supply chains • Large network of suppliers and logistics service providers • Transport to be provided both by suppliers and internally	• Mainly regional supply chains • Limited set of suppliers • Transport to be provided by suppliers
Logistics infrastructure	• Bi- or trimodal logistics infrastructure in use • Long import and export distances (transnational!) Proximity to feedstock sources less important • All locations close to or in inland waterways	• Dependence on intact road infrastructure and short distances • Low logistics costs • Central feedstock collection points mentioned as possible improvement of logistics • Proximity to feedstock sources important

Regarding the current and potential integration of Danube logistics in the form of inland waterway transport and/or the role of Danube ports as hubs within the supply chain, the selected cases also reveal different situations. With a view on present integration of ports and Danube logistics, a clear correlation between the cases' scale, radius of action and role in the supply chain can be identified:

Those cases looking at large-scale biomass processing for the generation of biofuels (e.g. Agrana, Hungrana) already rely on the integration of inland waterway logistics and regional service providers such as ports and transhipment companies. However, the role of these actors, degree of regular utilisation and the part of the supply chain covered by IWT for the cases differ (Agrana, Austria: regular import of biomass, quay without port status; ADM, Germany: regular import of biomass, regular export of residue products via utilisation of logistics service providers, direct location at the port; Hungrana, Hungary: occasional utilisation of two proximate port terminals for import; no direct location at the port; Bulmarket, Bulgaria: own port, utilisation for import of biomass, export of final products). All of these systems are described as functional and beneficial. However, all are also revealing challenges with regard to the utilisation of IWT, such as a lack of possibilities to tranship liquid cargo due to the status of the port (e.g. no possibility to tranship dangerous goods, no official port) and a high dependence on weather and nautical conditions. In all large-scale cases, managers expressed that a further integration of Danube logistics could be beneficial for their business model, especially in the context of reliable in- and outbound logistics.

Thus, the case studies have corroborated that Danube logistics are currently especially used and relevant for biomass-processing companies in the field of biofuels at large-scale production. However, two of the decentral cases (Spacva, Croatia, and Duna Bioenergy Ltd., Hungary) have both infrastructural and geographical potential as well as business model related reasons to consider the future utilisation of Danube logistics for their procurement and outbound logistics and/or to integrate the port locations close-by (Vukovar, Mohács) into their regional supply chains, making them biomass collection hubs (option for additional added value on regional level). In both cases, the responsible managers have indicated interest in these options; follow-up action is to be accompanied by the project partners.

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