Interreg
Danube Transnational Programme
ENERGY BARGE

ENERGY BARGE

Building a Green Energy and Logistics Belt

Project Code: DTP1-175-3.2

Deliverable 5.1.3

BioCampus Straubing GmbH / Port of Straubing - Pre-feasibility Pilot Study

June, 2018

Project co-funded by European Union funds (ERDF)

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

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 Deliverable 5.1.3 Pre-feasibility pilot studies of ENERGY BARGE. It has been prepared by BioCampus Straubing GmbH.

Due date of deliverable:	2018-06-30
Actual submission date:	2018-06-29
Start date of project:	2017-01-01
Duration:	30 months

Work package	WP5
Task	D 5.1.3
Lead contractor for this deliverable	BioCampus Straubing GmbH
Editor(s)	N/A
Author	BioCampus Straubing GmbH, Ann-Kathrin Kaufmann, Verena Dobler, Gerhard Schönbucher, Andreas Löffert
Quality reviewer	Birger Kerckow, Martin Behrens (FNR)

Version	Date	Author(s)	Reason for modification	Status
1.1	2018-02-07	BCG	Comments from MAHART on TIP	First draft
1.2	2018-06-21	BCG	Comments from WP leader MAHART	Final draft
1.3	2018-06-28	BCG	Final revision, reviewed by QAM	Final study

Background

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

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

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

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

Coordinator: MAHART (HU)

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

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

The key focus of the pre-feasibility study structure was to provide a guideline for the elaboration of feasible and economically sound investments to strengthen ports as logistics hubs for the bioenergy sector alongside the Danube. The study structure was elaborated based on previous experience gained in the preparation of infrastructure development projects funded by the EU and also guides issued by various development organizations including the European Commission (*eg. Guide to Cost-Benefit Analysis of Investment Projects Economic appraisal tool for Cohesion Policy 2014-2020 (European Commission 2014 - http://ec.europa.eu/regional_policy/sources/docgener/studies/pdf/cba_guide.pdf).* Previous ENERGY BARGE activities and deliverables, including experiences gained during the preparation of D 5.1.1 surveys, impressions gathered during the port exchange workshop and results and deliverables of WP4, also contributed to the development of the structure and finally the pre-feasibility studies.

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

- Port of Straubing (PP1 – BioCampus Straubing) is an operational logistics hub for biomass handling with a main focus on bioenergy utilization. The focus of its study is to put on a preliminary analysis of options to develop additional storage space for biobased feedstock and products serving the needs of current and future potential customers of services

offered in the port by both the port management itself and private logistics companies operating based on the port's infra- and superstructure.

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

Table of content

List of figures

List of tables

Executive Summary

This pre-feasibility study aims to investigate and analyse the necessities and options to improve the capacities of the Danube port of Straubing (Hafen Straubing-Sand) as a logistics hub for biomass handling with a main focus on bioenergy utilization. After a set of three pre-defined development options has been assessed and ranked for factors of importance and discussed with industrial stakeholders (development of integrated central bioenergy supply solutions for the steam demand of producing current and future settlers, development of additional storage options for biobased feedstock and products, concepts for energetic and material circular and sustainable utilization of the biobased residue material occurring in port infrastructure management such as roadside grass and landscaping materials), the subject of this study is on a preliminary analysis of options to develop additional storage space for biobased feedstock and products serving the needs of current and future potential customers of services offered in the port by both port management itself and the private logistics companies operating based on the port's infra- and superstructure. The primary focus is on open-air storage for woody biomass feedstock and products.

The multimodal Danube port Straubing-Sand, established in 1996, offers excellent infrastructural connection and has vast experience in handling biomass cargo with a current focus on bulk goods for the bioenergy and the agriculture sectors. The port of Straubing is situated right between two areas predominated by agriculture on the Western side ("Gäuboden") and forestry on the Eastern side (coniferous "Bavarian forest") as well as a comparatively dense cluster of biomass-processing industry for both energetic and chemical-material use of biomass, rendering the existence of versatile logistics options for import and export an important success factor.

The port capacity of 500,000 t/a for waterside transhipment has been exceeded by between 100,000 – 300,000 t/a in the recent years. Of the 220 ha of property to be settled in the port and greater port area (industrial park), some 40 ha are still available to be settled, however, scattered into several plots with few 'class 1' plots left. The port basin is fully settled. Between 80 and 90 % of the cargo handled has been biomass in the form of input feedstock for biofuel generation. Moreover, the port management, in cooperation with municipal and regional politics, follows a branding strategy to develop the port and its industrial area in line with the remaining region to become a full-fledged model region for renewable raw materials and sustainable bioeconomy. To complete the value chain offered by other players consisting of scientific elements, technology transfer, start-up support and innovation, the port's role in this development is the provision of attractive site advantages for bioeconomy companies of various sizes to settle in the region. Most important factors in this regard are availability of suitable and flexible settlement infrastructure including competitive utilities (steam, heat) as well as flexible inbound and outbound logistics options for both biobased feedstock and products / intermediates. Against the background of these limited capacities, current dependence on one big key account, an own biobased project (multipurpose demonstration plant for industrial biotechnology) and growing market demand from investors looking for site to realize bioeconomy projects with waterside connection, the port management has launched the provision of a comprehensive port development plan in early 2017. The plan's goal is to obtain reliable information about the market developments and the needed investments to meet those needs.

The ENERGY BARGE pre-feasibility study therefore falls into a crucial period of strategic development decisions at the port of Straubing and can thus contribute greatly to an overall

investment framework for the near to medium-term future. However, it has to be noted also that the study has to be compatible with the greater processes on strategic level, mainly the port development plan and the project of the multipurpose demo-plant. Firstly, the development plan underwent a lengthy planning procedure including a tender and contracting phase and was started with delay only in early 2018. The planning procedure for the multipurpose demonstration plant is currently delayed on EU level (notification process). Therefore, the analysis of options to provide additional storage for biobased materials in the port of Straubing in this pre-feasibility study was obstructed as crucial information on market demand on the one hand and input on financial and technical data for storage investment in line with greater expansion works of quay capacities according to the development plan on the other hand could not be obtained in time. Additionally, the analysis of viable spatial and operational options for new storage solutions resulted in a limited set of choices - the most feasible one being a new 3,000 m^3 short-term on-site storage with a focus on round wood at the new quay area run by the port management with an optional enlargement in form of a bunker with a mobile roof for wood chips. This investment however can only be realized in case the final investment decision for a South quay expansion as laid out in the greater port development plan is made. The time horizon for this expansion is 5 to 7 years, the time horizon for a versatile port expansion in the form of a second basin as also proposed in the development plan is 15 to 20 years.

As a result, the investment into new biomass storage as well as its operation at this stage would always have to be part of an extensive large-scale investment in port expansion (either quay or new basin). In this context, additional studies and assessments are needed, especially since a set of risk factors including uncertainty about future public funding schemes for port expansion and maintenance, Danube politics in Bavaria/Germany and investment decisions in bioeconomy projects on industrial side exists. Overall, for the sake of a realistic perspective, the pre-feasibility assessment of an investment project for additional biomass storage solutions at the port of Straubing has to be classified as premature. However, there is also a significant risk to lose site advantages in case investors in biorefineries and other biobased processing plants do not find the necessary prerequisites at the port of Straubing. Consequently, the development strategy for the region runs a risk of losing momentum.

Therefore, it is recommended to speed up the port performance and capacity assessment within the port development plan, integrate the need for biomass storage as analysed in the prefeasibility study, assess the investment needs for port expansion in detail, survey the market demand for transport and storage solutions for woody biomass and others in a deep-dive, develop innovative user concepts for storage options, and to assess and negotiate with current and potential future port-located private logistics companies their own strategies and options for storage portfolio expansion. In order to corroborate specific market demand and the impact an investment in the intermediate solution at the South quay could have to satisfy this demand, a further study following up on this premature pre-feasibility study shall be conducted in the last ENERGY BARGE project year, provided the results from the port development plan suggest economic viability of the quay expansion and recommend taking action.

1. Introduction of the implementing organisation

In order to assess the organizational, institutional and economic environment within future investments in the port of Straubing-Sand regarding its suitability for biomass handling could take place, the administrative and organizational structure of the port of Straubing-Sand and the entities in charge of management and operations are presented below.

1.1 Organizational structure and activities

Overall organizational structure

The multimodal Danube port Straubing-Sand (Hafen Straubing-Sand) is located on Danube km 2,313 in Straubing, Lower Bavaria, Germany. The port was opened in 1996 and is Bavaria's youngest inland port. In contrast to the majority of the Bavarian ports, the port of Straubing-Sand does not belong to the state-owned Bayernhafen Gruppe, but is both owned and run by an intercommunal cooperation on municipal level between the municipalities City of Straubing (Kreisfreie Stadt Straubing), Administrative District of Straubing-Bogen (Landkreis Straubing-Bogen) and the municipality Aiterhofen (Gemeinde Aiterhofen) – a so-called administrative union ('Zweckverband'). The official name of this intercommunal corporation under public law is 'Zweckverband Hafen Straubing-Sand' (ZVH). The ZVH, according to its statute, is the owner and landlord of the port area as well as the industrial park surrounding the port, which equals to an area of 220 ha (see Figure 3 and Figure 4).

Its statute (§5, Satzung Zweckverband Hafen Straubing Sand, ZVH, 1975) make the ZVH the body in charge of developing and running a tri-modal industrial park including an inland port based on the proceedings under development policy as stipulated in the legislation for urban development (so-called Städtebauförderungsgesetz). Furthermore, it states as a task of the ZVH the building and running of a start-up center (Gründerzentrum Straubing) as well as building and running an entrepreneurial center for renewable raw materials, the so-called BioCubator and the physical BioCampus (set-aside area of 8 ha dedicated for settlements of companies working along the bioeconomy value chain) with the additional subject of developing the entire region as a business and technology –focused model region for the use of renewable raw materials.

According to §5 (5) of the ZVH's statute, the ZVH has a free choice of either running its establishments (port, start-up center, BioCubator, regional management) itself or have it run by a third party. To this end, the ZVH is entitled to found own, independent entities to fulfil dedicated functions and activities. In order to fulfill the diverse tasks written down in the statute, the ZVH has made use of this entitlement, resulting in a complex corporate structure depicted in Figure 1:

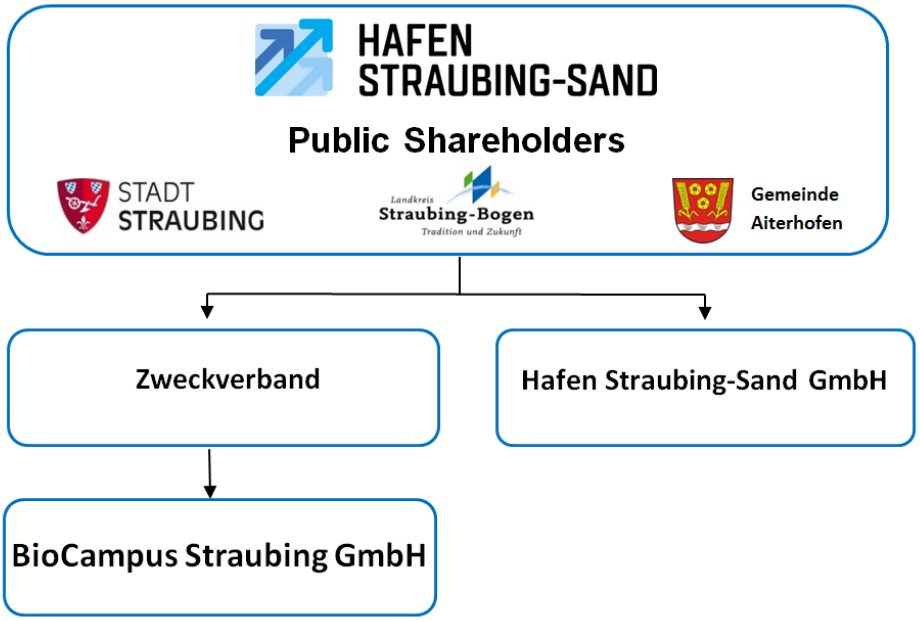

Figure 1: Shareholders and entities involved in the ZVH Straubing (own visualisation).

To this end, in March 2003, the ZVH established a limited liability company, the Hafen Straubing-Sand GmbH (HSG). The subject of the HSG, whose shareholders are the same as those of the ZVH (city, administrative district and Aiterhofen, see above), according to §2 of the company by-laws, is the operation of the port, including all services as well as the establishment and operation of a freight center. Additionally, in 2003, the ZVH founded another limited liability company, however as a 100% daughter of the ZVH (ZVH as sole shareholder), the BioCampus Straubing GmbH (BCG). The subject of this GmbH is to establish and manage a profile region for renewable raw materials in the areas of business and technology with a focus on activities and standards of regional business development.

Port: Ownership, management and operation

As has been laid out above, the port of Straubing has two major entities in charge. Additionally, regarding its operation, a number of port operators, namely settlers/tenants facilitating the transshipment, handling and storage inside the port area play a role. This structure shall be briefly clarified in the following section.

The port area, its entire infrastructure and superstructure including fixed and current assets (real estate, land/properties, roads, quay area, berths, cranes, rail tracks, etc.) lies in the ownership of the ZVH. This means that the ZVH has the sovereign right of a landlord in terms of any development projects and investment activities to be executed within the port area. It also regulates the relations to any settling companies, namely by selling or letting plots of land to these companies. It has been stipulated that all plots adjacent to the port basin must not be sold but will only be given to settlers on the basis of a hereditary leasehold ('Erbpacht').

The general management of the port including its general operation and the operation of the superstructure has been delegated to the HSG by the shareholders of the ZVH. The operation of the rail is also taken over by the HSG. All activities pertaining to the port basin are regulated by the port regulation of the port of Straubing-Sand. According to this document, the HSG is providing the port master, however, the regulatory port authority is the ZVH. The HSG is entitled to be the executing entity of the port regulation by the ZVH.

The HSG operates and maintains all port superstructure, mainly the cranes, and offers these services to the companies engaged in transshipment and logistics. It does however not engage in storage and own logistics commissioning. These business segments are left to the settling companies along the basin (see Figure 4). These companies offer specific services for a number of cargo types. In exchange for a location directly at the basin, the settled companies have contracts with the HSG, agreeing on annual fixed guaranteed transshipment quantities for which they will engage the services of the HSG. In case an annual guarantee amount is not met, a contractual penalty has to be paid.

According to the port regulation, the HSG is entitled to charge two fees for the utilization of the port basin and the berths, namely the pierage charge ('Ufergeld') and the port fee ('Hafengeld').

Based on this operational structure, the port of Straubing-Sand can be classified as a hybrid of a public service and tool port. It is primarily of public nature, the port authority owns the port infra- und superstructure and also employs personnel that operates the superstructure as a service to the private transshipment companies which also perform transshipments using their own staff (ENERGY BARGE Deliverable 4.2.2., inventory of logistics services).

These companies are either companies solely providing logistic services or processors which also engage in transshipment, using the port as a superstructure provider and one or more of the private transshipment companies as a service provider (Zweckverband Hafen-Straubing-Sand, 2018).

- Private transshipment providers are:
- Andorfer Sebastian GmbH & Co. KG, a cargo handling and processing company with storage options, focused on metals
- Hafenlogistik Straubing GmbH, a service provider in the range of port logistics with a hall for the storage of bulk cargo, two storage boxes, an underground bunker, 6 loading silos and an extensive outdoor storage area
- Reinsch Fulfillment GmbH, a logistics centre
- SR-Logistik Umschlags- und Logistik GmbH, a port logistics service provider with storage area next to the quay
- Universal Transport Ivanica GmbH, a port logistics service provider with outdoor storage area, specialised on heavy haulage (Donauhafen Straubing-Sand; 2018)

Basin settlers with need for transshipment / utilization of the port are:

- ADM Spyck GmbH, oil mill and biomass trader
- Bayernhof Erzeugergemeinschaften Vertriebs GmbH, agri-trading company
- BayWa AG, agri-trading company
- Mega Tierernährung GmbH & Co. KG, feed plant
- Raiffeisen Straubing GmbH, agri-trading company
- DoFu Donaufutter, feed plant

Those companies acquainted with experience in biomass handling (agro and forestry goods), trading or processing of these goods are marked in green.

Modal infrastructure, location and additional activities

In the following, an overview of the modal infrastructure, location and general activities within the port of Straubing-Sand is given to provide a content-related framework for the study.

The Danube port Straubing-Sand builds a geographical connection between the Rhine and the macro region Danube as depicted in Figure 2.

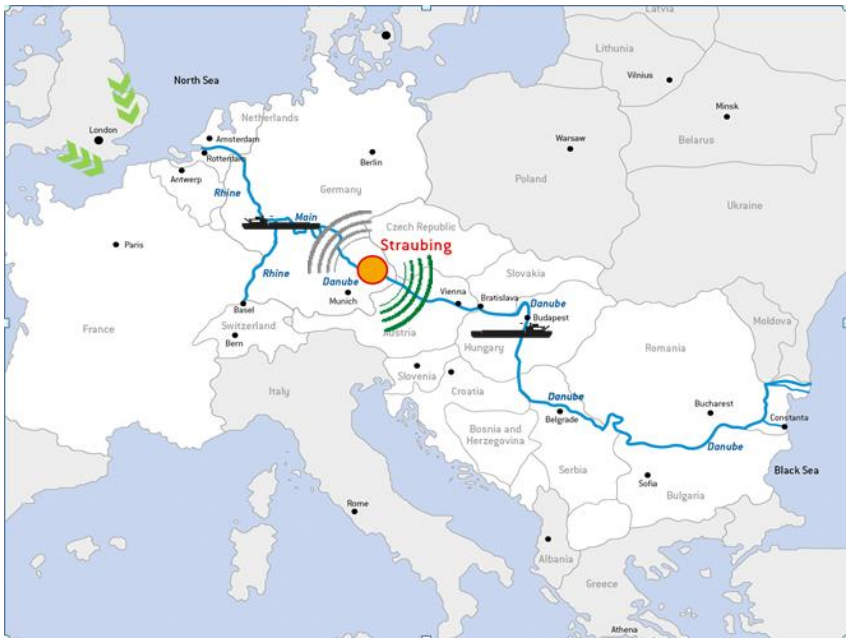

Figure 2: Geographical location of Straubing in Europe (own visualisation, 2014).

Figure 3 provides an overview of the modal connection of the port of Straubing-Sand. The port of Straubing-Sand is easily accessible through its connection to the Danube waterway and to the railway tracks. Furthermore the port is linked to the two highways A3 and A92 through the main road B20 as well as the state road SR12.

Straubing, with its more than 45,000 inhabitants is equipped with a regional airport. Moreover, the international airport Munich is accessible in less than 1 hour. A container terminal for intermodal transport of containers (first development step: railroad and vice versa) on the port area is currently in the planning phase, a more detailed description is provided in the following section.

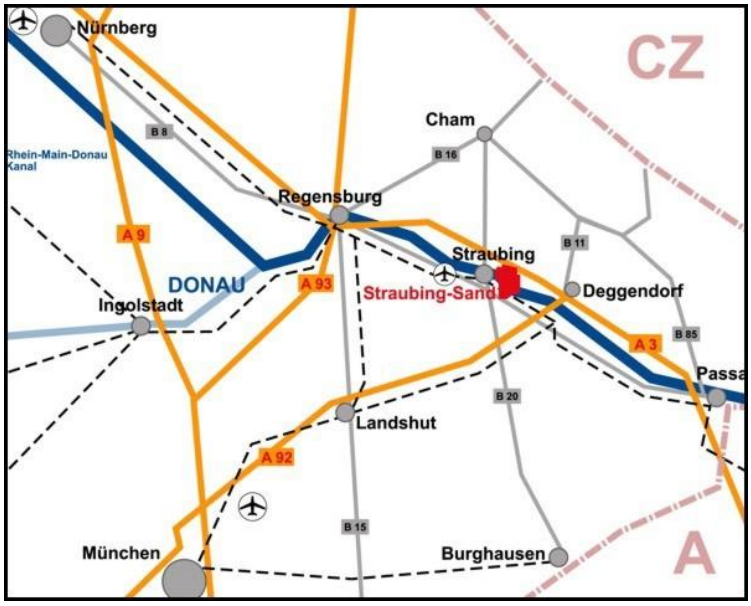

Figure 3: Modal connection of Straubing (own visualisation, 2015).

Figure 4: Danube Port Straubing-Sand, including port, industrial park, Business Start-Up Centre and BioCampus (Image: ZVH, 2017).

Figure 4 provides an aerial view of the current situation of the port of Straubing-Sand.

The port area is 220 ha large – most of the plots are being marketed to settled companies. The 220 ha area counts around 70 companies with more than 2,800 employees. Thereof, around 35 companies are located in the Business Start-Up center and the BioCubator. The main economic sectors are trade and logistics, production and services.

The port's surrounding trimodal industrial park offers completely developed industrial and commercial sites in different sizes, varying from 1,000 m² to 150,000 m². Medium-sized enterprises as well as global companies are counted among the residents. It has customers from biobased industry, trade and services together with lots of companies from the logistics sector.

The Business Start-Up center offers affordable and flexible area for offices and workshops for young enterprises. The center provides meeting and conference rooms together with additional services. Another special feature is the BioCampus. Straubing is profiling itself as the region of Renewable Raw Materials as a business and regional development smart specialization strategy. Research and development facilities, companies as well as the Technical University Munich Campus for Biotechnology and Sustainability are located in the city of Straubing, some 10 minutes away from the port area. Responsible for the networking is the Cluster for Renewable Raw Materials which is managed by the BioCampus Straubing GmbH. Furthermore the BioCampus Straubing GmbH is responsible for the site development, including active site marketing, to strengthen the role of the Region of Renewable Raw Materials.

Next to the Business Start-Up Center lies the BioCubator, a full-fledged wooden building, which is dedicated as an entrepreneurial center for companies along the biomass value chain. High-quality offices and laboratories are available. The tenants can also use all benefits, facilities and services, offered by the neighboring Business Start-Up Center. The ensemble of these two buildings is depicted below.

Figure 5: Start-up Center and BioCubator in the port of Straubing (Image: ZVH, 2017).

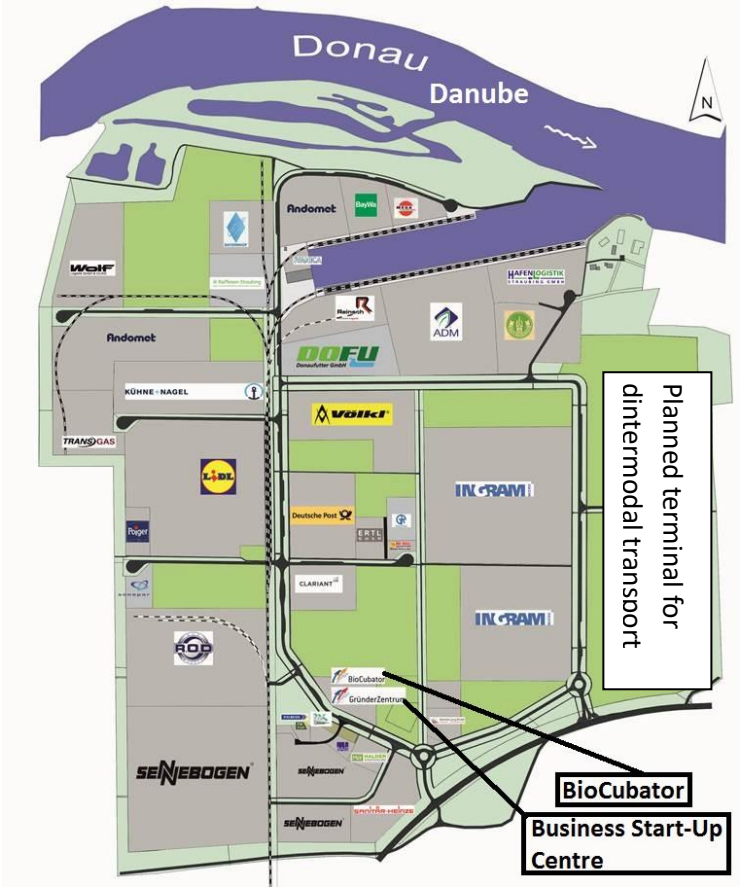

Figure 6: Danube Port Straubing-Sand incl. belonging entities (own visualisation, 2018).

The establishment of sector-specific entities such as the BioCubator is based on a political strategy to develop the region Straubing as a model region for the use of renewable raw materials and bioeconomy which started in the early 2000s both driven by Bavarian state and local/regional politics.

In order to sharpen the profile of the port and the industrial area surrounding it, the political decision was taken on municipal level to synchronize the already established port structure dominated primarily by companies from the agricultural sector and the development of the city of Straubing as location for a number of state-run institutions in the field of research and technology transfer for the energetic and material use of biomass/renewable raw materials. The means to do so is a development and marketing strategy focussing on value and supply chains for biobased chemistry and energy (cascading use of biomass). Under this strategy, the port of Straubing-Sand was branded "Green Chemistry Port" and a trademark was registered. The Green Chemistry Port was set out to function as a logistics hub for biobased raw materials/feed stock, semi-finished, and finished good/products. The Danube was set out as an environmentally friendly transport axis and the macro-region along the Danube was branded "green chemistry and energy belt", underlying the logic of decentral harvesting, local processing and central refinement, allowing to create added value along the Danube with a focus on rural areas. All activities regarding development undertakings by the ZVH and its subsidiaries are abiding to this development strategy and need to take it into consideration.

Derivation of pre-feasibility study subject

A high percentage of waterside freight handling in the port of Straubing-Sand is currently stemming from biomass, typically belonging to the cargo categories of agricultural and forestry goods. On rail, biomass currently makes up almost 100 per cent of all goods transported to and from the port area (focus: rape oil, soy oil). However, the port's business development strategy to sustainably profit from the bioeconomy development in Europe demands for, firstly, a more diversified product portfolio both regarding transshipment and the processing in plants in the port area itself by companies settled in the port. These, in turn, again need feedstock supply that could be guaranteed via the Danube transport axis. Secondly, the port management itself shall run by example and include, where economically viable and sustainable, "green" solutions regarding port infra- and superstructure. Therefore, the port of Straubing-Sand considered as a starting point for this study a business development strategy that builds on two kinds of project pillars to transform the port of Straubing-Sand and others into biomass and bioenergy hubs.

The two pillars are:

1) Encouraging and supporting companies processing biomass along the value chain and related value chains **to settle in the port** via active business development strategies and measures to improve the port's suitability and attractiveness regarding these companies' needs
2) **Install bioenergy appliances** and circular systems in the port itself to demonstrate commitment to economic and ecological sustainability

According to these two pillars, three potential project ideas were developed and assessed according to selection criteria in an internal workshop on 20.9.2017 with the port's managing director Andreas Löffert and the port master Martin Bayer and the results from the interviews conducted in WP 4 as well as WP 4's field visit were considered.

The following project ideas were developed:

1) Development of additional storage options for biobased products and feedstock;
2) Integrated and sustainable energy supply solutions in the context of the new port development plan;
3) Concept for energetic and material circular and sustainable utilisation of the biobased residue material occurring in port infrastructure management such as roadside grass and landscaping materials.

In the workshop, a number of selection criteria were developed. These are:

- activity must have a realistic economic and technical chance to be realised within a timeframe of max. 10 years;
- activity must be backed with customer demand
- activity must support customers of the port
- activity must enhance environmental performance
- activity must enhance role of biomass in the overall port performance
- activity must be in line with currently running or foreseeable activities in the port
- activity must incentivise modal shift to inland waterway / use inland waterway as logistics axis

- activity must offer an option to cooperate with/transfer to other ports along the Danube and outside the Danube region

Based on a group discussion, the following selection assessment was conducted, resulting in selecting project idea 1 as subject for the pre-feasibility study in ENERGY BARGE.

Table 1: Qualitative assessment and selection of project ideas.

Criteria	Option 1	Option 2	Option 3
Realisation chance within 10 years	*Positive*	*negative*	*Neutral to negative*
Customer demand	*existing*	*neutral*	*neutral*
Benefit for port customers	*beneficial*	*neutral*	*neutral*
Environmental performance	*neutral*	*beneficial*	*beneficial*
Role of biomass	*existing*	*existing*	existing
Conformity with other processes and projects	*neutral*	*neutral*	*neutral*
Modal shift incentive	*existing*	*neutral*	*neutral*
Cooperation and transfer option	*neutral*	*neutral*	*neutral*
Overall assessment	**1**	**3**	**2**

1.2 Description of technical, financial and legal capacity

The following section describes in more detail the technical, financial and legal capacity underlying the ownership and management of the port of Straubing-Sand in relation to its relevance for the planned project.

Technical capacity

3.7 million t goods are handled in the trimodal port (water, road, rail) per year on average. The majority thereof is still transshipped via road, as the modal split depicts.

The following development regarding cargo transshipment applies for the port of Straubing-Sand since 1996 (see table 2). 2017 marked a record year regarding waterside transshipment. 795 vessels were handled, two thirds of the waterside cargo was inbound traffic, one third outbound. As the port of Straubing-Sand's basin has been designed with a technical capacity of 500,000 t per anno, it becomes visible from these numbers that the port is running above its maximum bearing capacity, making a foresight development process towards potential expansion necessary.

Table 2: Cargo handled in the port of Straubing between 1996 and 2017 according to modes of transport and total (own statistics, 2017).

CARGO VOLUMES 1996 – 2017 (in tt)

Year	Water	Rail	Road	Total
1996	24	3		
1997	109	19		
1998	111	40		
1999	169	34		
2000	152	43		
2001	169	49		
2002	221	55		
2003	237	62		
2004	303	133		
2005	374	142		
2006	275	157	1.845	2.277
2007	282	135	2.138	2.555
2008	428	229	2.864	3.521
2009	493	253	2.465	3.211
2010	609	305	2.750	3.664
2011	637	343	2.754	3.734
2012	472	270	2.719	3.461
2013	486	256	2.674	3.416
2014	655	359	2.641	3.655
2015	539	322	2.910	3.771
2016	621	300	2.733	3.654
2017	795	338	2.876	4.009

The modal split for 2017 is depicted in Figure 7.

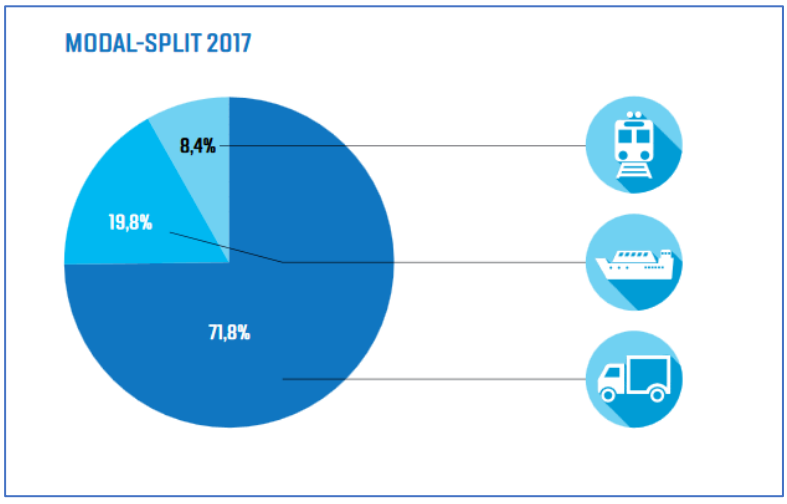

Figure 7: Modal split 2017 in the port of Straubing-Sand (own visualization, 2017).

In 2017, commodities from agriculture and forestry were the main type of goods handled, followed by chemical products. Other traded goods are food and beverages plus ores, stones, soils and other mining products. See Table 3table 3.

Table 3: Type and shares of of goods handled on waterside in 2017 (own statistics, 2017).

Type of Goods	Total (t)	Total (%)
Commodities from agriculture and forestry	590,970	69.3
Chemical products	88,943	11.2
Food and beverages	122,582	15.4
Ores, stones, soils and other mining products	25,256	3.2
Other goods	7,479	0.9
Total	795,250	100

Looking at the cargo types handled on waterside in Figure 8, it becomes apparent that there is a clear dominance of rape seed for the biodiesel production. This situation depicts a clear dependence of the port's performance on the ADM oil mill. This situation needs to be improved via a diversification strategy as will be described below and has to be one of the major focal points for the port of Straubing-Sand in the coming years. Clearly, Straubing focuses on the waterside and to increase a modal shift to water – not quite as other trimodal ports. However, the outlook for the ADM performance in Straubing is positive: the company has announced to invest heavily in its Straubing plant.

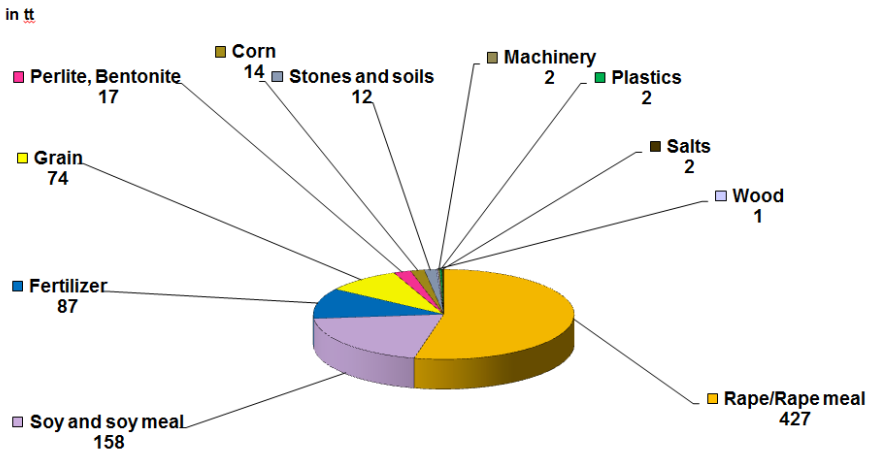

Figure 8: Cargo types transshiped on waterside in 2017 in thousand tons (own visualisation, 2017).

The Danube port Straubing-Sand has vast experience with the shipping of biomass and is specialized on this topic. This has led to an increase of water-side transshipment accruing around the year 2006 (Figure 9 and Figure 10). Especially compared to other Bavarian or German ports, an upward trend on waterside handling is visible. This development can be attributed to the increased biomass handling during the last years, with biomass accounting for the main proportions of waterside and rail-handling.

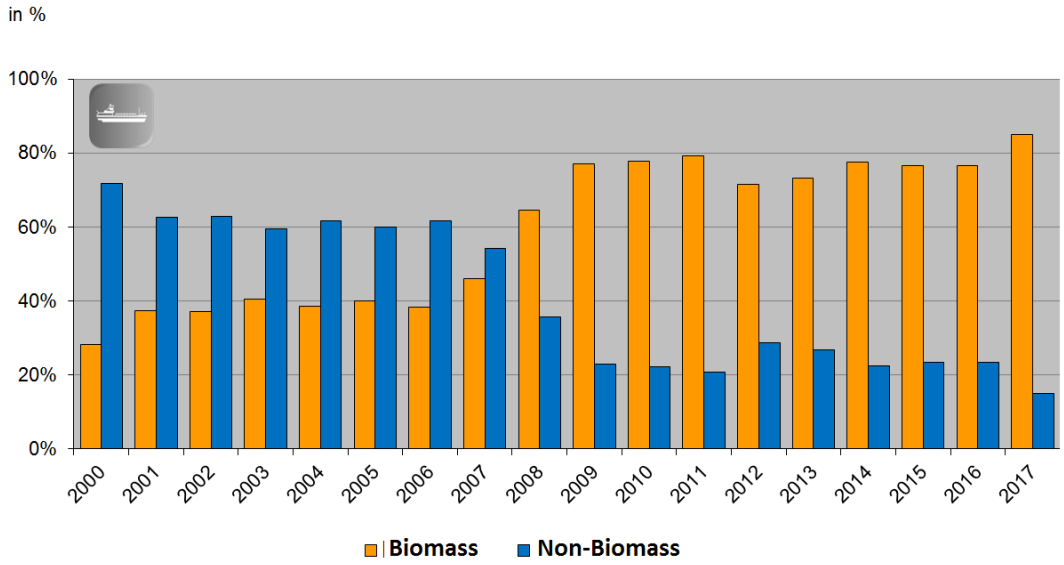

Figure 9: Share of biomass (orange) in total waterside transshipment (own visualisation, own data, 2018).

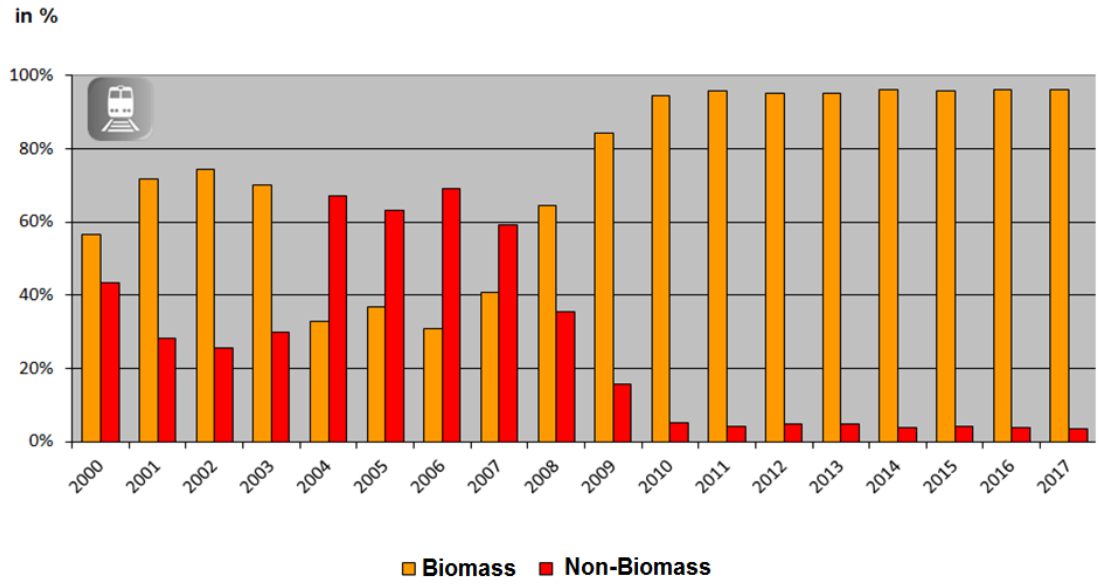

Figure 10: Share of biomass (orange) in total rail transshipment (own visualisation, own data, 2018).

Main infra- and superstructure

Regarding equipment and infrastructure, the port of Straubing-Sand disposes of comprehensive facilities for handling classic cargo goods. A visual overview is provided below in Figure 11.

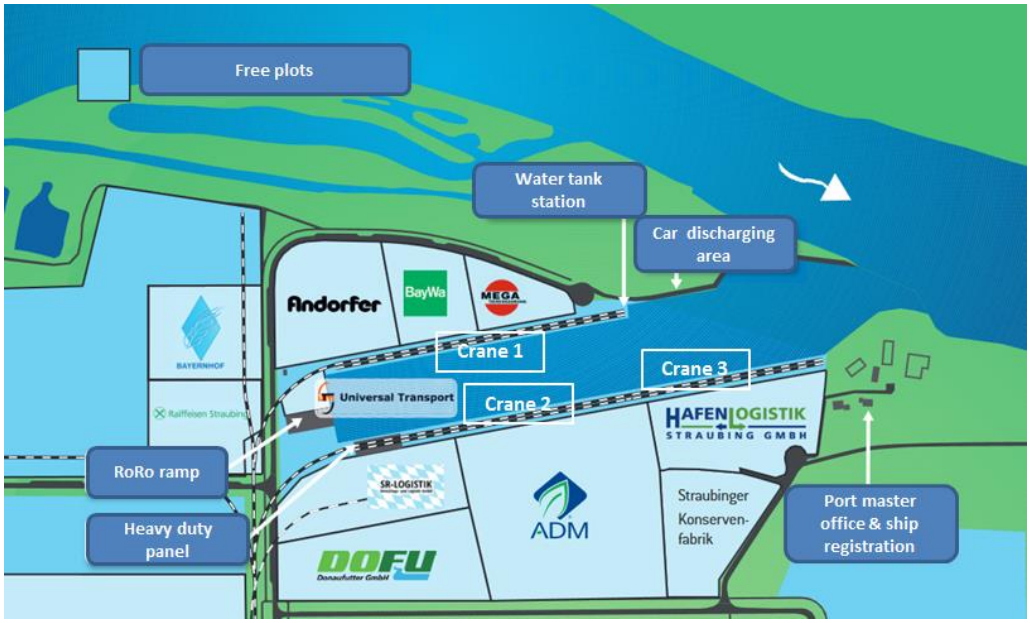

Figure 11: Overview of the port basin and major infrastructure (own visualisation, 2018).

The main infrastructural facilities as present in the port of Straubing currently are summarized in the following table.

Table 4: main port infrastructure and equipment in possession and operation of the ZVH (own data, 2018).

Facility	Description
Total area	220 ha, free: 42 ha
Port location	Danube-km 2313,3 right-hand side
Basin	Length 700 m, width 90 m, depth 9.9 m, entrance area 65 m wide
Quay	South quay 625 m, North quay 390 m, Roll-on/Roll-off ramp, heavy duty panel
General equipment	Power tanking stations, water tank station
Port capacity	500,000 t per anno waterside
Internal industrial railway track	2 loading tracks each on both quay sides with track switches, spanned by portal cranes; total legth of internal tracks: 5.3 km
Storage	No dedicated storage owned by port management itself, approx. 300 m^2 short-term open storage space without specific equipment available; all other storage options run and managed by private transshipment companies

Crane equipment	
Number	3 cranes, located at South quay west, South quay East and North quay
Type	Double jib level-luffing cranes on full-portal
Portal	Span: 11 m, height: 5.5 m
Discharge/ bearing capacity	Gripper and break bulk operation, 15 t between 8 – 15 m, 10 t at max. discharge of 27 m
Heavy duty operation	35 t between 8 – 15 m, 13 t at max. discharge of 27 m
Lifting hight hooks	18 m above quay top edge, 9 m below quay top edge
Gripper types	Numerous break bulk, polyp- and timber grippers

Most cargo-specific equipment such as silos, storage halls, other storage options such as boxes, conveyor belts, sucking devices, bobcats, forklifts, grain cleaning devices, etc. are owned and operated by the private transshipment companies listed above. They use the HSG's staff for crane operations according to their service contracts and pay the fees as listed above. A more detailed description of the storage facility situation and availability is provided in the project description.

Financial and legal capacity

The port of Straubing-Sand, including its trimodal logistics- and industry areas, is the result of an intercommunal collaboration in the region of Straubing. The district-free city of Straubing, the administrative district Straubing-Bogen and the municipality of Aiterhofen joined forces in the Administration Union port Straubing-Sand (Zweckverband Hafen Straubing-Sand ZVH) already in 1975 to build a new Danube port. Two thirds of the port area lies on the grounds of the city of Straubing and one third on the area of the community of Aiterhofen. In 1993, the development works for infrastructure and real estate began.

As the ZVH is landlord of the entire area, owns the port's infra- and superstructure, and its shareholders are the municipalities, a direct connection to the relevant authorities responsible for permitting procedures is established, making development processes more feasible to a certain extent. The ZVH's main regulatory body is its board, the so-called "Verbandsversammlung", which decides on major investments and management decisions as stipulated in the statute. The ZVH's three shareholders are represented in the board according to their share size, making the city of Straubing the biggest shareholder.

Based on this legal setup, the ZVH is allowed to plan, execute and operate new facilities in the port and the industrial park, given the board entitles its management to do so. The board also assigns the needed funds or decides on investment strategies, respectively. These have involved in the past investments funded by a combination of municipal funds, equity, credits/loans and public

funds by the Free State of Bavaria, depending on eligibility and availability of funding schemes. In case of projected increases in budgets, there is an option to finance these increases via so-called "Verbandsumlagen" or association levies, meaning increased contributions done by the shareholders.

The ZVH as main institution is funded by capital contributions from the shareholders. It has a balance sheet total of approx. 38 Mio. € including shareholders' equity of 5 Mio. €. With its legal status as a Zweckverband, it is not obligated to disclose its detailed financial data to the public.

The ZVH currently employs 12 employees (headcount). The HSG employs 10 employees (headcount). The BCG employs 3 employees (headcount).

Strategic capacity

The Danube port Straubing-Sand as mentioned above, brands itself as "Green Chemistry Port" in the vague of the development of a European bioeconomy. Straubing develops itself to a place of bio-based chemistry, because of its strengths in research and science, industrial conversion and biomass logistics. With its direct connection to the Rhine area, where the conventional chemical industry is located, Straubing could function as a connecting hub between the biomass-rich Danube region and the Rhine region, where conventional processes of the chemical sector are more and more focusing towards biobased feedstock (VCI Verband Chemischer Industrie, 2017). The port of Straubing-Sand works along this strategic route, however, the management is fully aware that this strategy is limited by nautical, economic and technical factors, amongst others.

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

1.3 Previous and current investments

As it is mentioned in chapter 2.2., the port is well-equipped. However, it is also running at and above maximum capacities and risks a dependence on only a hand full of key accounts regarding

the waterside handling (as described above). Therefore, due to its strategy to intensify biomass handling for energetic, material and chemical usage, to offer a broader portfolio addressing additional customers, and to prepare for future developments and market requirements, the ZVH has invested and is currently investing in a number of high-profile projects during the last years.

All projects aim towards improving the port's market position and performance, taking into consideration its strategy as an important building block in the region's profile as model region for the chemical-material and energetic use of renewable raw materials. It is important to note that this complex constellation of investment projects currently underway has a decisive impact on the maturity and depth of the investment project (storage for biomass) under review for this pre-feasibility study as this project needs to be integrated in the current developments which have been initiated before the ENERGY BARGE project was contracted. Mainly, the port development plan and the planning of a multipurpose demo-plant for industrial biotechnology based on biomass materials are of relevance in this respect. But also, the new port master's office which is currently being built plays a role as it significantly limits availability of potential sites for the development project.

Generally, the ZVH has a comparatively strong capacity to implement infrastructural projects. As a publicly held entity, is has a significantly lower entry barrier to public funding schemes. However, the current political and legal framework in Bavaria and on EU level (Block Exemption Regulations for State aid, GBER) are currently colliding in such a way that public financial support for maintenance works and superstructure investments is virtually impossible.

The most important investment projects recently finished or currently underway are listed in Table 5.

Table 5: Investment projects run by the ZVH in the port of Straubing-Sand (own data, 2018).

Investment project	Status	Funding
Container terminal	Planning phase; planning approval procedure	Co-funded, federal level (max. 80 %)
Port master's office	Construction phase	Minor co-funding (15 %), State-level
Major maintenance: Basin dredging (dregding step 1)	Completed in 2018; tendered to specialist firm with floating crane	No co-funding yet (ex post funding possible)
Basin dredging step 2 (context: Danube dredging)	Planned for 2019/20, funding procedure started	Co-funding, state-level
Port development plan	Preparation phase; tendered to engineering firm, delayed, finalization end of 2018	No co-funding, financed by own funds

Multipurpose demonstration plant for industrial biotechnology processes	Planning phase, notification at EU commission	GBER co-funding by the Free State of Bavaria, funding rate between 80-100 %

2. Analysis of the current situation

As described above, the port of Straubing has established a profile for both the transshipment of biomass cargo as well as for being a location and model region for the downstream processing of biobased material into added value products, both in chemical-material as well as energetic terms. This profile shall be further deepened, a number of strategic steps have been negotiated up to this point. One of these steps is the analysis of the technical, strategic and economic feasibility to establish additional storage facilities for biomass cargo which shall be undertaken in the course of the ENERGY BARGE project in order to prepare a potential large-scale investment beyond the project's life time.

Before the actual investment project, its objectives and framework are further investigated. An analysis of the current situation of the port of Straubing-Sand regarding its position along the biomass and bioenergy value chain, regional biomass potential and availability, technical conditions and restrictions and the site's strengths, weaknesses, opportunities and threats in this sector is provided below. As basis of the current situation's analysis, but also for the assessment of future requirements, expert discussions with relevant actors were conducted during a period of 2 months in January and February 2018, both in person and via phone. These are:

Port management:

- Managing director ZVH & HSG
- Port master
- Technical director ZVH

Logistics companies:

- Hafenlogistik Straubing GmbH
- SR Log GmbH /Reinsch

Current port clients / forwarding companies biomass:

- Plant manager ADM
- TTW Waldpflege, wood trader

Potential port clients biomass:

- INACO Service GmbH, interested in transporting > 100,000 t/a of undisclosed biomass residues to Straubing
- Bio Refinery Development BV, interested in transporting > 200,000 t/a round wood and/or wood chips to possible biorefinery project location
- Business development director Multipurpose Demoplant Straubing

Engineering companies involved in port development plan and multipurpose plant:

- Sehlhoff GmbH

As the development goal of the port is not only to facilitate biomass transport, but to also become a production and value creation hub, no specific focus on a certain type of biomass, but rather an encompassing overview, on the regional supply and demand situation with a focus on the industrial player active in the port, is given.

Prior to this, the following section briefly analyses the supply and demand situation for renewable raw materials on a German federal level. This way, a reference framework for the regional situation in Straubing can be created.

Looking at a federal level, in Germany, the utilization of agricultural land for industrial and energetic use is on a comparatively high level, however, the cultivation area in hectare is stagnating on this level, as the overview provided by the ENERGY BARGE lead partner Fachagentur Nachwachsende Rohstoffe (FNR), depicts clearly. The majority of these resources goes into the energetic utilization sector, mainly into the biogas and biofuels for transport sectors. Of the 16.7 Mio. ha of land in Germany used for agricultural purposes, only 16 % are used for material/industrial (2 %) and energetic (14 %) purposes (FNR, 2018a).

Table 6: Culitivation of renewable resource in the crops field (no forestry) (FNR; 2018a).

CULTIVATION OF RENEWABLE RESOURCES IN GERMANY 2015 – 2017 (IN HECTARES)

Plants	Feedstock	2015	2016*	2017**
Industrial crops	Industrial starch	108,000	128,000	128,000
	Industrial sugar	12,300	12,800	15,400
	Technical rapeseed oil	138,000	132,000	131,000
	Technical sunflower oil	7,100	7,740	7,740
	Technical linseed oil	3,500	3,500	3,500
	Plant fibres	1,490	1,520	1,520
	Plant-based drugs and dyes	12,000	12,000	12,000
	Industrial crops total	**283,000**	**298,000**	**300,000**
Energy crops	Rapeseed oil for biodiesel/vegetable oil	805,000	720,000	713,000
	Crops for bioethanol	238,000	259,000	251,000
	Crops for biogas	1,340,000	1,394,000	1,374,000
	Crops for solid fuels	11,000	11,000	11,000
	Energy crops total	**2,390,000**	**2,380,000**	**2,350,000**
Total acreage of renewable resources		**2,680,000**	**2,680,000**	**2,650,000**

Sources: FNR, BMEL (2018) *preliminary values **estimated values
Values rounded to significant digits, deviations in the sums result from rounding of the numbers © FNR 2018

Regarding wood, the main user sector with 52 % of the entirety of 132.4 Mio. m^3 of utilized wood was the energy sector on federal German level in 2015 (FNR, 2018b). The second largest sector is depicted by the saw mill industry (27 %), followed by wood used as a material (12 %), use by the pulp industry (8 %), and others (1 %). Innovative applications of wood and its components (cellulose, hemicellulose and lignin) can be located in the sectors of material use as well as chemical pulps.

The ENERGY BARGE country report for Germany has shown that the biggest unused domestic potential for bioenergy generation on federal level lies in forestry and agricultural residue

materials as well as in waste streams (cf. FNR, 2017, ENERGY BARGE deliverable 3.1.1.). The same feedstock materials can be used as input for chemical-material utilisation in innovative biorefinery processes.

2.1 Supply of biobased raw materials on regional level

The Danube port Straubing-Sand is in an excellent position for the supply of biobased raw materials. It is surrounded by two main natural/cultural areas: the Bavarian Forest and the Gäuboden. While the Bavarian Forest is a source of mainly coniferous wood, the Gäuboden is one of the most fertile agricultural areas in Germany. These areas are main suppliers for the Danube port Straubing-Sand and its agri-trading companies in terms of outbound logistics and for the producing companies in the port regarding their regional supply.

Figure 12: Bavarian Forest and Gäuboden (own visualisation, own map, 2015).

Bavarian Forest and wood supply

The area of the Bavarian Forest has a fundamental importance for the whole region. Together with the connected national park Šumava in the Czech Republic, it forms the biggest connected forest area in Central Europe (Bayerisches Landesamt für Umwelt (b); 2018). The Bavarian Forest itself has more than 480,000 ha land area.

Figure 13: Location of the Bavarian Forest (Bayerischer Wald, Germany) (Nationalpark Land; 2018).

67% of the Bavarian Forest's wood resources consist of coniferous trees. Spruces make three quarters of the coniferous trees and even an amount of 50.6% of the whole tree species (hard and coniferous trees summed up) (LWF (d); 2018).

The stock of wood in the Bavarian Forest accounts 26,598,782 m^3 deciduous trees and 76,339,575 m^3 coniferous trees (LWF (e); 2018). Between 2002 and 2012, the Free State of Bavaria had an annual increment of around 29.5 Mio m^3 wood. In this period Bavaria had the second highest increment compared to other German states. Compared to the last period, these increments have decreased (LWF (f); 2018). The Bavarian Forest had a total accretion from around 32.2 Mio m^3 wood during the years 2002 to 2012 (LWF (g); 2018).

The main users of wood in Bavaria are saw mills. One example is the large sawmill 'Holzwerke Weinzierl GmbH' in Vilshofen. The company only uses wood from Bavarian forests. Their product assortment contains wood pellets, construction timber, combustion timber, squared timber for packaging, laths, timber for shuttering and others and they use the Danube as transport route (Holzwerke Weinzierl; 2018).

Gäuboden

The Gäuboden is one of Europe's most fertile agricultural areas. In its length, it is located in the Danube valley between Regensburg and Vilshofen and thus has direct connection to the Danube (Bayerisches Landesamt für Umwelt (c); 2018). The territory is approx.. 15 km wide and is situated in the South of the Danube and the Bavarian Forest (Gemeinde Strasskirchen; 2018). The Gäuboden can be split in two sub-spaces. The Gäuboden landscape with Straubing as the urban center and simultaneously the biggest city in the whole Gäuboden area, and a river landscape with the Danube and the estuary of the Isar (Bayerisches Landesamt für Umwelt (c); 2018). The whole region is relatively sparsely populated (Gemeinde Strasskirchen; 2018). 80 to 90 % of the area is agriculturally used, mostly as arable land. There is almost no forest area. The Gäuboden is labelled as 'Granary of Bavaria', because the soils are one of the best in Bavaria and even Germany. Due to

the 6 m deep mineral-rich and good aerated loess soil it is very fertile and easy workable. (Bayerisches Landesamt für Umwelt (c); 2018).

The counties Deggendorf, Dingolfing-Landau, Regensburg, Straubing-Bogen as well as the cities Regensburg and Straubing belong to the Gäuboden. All of them have direct or proximate access to the Danube.

The three main cultivated crops in the region are sugar beets, potatoes and maize.

Other relevant crop types cultivated in the Gäuboden area are:

- Rape with an average of 40 dt/ha yield
- Energy crops including short rotation coppice, switch grass and miscanthus

All these crops are potential feedstock for bioenergy generation on regional level. Currently, the main processing industrial sites for sugar beets and potatoes are the Südzucker sugar plant in Plattling as well as the Südstärle starch plant in Sünching (Bayerischer Bauernverband; 2015).

Additional biomass supply sources are provided by biomass residue potential, both regarding primary residue availability as a direct result of agricultural and forestry practice (straw, wood chips from prunnings and thinnings) and regarding secondary residue materials resulting from industrial processes transforming biomass feedstock e.g. saw dust, rape meal,. It is hard to capture the exact availability of biobased residue material in the Gäuboden and Bavarian forest region, because there has not been a consistent comprehensive inventory executed. Especially for stakeholders like farmers and the processing industry, this knowledge would be of high usability. The utilization of residuals is getting progressively relevant and it is important to implement a reliable survey during the next years on Bavarian state level. A first attempt into this direction has been undertaken by the Bavarian expert panel for bioeconomy (Sachverständigenrat Bioökonomie Bayern, 2017).

2.2 Demand for biobased raw materials

There is a comparatively strong demand in the vicinity of the port of Straubing-Sand for biobased raw materials, both for energetic and material use. Mentioned below are the most important industrial actors in the region.

In the following the biomass-processing and/or trading companies settled directly in the Danube port Straubing-Sand are listed:

- ADM Spyck GmbH, plant Straubing processes oilseeds to produce plant oil (rapeseed and soy) that is further transported by rail to biodiesel plants in the Southwest of Germany. They are one of the main customers in the port
- The Bayernhof Erzeugergemeinschaften Vertriebs GmbH is a trade organisation for farmers.
- The BayWa AG works as a logistics service provider and an agricultural hub/trading company.
- The Clariant Produkte (Deutschland) GmbH is one of the world's leading companies in the range of specialty chemicals. They operate a demonstration plant in Straubing, where lignocellulosic residue material, mainly straw, is converted to cellulose-ethanol which is

primarily targeting the biofuels sector; in its demo-plant, it processes between 5,000 to 7,000 t of lignocellulose residue material annually.
- The DoFu Donaufutter GmbH produces animal feed for pigs, cattle and horses. As a result they have a high demand in grains, maize and other raw materials.
- The Mega Tierernährung GmbH & Co. KG produces animal feed for poultry and therefor also have a high demand in raw materials.
- The Raiffeisen Straubing GmbH distributes agricultural products and building materials. Furthermore it acts as a service provider in the transport sector and biomass logistics.

Additionally to those large-scale companies, in the following, biomass-related companies located in the BioCubator are mentioned. These companies currently work with small amounts of biomass due to their development stage. Also, they target the material use of biomass:

- The Biofibre GmbH develops bioplastic granulates which are strengthened with natural fibres such as wood fibres.
- CASCAT is a start-up in the range of industrial and synthetic biotechnology. Their concept is the production of basic and fine chemicals based on renewable raw materials via chemical and biological catalyst routes.

But also regional companies, not directly located in the port but in a radius vicinity of max. 100 km play an important role in the market of biomass products and therefor have a high demand in biomass:

- H. Hiendl GmbH & Co. KG, located in Bogen is a producer and service provider in the range of plastics technology. Apart from conventional polymers the company also uses plastics which are strengthened with natural fibres.
- Kelheim Fibres GmbH is a worldwide leading company. The company produces viscose fibres based on wood from a sustainable forestry. These fibres are used in the textile-, health- and technical area as well as for special papers.
- LEIPFINGER BADER produces bricks. Recently they invented a new innovation: a brick which is insulated with 100 % natural wood fibres (LEIPFINGER BADER Ziegelwerke, 2018).
- Südstärke GmbH operates two factories for potato starch in Bavaria. Next to starch, the plant also produces starch derivate and distributes by-products like potato protein, pulp, potato water and syrup

(If not marked otherwise, all information stems from the cluster partner index of the BioCampus website) (BioCampus Straubing GmbH, 2018).

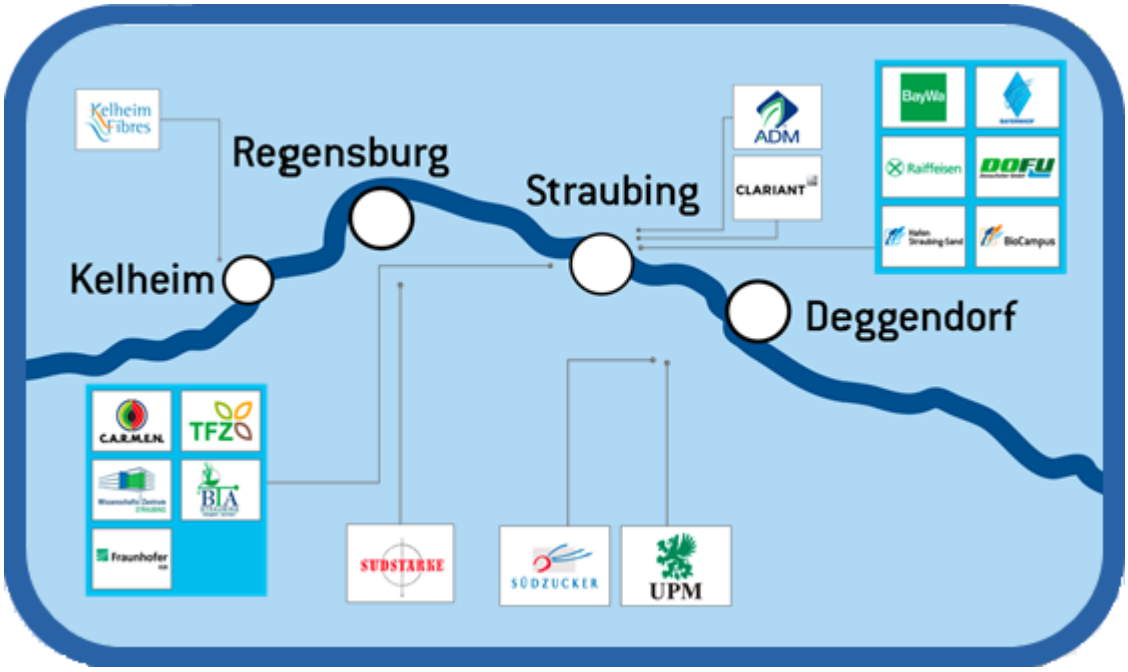

Figure 14: Main partners of the Renewable Raw Materials Cluster in the region (own visualization).

All companies mentioned above are partners in the Renewable Raw Materials cluster which is managed by the BioCampus Straubing GmbH. Its purpose is to promote cooperation and build networks. Potentials for innovation shall be recognized and used. Additionally research and development facilities are cluster partners.

As has become visible above, the port of Straubing-Sand is located in an area with an already sharp profile on biobased industries. This profile shall be extended in the near future as the major focus shall be on industrial applications using biomass for integrated energy and product generation. This is also the focus area of all port development procedures as only large volume feedstock streams are of particular relevance for inland water transport and thus a sustainable increase in waterside transshipment in the port of Straubing-Sand.

In order to provide a full picture, however, a brief indication of the bioenergy end-user market in the port vicinity shall be given here. The region itself was one of Germany's "bioenergy regions" for a project runtime of five years. In the surrounding region, there are numerous, especially decentral bioenergy appliances, e.g. biomass heating plants supplying villages and public buildings with heat and sometimes also electricity or biogas plants, as shown in the figure below.

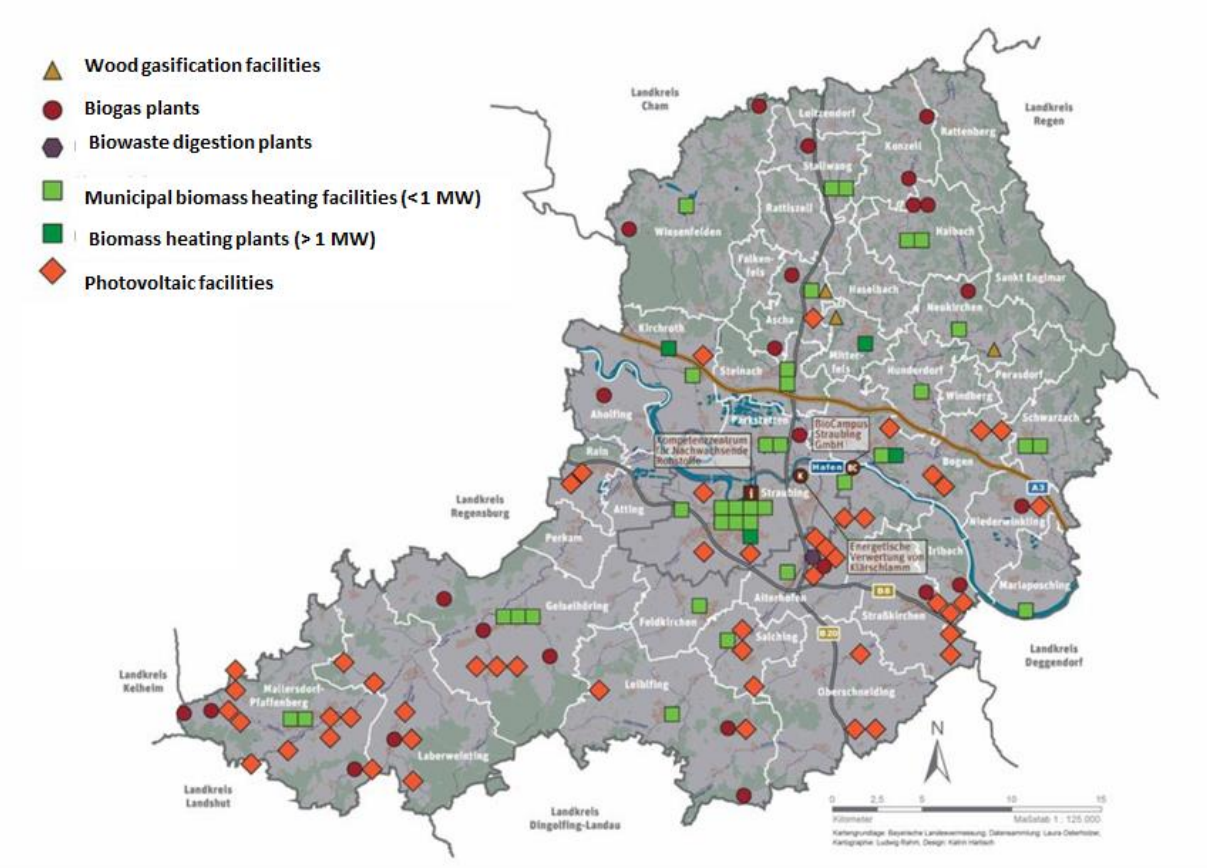

Figure 15: The different bioenergy appliances in the administrative district of Straubing, surrounding the port (Bioenergieregion Straubing-Bogen, 2015).

In the administrative district of Straubing-Bogen (99,000 inhabitants), there are 41 installed public biomass plants with an installed capacity of 12 MW and an electricity production of 75,200 MWh annually. 51% of electricity consumption of private households in the district originates from biomass installations (Energieatlas Bayern, 2016).

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

2.3 Existing value chains, industrial and logistics capacities for energy biomass

On a federal level, the bioeconomy as an industrial sector, embracing the energetic and industrial use of biobased materials in Germany, is expanding. According to numbers provided by the FNR, the bioeconomy-related sectors generated a total revenue of 196.9 Mio. € and employed over 1 Mio. people in 2014 (FNR, 2018b). With a strong agricultural and forestry industry, Bavaria accounts for a significant share of this performance (Sachverständigenrat Bioökonomie Bayern, 2017).

As has been shown above, the regional biomass availability and demand side surrounding the port of Straubing-Sand are well-established and favourable for the development of a functioning bioeconomy, both in terms of energetic and material use of biomass. Consequently, as has already been shown, there are functioning value chains established in and around the port of Straubing-Sand which rely on biomass as input material. These are depicted in an exemplifying manner in more detail below.

As a starting point for the existing value chains, Straubing is home to the most relevant Bavarian institutions regarding the production and use of biomass for energetic and industrial purposes and thus is labelled as "Region of Renewable Raw Materials". The Bavarian and private institutions located in Straubing are:

- TUM Campus SR: a campus of the Technical University of Munich specialized on biotechnology and sustainability. Students can acquire their Bachelor's degree in the study programmes: Chemical Biotechnology, Renewable Raw Materials and Technologically and Management-Oriented Business Administration (TUM CS (a); 2018). Master's degrees are possible in Biomass Technology and Renewable Raw Materials (TUM CS (b); 2018)
- Fraunhofer BioCat, affiliate group of the Fraunhofer IGB, focussing on research on biotechnology and bio- and chemo catalysis
- TFZ, the Technology and Support Centre which deals with research and project management for cultivation and usage of renewable raw materials
- C.A.R.M.E.N. e.V., the Bavarian marketing coordination agency for renewable raw materials and energy. They initiate new technologies and products and advise farmers and consumers over possible applications of biomass and biobased energy options
- Office of the Bavarian expert panel for Bioeconomy in Bavaria

On regional level, the BioCampus Straubing GmbH is responsible to transfer the services the above institutes offer to the relevant corporate and private actors in the region. The main tool for this transfer is the regional cluster "Renewable Raw Materials". The strong bond between industry and research & development institutions helps to directly transfer the knowledge to the existing processes in the value chains.

Existing value chains are based both on domestic biomass resources as well as on import and export of feedstock, depending on the scale of production of the relevant industry actors. In the cluster, big multinationals as well as small and medium-sized companies and start-ups are active. This includes the above-mentioned BayWa AG, Bayernhof Erzeugergemeinschaften Vertriebs GmbH, Raiffeisen Straubing GmbH and the TTW Waldpflege GmbH.

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

- ADM Spyck GmbH
    - Feedstock: Rape seed & soy intermediary product processed in port: Vegetable oil; residue material: meals for feed industry, final bioenergy product: biodiesel (processed in Southwest Germany); other final products: food & feed, technical lubricants, R&D for vegetable oil utilization; currently using the port in a trimodal manner; import almost entirely via Danube

- Clariant Produkte Deutschland GmbH

- Feedstock: lignocellulosic agricultural residue material, mainly straw, however in demonstration scope (2,000 t of product p.a.); final bioenergy product: bioethanol for blends in biofuels; can also be used as platform chemical for chemical industry

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

- BayWa AG trading centre; mainly trade, also bioenergy market (e.g. receiving maize slop as residue material from Hungarian biogas plants via ship for further trading into feed industry, e.g. for the production plant of the DoFu animal feed plant located in the port of Straubing-Sand)
- Bayernhof Erzeugergemeinschaften Vertriebs GmbH, mainly agricultural trade
- The Raiffeisen Straubing GmbH, mainly agricultural trade
- TTW Waldpflege GmbH, Service provider for forest owners with an own branch for energy wood products such as chips and pellets; occasional use of inland waterway transport to ship round wood from Straubing to Austrian saw mills (Enns)

The logistics needed by the industrial processing industries are provided by a number of transshipment companies settled in the port. These are (ZVH, 2018):

- Andorfer Sebastian GmbH & Co. KG, a cargo handling and processing company with storage options, focused on metals
- Hafenlogistik Straubing GmbH, a service provider in the range of port logistics with a hall for the storage of bulk cargo, two storage boxes, an underground bunker, 6 loading silos and an extensive outdoor storage area
- Reinsch Fulfillment GmbH, a logistics centre
- SR-Logistik Umschlags- und Logistik GmbH, a port logistics service provider with storage area next to the quay
- Universal Transport Ivanica GmbH, a port logistics service provider with outdoor storage area, specialised on heavy haulage

These are only the already existing value chains. However, market demand for promising future value chains with a realistic development option in the port of Straubing-Sand is increasing, forming the basis for an assessment of feasibility in future port enhancement investments. A more detailed analysis of these issues is provided in chapter 0.

2.4 Currently available infrastructure at the port, technical conditions

The general infrastructure of the port as owned by HSG and ZVH including existing equipment and technical conditions has been outlined in chapter 2.2.

In this sub-chapter, a focus is put on the available infrastructure equipped for biomass handling, transshipment and storage.

Port management

As pointed out before, biomass materials, currently mainly dry bulk goods as rape and soy as well as other grains, are a regular cargo transshipped in the port of Straubing-Sand. The HSG staff operates the three cranes to load and unload the barges. There are specific bulk good and wood grippers available which facilitate the handling of dry bulk biomass and also log wood, two of which have been newly acquired five years ago. With this equipment, any type of biomass can be dealt with. In the last 10 years, the share of round wood handled in the port of Straubing-Sand has decreased significantly, due to the installation of a big saw mill in Ingolstadt / Kösching established by the Binder Corporation. Since then, the log wood stream from the Bavarian forest to Austrian saw mills facilitated via the Danube in the past (e.g. in 2005: 112,000 t/a transshipment in the port of Straubing-Sand) has experienced a shift towards Ingolstadt, a route which is facilitated via road and truck transport. Moreover, the quay area has been built on quite extensively in the last ten years, decreasing open space for intermediary storage of log wood. Therefore, round wood currently has a rather limited share (2017: 1,000 t). Requests both for outbound and inbound transshipment of log wood are increasing again but cannot be served due to limited open space storage.

Due to the high amount of biomass handling, the port is equipped with the most frequently needed equipment. Nevertheless, according to the port master, there would always be a certain need to upgrade and increase the technical equipment and facilities – especially with regard to modernization and more efficient equipment. In the light of the port development plan, the acquisition of at least one new gantry crane and one mobile crane are considered.

The port management itself does currently not offer extensive and versatile storage options for biomass products (e.g. warehouses, silos, covered areas). There is limited open space with concrete ground to prevent influx to the ground water or humidity from the soil to the stored goods (300 m^2), see an example of round wood storage in Figure 16: Southern quay, H&H handling with mobile crane in the front, log wood storage in the background

Figure 16: Southern quay, H&H handling with mobile crane in the front, log wood storage in the background (ZVH, 2014).

The planned multipurpose demonstration plant for biotechnological processes based on biomass will be built approx. 1 km away from the port basin, on the physical BioCampus. At the moment, the construction has not begun yet and is scheduled for the end of 2019, the earliest. Surrounding the planned plot, there is an area of 5.6 ha freely available for additional storage space development, but no preparatory works have been done.

Private transshipment companies

The private transshipment companies listed above own and operate all specialized handling equipment needed for their processes and not provided by the port management. This includes:

- bobcats
- fork lifts
- conveyor belts
- vacuum sucking devices
- hoppers
- grain cleaning facilities

Based on the discussions with the port master and managers of the private transshipment companies SR Logistik GmbH and Reinsch/SR Log as well as the plant manager of the processor ADM, the majority of product-specific storage capacities currently are provided by the private transhipments companies located in the port. These capacities are solely utilized by these companies for their corporate purposes.

The total storage capacity of all settled companies sums up to 60,000 t.

The storage facilities are product-specific and include:

- uncovered storage areas
- storage boxes
- dry bulk storage halls
- fixed silo facilities
- underground bunker
- mobile silos

Spatial situation: limited availability

In the discussions with involved expert stakeholders (see page 28), it became apparent that both the port management of the HSG and the settled companies currently work at the edge of available capacities, limitations stem mostly from lacking availability of expansion space. As can be seen in the aerial view image below as well as in Figure 11, the entire quay is built in, the companies do not own additional unbuilt land for new developments (exception: DoFu feed plant). This situation applies for all kinds of development projects, irrespective of the objective and is mainly caused by the restricted access to the quay and basin. Three plots could be connected via conveyor belts or pipelines, but can only be sold or rented in their entirety (47,000 m^2, 29,000 m^2, 30,000 m^2), meaning that they are not suitable for settling companies for small- to medium-scale expansion.

Figure 17: Areal view of port basin with parcels of settlers, available plots marked red (own visualization, adapted from Bayernatlas, 2018).

Moreover, as has been described above, the port basin and transshipment on waterside run beyond maximum capacity. Port expansion measures including construction of a new basin requires a planning and realization horizon of approximately 20 years, including acquisition of land, technological and engineering solutions, funding and permission-related aspects as well as concepts for sustainable solutions. However, actions have to be taken now in order to avoid losing business. Therefore, in order to assess measures to improve the situation in the short- to medium-term (2-10 years), a port development plan has been tendered and contracted to an engineering company (Sehlhoff). The objectives of this plan are twofold and pose the question „how does tomorrow's port look like?". Firstly, the plan aims at exploring the potential market development for inland waterway navigation and most relevant cargo types with a focus on modal shift options and a time horizon of 10 to 20 years. Secondly, on a technical basis, the development plan shall provide an assessment of the future viability of the port's infrastructure and equipment as currently available. Additionally, it shall be analysed which conditions have to be created in terms of additional berths, rail tracks facilities and conveyor and storage systems, how they could be created under given spatial restrictions and which costs would accrue in which timeframe. Figure 18 shows potential additional berths as have been proposed by the engineering company.

Figure 18: Potential additional berths, marked in orange, blue: future container terminal (own Visualization, ZVH, 2018).

The results of the development plan's work packages are not available at the time of compilation of this study. Therefore, the results of this pre-feasiblity study will be fed into the development plan in order to ensure that storage option issues will be taken into consideration.

3. Development issues

As described above, the port of Straubing-Sand currently stands at a strategic and infrastructural crossroads. Given the positive market develops in recent years and the business development endeavours to settle new biomass-processing companies materialized (also in the context of the multipurpose demo-plant, which shall have an aimed-for pull-effect for attracting further companies), the port will have to be expanded. As a first step, a port development plan analysing short- to medium-term expansion measures to serve medium-term demands can be considered before a comprehensive port expansion with approx. 20 year planning horizon.

In this context, the development needs the port of Straubing-Sand is confronted with, extend beyond the scope of this ENERGY BARGE pre-feasibility study. However, there is currently a set of known projects and developments which shape the future requirements for investment projects in the port of Straubing-Sand and have a realization window of 1 to 5 years. These projects all pertain to biomass and bioenergy -related business and therefore have implications for this study. The developments and their requirements are presented below and possible options for solutions are deduced. The aim is making these biomass-related requirements visible in a broader context and assess possible solutions, specifically how they feed into the greater port development plan and expansion investments.

3.1 Analysis of future requirements and demand

Due to the situation described in the previous section, the following analysis only focuses on future requirements the port of Straubing-Sand faces with respect to currently known bottlenecks and requirements in the context of storage options for biomass feedstock.

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

Based on current market outlooks for the biobased economy, specific types of biobased materials might become increasingly interesting for both processing and trading companies, for example hard and soft wood, wood residue material, lignocellulosic residues or agri-crops such as sugar beet or thick juice. These biomass types can be used in large volumes in biorefineries and cascading processes for production of bioenergy and biobased products once investment decisions pick up (biofuelsdigest.com, 2017; Dammer et al., 2017).

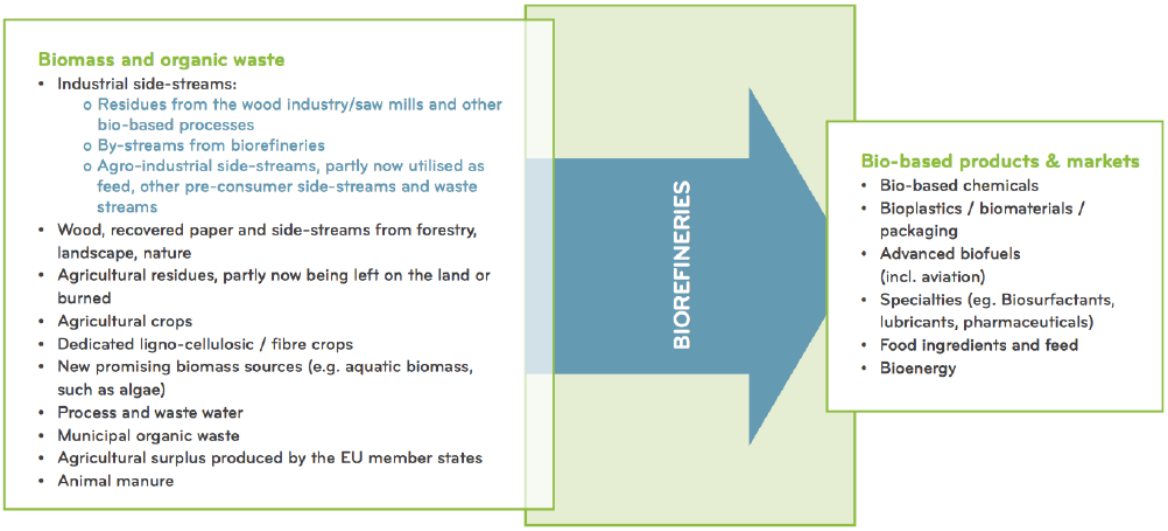

Figure 19:Biobased-value chains in biorefnieries (nova institute, 2017, p.170).

Political agendas on EU, German and Bavarian level also support the development towards a biobased economy both in terms of energy and material use. They support it with extensive funding programmes such as the Private Public Partnership „Biobased Industries Consortium" (BIC, 2018) or the call for proposals „Innovation rooms bioeconomy" by the German Ministry for Education and Research (PTJ, 2018) as well as by the Bavarian bioeconomy strategy.

The expert interview for this study support this outlook, as can be seen in the following list of indicators which have materialized at the port of Straubing-Sand since 2016 (Table 9).

Table 7: Future demand for biomass logistics in the port of Straubing-Sand (own data, 2018).

Indicators for increased demand	Manifestation of demand in Port of Straubing
Concrete requests of potential settlers for sites and logistics options (supply of feedstock)	Company looking for investment site for production plant /w >100,000 t of sugar-base d biomass input per year
	Company looking for investment site for biorefinery plant /w >150,000 t of lignocellulosic biomass input per year with need for buffer storage (1-3 weeks)
	Company/project looking for investment site for biorefinery plant /w >400,000 t of lignocellulosic biomass input per year with need for storage
	Company looking for investment site for bioenergy generation /w >100,000 t of residue biomass input per year with need for storage
Project development for open access multi-purpose demo-plant for industrial biotech processes based on biomass feedstocks at the industrial park of the port of Straubing-Sand	Unclear input volumes, but max. 5,000 t/a; necessity to store a set of different biomass feedstock types both dry bulk and liquid bulk, however in limited volumes; potentially inbound via road; pull-function for additional settlers assumed
ADM as key account for waterside transhipment to expand its portfolio towards soy	Potential for additional dry bulk on waterside
Concrete interest of settled traders to increase use of IWT	Company looking for outbound shipping of log wood on a regular basis (undisclosed quantities)
Private transshipment companies settled in the port with confident outlook for development of agri- and forestry cargo	Transshipment companies have limited spatial options to respond to increases in volumes of cargo to be transshiped and stored

The set of these requests indicates a clear rising demand for industrial sites for bioeconomy projects which require a suitable site portfolio including logistics infrastructure and storage, competitive feedstock availability, utilities in place such as steam, as well as favorable and attractive living conditions. This in turn corroborates the assumed additional demand of trading, transhipping and processing companies, including already settled ones and companies, which are interested in settling. They are asking for versatile options for short and medium term storage of biomass cargo, both inbound and outbound.

Clearly, a dedicated market study on market demand for biobased feedstock and related logistics has to be conducted. Furthermore, the specific needs related to the requests addressed to the port of Straubing-Sand have to be further clarified (volumes of storage, duration of storage, willingness to pay, etc.). However, none of the potential customers were willing to disclose more concrete data at this point.

3.2 New technological solutions foreseen

As laid out above, the port management itself does currently not offer any considerable specific storage areas for different kinds of goods. There is some space available for short-term open storage directly at the quays (approx. 300 m^2 in total) with solid, concrete ground. Based on the needs addressed, new storage solutions for biomass need to be assessed according to their feasibility.

Storing biomass is often necessary due to its seasonality, while production processes for energetic or material use are continuous processes. Therefore to provide a constant and regular supply of feedstock for plants requires either storage or multi-feedstocks to be used, both of which tend to add cost to the system. Reducing the cost of handling and stable storage of biomass feedstocks are both critical to developing a sustainable supply of large quantities of biomass to biomass processing plants (Zafar, 2017).

There are numerous technological options for biomass storage on the market. The general suitability of a specific storage system depends on a number of factors which have to match the demand and the properties of the biomass to be stored. These factors include:

- Utilisation method of the biomass:
  - Process / utilisation path uses mixture of different types of biomass
  - Process / utilisation path uses pure biomass/single biomass type
  - Processes utilising moist biomass, e.g. anaerobic digestion or fermentation
  - Processes utilising dry biomass / biomass with low moisture content
  - Input of stored biomass into one single utilisation
  - Input of stored biomass into several types of utilisation
  - Decentral process, small to medium amount of feedstock needed
  - Central process, large-scale plants, high amounts processed

- Type of biomass:
  - Weight, density and volume
  - Size
  - Moisture content
  - Break bulk, dry bulk, liquid bulk
  - Packaging, e.g. in big bags, bundles/bales, tanks or containers
  - Seasonality

- Logistics:
  - Utilisation frequency and logic (first in – first out, last in – first out, etc.)
  - Minimum and maximum storage duration
  - Modes of transport used for delivery to and from storage
  - Modes of loading and unloading storage facility
  - Number of users
  - Costs of storage accepted

The general necessity of biomass feedstock storage depends on the type and logic of utilization. Classical storage locations are either the site of production of the feedstock (e.g. field, forest), intermediate sites, e.g. collection centres, or the processing plant/site itself. For agricultural and forestry biomass in conventional utilization, e.g. in biomass power plants or sugar factories, the following storing options are most commonly known (Zafar, 2017):

- Feedstock is hauled directly to the plant with no storage at the production site (i.e. field) – *just in time*
- Feedstock is stored at the production site (e.g. field) and transported to the plant on needs basis

- Feedstock is stored at a collective intermediate storage facility and then transported to the plant from there

Large-scale production plants, e.g. vegetable oil mills or biorefineries, storage directly at the plant site allowing for buffers is common – either with own storage options such as silos or the trader has to take care of the intermediate short-term storage.

Solutions practicable for port of Straubing-Sand

Out of these, based on the needs described above, the general options most relevant for the Straubing port location are:

- Storage at intermediate storage facility and transport to location of utilization from there (e.g. pre- or post-haulage for transport on water)
- Buffer storage for large-scale production plants

Based on the needs assessment above, solutions addressing these needs would be:

1) Versatile feedstock-specific storage including storage boxes, halls, bunkers, silos, and tanks for agricultural and forestry bulk and liquid bulk, operated by port management itself or rented to settled private transshipment companies directly at the quay to facilitate vessel loading and unloading

2) Extension to short-term on-site storage next to quay serving the buffer storage needs of potential settlers (mobile cover, solid ground) only for specific open-air storage feedstock, esp. log wood and lignocellulosic residue material coverable with tarps, additional limited wood chips storage option possible (feedstock request: lignocellulosic material), operated by port management itself and made available to private transshipment companies and trading / processing companies

3) Facility-specific storage only for demonstration plant (wood chips, log wood, residue material, thick juice and molasses, big bags refined sugar), operated by demonstration plant, next to plant

Option 1 cannot be realised to meet the needs addressed above due to both business-model related and technical reasons. Firstly, when introducing this option to the port's managing director, it was clearly stated that entering the classical storage business for a number of different biomass types is not foreseen in the port management's business model, mainly because this kind of business is served by the transshipment companies such as SR Log or Hafenlogistik Staubing GmbH. Also, warehousing is being served by BayWa, Bayernhof and Raiffeisen. If they wish to extend their capacities, they will have to acquire or heritage rent the available plots in their entirety. Moreover, the port management and ZVH themselves do not dispose of enough free quay area for realization of such a large-scale facility at the moment (approx. 25,000 t storage capacity, 5,000 m^2). This situation will also not improve with the mid-term expansion of the South quay as currently under study in the port development plan but only when a second basin is being planned.

Option 3, the facility specific storage, will definitely be needed in the vague of the construction of the multi-purpose demo-plant, as has been the result of a market demand study compiled for this

project. An extra storage hall with partitions for different feedstock of multiple clients as well as operating materials is required. The VTU engineering is estimating the construction costs to be 50,000 € (status: rough cost estimate), however, it is not including this storage hall in the overall construction cost estimation it has conducted as this is a design-to-budget project based on public funding with a max. of 20 Mio € which has been exceeded already with the basic process engineering. Therefore, the storage hall has been deleted from the planning with the intention to add it at a later stage. However, as this storage will only be needed for small-scale amounts of feedstock since the plant has demo-character (delivery via road) and does not produce continuously and secondly, it will only be usable for clients of the plant, it will not add to a modal shift from road to water and thus has no decisive impact for the goals of ENERGY BARGE.

Based on this, the preferred solution for this study is **option 2**, short-term / intermediary open air storage at the new South quay expansion, the size and features of which being limited by the space available there. This storage solution can facilitate both loading and unloading logistics of log wood transshipment to serve customer requests better than currently possible as well as serve as buffer storage for log wood and woody residue material for potential large-scale biorefinery plants, creating a site advantage currently not existing at the port of Straubing-Sand and thus limiting options for business. Options for mobile fencing and coverage via tarps as well as a silo bunker with mobile cover and walls and fit for access via trucks and bobcats for buffer storage of wood chips to be rented to clients (processing industry/biorefineries as well as logistics companies) shall be available.

The condition for realization is that the port development plan suggests economic and technical feasibility for the expansion of the South quay. Therefore, at this stage, the preliminary feasibility of this storage option has to be termed as premature.

Depending on the utilization path, log wood needs to be stored in a way the quality is not diminished. For this, it either has to be ensured that the moisture content stays very high or that the wood dries up quickly below the fibre saturation point. Log wood storage can thus be divided into two main categories and sub-categories with different costs and advantages and disadvantages depending on the utilization (Waldbesitzervereinigung Frankenwald, 2001):

- Dry storage (see Figure 20):
  - stacks with bark (all wood types, 1-2 €/solid cubic meter)
  - stacks without bark (only coniferous wood, 4 -8 €/solid cubic meter)
  - pre-dried log wood (only coniferous wood, 7 – 15 €/solid cubic meter)
- Wet storage (see **Fehler! Verweisquelle konnte nicht gefunden werden.**):
  - Sprinkling storage (all wood types, 12 – 25 €/solid cubic meter)
  - Floating storage (all wood types, 5 – 15 €/solid cubic meter)

Wet storage is mainly used for large wood quantities and long-term storage. It requires water authority permits. It is often used at saw mills which require a high quality of their wood. Therefore, this storage solution is not of relevance for the project at the port of Straubing-Sand as only short-term and buffer storage of max. 2 weeks is assumed and thus it can be ruled out.

For the purposes of facilitating business of sending and receiving log wood on waterside and offering short-term buffer storage for processing plants, the dry storage option therefore is theoretically suitable. This storage solution does not require sophisticated technological

preconditions. Decisive factors are multimodal and crane accessibility as well as proximity to the quay. Open storage solutions also should include security features such as an option for mobile fencing and tarps in case of more valuable and easy-to-move or contaminable pest-prone goods are stored. An example of how open storage at quays function is given in the picture below which shows the port of Wismar in Northern Germany.

Figure 20: Log wood short-term storage at the quay at the port of Wismar (Hafen Wismar, 2018).

An additional attractive storage solution would be an option to buffer-store wood chips, especially for the biorefinery clients which either chip on site or buy the wood chips as their feedstock needs to be chipped for their processes.

For both energetic and material utilization of wood chips, it is of utmost importance to ensure avoidance of moisture influx but sufficient ventilation at the same time. The maximum storage duration of 3 months should not be exceeded (Bayerische Staatsforsten, 2017). Interesting solutions here are covered underground bunkers or bunker silos with walls and concrete ground plate, as seen below, here with mobile covers. These solutions are examples from the company Blommaert which can be a potential supplier of such solutions.

Figure 21: Underground bunker and walled bunker with covered roofs for wood chips storage (Blommaert Aluminium Constructions, 2018).

However, wood chips, especially if only for a brief period of time, can also be stored open-air with a tarp or fleece cover. For outside storage, due to the self-inflammable character of wood chips, not more than 3,000 m^3 may be stored and must have a distance of min. 10 m to the next building. Areas of open air storage should be sun- and wind-exposed as well as dry (TFZ, 2017).

3.3 SWOT analysis on biomass logistics

In the following table, an assessment the current and future performance of biomass logistics in the port of Straubing-Sand with a focus on wood and woody biomass residues is provided.

Table 8: SWOT analysis biomass logistics port of Straubing-Sand.

Strengths	Weaknesses
• Good external transport connections: motorways A3, A92, B20; Airports (own regional airport and Munich international airport reachable in about 1 hour), railway connections (connection to the railway net of the Deutsche Bahn); 5.3 km of own industrial rail tracks • Trimodal port (water, road, rail) • Strong producing industrial cluster settled directly in the port, including big players from the biomass and bioenergy sector • 80% of waterside and 95% of rail transshipment already biomass cargo • Most common technical equipment for handling biomass is available • Proactive strategies to encourage modal shift to inland waterway transport in place • Proactive strategies and staff to establish port and surrounding region as model region for energetic and material utilisation and valorisation of biomass ("Straubing – region of renewable raw materials") including strong corporate network • Surrounding area with strong agricultural and forestry-sectors (Bavarian Forest and Gäuboden), providing a base for feedstock for energetic and material utilization of biomass as well as potential for export • Several experienced logistic providers located in the port offer logistics and handling services for all kinds of biomass intermediaries and products	• On the Danube section Straubing-Vilshofen: low-water periods can negatively affect navigability • The port management itself does currently not offer extensive and versatile storage options for biomass products (warehouses, silos, roofed areas) • Waterside transshipment runs beyond maximum capacity • Private transshipment companies in the port are limited regarding spatial expansion • Heterogeneous forest owner structure (many owners with small forest area) complicates wood trading and utilization
Opportunities	**Threats**
• In case an industrial use of fossil fuels to renewable resources as basis for economy (bioeconomy) takes place in the previous years, demand for biomass (especially wood and woody residues) from industry side and industrial willingness to invest will increase; not only in the bioenergy sector but especially in the chemical-	• Regensburg can be a competitor with its well-equipped port • Availability of free industrial plots is limited, new land acquisition must take place

material utilization; demand rise is expected an can positively affect the development of ports such as Straubing which are using this sector already as a yardstick for their business development strategy • Expansion of wood-based bioeconomy (energetic and material use) along the Danube might develop additional export options for wood from Bavarian Forest and new markets for IWT • Currently planned production capacities for soy crushing at ADM side poses opportunities for higher IWT imports of Danube soy • Plans to build an open access multi purpose demo-plant for industrial biotechnology processes to develop new biofuels and biomaterials in the port area might further attract biomass-processing companies to Straubing	• Permitting procedures for extensive port expansion measures might take longer than expected, delaying capacity-upgrade of the port • In case bioeconomy development picks up pace and port of Straubing-Sand is not able to expand performance and capacity in time, site advantages might vanish • In case of increased discussion about ''food or fuel'' and similar discussions, farmers might not be willing any longer to increase their share of biomass supply for non-food purposes such as bioenergy or bioeconomy as a whole • Especially bioenergy demand side might face significant threats due to U-turns in EU and German bioenergy policy

4. Project description

Above, the most suitable solution for new storage solutions from a demand side has been deduced. It has also been analysed that any investment project in additional biomass storage options supporting loading and unloading to/from vessels depends on a previous extension of the South quay which in turn depends on the results and recommendations of the port development plan and a subsequent realization of the quay extension project. The planning, construction and operation of the open-air storage solution then could and should be integrated in the planning, investment, realisation and operation of the additional quay area.

Below, the premature investment project for the biomass storage is described in more detail.

4.1 Aims of the development

Overall, as described above, the main aim of the development project under review is to improve the port's overall attractiveness in terms of services and infra/superstructure provided. The port shall be equally appealing to currently existing clients from the biomass and bioenergy value chains (suppliers, traders, logistics service providers, processors, end users) as well as function as a site advantage for project developers/investors looking for a new site for a biorefinery project or a logistics option for shipping biomass on the Danube.

This main aim can be specified as follows into a set of sub-objectives:

- Serving currently unmet demand of current and potential clients with additional service offers in a restricted manner in the short to medium-term as long as greater port expansion has not taken place

- Providing input for the greater port development plan
- Widening the currently restricted client and cargo portfolio towards wood-based supply- and value chains
- Re-attracting wood-based cargo into the port
- Encouraging a modal shift in favour of IWT
- Further improving the port's and region's profile as a model region for the energetic and material use of biomass and the branding of the port as Green Energy and Chemistry Port
- Establishing a broader set of infra- and super-structural site advantages in the competition for bioeconomy investment projects

4.2 Definition of development needs

The analysis above has shown that developing additional storage areas for woody biomass at this stage mainly serves as an intermediary solution to serve existing demands for wood transshipment and to cater potential new settlers looking for buffer storage solutions for their large-scale wood-based biorefinery projects.

The final scope and size of the additional storage will be significantly determined at this stage by limited available space at the quay. The realization timeframe depends on the actual final decision of expanding the South quay. If the South quay is being built, the additional storage area can be available in 5 years the earliest. A more versatile storage service portfolio can be planned and integrated given the greater port expansion project for a second basin and surrounding terminal area is being followed up on.

The following needs have to be addressed by the development project based on the demand analysis:

- Suitability for storage of both log wood and residue material & wood chips
- Location at quay to facilitate loading and unloading of vessels
- Accessibility by road and rail for multimodal transshipment
- Availability of mobile coverage solutions
- Space for at least one vessel load equalling approx. 1,000 t of wood chips
- 100 m^2 space for at least one vessel load of round wood, approx. 1,000 t (equal to solid cubic meters depending wood type) (Bayerische Staatsforsten, 2017)
- Accessibility/Usability for multiple users
- Availability of suitable handling equipment

4.3 Definition of planned products/services

If realized, the development project shall offer a set of services.

These are:

- Short-term open air storage of log wood between pre- /post-haulage and shipping (max. 1 week)
- Short-term tarp-covered storage of log wood

- Buffer storage of log wood (max. 3 weeks), optional coverage
- Short-term open-air storage of wood-chips (max. 2 weeks)
- Short-term tarp- or fleece-covered storage of wood chips
- Storage in walled bunker with mobile cover for wood chips
- Optional: Security add-on via mobile fencing system
- Stack securing services
- Maintenance and cleaning works of storage area

4.4 Target group/stakeholders

As described above, a number of different actors have expressed storage need for lignocellulosic material, mainly log wood and wood chips. These actors are the potential customers of the storage area and thus can be described as primary target group.

Generally speaking, the following sub-customer groups can be identified – these can be both SMEs as well as larger enterprises in the field of biobased industries and bioenergy as defined by the project:

- Private transshipment and logistics companies (transport, handling, storage) commissioning for their clients
- Wood suppliers
- Wood traders
- Wood processors
- Wood end users

It does not make a difference which transport mode is used for the biomass to reach the storage site.

A set of existing and potential clients with interest to make use of the storage area / rent it that can be disclosed includes:

- TTW Waldpflege GmbH
- INACO Services GmbH
- SR Log GmbH / Reinsch
- Hafenlogistik Straubing GmbH
- BioRefinery Development
- Management Multipurpose Demo-Plant for Biotech Processes

Besides the main target group, being the customers, a set of additional stakeholders needs to be identified, considered and involved at specific stages of the potential project development.

All other logistics service providers settled in the port of Straubing-Sand which are currently not active in wood logistics and transport have to be considered as well since they might enter into this business segment once suitable infrastructure is available. Therefore, these actors also need to be included in a deeper market demand analysis. They depict the group of SMEs and enterprises from the Danube logistics sector.

Additionally, the Zweckverband Hafen Straubing-Sand as well as its port management entity, the HSG, which will potentially be the operator of the storage area function as stakeholders. Therefore, also their shareholders, namely the municipalities of Straubing and Straubing-Bogen as well as Aiterhofen have to be accounted for. They also take the role of permitting authorities,

making them considerably important. These institutions represent the stakeholder group of regional public authorities and policy makers.

Since there might be a chance to obtain public funding for the enhancement of the port performance and Bavarian state level, the governments of Lower and Upper Bavaria as well as the ministry responsible, namely the Bavarian Ministry for Domestic Affairs and Transport function as stakeholders. These entities should be consulted at a very early stage of planning in order to allow for lengthy funding application procedures and to avoid planning steps that inhibit eligibility of funding.

Finally, the engineering and construction companies responsible for planning and execution of the project as well as the suppliers for specific equipment elements such as covers, fence systems and tarps have to be included in the set of relevant stakeholders.

4.5 Location, site

As has been defined above in the needs assessment, the storage facility needs to have trimodal accessibility, meaning that it has to be located directly at the quay as well as with connection to the rail tracks. As can be seen in figure 22 below, all current quay areas are built on and in possession or utilization, respectively, by the port management and/or private transshipment companies.

In blue and red markings, the expansion measures as foreseen in the port development plan being drafted are indicated. Only the expansion at the South quay will result in a quay expansion with options for storage utilization. Since the forest area North of additional berths at the North quay are environmental protection zone, no utilization beyond the already existing road which marks the Northern border of the port basin is possible.

Consequently, only the South quay expansion site offers suitable options for the storage development – and also only, in case the quay expansion is being realized. All currently visible buildings (deserted living houses) have been demolished in April 2018 since on the right hand side of the red roof visible; the new port master office including ship register is being built.

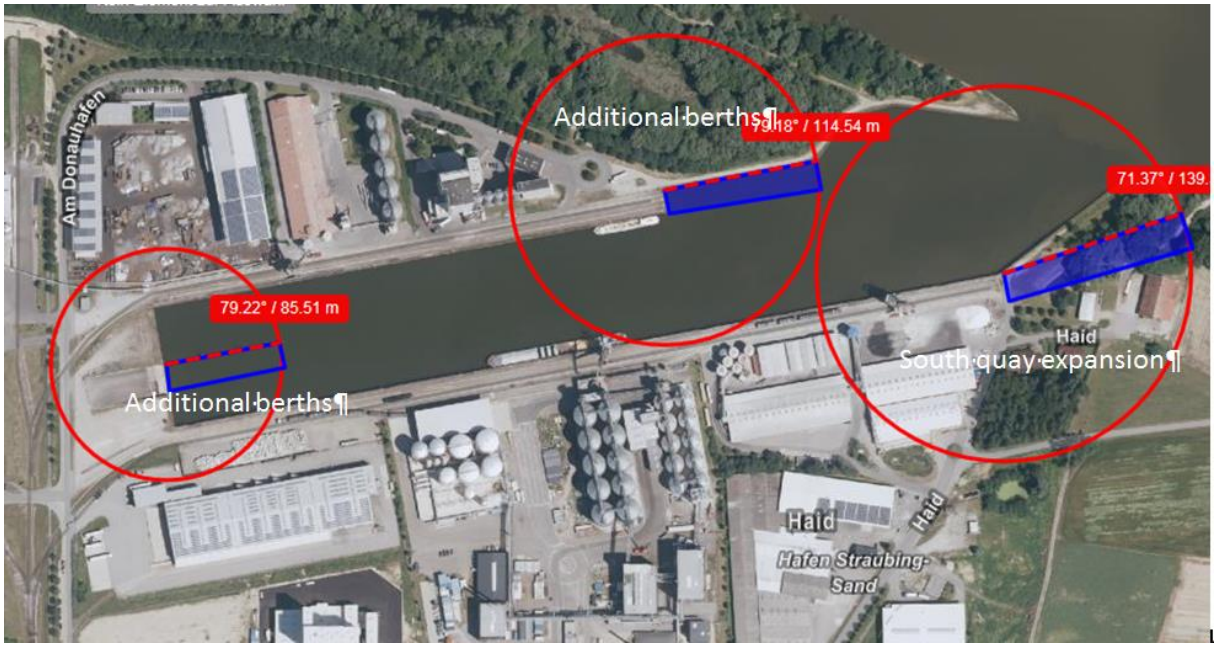

Figure 22: Current setting situation at the quay and quay expansion potential (own visualisation, based and modified after Bayernatlas, 2018).

It has been stated that another major development and investment project currently under preparation at the port of Straubing-Sand is the combined transport container terminal (rail / road). The terminal location is planned as visible below in Figure 23. Therefore, when finalizing the construction planning for the quay expansion as well as the storage, this route needs to be considered. On the other hand, it allows direct rail access to the potential storage location once the rail track connection to the container terminal is established.

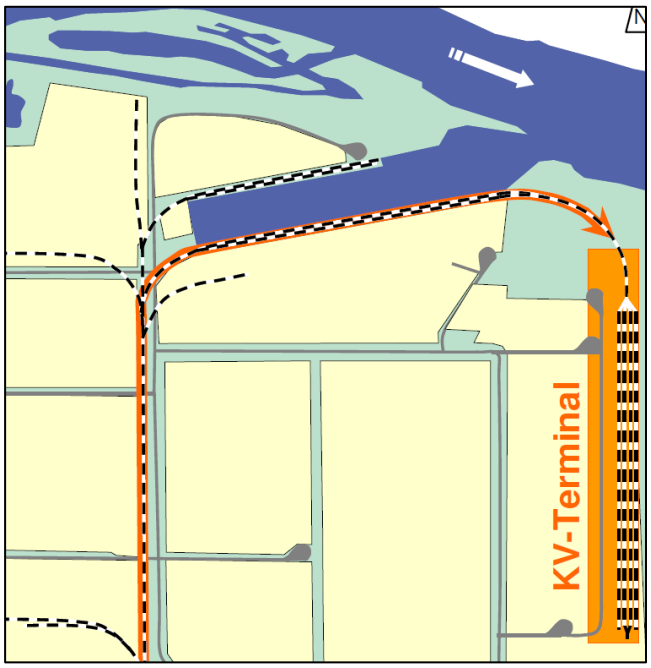

Figure 23: Planned route of rail tracks for combined transport terminal (own visualization, 2018).

Although the restricted space available and the projects running in parallel but not synchronized are posing significant challenges and restrictions, the location marked in red below depicts the only possible solution catering all the needs defined above.

It is an area with above 3,000 m^2, allowing enough space for realization both a wood chips bunker of sufficient parameters and a log wood storage site. Directly at the quay edge as well as close proximity to the rail tracks (once the container terminal is finalized, this location will have direct rail track access).

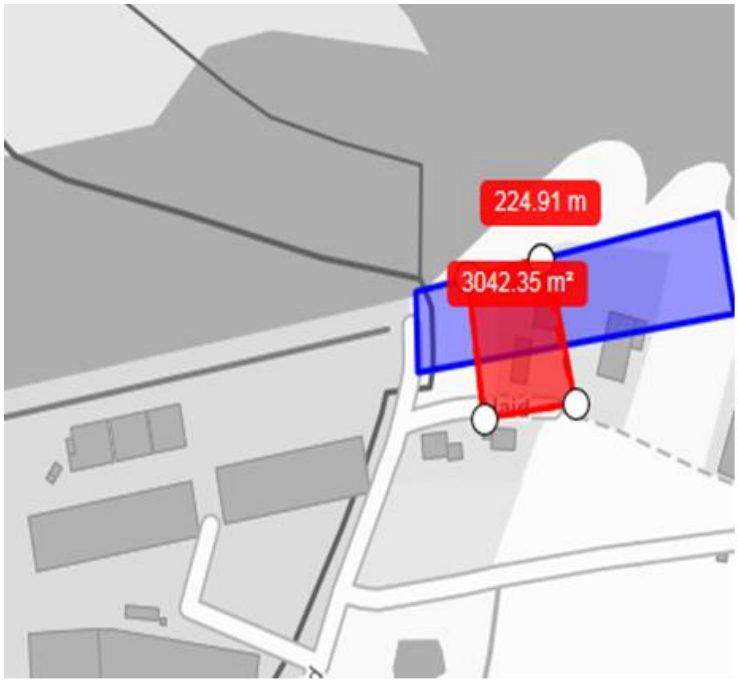

Figure 24: Most suitable location allowing for capacity above 3,000 m² (own visualisation, based and modified after Bayernatlas, 2018).

4.6 Technical parameters/capacities

The development project under scrutiny here is not a complex technological facility as for example a biomass power plant would be. However, a number of parameters need to be considered.

Firstly, the maximum size and capacities of the open-air storage as well as the wood chip storage bunker are determined by their size, and this again is determined by the space available as depicted in the visualization in Figure 24

In the following table, the maximum parameters possible for the entire storage area are presented, as well as an example for division of the entirety of the area into the two utilization sections. Clearly, the bunker will accrue a comparatively higher share of the entire investment cost as it requires more sophisticated engineering services as well as material. Therefore, its share of the entire size needs to be clearly considered in a cost-benefit analysis once the demand numbers from the port development plan are available. Until then, the exemplifying allocation shall be assumed as it allows for almost 2,000 m^2 of open air storage which would serve the potential clients' requests for buffer storage for the biorefinery project.

Table 9: Preliminary size and capacity parameters.

Parameter	Specification
Entire storage area – maximum possible	
Surface	Approx. 3,050 m^2
Side length East-West	50 m
Side length North-South	61 m
Open-air storage area (flexible)	
Surface	Approx. 1,840 m^2
Capacity log wood	Approx. 18,000 solid m^3
Side length East-West	48,5 m
Side length North-South	38 m
Share of entire surface open air	60 %
Wood chip bunker (flexible)	
Surface entire area	Approx. 1210 m^2
Surface bunker	200 m^2
Length	20 m
Width	10 m
Height	4 m
Capacity	800 m^3
Surface surrounding area and streets, additional capacity	1000 m^2
Share of entire surface bunker	6 %
Share of entire surface bunker area	30 %
Share of connecting streets and rail tack	10 %

Additionally, the following parameters have to be ensured:

- Storage facilities have to ensure a minimum 10 m distance to adjacent buildings and other storage facilities due to property as flammable good (C.A.R.M.E.N., 2017)
- Accessibility via road, also with heavy duty vehicles
- Accessibility via rail
- Option to store mobile temporary cover equipment (tarp, fleece)
- Construction and engineering-related integration into the other development projects (port development plan, port master's office, container terminal) taking place at the site

4.7 Technology and equipment

As described above, the foreseen development project as a stand-alone solution is not a technologically complex facility. The most important equipment elements required only for the planned storage solutions are listed in the following:

- Concrete ground flooring throughout
- Drainage systems for both open-air and bunker storage
- Concrete silo bunker casing
- Mobile cover roof system for silo bunker including ventilation
- Environmentally friendly and reusable mobile cover material (tarp, fleece)
- Electronic control system for mobile cover
- Storage for mobile cover materials (tarp, fleece)
- Mobile fencing system elements incl. gate (min. 200 m)

- Surveillance camera system
- Additional wood gripper
- Portal access for crane
- 1 Fork lift
- 1 Bob cat
- 1 Truck scale

However, the storage solution as presented here will only be realizable in case the South quay expansion takes place. This will involve a much more versatile development project which requires extensive planning processes and engineering services. Therefore, the list above is tentative and not exhaustive.

4.8 Design and permissions

As described above, the final and exact design and detail engineering of the storage solution under scrutiny will have to be integrated into the planning procedure for the quay expansion. In either case, even as a stand-alone solution, to define the detail engineering design would first require a broad feasibility study. Both the feasibility study and the detail engineering reach beyond the scope of this study.

This situation also influences the permission and authorization procedures that need to be undergone. Commissioning a classic open-air wood storage and/or wood chips silo bunker cannot be compared with the processes required for the expansion of port infrastructure such as a quay area.

The classic procedures to be undergone for any public construction process in general, including the construction of the storage solution include:

- Planning procedure according to “HOAI” (Honorarordnung für Architekten und Ingenieure) phases of service– which is the German fee regulation imposed on architects and planning engineers acting as public contractors; this also includes the permission procedure (phase 4)

- Tendering and contracting procedure according to “VOB”(so-called ‘Vergabe- und Vertragsordnung für Bauleistungen’), for both engineers and construction contractors – which is the German regulation for public contracting, Bavarian specifications have to be ensured.

For the storage, as no direct processing is attached, no permission according to “BImSch” (Bundesimmissionsschutzgesetz), the German Emission protection legislation, is needed.

However, the provisions as laid out in the ordinance for the avoidance of fire hazards (Verordnung über Verhütung von Bränden) determine that no flammable goods, including wood chips and log wood may be stored outside above a maximum of 3,000 m^3 in one storage unit. This unit needs a minimum distance of 10 m to other units and buildings.

4.9 Partners to be involved

Besides the potential target group of the development project, namely the customers, as mentioned above, a set of partners and stakeholders play a significant role in the further planning. These also include the actors involved in the projects being developed in parallel in order to ensure integrative processes.

Partners to be involved are:

- ZVH (landlord & owner)
- HSG as port authority
- Other settled logistics service providers
- City of Straubing and district administrations including departments in charge (building authorities, environmental agency, sewage company)
- Ministry for domestic affairs and transport Bavaria
- Engineering company Sehlhoff (port development plan)
- Engineering company Fritsche (port dredging)
- Construction company Baumann (port master's office)
- Future engineering company for container terminal
- Future engineering company for multipurpose demo plant
- Consultants for contacting procedures
- Internal consultant on market development: BioCampus Straubing GmbH

The main objective for all partners involved is the sensible, sustainable and economic integration of all envisaged single projects via management of investment and construction decisions.

4.10 Recommended implementation schedule

The realization of the storage option under scrutiny depends greatly on the decision to expand the South quay of the port basin, which, in turn depends on the outcome and recommendations of the port development plan which was commissioned before the ENERGY BARGE pre-feasibility study methodology was shaped. Therefore, it is quite difficult to present a reliable implementation schedule in the form of a GANTT diagram (classic project planning tool for project phase visualization).

Generally, the main phases of a project (pre-condition: financing has been ensured) such as the storage proposed for this study include the following main stages after the pre-feasibility study:

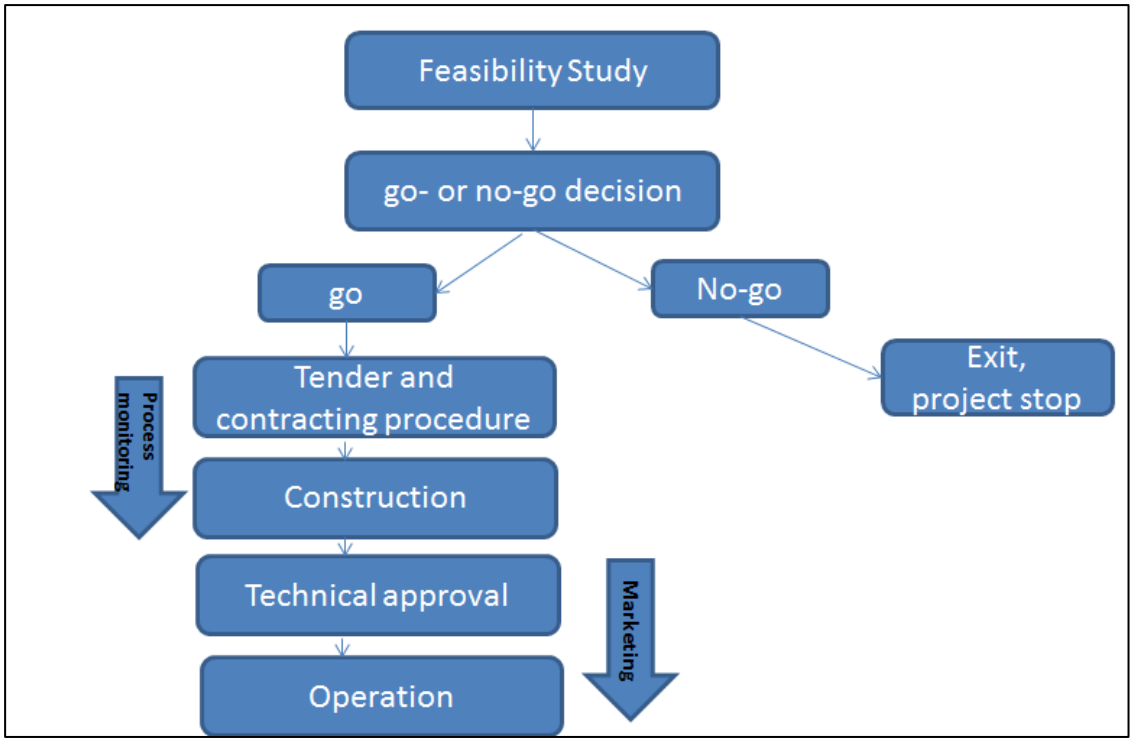

Figure 25: Scheme of process steps after pre-feasibility study (own visualisation, BioCampus, 2018).

Clearly, it has to be recommended to upgrade this study once the financial, spatial, and market-demand related data of the port development plan are available. This mainly includes the financial and market demand aspects of this study, ideally with the support of the external expertise of the engineering company in charge. In case this corroborates preliminary feasibility of the storage solution and delivers a more mature result than the current version recommending follow-up on the project, and the port development plan also suggests implementation of the first expansion step, a comprehensive time frame for the "roof development" of the quay expansion and a sub-time schedule for the storage facilities needs to be designed. The engineering and construction of the storage solution will heavily depend on the steps to be taken for the quay expansion.

The performance specification of the port development plan tender documents assumes a minimum realization time of five, a maximum one of ten years for the quay expansion, including all necessary steps. Therefore, the earliest year of operation for the storage facility under current conditions would be 2023.

4.11 Investment costs, financing

Given the circumstances described above, giving a realistic and reliable estimation of investment costs is not feasible at the current point as no data regarding the quay expansion is available.

Major cost drivers will include:

- Extensive soil movements and works above and under water
- Statics enhancement works
- Establishing rail connection for logistics and putting crane in place
- Concreting works
- Contractor fees

The funding for both the quay expansion and the storage development project will have to be facilitated via a mix of association contributions by the shareholders, reserves that have been made for port performance upgrading measures, loans and to a minor extend via public funds available for infrastructure development. To this end, negotiations with the respective responsible authorities and ministries have to be undertaken.

5. Operation

As described in chapter 4 the implementation and realisation chance of the storage development project under scrutiny highly depends on the port's other development projects running in parallel, mainly the go/no go decision to expand the South quay in order to create new quay area which is currently not available.

In chapter 0, it was pointed out that the earliest realization date of the storage project would be mid-2023, meaning that all aspects of potential operation lie in the medium-term future. Consequently, all assumptions mentioned below are of merely tentative and theoretical nature. A decisive factor here is played by unknown development of staff cost, however, a general cost increase in line with the long-term development has to be assumed.

The tentative and premature nature of this chapter is also due to the fact that the investment data for the storage can only be estimated on a reliable basis in the context of the investment needs for the quay expansion which is not available at the point of final compilation of this report. At the same time, investment costs are decisive for computing pricing, cash flow and consequently cost-benefit analysis, which is why these chapters could not be backed with data at this point.

5.1 Project Management Organisation, human resources

It has been pointed out before that different variants for investment and operations organization could be possible to realize the storage facility project. These variants mainly differ regarding the responsibilities and roles the different actors can play in the course of the project implementation.

Relevant roles to be taken over are:

- Owner
- Investor
- Operator incl. maintenance
- Logistics

The possible scenarios regarding roles possible are presented below.

Table 10: Project management scenrarios (own data, 2018).

	Owner	Investor	Operator/maintenance	Logistics
1.1.	Zweckverband Hafen Straubing-Sand owns the site as well as the infra/superstructure	Zweckverband or Hafen Straubing-Sand GmbH (HSG) invests in project representing its shareholders	ZVH contracts HSG with operations and maintenance for the storage facility for a fixed amount of time with option for extension	HSG facilitates handling and transshipment as well as other logistics services for clients
1.2.				Multiple private transshipment companies act as clients of HSG on behalf of their own client
2.1.	Zweckverband Hafen-Straubing Sand owns the site but leases it to a single private transshipment company based on leasehold		Private transshipment company is in charge of operating and maintaining the facility according to own business model; HSG is in charge of operations of the crane superstructure and needs to be contracted for crane services	Private transshipment company is in charge of logistics of the facility according to own business model
2.2.		Private transshipment company invests in storage facility		Private transshipment company is in charge of logistics of the facility according to own business model
3.1.	Zweckverband Hafen-Straubing Sand owns site but leases it to a single biomass processing company	ZVH invests in storage facility	Private biomass processing company is in charge of operating and maintaining the facility, e.g. by subcontracting to logistics company	Private biomass processing company is in charge of managing logistics, e.g. by subcontracting to logistics company
3.2.		Private biomass processing company invests in storage facility		Biomass company is in charge

Based on the fact that the port of Straubing-Sand is aiming towards portfolio expansion of services, the most likely scenarios at the moment are 1.1. and 1.2. The pre-condition always is that the port development plan suggests economic viability of the quay expansion and investment decisions can be secured in the round of the shareholders.

5.2 Operation and maintenance costs

Clearly, the operations and maintenance costs depend on the final size and features of the facilities realized as well as the business model version opted for as presented in the previous chapter.

The classical operations tasks involved in running the storage facility include – based on the business model chosen – the following aspects (non-exhaustive list):

- Commissioning and management of orders including issuing offers, scheduling of stored goods and storing durations
- Provision and operation of handling equipment as needed (crane, gripper)
- Provision of storage documents and planning
- Logistics on site
- Provision of trained staff
- Monitoring and provision of safety regulations including insurance and liability disclaimer during loading/unloading times
- Management of freight documents
- Surveillance and security
- Cleaning and maintenance of loading and storage areas
- Maintenance of handling equipment
- Marketing

Based on the business model chosen, these tasks either materialise at the owner or operator of the site or the company holding the sub-contract. Clearly, this also has an influence on the staff needed for operation and maintenance works on the side of the HSG. Currently, the HSG employs 10 employees in headcount, equalling to 8 full time equivalents (FTE). Work is organized in two shifts including weekends. This model deems adequate for the storage operation itself and serving it with crane services as well.

5.3 Pricing

Since the pricing of the storage offered in the foreseen facility must be calculated at least partially based on the investment costs which have to be accrued through the operation of the facility and these are not available, no reliable pricing estimations can be given here. Clearly, the pricing of the storage must reflect the value of the stored goods as well as aiming at accruing the investment costs and depreciations and the coverage of the running costs including staff, maintenance and port usage fees.

Elements influencing the storage costs include (non-exhaustive list):

- Type of contract (HSG as storing agency or via private logistics service provider)
- Type of good stored
- Type of storage option used
- Share of available space used
- Duration of storage
- Intensity of maintenance and supervision of HSG staff necessary (staff intensity)
- Additional fees in case of pre- or post-haulage storage in connection with utilization of waterside transshipment

The following port-utilization fees apply for cargo vessels in the port of Straubing-Sand as being charged today – they will potentially rise in parallel to general inflation tendencies within the next years:

Table 11: Fees payable for cargo vessels in the port of Straubing, based on port regulations (HSG, 2014).

Fee type	Specification
Pierage charge (according to "Güterverzeichnis für den Verkehr auf deutschen Binnenwasserstraßen")	
Goods of categories I – IV	0.40 €/t
Special fee for rape and rape meal	0.36 €/t
Port fee (after official loading/unloading time for the relevant load has expired, due the first day after official loading/unloading time, e.g.: 1,000 t: 5 days	
Days 1 -4, daily fee	50.00 €
From day 5 onwards, daily fee	75,00 €

5.4 Preliminary cash flow estimates

Since the cash flow is the dependent variable of pricing, fees, demand quantification and quality and operation costs and neither indicators for pricing nor for demand quantification are available in a reliable manner, it is at this current point not possible to provide reliable and realistic preliminary cash flow estimates.

It is clear that once available, the cash flow estimates must be positive in order for a final investment decision to be positive.

5.5 Cost-benefit analysis

Since both the cost as well as the actual demand and thus benefit inferable from this demand depend on the data and information for the quay expansion which is under scrutiny in the delayed port development plan, no realistic cost benefit analysis can be provided at this stage.

5.6 Market analysis and marketing concept

The new storage area as a theoretical stand-alone service offers logistics solutions in the field of short-term/intermediate and buffer storage. Both elements of the project, the open-air storage as well as the silo bunker are primarily targeting the woody biomass feedstock field, meaning all kinds, sizes and quality ranges of log/round wood, wood chips including forestry wood chips, industrial wood chips, saw dust, mulch, as well as differently cut wood such as fire wood, etc.. Additionally, different manufactured or semi-manufactured wooden products for material use in the construction with option to store open-air or with mobile coverage can be stored. Moreover, other lignocellulosic biomass types, for example residue materials such as landscaping materials, cuttings, shavings and prunnings from forest maintenance work or similar can be of relevance.

For these products, the most obvious clients have already been analysed in chapter 4.4., 4.4 Target group/stakeholders.

Additionally, without a doubt, especially the open-air storage area can be used for and marketed towards all other kinds of break bulk or dry bulk cargo with a need for intermediate storage in

direct proximity to the quay. Looking at the current portfolio of the port, these could especially be bundles of recycling plastic material on palettes, agricultural machinery, as well as occasionally high&heavy products. Clearly, other cargo types of these sorts might be of interest as well. The silo bunker however has to be exclusively for biobased dry bulk materials suitable for covered storage.

In either way, it would be advisable to aim for stored products, especially at the open-air site, that require pre- or post-haulage and have an inbound or an outbound connection via waterway. The reason for this is that this business model would yield the highest revenues for the port management as the cash flow would include the pierage charge as well as potentially the port fee.

Since the objective of the ZVH and also the official bodies of the region of Straubing is to further strengthen the region's profile as model region for biobased economy, bioenergy and biomass logistics by both offering attractive settling conditions for companies operating along the biomass value and supply chains as well as increasing the biomass handling in the port, the new storage site (as well as the quay expansion as a whole) once realized shall proactively be marketed in such a manner. It has to be clearly emphasized that an investment decision to expand the logistics service portfolio for biomass companies has been made on the basis of an extensive demand analysis via the port development plan and the ENERGY BARGE project.

The BioCampus Straubing GmbH as subsidiary of the ZVH responsible for marketing the port in the biomass branch will be in charge of integrating the addition of the service portfolio into the general marketing material and activities as well as in business development and settlement negotiations, so as to achieve a positioning as new site advantage. Moreover, the new business development manager that is foreseen for the port activities shall proactively utilize instruments of inbound marketing to interest potential customers in need of storage space with inland waterway connection.

5.7 Partners involved in operation

It has been determined that the storage area shall be in investment- and ownership of the ZVH and shall be operated by the HSG either directly or in a way that in its function as port authority, it rents the storage facilities for a fixed and contracted price depending on time of storage, modes of transport used and capacities needed to a logistics company which in turn charges their client.

In the following list, all stakeholders involved in the operation of the new storage area along and aside the supply and value chain are mentioned:

- Zweckverband Hafen Straubing-Sand, landlord and contracting party for heritage rent of quay-settled companies
- Hafen Straubing Sand GmbH, port management and authority, operator of the storage
- BioCampus Straubing GmbH, marketing body for biobased industry in the port of Straubing
- Maintenance service providers, e.g. for mobile cover
- Shipping companies, e.g. Bavaria
- Logistics service providers, e.g. SR Log/Reinsch
- Biomass processing companies, e.g. BioRefinery BV, INACO, Multipurpose Demoplant
- Forestry owners, e.g. Bayerische Staatsforsten, TTW Waldpflege
- Permitting authorities
- Security service providers

- Deutsche Bahn as facilitator of rail track
- Future operator of combined transport container terminal
- Other port operators and authorities active in woody biomass logistics

5.8 Co-operation possibilities with other ports

Before the pre-feasibility study was started, the following logic for transnational cooperation with other ports was drafted:

A system that could be used to establish and facilitate cooperation between ports would be the upgrading value chain system, assuming e.g. that sunflowers are harvested in Bulgaria, brought to a port where e.g. storage for the sunflower seeds is needed before transport, or where e.g. the seeds are already hulled and storage for the hulls and the actual seeds are needed and then transported onwards and in an upstream-port, e.g. a conversion facility is nearby and again, the second port could offer storage for the seeds and even potentially for the sunflower oil.

This logic actually resembles the green energy and chemistry belt concept, which is presented in an exemplifying visualization below:

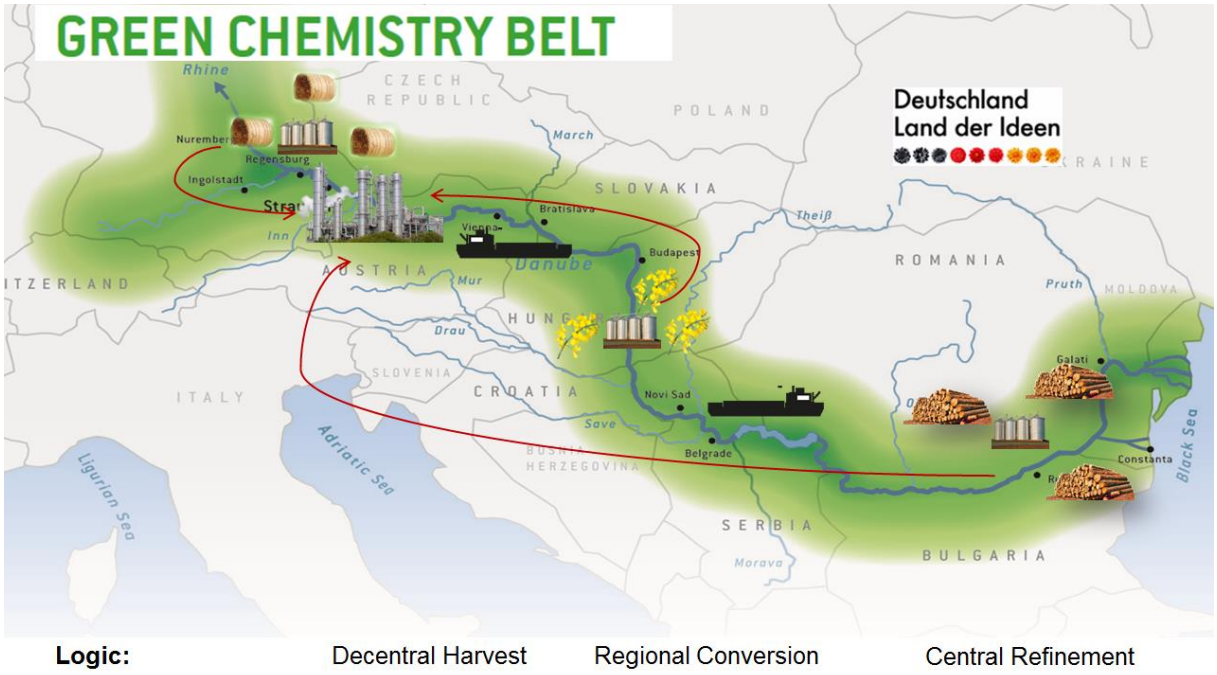

Figure 26: Green Energy and Chemistry Belt concept (own visualisation, 2018).

Since the ENERGY BARGE partner ports in Vienna, Austria (PoVi) and Vukovar in Croatia (PoVu) are also studying investments into upgrading their logistics performance and service portfolio for wood-based cargo, a cooperation and coordination of the relevant business and trading actors at these three sites is needed for follow-up negotiations once the studies have been concluded. Also, other ports outside the project consortium could act as business development partners according to the pattern described above. As mentioned, the deep-dive assessment of the wood-logistics market on the waterside could add additional information and business partners to the landscape.

6. Risks and barriers

This study has a premature character due to the currently complex planning and project development situation at the port of Straubing-Sand. Therefore, also the risks and barriers are quite diverse, especially regarding the implementation phase.

Those risks and barriers are presented here in a theoretical manner and cover the following aspects:

- Institutional and strategic risks
- Financial and economic risks
- Technical risks

These risk types have been chosen as they depict the standard risk types assessed by the Port of Straubing when assessing construction investment projects.

Moreover, the likelihood for a risk to materialize can differ. For reasons of simplification, the following categories are chosen:

- Low risk
- Medium risk
- High risk

The impact level of a risk in case of occurrence differs as well:

- No or insignificant impact
- Medium impact
- Significant impact

Based on these conditions, the following risk assessment for the time before and during implementation as well as during operation can be done:

Table 12: Risk assessment table (own visualisation).

Type of risk incl. specification	Likelihood of risk	Impact of risk
Institutional and strategic risks		
Port development plan does not suggest follow-up investment	medium	significant (project exit)
Port development plan does not suggest storage options for biomass cargo	low	significant
Port development strategy abandons biomass focus strategy	low	medium
Planning and construction process gets delayed (legal, planning, subcontracting, etc.)	high	medium
Conflicts arise between different stakeholders	low	medium
Development decisions and procedures are too slow and site advantages are lost / attractiveness for investors vanes	medium	significant
Financial and economic risks		

Lack of shareholder interest	low	significant
Lack of public funding	medium	medium
Construction cost spikes and increases	medium	medium
Inland waterway navigation conditions further deteriorate, transport mode loses standing with forwarding companies	medium	significant
Biobased economy does not manage to enter into growth and investment phase, resulting in lack of demand	medium	significant
Technical risks		
Technical issues occurring during construction or operation	medium	low
High maintenance costs	low	medium
Technical solutions offered do not or only partially meet the requirements and demand	low	significant
Storage options offered are not sufficient / conceptualized too small, making expansion required too soon	low	significant

For all these risks, a risk management strategy must be designed which develops measures to mitigate or prevent the materialization of the mentioned risks or at least establishes foresight procedures which could provide strategies for resolution.

7. Recommendations

Generally, the port of Straubing-Sand has always exercised a proactive investment strategy, meaning that investments have been done in order to create a service offer, even though no secured demand and fixed client contracts were available. Therefore, as a result of this study, it is generally recommended for this project and the overall strategy to develop the site as a model region for utilization of biomass shall further be followed up on.

To this end, a set of steps to follow up on this study and to accompany the development planning still running is recommended:

- Speed up the port performance and capacity assessment within the port development plan as well as all follow-up measures resulting from the assessment
- Ensure integration of results of this study and the demand for biomass storage in the port development plan via regular involvement of BCG-representatives in briefing rounds with engineering company Sehlhoff
- Contract a deep-dive detailed market and demand analysis along the wood supply chains to corroborate the case-based assumptions underlying this study
- Instruct corroboration of this study's weak data material on the basis of results of port development plan

- Ensure integration of results of this study in all negotiations for potential future greater port expansion in shape of a new basin and terminal area

- Assess and negotiate with current and potential future port-located private logistics companies their own strategies and options for storage portfolio expansion, potentially in short to medium term to develop offers and solutions for clients with current demand

- Assess and negotiate with other wood-transporting ports about options for joint business development activities

8. References

Bayerischer Bauernverband, (29.04.2015). Landwirtschaft in Bayern: Landkreis Straubing Bogen. [online] Available at: https://www.bayerischerbauernverband.de/landwirtschaft-in-straubing-bogen?suchbegriff2= [Accessed 13.03.2018].

Bayerische Landesanstalt für Wald und Forstwirtschaft (LWF), (2018a). Waldbesitz. [online] Available at: http://www.lwf.bayern.de/waldbesitz-forstpolitik/waldbesitz/index.php [Accessed 13.03.2018].

Bayerisches Landesamt für Umwelt, (2018a). Blum, Peter. Entwurf einer kulturlanschaftlichen Gliederung Bayerns als Beitrag zur Biodiversität. 30 Innerer Bayerischer Wald. [online] Available at: https://www.lfu.bayern.de/natur/kulturlandschaft/gliederung/doc/30.pdf [Accessed 13.03.2018].

Bayerisches Landesamt für Umwelt, (2018b). Kulturlandschaftliche Empfehlungen für Bayern. 30 Innerer Bayerischer Wald. [online] Available at: https://www.lfu.bayern.de/natur/kulturlandschaft/empfehlungen/doc/30.pdf [Accessed 13.03.2018].

Bayerisches Landesamt für Umwelt, (2018c). 33 Dungau (Gäuboden). [online] Available at: https://www.lfu.bayern.de/natur/kulturlandschaft/entwurf_gliederung/doc/33_dungau.pdf [Accessed 13.03.2018].

Bayerische Staatsforsten, (2017). Pressemitteilung Vorsorge für den Wald in Krisenzeiten. [online] Available at: http://www.baysf.de/de/medienraum/pressemitteilungen/nachricht/detail/vorsorge-fuer-den-wald-in-krisenzeiten.html [Accessed 01.06.2018].

Biobased Industries Consoritum (BIC), (2018). Home. [online] Available at: https://biconsortium.eu/ [Accessed 01.06.2018].

BioCampus Straubing GmbH. (2018). Netzwerkpartner. [online] Available at: http://www.straubing-sand.de/biocampus/clusterpartner/ [Accessed 13.03.2018].

Bioenergieregion Straubing-Bogen, (2015). Die Region [online] Available at: http://www.bioenergie.straubing-bogen.de/index.asp?NAVIID={8F1F2DB5-BABF-4EC5-AB2B-871CC3F36D12} [Accessed 13.03.2018].

Biofuelsdigest.com (2017), The top 20 European biorefinery projects. [online]. Available at: http://www.biofuelsdigest.com/bdigest/2017/11/22/the-digests-2017-guide-to-the-20-top-european-biorefinery-projects/ [Accessed 10.06.2018].

Blommaert Aluminium Constructions, (2018). Mobile covers. [online] Available at: https://www.blommaertalu.com/de/mobile-dacher [Accessed 01.06.2018].

Bundesimmissionsschutzgesetz, (2018). Gesetzestext. [online] Available at: http://www.gesetze-im-internet.de/bimschg/ [Accessed 01.06.2018].

CARMEN e.V., (2017). Selbstentzündung. [online] Available at: https://www.carmen-ev.de/files/festbrennstoffe/Biomasseheizwerke/Selbstentzuendung.pdf [Accessed 01.06.2018].

Dammer, L. et al., (2017). Current situation and trends of the bio-based industries in Europe with a focus on bio-based materials, [online] Available at: http://bio-based.eu/download/?did=106705&file=0 [Accessed 01.06.2018].

Energieatlas Bayern, (2018). Startseite. [online] Available at: http://geoportal.bayern.de/energieatlas-karten/?wicket-crypt=NTGh0BgJPdc [Accessed 13.04.2018].

ETA Energieberatung, (2016). ETA Holzrechner. [online] Available at: https://www.eta-energieberatung.de/Tools/eta-holzrechner/holzrechner.htm [Accessed 01.06.2018].

European Commssion, (2014). Guide to Cost-Benefit Analysis of Investment Projects [online] Available at: http://ec.europa.eu/regional_policy/sources/docgener/studies/pdf/cba_guide.pdf [Accessed 15.12.2017].

Fachagentur für Nachwachsende Rohstoffe (FNR), (2017). Basisdaten Bioenergie 2017. [online] Available at: http://www.fnr.de/fileadmin/allgemein/pdf/broschueren/broschuere_basisdaten_bioenergie_2017_2.pdf [Accessed 01.06.2018].

FNR, (2018a). Daten und Fakten Anbaufläche für nachwachsende Rohstoffe 2017. [online] Available at: https://mediathek.fnr.de/grafiken/daten-und-fakten/anbauflache-fur-nachwachsende-rohstoffe-tabelle.html [Accessed 01.06.2018].

FNR, (2018b). Basisdaten biobasierte Produkte 2018. [online] Available at: https://www.fnr.de/fileadmin/allgemein/pdf/broschueren/Basisdaten_biobasierte_Produkte-2018_web.pdf [Accessed 01.06.2018].

Gemeinde Strasskirchen, (2018). Gäuboden – Kernland des Ackerbaus. [online] Available at: http://www.strasskirchen.de/gaeuboden-kernland-des-ackerbaus/150/115/9271/ [Accessed 13.03.2018].

GENESIS Online-Datenbank, (2018a). DESTATIS Statistisches Bundesamt. Ernte: Kreis, Durchschnittlicher Hektarertrag, Fruchtart (Getreide), Jahre. 2015. [online] Available at: https://www-genesis.destatis.de/genesis/online/logon [Accessed 13.03.2018].

GENESIS Online-Datenbank, (2018b). DESTATIS Statistisches Bundesamt. Ernte: Kreis, Durchschnittlicher Hektarertrag, Fruchtarten (Hülsen-, Hackfrüchte, Futterpflanzen, Handelsgewächse), Jahre. 2015. [online] Available at: https://www-genesis.destatis.de/genesis/online/logon [Accessed 13.03.2018].

Hafen Wismar, (2018). Holz und Forstprodukte. [online] Available at: https://www.hafen-wismar.de/de/hafenlogistik/holz_forstprodukte [Accessed 01.06.2018].

Holzwerke Weinzierl, (2018). Die Produkte. [online] Available at: http://www.holzwerk-weinzierl.de/d/03_01_produkte.php [Accessed 13.03.2018].

LEIPFINGER BADER Ziegelwerke, (2018). Silvacor. [online] Available at: http://www.leipfinger-bader.de/produkte/innovationen/silvacor/ [Accessed 13.03.2018].

LWF, (2018b). Waldfläche. [online] Available at: http://www.lwf.bayern.de/bwi/080772/index.php [Accessed 13.03.2018].

LWF, (2018c). Schreiber, Roland. Vielfalt im privaten Waldbesitz. Folgerungen für Forstverwaltung, Forstbetriebsgemeinschaften und Holzindustrie. [online] Available at: https://www.lwf.bayern.de/mam/cms04/service/dateien/vielfalt_im_privaten_waldbesitz.pdf [Accessed 13.03.2018].

LWF, (2018d). 1.60 Waldfläche (insgesamt) nach Baumartengruppen (Wuchsgebiete). [online] Available at: http://www.lwf.bayern.de/bwi/124751/index.php [Accessed 13.03.2018].

LWF, (2018e). 6.62 Holzvorräte nach Baumartengruppen (Wuchsgebiete). [online] Available at: http://www.lwf.bayern.de/bwi/124756/index.php [Accessed 13.03.2018].

LWF, (2018f). Zuwachs. [online] Available at: http://www.lwf.bayern.de/bwi/080768/index.php [Accessed 13.03.2018].

LWF, (2018g). 8.63 Zuwachs 2002 - 2012 nach Baumartengruppen (Wuchsgebiete). [online] Available at: http://www.lwf.bayern.de/bwi/124757/index.php php [Accessed 13.03.2018].

LWF, (2018h). 9.64 Nutzung 2002 - 2012 nach Baumartengruppen (Wuchsgebiete). [online] Available at: http://www.lwf.bayern.de/bwi/124759/index.php [Accessed 13.03.2018].

LWF, (2018i), Lagerung von Hackschnitzeln. [online] Available at: http://www.lwf.bayern.de/forsttechnik-holz/holzverwendung/055903/ [Accessed 13.06.2018].

Nationalpark Land, (2018). Routenplaner. [online] Available at: http://www.nationalpark-land.de/routenplaner.htm [Accessed 13.03.2018].

Projektträger Jülich (PTJ), (2018). Innovationsräume Bioökonomie. [online] Available at: https://www.ptj.de/projektfoerderung/biooekonomie/innovationsraeume [Accessed 01.06.2018].

Regionalstatistik Deutschland, (2018). Statistische Ämter des Bundes und der Länder. Landwirtschaftliche Betriebe und deren landwirtschaftlich genutzte Fläche (LF) nach Kulturarten - Jahr - regionale Tiefe: Kreise und krfr. Städte. 2010. [online] Available at: https://www.regionalstatistik.de/genesis/online/ [Accessed 13.03.2018].

Sachverständigenrat Bioökonomie Bayern, (2017). Schwerpunktthema Nachhaltige Landnutzung und Ressourcenstrategie. [online] Available at: http://www.biooekonomierat-bayern.de/dateien/Publikationen/SVB-Schwerpunktthema_Nachhaltige_Landnutzung_und_Ressourcenstrategie.pdf [Accessed 13.04.2018].

Technologie- und Forschungszentrum für Nachwachsende Rohstoffe, (2017). Bericht 55 Lagerung von Hackschnitzeln. [online] Available at: http://www.tfz.bayern.de/mam/cms08/festbrennstoffe/dateien/tfz_bericht_55_lagerung_hackschnitzel_ges.pdf [Accessed 01.06.2018].

TUM Campus Straubing (TUM CS), (2018a). TUM Campus Straubing Bachelor Degrees. [online] Available at: http://www.cs.tum.de/de/studieninteressierte/bachelor/ [Accessed 13.03.2018].

TUM CS, (2018b). TUM Campus Straubing Master Degrees. [online] Available at: http://www.cs.tum.de/de/studieninteressierte/masterstudiengaenge/ [Accessed 13.03.2018].

Verband Chemischer Industrie (VCI), (2017). Pressemitteilung Chemie 4.0. [online] Available at: https://www.vci.de/presse/pressemitteilungen/chemie-4-punkt-0-innovationen-fuer-eine-welt-im-umbruch-studie-von-deloitte-und-vci.jsp [Accessed 13.04.2018].

Verordnung über Verhütung von Bränden, (2013). Verordnung über Verhütung von Bränden. [online] Available at: http://www.gesetze-bayern.de/Content/Document/BayVVB-G1 [Accessed 01.06.2018].

Waldbesitzervereinigung Frankenwald, (2001). Rundholz lagern. [online] Available at: http://www.wbv-frankenwald.de/wbv/docs/merkblaetter/mb-7-rundholz-lagern.pdf [Accessed 01.06.2018].

Waldwissen.net, (2017). Rundholzlagerung. [online] Available at: https://www.waldwissen.net/waldwirtschaft/holz/lagerung/lwf_rundholzlagerung/index_DE [Accessed 01.06.2018].

Zafar, S., (2017). Biomass storage methods. [online] Available at: https://www.cleantechloops.com/strorage-biomass/ [Accessed 01.06.2018].

Zweckverband Hafen Straubing Sand (ZVH), (1975). Satzung des Zweckverbands. Straubin, 1975.

ZVH, (2018). Firmen. [online] Available at: http://straubing-sand.de/donauhafen/firmen/ [Accessed 13.03.2018].

Interreg
Danube Transnational Programme
ENERGY BARGE

Contact

BioCampus Straubing GmbH / Port of Straubing
Europaring 4
94315 Straubing

E-mail: ann-kathrin.kaufmann@biocampus-straubing.de

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

Project co-funded by European Union funds (ERDF)