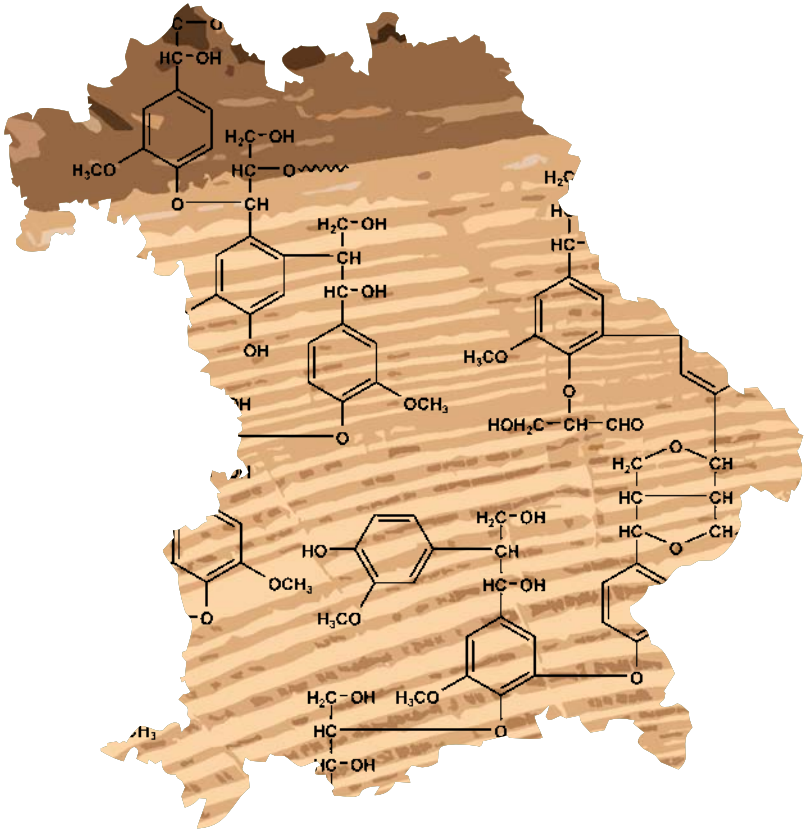
A lignocellulose-based bioeconomy



Bavaria as location for wood and straw-based biorefineries

Raw materials – Sites – Stakeholders

Cluster Forst und Holz in Bayern

Cluster Offensive Bayern

Content

Cluster Forst und Holz in Bayern

Imprint

Publisher:
Cluster-Initiative Forst und Holz in Bayern gGmbH
Am Zentrum Wald-Forst-Holz Weihenstephan
Obere Hauptstraße 36
D-85354 Freising
E-mail: post@cluster-forstholzbayern.de
Internet: www.cluster-forstholzbayern.de

Represented by/Responsible:
Managing Director Dr. Jürgen Bauer

Editing: Dr. Jürgen Bauer, Jorun Klinger-Illner, Stefan Torno

Partners: Bavarian Bioeconomy Expert Council (SVB)
C.A.R.M.E.N. e. V., Bayern Innovativ GmbH

Realisation: KOLLAXO Markt und Medien GmbH
Internet: www.kollaxo.com

Design: Die Werkstatt Medien-Produktion GmbH

Title photo: based on an original by Ralf Rosin

1st edition, September 2023

Images: Cluster-Initiative Forst und Holz in Bayern gGmbH

The brochure was printed on PEFC-certified paper at a PEFC-certified printer.

Sources and further literature can be obtained by request from the author.

The production of the brochure was funded by the Bavarian State Ministry of Economic Affairs, Regional Development and Energy.

Foreword

Bavarian bioeconomy writ large

The linear economic system that has predominated until now relied on the processing of fossil raw materials into products that were costly to dispose of and generated considerable dependencies. Since the beginning of 2022 we are now witnessing a change of priorities in all economic areas:

Combined with a change in direction in energy policies, the bioeconomy can also lead to more climate protection while boosting domestic economic strength. Seen in this context, the supply of wood plays a major role. For this we need, on one hand, robust and active forest management, built on a foundation of sustainability. On the other hand we need to intensify our research, and network with innovative enterprises. Further strategic components of our work with proHolz Bayern in the Bavarian Forestry and Wood Cluster include an exchange of knowledge, communication as well as the strengthening of regional supply chains.

Cluster Spokesmen Prof. Dr. Hubert Röder and Alexander Gumpp

With this in mind this brochure is intended to underpin the stated goals and is to be understood as a further component of the Bavarian bioeconomy strategy.

We warmly invite you to get in touch with us and the partners presented in this brochure.

We can proudly say: In Bavaria we have great potential for wood and straw, an active research community, and enormous interest in the bioeconomy in businesses, associations and state institutions.

Your Cluster Spokesmen

Prof. Dr. Hubert Röder

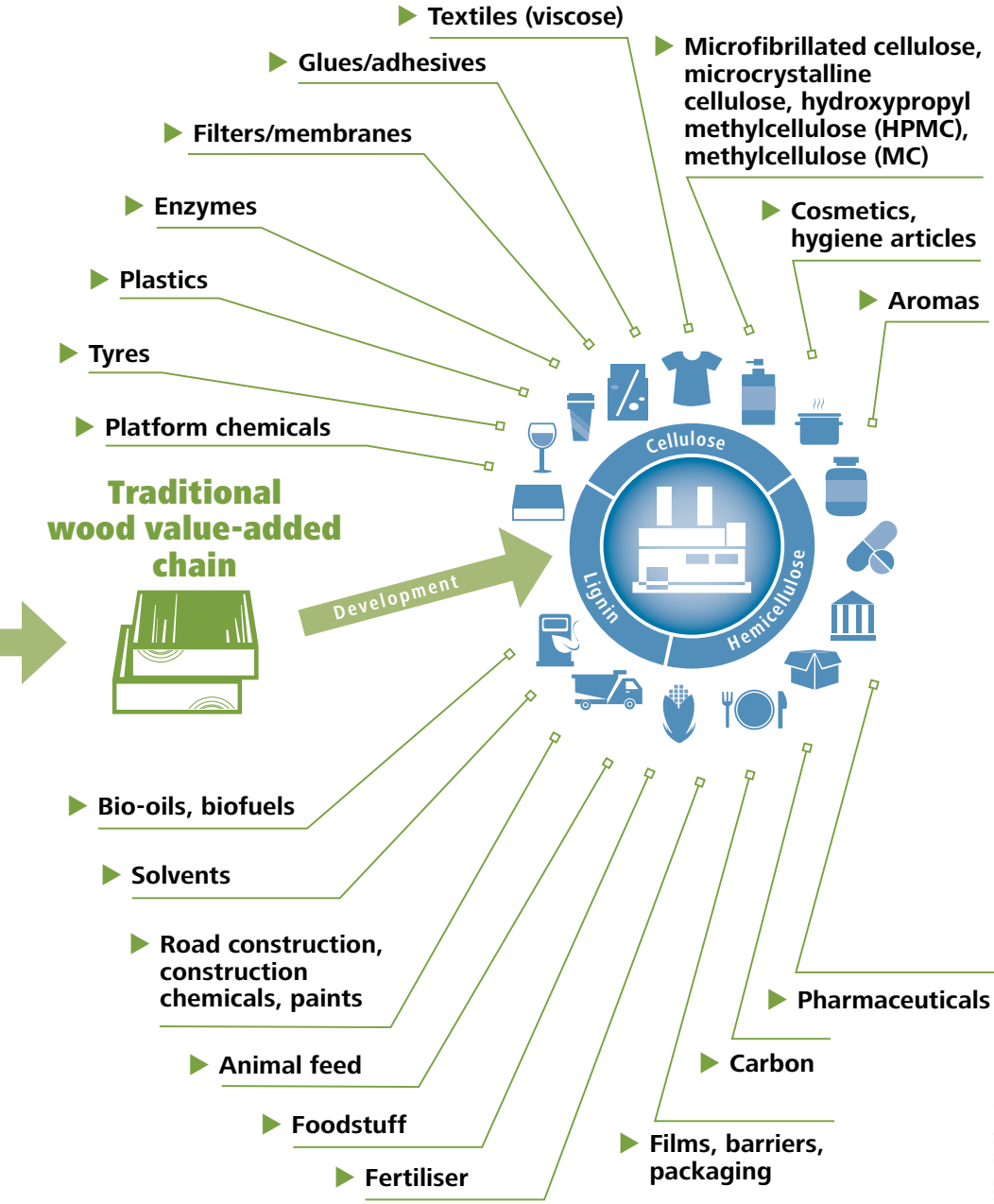
Alexander Gumpp

Bioeconomy – what is it about?

The concept of bioeconomy comprises the generation, opening up and utilisation of biological resources, processes and systems in order make available products, methods and services. One of its main aspects is regenerative raw materials. The sustainable raw material most available in Bavaria is wood; and because of the available quantities, of all the raw materials from agriculture, straw is the most prominent.

Biorefineries provide a way of exploiting virtually all materials contained in wood and straw, with their different components and ingredients. Here, in addition to the manufacture of paper, the most common biomolecule of plant biomass – the cellulose – can also be harnessed for textiles, and medical, cosmetic or pharmaceutical products. Hemicellulose is used to produce xylose as basis for xylite (sugar substitute) and furfural, an important platform chemical for producing medicinal products. Lignin is used as dispersing or binding substance in the construction material, textile and wood materials industries, and a whole variety of specific products such as flavouring agents (e.g. vanillin), ethylene, benzene or acetylene or precursors for bio-carbon fibres can be produced.

By storing carbon (CO_2 from the atmosphere) in renewable products and by additionally avoiding the CO_2 emissions caused by fossil raw materials, the bioeconomy can make a considerable contribution to climate protection.



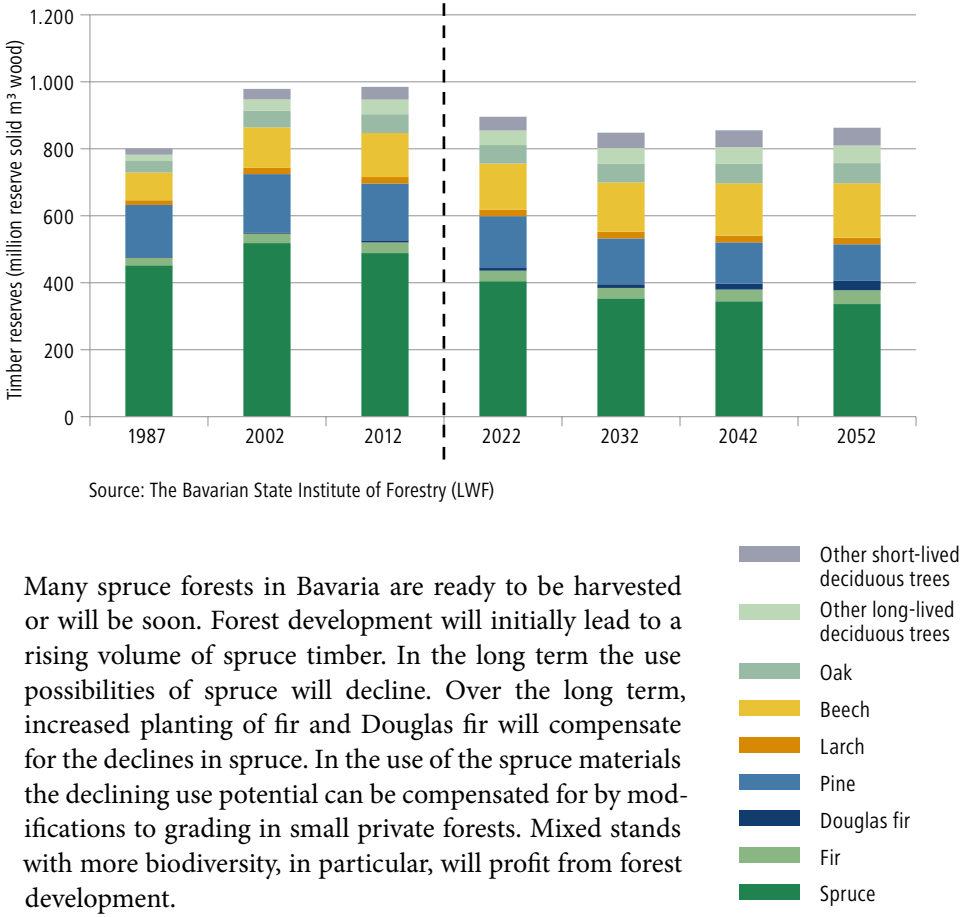
Source: .bwc management consulting, Abensberg; modified

Raw materials – the potential of forest timber

Sufficient timber is supplied by the large reserves and through forest development

The development of timber reserves appears stable for coming decades, with the highest stocks per hectare in European comparison. For Bavaria, the third National Forest Inventory (2012) determined an area of forests of 2.6 million ha and timber reserves of 987 million m³. In the survey period (2002–2012), annual growth amounted to 29.5 million m³, while an average of 28.1 million m³ was used.

FIG. 1: DEVELOPMENT OF RESERVES BY TREE TYPE

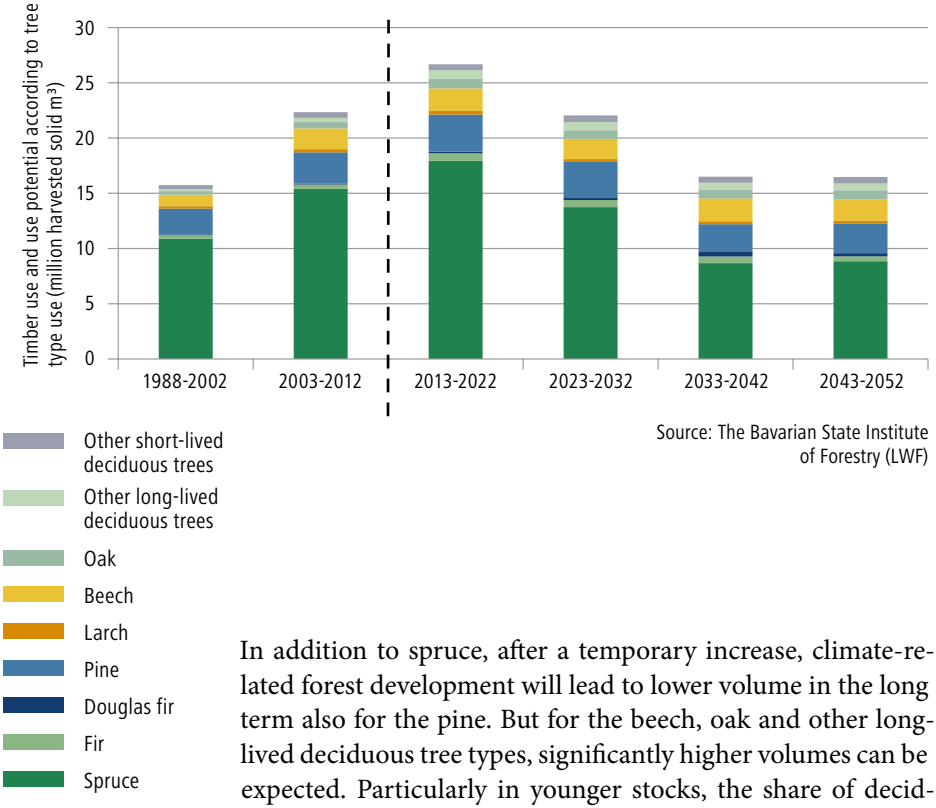


Source: The Bavarian State Institute of Forestry (LWF)

Many spruce forests in Bavaria are ready to be harvested or will be soon. Forest development will initially lead to a rising volume of spruce timber. In the long term the use possibilities of spruce will decline. Over the long term, increased planting of fir and Douglas fir will compensate for the declines in spruce. In the use of the spruce materials the declining use potential can be compensated for by modifications to grading in small private forests. Mixed stands with more biodiversity, in particular, will profit from forest development.

The development of timber use and use potential in Bavaria is shown in Figure 2:

FIG. 2: DEVELOPMENT OF TIMBER USE UNTIL 2012 AND USE POTENTIAL STARTING 2013 ACCORDING TO TREE TYPE



Source: The Bavarian State Institute of Forestry (LWF)

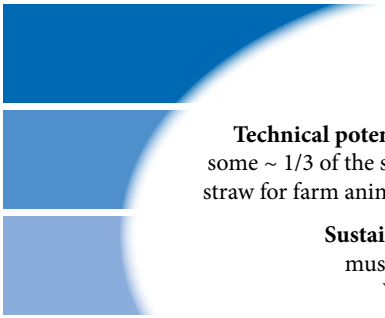
In addition to spruce, after a temporary increase, climate-related forest development will lead to lower volume in the long term also for the pine. But for the beech, oak and other long-lived deciduous tree types, significantly higher volumes can be expected. Particularly in younger stocks, the share of deciduous wood has increased dramatically. Use, however, did not rise after 2012 and currently amounts to roughly 16–18 million harvested solid m³. The greater potential was not utilised in the 2013–2022 period, and that is why it has shifted to the future. Following successful forest development the volume of wood will adjust itself to today's levels again in the long term.

Raw materials – the potential of straw

Good local conditions for producing high yields in international comparison.

Bavaria enjoys high volumes of straw from grain farming, which varies widely, however, depending on region. Potential straw quantities available in Bavaria are as follows:

FIG. 3: POTENTIAL STRAW QUANTITIES IN BAVARIA
(ACCORDING TO GAUS ET AL. 2015)



Theoretical potential. Roughly **5 million t/a** fresh weight straw grows annually in Bavaria, accounting for the theoretical potential.

Technical potential. With current harvesting methods (due to which some ~ 1/3 of the straw growth remains on the field), and deducting the straw for farm animals, of the 5 million t/a roughly ~ **2 million t/a** is left.

Sustainable potential. Of the 2 million t/a, another portion must remain on the field for sustained humus production. With this deducted, **1.4–1.8 million t/a** could be sold.

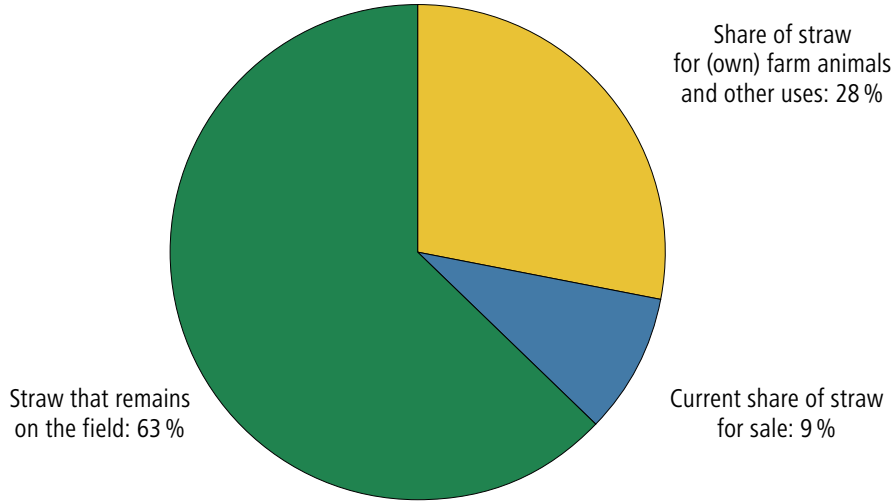
Roughly a quarter of Bavarian grain farmers already sell straw, while roughly a third still do not make use of this option. Certain potential accordingly exists.

"In terms of quantity and availability, straw is to be viewed merely as supplement to wood. In certain regions, however, it shows potential and can make a contribution to supply security for the bioeconomy."

Dr. Thomas Decker, GreenSurvey

FIG. 4: UTILISATION OF ANNUAL GRAIN STRAW GROWTH

(ACCORDING TO GAUS ET AL. 2015)



Straw: Produced by the region for the Bavarian bioeconomy

- Straw is ideally suited for the bioeconomy
- Straw is a residual product and has no bearing on the food-vs.-fuel-vs.-forage problem
- Straw sales represent an additional source of income for Bavarian farmers
- The availability of straw on the market can be increased through pricing and enhanced support for farmers
- Straw is an ideal base material for
  - Platform chemicals
  - Sustainable packaging materials
  - Insulation materials for the construction industry

Arguments in favour of biorefineries in Bavaria

Raw materials from agriculture and forest management

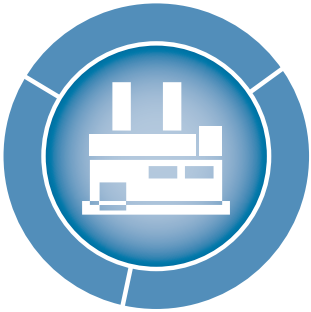
- Generally high and lasting potential for wood utilisation
- Nationally, timber reserves at the highest levels
- Forest development is an assured source of sustained supplies of wood of which certain types as well as residual materials from processing are suitable for biorefineries
- Sustained, utilisable straw potential exists
- Promoting the provision of straw for biorefineries through the development of new business and support models is possible
- Capacities of further raw materials from farming can be utilised
- Residual products and by-products accrued in the processing of wood and straw reduce the use of primary raw materials
- Intensification of the recycling economy increases the supply of secondary raw materials
- The development of new concepts and methods for using and processing waste wood facilitates the utilisation of additional resources
- Potential for new utilisation concepts for land that is hardly used, has other uses or is not used at all
- Potential to modify land use in connection with new production systems
- With the use of lignocellulosic raw materials from residual agricultural products (particularly straw) and wood, the raw materials do not compete directly with food and forage production

Research and development, clusters, networks

- Diverse research environment exists with universities, institutions of higher education and research institutes
- Intensive research and development in the field of chemical and biotechnological
- conversion of lignocellulose-based carbohydrates and their further processing
- Strategic partnerships and networks across industries and sectors within Bavaria as well as nationally and internationally
- High-performance clusters exist for the main key industries

Locations, industry, infrastructure

- Potential to incorporate biorefineries in existing industries
- Wood industry locations with potential for expansion (integration and expansion)
- Chemicals industry with capabilities both as manufacturer as well as processor of intermediate and end-products
- Rising number of biotechnology companies
- Booming start-up scene
- Demand growing strongly in sales markets for intermediate and end-products (e.g. chemicals industry, plastics industry)
- Demand and potential in the area of pulp or the pulp industry
- Efficient machine and plant engineering
- Regions with extremely well-developed infrastructures (e.g. motorways, rail facilities, inland ports)
- Development and operation of pilot and demonstration plants for lignocellulose biorefineries
- Possibilities for integration in the trans-European "Green Chemistry Belt" along the Danube
- Strategic possibilities to link up with neighbouring regions (raw materials and products)



Strategy, support

- The bioeconomy strategy of the Bavarian state as guidepost to point the way
- Bavarian Bioeconomy Expert Council (SVB) as independent consultation body
- Strategic organisations and incentive programmes to support and attract businesses and the industrial implementation of new technologies
- Established stimulation programmes for transnational research and cooperation

The Bavarian bioeconomy strategy

In the Bavarian state government's "Future.Bioeconomy.Bavaria" bioeconomy strategy the Free State of Bavaria is envisaged to become the leading location for sustainable products and methods of production, and thus a model for other regions. More than 300 stakeholders from business, science and society contributed ideas and proposals. The Bavarian bioeconomy strategy was developed by Bayern Innovativ GmbH in close cooperation with the Bavarian Bioeconomy Expert Council (SVB) and the Interministerial Working Group on Regenerative Raw Materials and Bioeconomy along with Bavarian clusters. This strategy defines specific measures for significantly reducing the utilisation of fossil raw materials and CO_2 emissions in Bavaria.

With proposals and examples of innovation from business and science the strategy was formulated for how Bavaria, as territorial state with traditionally strong agriculture, food, forestry and timber industry, can implement the concept of the bioeconomy. The primary issue here is the replacement of fossil resources as raw material for energy and production with raw materials and products from forestry and the agricultural sector. Particularly in the area of timber products and the use of timber as raw material, new production chains and the establishment of new sales markets are anticipated, even for the increasing deciduous wood types.

"With this strategy, we as state government are helping businesses and researchers develop products that are competitive and ready for market. For the domestic forestry and timber industry in particular, in the medium and long term at a minimum completely new markets will open up."

Hubert Aiwanger, Bavarian State Minister for Economic Affairs, Regional Development and Energy

The fact that industry-specific stakeholders such as the Forestry and Wood Cluster are involved in determining the strategy, is all the more important: "We welcome the large-scale participation process for the bioeconomy strategy and we are certain that we as cluster initiative can provide important impetus for the Bavarian forestry and timber industry," remarks Dr. Jürgen Bauer of the Forestry and Wood Cluster in Freising.

Bavarian Bioeconomy Expert Council (SVB)

The goal of the SVB is to "promote a dialogue in society focused on the bioeconomy and develop the recommendations for the general conditions required for successful implementation of a bio-based economy." The composition of the SVB demonstrates that the Bavarian state government views the bioeconomy as a task involving the whole of society: Members of the council contribute expertise from fields such as biodiversity, nutrition, safe and healthy food, biogenic sources of energy, biotechnology, industrial utilisation of regenerative raw materials, sustainable products from forestry and agriculture, and environmental and social ethics. The office of the SVB is located within C.A.R.M.E.N. e.V., at the Centre of Excellence for Renewable Resources (KoNaRo) in Straubing.

Based on:
"Whitepaper, Bioeconomy as an Economic System", Bayern Innovativ GmbH, 2021

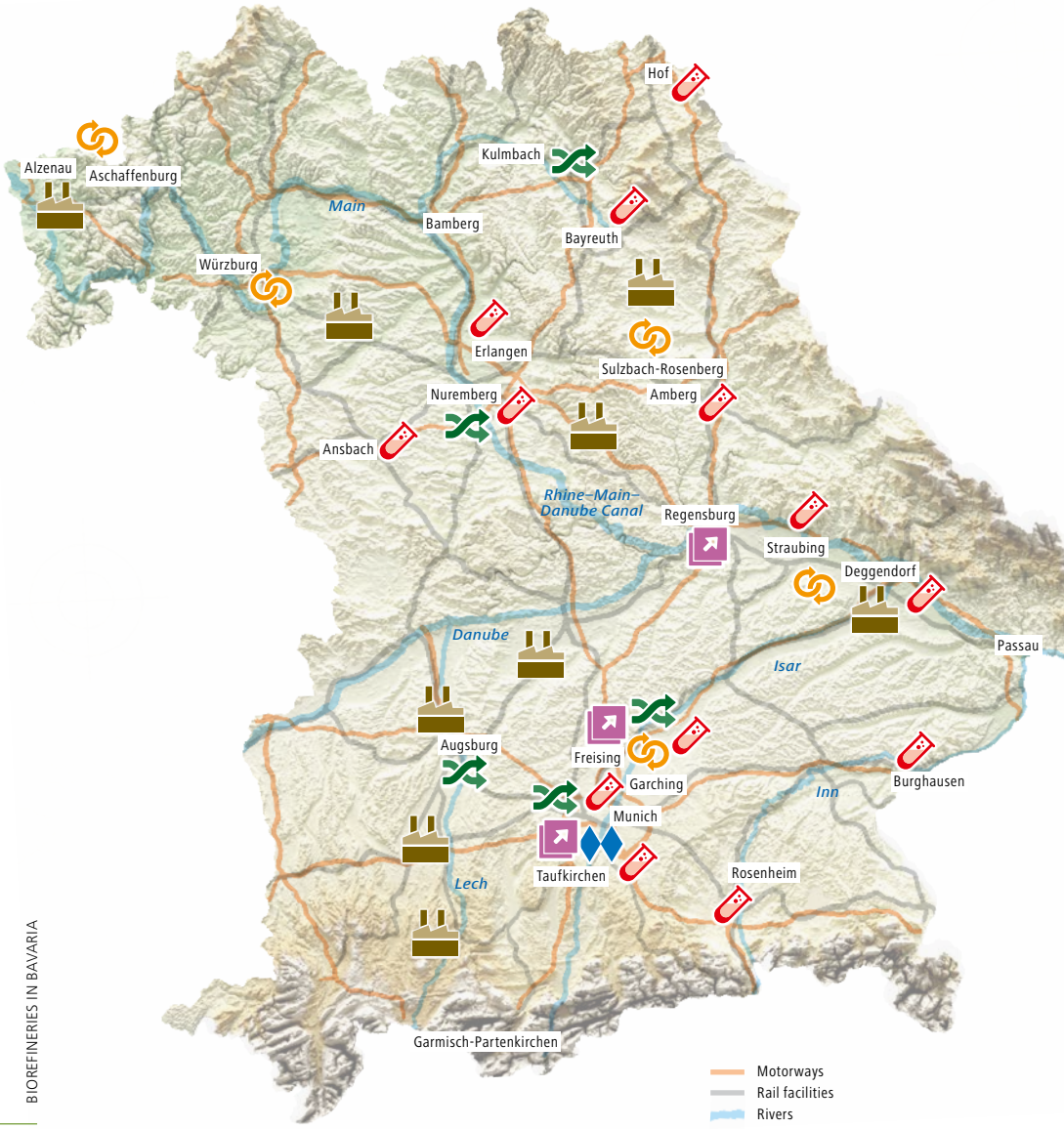
Success through networks

In the framework of its Cluster Offensive Bavaria, the Bavarian state government supports the operation of 17 state-wide platforms in high-tech and traditional industries of the Bavarian economy. The central focus of the cluster platforms is to link up companies with other companies and research institutes. Thanks to the strong professional orientation of Bavarian cluster policies, collaboration with the clusters opens up access to a densely linked network of companies of all sizes – from specialised suppliers and producers, right to service providers – outstanding research institutes and institutions of higher education and qualified experts.

Cluster Forst und Holz in Bayern

Cluster Offensive Bayern

Lignocellulose-based research and development sites in Bavaria



Legend

Associations in the Bavarian Forestry and Wood Cluster with proHolz Bayern

Bavarian state ministries with "Invest in Bavaria"

Bavarian cluster initiatives that are working on the Bavarian bioeconomy strategy

Bavarian universities and institutions of higher education doing research on the bioeconomy

Bavarian research institutes and bioeconomy network organisations

Sites of the paper, pulp and timber-derived products industry that consume wood

Associations in the Bavarian Forestry and Wood Cluster with proHolz Bayern

- Bavarian Forest Owner Association, (Bayerischer Waldbesitzerverband), Munich
- Bavarian State Forests (Bayerische Staatsforsten AöR), Regensburg
- Bavarian Farmers Association, (Bayerischer Bauernverband), Munich
- Bavarian Paper Associations (Bayerische Papierverbände), Munich
- Association of the Wood Industry and Plastics Processing Bavaria/Thuringia in the Federal German Sawmill and Wood Industry Association (DeSH) (Verband der Holzindustrie und Kunststoffverarbeitung Bayern/Thüringen e. V. im Deutschen Säge- und Holzindustrie Bundesverband e. V. (DeSH)), Munich
- State Guild of the Bavarian Carpenter Trade (Landesinnungsverband des Bayerischen Zimmererhandwerks), Munich
- proHolz Bayern, Freising

Bavarian state ministries with "Invest in Bavaria"

- Bavarian State Ministry of Food, Agriculture and Forestry (StMELF), Munich
- Bavarian State Ministry of Economic Affairs, Regional Development and Energy, Munich
- "Invest in Bavaria – The Business Promotion Agency of the Free State of Bavaria, Munich"

Bioeconomy institutions in Bavaria

Cluster initiatives and networks

- Bavarian Corporation for Innovation and Knowledge Transfer (Bayerische Gesellschaft für Innovation und Wissenstransfer mbH), Nuremberg
- Bavarian Chemistry Cluster (Chemie-Cluster Bayern GmbH), Munich
- Food Cluster, Kulmbach
- Bavarian Forestry and Wood Cluster (Cluster Forst und Holz Bayern gGmbH), Freising
- Industrial Biotechnology Cluster (Cluster Industrielle Biotechnologie Bayern Netzwerk GmbH), Munich
- New Materials Cluster, Bayern Innovativ GmbH, Munich
- Environmental Technology Cluster (Trägerverein Umwelttechnologie-Cluster Bayern e.V.), Augsburg

Universities and institutions of higher education

- **University of Erlangen–Nuremberg** – Research on sustainable food production and materials sciences
- **Ansbach University of Applied Sciences** – Research on sustainable and climate-neutral generation of biomass and resource efficiency
- **Hof University of Applied Sciences** – Development of natural bioplastics and biogenic additives as well as compounding, extrusion and injection moulding, and the recycling of biopolymers
- **Munich University of Applied Sciences** – Development of sustainable materials, e.g. biocementation or utilisation of plant proteins from by-products for technical applications
- **Weihenstephan-Triesdorf University of Applied Sciences** – Research and development inter alia in biotechnology, bioengineering, utilisation of biomass, forestry, agriculture and food technology
- **University of Applied Sciences Amberg-Weiden** – Course of study in biotechnology and environmental process engineering
- **Deggendorf Institute of Technology** – Development of sustainable plastics and bionic solutions (BayBionik project network)
- **Nuremberg Technical University** – Research on uses of lignocellulose from wood to produce innovative bio-based substances and products
- **Rosenheim University of Applied Sciences** – Research and development for the wood-based bioeconomy, with focus on wood and plastics technology, chemical engineering on the Burghausen campus, planning of the centre for bio-based materials in Waldkraiburg
- **Technical University of Munich** With Straubing campus for biotechnology and sustainability, the TUM Pilot Plant for Industrial Biotechnology in Garching, and the technical facility for algae cultivation at the Ludwig Bölkow Campus, Taufkirchen
- **University of Bayreuth** – Research on microorganisms and enzymes as biocatalysts for industrial production and bio-based materials and substances

Research institutes and network organisations

- **The Bavarian State Institute of Forestry (LWF), Freising** – Research institute of the Bavarian Forestry Administration. Applied R&D work as foundation for sustainable forest management
- **The Bavarian State Institute of Agriculture (LfL), Freising** – Bavarian State Ministry of Food, Agriculture and Forestry (StMELF) research institute, research for sustainable agriculture and food industry
- **BioCampus Straubing** – Strengthening of the Straubing region in the field of regenerative raw materials and bio-based economy, inter alia through the Technology and Entrepreneur Centre, the PlanB Biobased.Business.Bavaria entrepreneur competition, and the planned BIOCAMPUS MULTIPILOT multi-use demonstration facility
- **Bioeconomy Council, Straubing** – Consultation services to the Bavarian state government on development and designing the general conditions for implementing a bio-based economy in Bavaria and promotion of dialogue in society
- **C.A.R.M.E.N. e.V., Straubing** – The central agricultural raw material marketing and energy network for coordinating collaborations in the field of regenerative raw materials between state, science, agriculture and forestry as well as businesses
- **Fraunhofer IGB, Straubing location**– Inter alia research on industrial biotechnology, bio-inspired chemistry, and sustainable catalytic processes
- **Fraunhofer ISC, Würzburg** – Research on finishing and efficient utilisation of the substance of biogenic materials
- **Fraunhofer IVV, Freising** – Research on sustainable foods, packaging, recycling and environment
- **Fraunhofer IWKS, Alzenau** – Research on bio-based raw materials, bioplastics, phosphor recovery, urban mining, separating and sorting technology
- **Fraunhofer UMSICHT, Sulzbach-Rosenberg** – Technologies for processing biogenic residual and waste products for synthetic fuels and base materials for chemicals and chemical recycling
- **NAWAREUM, Straubing** – Information and theme centre focused on transforming the energy and raw materials supply in Bavaria
- **The Technology and Support Centre (TFZ), Straubing** – Research on the provision and utilisation of energy sources and raw materials from harvested goods and residual products from agriculture and forestry
- **SKZ Würzburg** – Materials development of biopolymers for a variety of plastics applications

Based on:
"Whitepaper, Bioeconomy as an Economic System", Bayern Innovativ GmbH, 2021

Activities in the Bavarian Forestry and Wood Cluster

With an annual turnover of **41 billion euros, a work force of 163,000, and 22,500 business operations**, the forest, timber and paper economy is a key industry in Bavaria (LWF, 2020). The Cluster Initiative implements the following goals related to the bioeconomy:

1. Formation of a bioeconomy network in the Bavarian university scene

The linking-up of various areas of expertise related to wood at Bavarian institutions of higher education and research institutes has been actively promoted by the Bavarian Forestry and Wood Cluster since 2018.

2. Expansion of the support infrastructure

The Free State of Bavaria is continuously expanding the support infrastructure. Bavarian cluster policies support innovative projects for the development and implementation of the bioeconomy from the research lab right to production on an industrial scale. Here, the Forestry and Wood Cluster Initiative works in close cooperation with pertinent ministries and state offices.

3. Cross-clustering and cross-industry networking

The goal of strengthening "cross-clustering" – which refers to cross-industry cooperation on the state, federal and European levels – is to improve the networking of the different industries and involve them in development early on. Close contacts are generated especially in the neighbouring clusters of New Materials, Chemistry and Environment.

4. Cross-border cooperation and internationalisation

In the course of interregional networking, in a first step cooperation between Bavaria and bioeconomy clusters in Scandinavia and bordering regions in Central Europe is being strengthened.

5. Innovation management

The focus of innovation management is on strengthening the innovative power of all stakeholders along the forest and wood value-added chain. On one hand, small and medium size enterprises are engaged, but also important key stakeholders and users of new kinds of technologies are targeted. The technical forums "bonding wood" or "wood as new work material" operated by the cluster and its partners can be viewed in this context. See www.cluster-forstholzbayern.de for more information.

6. Promoting the wood-based bioeconomy on the political level

To transform the economy, the support of society and politics is essential. This cannot be obtained without promoting the opportunities the bioeconomy offers. The proHolz Bayern promotion organisation at Cluster gGmbH makes it possible to effectively achieve this goal with the help of numerous exhibitions and information campaigns.