

TUMCS

TUM

Technical University of Munich

Campus Straubing

for Biotechnology and Sustainability





*Students at the campus in Straubing,
in the background the towers of St. Peter's Church*

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Preface



Prof. Dr. Volker Sieber
*Rector of TUM Campus Straubing,
Chair for Chemistry of Biogenic Resources*

Dear reader,

Climate change and environmental degradation due to the exploitation of our planet are our time's challenges which we must face. To preserve Earth for future generations, we need strategies and sustainable technologies for a change towards a biobased economy.

Under the umbrella of Bioeconomy the Campus Straubing for Biotechnology and Sustainability of the Technical University of Munich (TUM) unites expertises in numerous disciplines to develop innovative solutions. With a range of courses unique in Germany, TUM Campus Straubing (TUMCS) develops experts who shape a sustainable future and the path to reach it.

On the following pages you learn more about the TUMCS and how we further the change toward a more sustainable economy and way of life.

Sincerely,

A handwritten signature in blue ink, appearing to be 'V. Sieber', written in a cursive style.



*New building „Nachhaltige Chemie“
Uferstraße, Straubing*

Technical University of Munich

The Technical University of Munich (TUM) is one of the most research-intensive technical universities in Europe with around 600 professors, over 45,000 students and 11,000 employees.

Its focus is on engineering, natural sciences, life sciences and medicine, linked with economics and social sciences. TUM acts as an entrepreneurial university that promotes talent and creates added value for society. Thereby it benefits from strong partners in science and industry. It is represented worldwide with the TUM Asia campus in Singapore and liaison offices in Brussels, Mumbai, Beijing, San Francisco, and São Paulo.

Nobel Prize winners and inventors like Rudolf Diesel, Carl von Linde and Rudolf Mößbauer conducted research at TUM. It was named a

university of excellence in 2006, 2012 and 2019. In international rankings, TUM ranks regularly among the best universities in Germany.

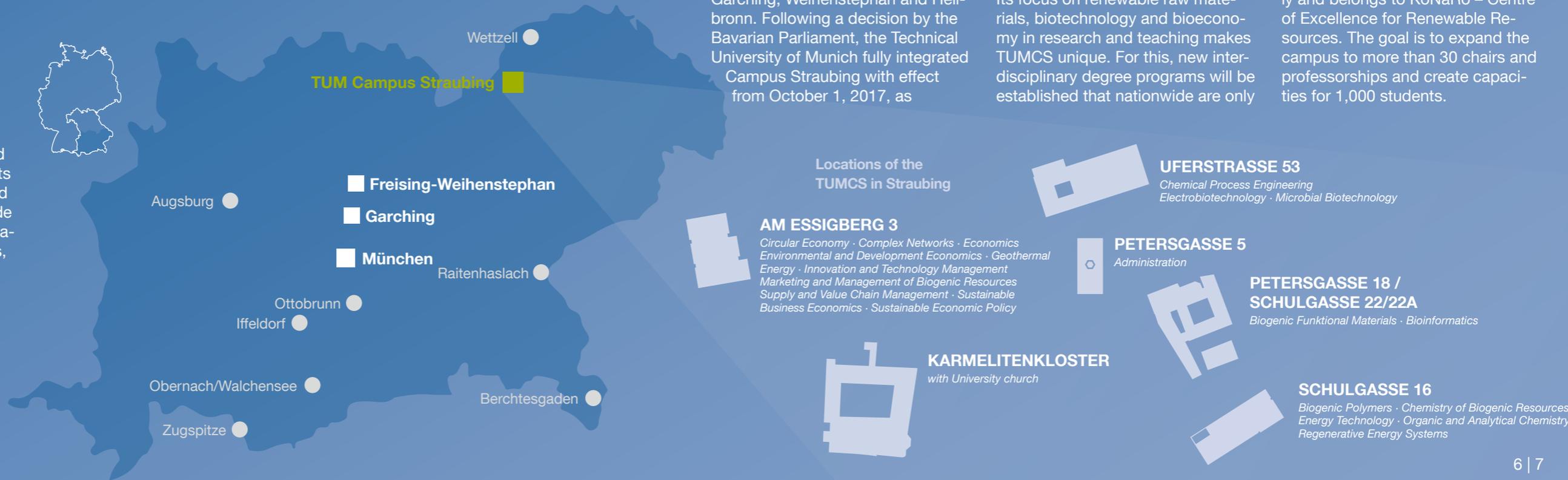


TUM Campus Straubing

The Campus Straubing for Biotechnology and Sustainability is one of five major locations of the TUM in Germany besides Munich, Garching, Weihenstephan and Heilbronn. Following a decision by the Bavarian Parliament, the Technical University of Munich fully integrated Campus Straubing with effect from October 1, 2017, as

an Integrative Research Center. Weihenstephan-Triesdorf University of Applied Sciences (HSWT) acts as a close cooperation partner. Its focus on renewable raw materials, biotechnology and bioeconomy in research and teaching makes TUMCS unique. For this, new interdisciplinary degree programs will be established that nationwide are only

offered by TUM in Straubing. Currently, 20 professors work at Campus Straubing which expands its teaching capacities systematically and belongs to KoNaRo – Centre of Excellence for Renewable Resources. The goal is to expand the campus to more than 30 chairs and professorships and create capacities for 1,000 students.



FOUNDATION

Centre of Excellence for Renewable Resources together with the Technology and Support Centre and C.A.R.M.E.N. e.V.

GOAL

6 professorships



1998–2001

2008

INAUGURATION

of the new building at Schulgasse 16

2009



2012

START EXPANSION 3.0

with eight new degree programs

GOAL

30 professorships, 1.000 students

2015



2017

INAUGURATION

module construction at Schulgasse 22a and appointment of seven new professors

2018



2021



START

of teaching activities with the master program Renewable Resources



START EXPANSION 2.0

with the bachelor program Renewable Resources

GOAL

12 professorships, 500 students



REORGANIZATION

as TUM Campus Straubing for Biotechnology and Sustainability in cooperation with Weihenstephan-Triesdorf University of Applied Sciences

TUMCS



COMPLETION

of the new building „Nachhaltige Chemie“ at Uferstraße with lecture theater

Renovation former youth office/Petersgasse 5

Research Profile



As an Integrative Research Center of the Technical University of Munich, the TUM Campus Straubing stands for interdisciplinary research for the realization of sustainable change in raw materials and energy supply in all areas of life.

The overexploitation of fossil and natural resources, the associated release of climate-damaging gases with the consequence of global warming, the shortage of key raw materials as well as increasing amounts of waste are decisive arguments for a comprehensive change towards the sustainable use of biogenic raw materials. The use of renewable raw materials in chemical, material and energy value chains makes a comprehensive and diverse contribu-

tion to the sustainable supply of raw materials and energy.

Central areas of research are bioeconomy, circular economy, establishment of new and innovative high-performance technologies for the material and energetic use of biogenic and other regenerative raw materials as well as their economic evaluation. In addition, we support innovations in bioeconomy by developing business models, novel products and technologies and bringing them to market maturity with the central goal of a sustainable economy.

The following pages contain information regarding research focuses and selected projects at TUMCS.

Biogenic Materials

Materials are fundamentally important for innovations in engineering as well as for the manufacturing of consumer goods. Biogenic and biobased materials from renewable resources are a prerequisite for the sustainable production of advanced structural and functional materials for a variety of applications in all areas of industry (automotive, mechanical engineering, aviation, boat building), society (architecture, civil engineering, medicine) and environment (energy technology, recycling, biodegradation).

RESEARCH GROUPS



Prof. Dr. Rubén Costa
Biogenic Functional Materials



Prof. Dr. Herbert Riepl
Organic and Analytical Chemistry



Prof. Dr. Volker Sieber
Chemistry of Biogenic Resources



Prof. Dr. Cordt Zollfrank
Biogenic Polymers

Biopolymers and bionic light guides

Light guides play an important role in advanced data transmission. The Chair for Biogenic Polymers (Prof. Zollfrank) develops optical fibers and waveguides which consist solely of renewable resources. Cellulose from wood, especially, is a material with high potential for use in optical technologies. In a cooperation project with the University of Bayreuth (FibreLab), based on biological models optical fibers, among other things, are created from composite material made from cellulose and spider silk proteins. The starting materials for biopolymer and bionic light guides are sustainably available and possess favorable, environmentally compatible characteristics.

Bio-hybrid LEDs and Solar Cells

The Chair of Biogenic Functional Materials focuses on building bridges between biology and technology for next-generation bio-hybrid lighting (LEDs and LECs) and photovoltaics (solar cells and windows). Are biogenic materials stable enough for your technologies at home? Can we produce parts of our structural components based on bacteria? Well, the answers are yes! The goal of Prof. Costa and his team is the advancement of commercial LEDs, LECs and solar windows to replace until now expensive, rare, toxic, or difficult to recycle materials with sustainable and affordable protein materials without performance losses.

Chemical Biotechnology

Chemical or industrial biotechnology is one of the future key technologies of bioeconomy and uses enzymatic and microbial systems to produce a variety of bulk and fine chemicals, fuels, materials, and pharmaceutical precursors based on renewable raw materials. Applying biochemistry, biocatalysis, bioinformatics, bioprocess engineering, electrobiotechnology, microbiology, molecular and synthetic biology, new sustainable production processes are developed and optimized.

RESEARCH GROUPS



Prof. Dr. Bastian Blombach
Microbial Biotechnology



Prof. Dr. Dominik Grimm
Bioinformatics



Prof. Dr. Nicolas Plumeré
Electrobiotechnology



Prof. Dr. Volker Sieber
Chemistry of Biogenic Resources

Vibrio natriegens – the new platform for industrial biotechnology

Vibrio natriegens is the fastest growing, non-pathogenic organism on our planet which, under optimal conditions, can double in less than ten minutes. Due to this outstanding capability, this bacterium is a promising new platform organism to generally increase productivity and decrease production costs of future biotechnological processes significantly. To fully draw from this potential, the professorship Microbial Biotechnology (Prof. Blombach) develops innovative production processes to produce chemicals and fuels from biogenic resources using *Vibrio natriegens*.

Design of enzymes for the synthesis of biobased products

Nature holds ready a multitude of biocatalysts (enzymes) to transform biogenic substrates efficiently. However, these enzymes seldom meet the demands of technical processes which is why they need to be optimized in their robustness, amongst other things. Synthesis of new biobased products also requires especially designed enzymes with new mechanisms and specificities. The two professors, Dominik Grimm (Bioinformatics) and Volker Sieber (Chemistry of Biogenic Resources), work together on designing those innovative enzymes using protein chemical forecasts, microfluidic ultra-high throughput analytics and machine learning.

Sustainable Chemicals & Processes

A large number of basic and fine chemicals, fuels, and other products can be produced via material use of biogenic resources and via recycling. In the interdisciplinary collaboration of chemistry, biotechnology, energy engineering, and process engineering, novel sustainable synthesis pathways and respective processes are developed.

RESEARCH GROUPS



Prof. Dr. Bastian Blombach
Microbial Biotechnology



Prof. Dr. Jakob Burger
Chemical Process Engineering



Prof. Dr. Matthias Gaderer
Regenerative Energy Systems



Prof. Dr. Herbert Riepl
Organic and Analytical Chemistry



Prof. Dr. Volker Sieber
Chemistry of Biogenic Resources



Prof. Dr. Cordt Zollfrank
Biogenic Polymers



Data Science & Optimization

Data science, the generation of knowledge from data, is gaining importance in an increasingly digitalized world. The methods used are numerous and range from the analysis of big data to state-of-the-art data mining and machine learning methods. This goes along with the increasing application of discrete and quantitative methods of applied mathematics and informatics. This includes the development and application of optimization models and methods for decision support.

RESEARCH GROUPS



Prof. Dr. Jakob Burger
Chemical Process Engineering



Prof. Dr. Dominik Grimm
Bioinformatics



Prof. Dr. Alexander Hübner
Supply and Value Chain Management



Prof. Dr. Clemens Thielen
Complex Networks

Optimization to adapt to climate change

Given the extent of damage of heavy rainfall and the increased frequency of these events due to climate change, one of the key challenges in urban drainage systems is how to handle floods caused by heavy rain.

Within Prof. Thielen's project "Incentive systems for communal flooding precautions (AKUT by its German initials)" innovative optimization models are developed to determine the best possible precaution concepts and the necessary incentives for their implementation with citizen participation.

Reinforcement learning in process engineering

This area of machine learning enables training of an artificial intelligence (AI) to independently solve a certain problem. This joint project of Prof. Burger and Prof. Grimm uses and expands this concept to support the planning process for synthesis of flow diagrams in process engineering. In this process, the AI creates flow diagrams to given tasks and subsequently receives feedback which directs the learning process.

Renewable Energies

Renewable energies can make an enormous contribution to the decarbonization of the energy sector. In addition to improving the supply of energy from fuels such as biomass or residual materials, another focus is on integrating renewable energies into the existing energy system. Through innovative approaches and ideas, we actively help to shape the transformation of the energy system.

RESEARCH GROUPS



Prof. Dr. Jakob Burger
Chemical Process Engineering



Prof. Dr. Matthias Gaderer
Regenerative Energy Systems



Prof. Dr. Josef Kainz
Energy Technology



Prof. Dr. Thomas Vienken
Geothermal Energy

OME as an alternative to diesel fuel

Synthetic fuels like oxymethylenether (OME) can lower CO₂ emissions and result in a cleaner combustion. To produce components for OME as an alternative to diesel, Prof. Burger, chair of Chemical Process Engineering established a demonstration plant at TUM Campus Straubing.

OME is a group of substances – which due to integrated oxygen burns practically soot-free – of which only a certain part is suitable for usage as fuel. The demonstration plant produces exactly this component and realizes the “OME Technologies Process” at pilot scale.

Biogas as time-independent renewable energy source

Within the project „BioCore“ of the professorship of Regenerative Energy Systems (Prof. Gaderer) and the Chair of Energy Systems (TUM Garching) a new technology for the use of biogas is being developed. Biogas is a renewable energy source which is independent of weather conditions. This technology – based on a combination of high-temperature fuel cell and electrolysis – for the provision of electricity and methane gas reaches a significantly more efficient and economical exploitation of biogases.

Further research areas are, amongst others, the increase in efficiency of biobased energy systems through better usage of warmth at a low temperature level and the evaluation of fuels which are produced through synthesis of hydrogen and CO₂ with renewable power (e-fuels).

Management & Sustainability

To enable the structural change towards a bioeconomy and more sustainable economic systems, it is essential to accompany the transformation processes from an economic and social perspective. This is achieved through basic and application orientated research in core subjects of management, economics, and sustainability sciences.

RESEARCH GROUPS



Prof. Dr. Claudia Doblinger
Innovation and Technology Management



Prof. Dr. Magnus Fröhling
Circular Economy



Prof. Dr. Alexander Hübner
Supply and Value Chain Management



Prof. Dr. Klaus Menrad
Marketing and Management of Biogenic Resources



Prof. Dr. Hubert Röder
Sustainable Business Economics

We save food

In Germany, every year close to twelve million tons of food end up as waste. The challenge of the food trade is to meet customers' needs for fresh and available products, and at the same time reduce overstock. Therefore, Prof. Hübner and his team research how to avoid food waste in trade through intelligent planning and logistics concepts combined with high customer satisfaction. They identify relevant influencing factors in business processes and use these to optimize current calculation methods and, thus, address profitability and resource protection equally.

Flexible concepts for living

The professorship Circular Economy (Prof. Fröhling) and the professorship Marketing and Management of Biogenic Resources (Prof. Menrad) are developing together with C.A.R.M.E.N. e.V. and regional wood construction companies three special living concepts. When reaching retirement age, living space needs to meet the same requirements as living space used by young families: it needs to be affordable and comfortable, for example, or offer a healthy indoor climate. Behind these criteria stand the aspects of ecology, economy, and social justice. The project examines the question of how these criteria can be integrated in actual living concepts.

Economics & Sustainable Policy

The change to a bioeconomy carries far-reaching economic and social consequences. These cause economic questions on micro and macro levels: Which economic and regulatory frameworks are necessary for the bioeconomy to be truly more sustainable? Which consequences result from the bioeconomy regarding poverty, food security and inequality? How do consumers and voters perceive this change and how can economic behavioral research help increase acceptance for a bioeconomy? These and other questions are answered by fundamental and applied research with the help of empirical approaches.

RESEARCH GROUPS



Prof. Dr. Anja Faße
*Environmental and
Development Economics*



Prof. Dr. Sebastian Goerg
Economics



Prof. Dr. Andreas Ponderfer
Sustainable Economic Policy

International repercussions of local acting

Transformation to a bioeconomy calls for complex political measures to work on a national level in a most efficient and cost-effective way. Prof. Faße focuses on the German and European point of view of creating a portfolio of such measures which is linked tightly with repercussions on international trade and prosperity of emerging and developing countries which are suppliers of important natural resources but also buyers of bioeconomic products. These global effects of national acting enable a holistic view on the necessity of an international bioeconomy strategy.

Social change and human behavior in bioeconomy

Change from a fossil-based economy to a sustainable biobased economy requires broad social acceptance. In Germany, too, there are big differences regarding the support of various options for action to design a bioeconomy. Based on representative surveys the professorships Economics (Prof. Goerg) and Sustainable Economic Policy (Prof. Ponderfer) link socio-economic variables with attitudes to such topics as bioeconomy and sustainability on an individual level. Such links allow purposeful development and assessment of political measures.

Education



Prof. Burger and students during a course

If you want to change the world in a sustainable way, the TUM Campus Straubing offers various possibilities for studying. Although all study programs pursue the goal of qualification in the field of sustainability and bioeconomy, the choice of the course of study can lead to different emphases depending on personal interests.

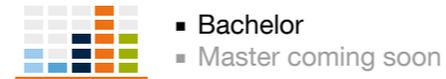
The focus of research and study at the campus is on the areas of chemical use and energy recovery, the development of sustainable materials and research into economic aspects relating to the production, marketing and use of renewable raw materials. By choosing a course of

study and various optional modules, students can specialize in one area or cover a broad range of sustainability topics.

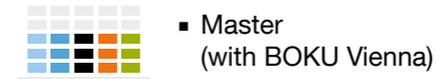
Due to a particularly high supervision ratio, the described choices, and the close connection of basic and application oriented as well as interdisciplinary research and teaching, study at the TUM Campus Straubing responds very well to students' interests, offers flexibility and a view beyond one's own nose and, thus, prepares optimally for professional challenges.

INTERDISCIPLINARY STUDY PROGRAMS AT TUMCS

BIOGENIC MATERIALS



BIOMASS TECHNOLOGY



BIOECONOMY



CHEMICAL BIOTECHNOLOGY



TECHNOLOGY OF BIOGENIC RESOURCES



SUSTAINABLE MANAGEMENT AND TECHNOLOGY





The Green Office at

TUM Campus Straubing

The Green Office (GO) is a contact point for impulses on the subject of sustainability and deals with their practical implementation on campus. It is run by students for students, so that they can become designers of change at the universities. Sustainability should be anchored in the various university structures through the GO with Jonathan Bauer (pictured left) and Adrian Heider (pictured right). At the same time, the aim is to promote and stimulate a more sustainable way of life for all actors on campus. In addition, we will carry our ideas and topics

to schools and the public. Furthermore, the GO coordinates projects, simplifies the communication of existing initiatives, networks actors and sets new impulses itself.

Projects within the framework of the GO can be of very different kinds: from initiatives for waste separation and recycling, to lectures, lecture series or auditorium cinemas, to workshops and excursions, there is a whole range of possibilities.

Contact: greenoffice@cs.tum.de

Studying in Straubing



LEISURE & CULTURE

This young university city in Lower Bavaria covers an area of 68 km² and is home to almost 48,000 residents. It is the vibrant center of the fertile Gäuboden with 8,000 years of history where tradition, modernity and innovation are united successfully.

Straubing is connected with Europe through good traffic connections, a train station, the airfield Straubing-Wallmühle and the port of Straubing-Sand. Due to its position at the Danube and its close proximity to the Bavarian Forest, Straubing offers a great variety of leisure opportunities as a perfect balance to research and studies.

LIVING

Aside from excellent studies and the possibility of obtaining a prestigious degree at TUM, regarding living Straubing also has advantages over metropolitan cities: looking for a room or an apartment is easier and quicker. Consequently, the start of university life is more relaxed and makes it possible to concentrate on studies right from the start.

Region of Renewable Resources

For years Straubing has been enjoying the excellent reputation as the “region of renewable resources” far beyond eastern Bavaria. Not only the city itself, but also the county Straubing-Bogen as well as numerous partners from society, politics, industry, and academia have dedicated themselves to sustainability like TUM Campus Straubing.

Agricultural and forestry land throughout the Gäuboden as well as the Bavarian Forest and the port at the Danube facilitate the supply of millions of tons of biomass for commercial use.

In Straubing more and more industrial companies use biobased resources originating from the European Danube area. The region therefore offers excellent prerequisites to master the approaching change in raw materials in the industry. Wood in particular is a key resource of the region which is also considered the sprout of the Bavarian bioeconomy.

In the vicinity TUM Campus Straubing cooperates closely with research and education facilities as well as technical research institutions such as the Technology and Support Centre (TFZ), the Centralen Agrar-Rohstoff-Marketing- und Energie-Netzwerk Central Agricultural Resources Marketing and Energy Network (C.A.R.M.E.N. e.V.) at KoNaRo - Centre of Excellence for Renewable Resources or the institutional part BioCat of the Fraunhofer Society.

The BioCampus and the BioCubator at the Technology and Start-up Center – both located at the port Straubing-Sand – are further important actors for the profiling of the region as an industry and technology location for renewable resources. Amongst others, two TUM spin-off companies are located at the port: CASCAT (a biotechnology company) and Green Survey (an agency for market investigation). Both of whom won the “Plan B” founder competition of the BioCampus and established successful green start-ups.



Cooperation



The Weihenstephan-Triesdorf University of Applied Science (HSWT) has been cooperating successfully with the Technical University of Munich (TUM) for several years – first at the former Straubing Center of Science, and more recently at the Campus Straubing for Biotechnology and Sustainability of the TUM (TUMCS). Currently, eight HSWT professorships teach in Straubing and conduct interdisciplinary research on topics related to the use of biogenic resources. The HSWT professorships at the TUMCS usually have a second membership at the TUM.

www.hswt.de

**UNIVERSITÄT FÜR
BODENKULTUR WIEN**



Straubing has been cooperating successfully with the University of Natural Resources and Life Sciences Vienna (BOKU) for a long time. First, the former Centre of Science Straubing started collaborating with BOKU in 2008 for the master program Renewable Resources (double degree). As of late the program Biomass Technology exists as a joint degree of BOKU and TUM Campus Straubing and offers the opportunity of a broadly diversified education in the field of biomass production and use. Thereby the partners' expertises complement each other.

boku.ac.at

**UNIVERSITÉ DE
TUNIS EL MANAR**



Within the project of the Deutschen Akademischen Austauschdienstes (DAAD) and the „TUM.Africa“-initiative a joint master program was created, „Technology and Management of Renewable Energies“ at TUM and the Université Tunis el Manar in Tunisia. The aim is to educate students from all African countries on the development, implementation and maintenance of a power supply system that is based on renewable energies and adapted to the specific situations of African countries. Parts of TUMCS's range of courses are integrated into this offered course.

www.utm.rnu.tn



**GLOBAL BIOECONOMY
ALLIANCE**

Established at TUM Campus Straubing this network unites leading universities in the field of bioeconomy. This currently trilateral alliance of TUM, University of Queensland (Australia) and Universidade Estadual Paulista (Brazil) creates a platform for student exchange, joint studies and the transfer of experience and analyzes social and economic repercussions of economic change. Currently in negotiations to join are potential future partners such as universities in Canada, China, and Africa.

www.bioeconomy.world



**SYNBIOFOUNDRY
@TUM**

SynBiofoundry is a technology and automation platform for synthetic biology at TUMCS. This platform was established by Prof. Sieber, Prof. Blombach and Prof. Grimm to develop and optimize biotechnological production processes for academia and industry. Apart from developing biocatalysts and microbial production processes SynBiofoundry also offers support for entrepreneurial ideas and scaling of new and existing processes. Through inter-disciplinary research new technologies are developed in line with bioeconomy together with university and industry partners.

cs.tum.de/forschung/synbiofoundry



**SUSTAINABILITYDIALOGUE
@TUM**

In 2019 the SustainabilityDialogue@TUM was started to develop and establish sustainable industry and economy systems. It is a platform for a regular exchange of knowledge and experience for industry representatives across any company or department boundaries. So far more than 20 partners from corporations, start-ups and local companies pursue interdisciplinary exchange of knowledge as well as cooperation in the education on sustainability. The SustainabilityDialogue@TUM also offers a contact platform for students and industry.

www.scm.cs.tum.de

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