Karlsruhe Institute of Technology

Institute for Industrial Production

Annual Report 2025

Chair of Business Administration, Production and Operations Management




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Preface

This annual report of the Chair of Business Administration, Production and Operations Management at the Institute for Industrial Production (IIP), Karlsruhe Institute of Technology (KIT) reflects our main activities during the year 2025. Our three research groups "Sustainable Value Chains", "Resilient Systems and Risk Management", and "Resource Management in the Built Environment" have conducted numerous projects on a regional, national and international level covering a broad range of topics around production, logistics, circular economy, risk management, and others. The team of the Chair consists of about 25 researchers, 4 administrative staff and a several student assistants.

During 2025, we worked on 26 third party funded research projects. We published 15 peer-reviewed journal papers, numerous articles in conference proceedings and book chapters. 2 PhDs were completed. Teaching activities resulted in around 530 exams, about 65 bachelor and master theses were supervised. Furthermore, to the various activities at KIT, we managed to continue and broaden our national and international networks.

We hope that this report inspires your interest in our activities. Any comments are welcomed. We look forward to future collaborations around our research and teaching activities.

Prof. Dr. Frank Schultmann

Research Groups

Sustainable Value Chains

Head of research group: Dr. Andreas Rudi

The research group Sustainable Value Chains develops strategies for a more sustainable design of value chains and production systems as well as the affiliated logistical, organisational and information related functions. In this context, sustainability is defined as the joint consideration of economic, ecological and social aspects. Major areas of research are related to circular economy concepts regarding both material or product cycles (closed-loop supply chains, reverse logistics) and the use of renewable, bio-based resources in industrial value chains (bioeconomy).

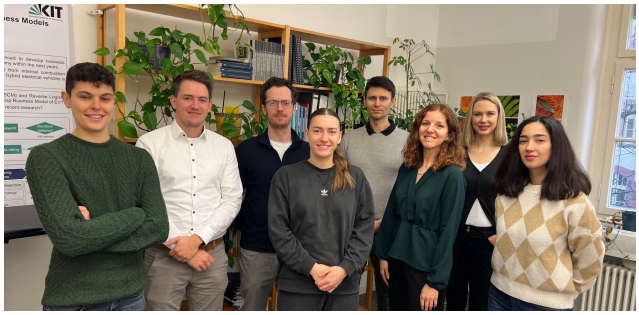
To cope with the related manifold problems, different approaches from economics, engineering as well as environmental and social sciences are implemented, adapted and enhanced. Interdisciplinary methods and models are developed based on the regarded problems and transferred to specific industrial applications.

A focus task is the development of multi-dimensional planning models that enable an integrated analysis, assessment and optimization of material streams, complex interconnected plants or complete production networks. Other aspects considered are empirical stakeholder and acceptance analyses and policy advisory.

A further aim of our work is the development of sustainable concepts for material flow management and for decision support at regional, national and global scale. The research focus is currently on industrial plants, products and networks of the chemical and energy industry (PtX) as well as on the utilization of biomass (in biorefineries) and the production of animal-based food (pork value chain).

Typical methods applied are:

- Process simulation and system analysis
- Investment and production cost estimation (techno-economic analysis)
- Empirical social studies (especially questionnaire-based surveys and statistics)
- Life Cycle Assessment (LCA)
- Operations Research based modelling (optimization and multi-criteria decision making)



Members of the research group (from l. to r.): Alexander Schneider, Paul Heinzmann (until spring 2025), Raphael Heck, Nina Treml, Andreas Rudi, Diana Temnova Deguy, Sandra Huster (until summer 2025), Sonia Alikhah.

Resilient Systems and Risk Management

Head of research group: Dr. Sonja Rosenberg

The resilient systems and risk management research group develops and provides methods and tools for systematic and comprehensible decision support for complex, uncertain, and dynamic systems. Their research interests extend beyond traditional risk management boundaries.

Today, stakeholders such as companies, communities, and governmental institutions face uncertainties in their systems due to increased complexity from rapid technological changes, global interdependencies, and evolving regulatory landscapes. These systems can include supply chain networks, markets, or critical infrastructures and sectors. Despite the diversity of these systems, the common goal is to improve decision-making.

Consequently, the group's ongoing projects focus on various research areas:

- LandWandel: This project aims to enhance communities' capabilities to make informed and resilient decisions about climate adaptation measures. It connects the socio-technical analysis of the IIP with regional climate change modeling from project partners.
- KommMa: This project seeks to provide a comprehensive database that enables communities to develop individual climate protection strategies tailored to their specific characteristics.
- KorPSA: This research focuses on identifying potentials and risks for carbon management strategies of various stakeholders with a focus on the Upper Rhine region.

In 2025, the research group was joined by two new members, Ines Hofmann and Moritz Fierke. Additionally, Katharina Eberhardt finished her dissertation on "Strengthening Resilience for Critical Supply Chain Networks: Strategic Optimization and Decision Support".

Typical applied methods within the group are:

- (Empirical) social studies (questionnaire-based surveys and expert interviews)
- Vulnerability and scenario analysis
- Operations research based modelling with a focus on uncertainty and dynamics, including stochastic and robust optimization
- Socio-technical system analysis
- Technology forecasts and market uncertainty assessment

This year members of the group attended important national conferences and workshops such as the "Research for civil protection" by the Federal Office of Civil Protection and Disaster Assistance. Several peer-reviewed articles have been published showing the great contribution of our research projects to today's international research world. Additionally, Katharina Eberhardt successfully defended her doctoral thesis.

Members of the research group (from l. to r.): Ines Hofmann, Moritz Fierke, Katharina Eberhardt, Sonja Rosenberg.

Resource Management in the Built Environment

Head of research group: PD Dr. Rebekka Volk (until 05/25), Dr. Justus Steins (from 06/25)

The Resource Management in the Built Environment group carries out technical, economic and environmental model-based analysis of energy- and resource-efficient technologies and sustainable policies, as well as their potentials regarding the built environment. Especially, we work in the fields of circular economy and sustainable urban development.

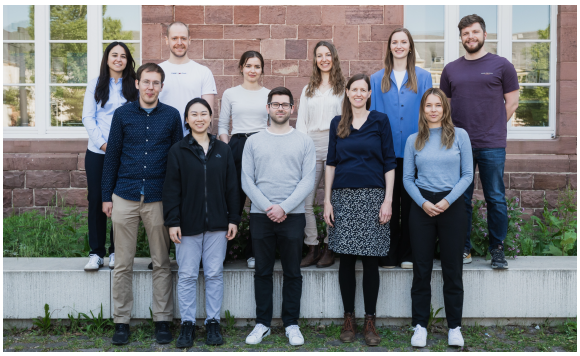
These research areas are essential to address the growing environmental and societal challenges linked to urbanization, resource scarcity, and climate change. Circular economy approaches enable a transition from linear consumption patterns toward regenerative systems that minimize waste and maximize resource efficiency. Sustainable urban development, in turn, ensures that cities evolve in a way that balances economic growth, social well-being, and ecological resilience. Together, these fields provide the foundation for transforming current infrastructures into future-ready, low-impact environments.

Typical methods used in the group are:

- Life cycle analyses based on DIN EN ISO 14040/14044 and DIN EN 15804
- (Techno-)economic assessments
- Optimization modelling (e.g., for recycling networks)
- Material and building stock and flow models

Main group activities:

- Conference contribution titled “Multi-Level Secondary Resource Hubs for Construction and Demolition Waste” at the 12th International Conference on Industrial Ecology
- Publication in the Journal of Industrial Ecology, “Future disposal surge: A new quantification approach for predicting waste from external thermal insulation composite systems in Germany”, DOI: 10.5445/IR/1000179262
- Conference contribution titled “Thermal Insulation, Lasting Consequences: Forecasting ETICS Waste and its Sustainability Challenges” at the Sustainable Built Environment 25 WesMED Conference
- Conference contribution titled “Sustainable use of post-demolition concrete as recycled aggregates and cement substitute: Recycling potential in Germany” at 15th fib International PhD Symposium in Civil Engineering in Budapest, Hungary



Members of the research group (from l. to r.): back row: Theresa Kaya, Rafael Bischof, Lena Fuhg, Elena Vollmer, Antonia Frank, and Sebastian Rauscher; front row: Niklas Braun, Xin Ying Chan, Justus Steins, Rebekka Volk and Teresa Oehlcke (missing on the picture: Simon Steffl, Janik Unterlöhner)

Research Projects

AI4EOSC – Artificial Intelligence for the European Open Science Cloud

Elena Vollmer, PD Dr. Rebekka Volk

Partners: Agencia Estatal Consejo Superior De Investigaciones Científicas M.P. (CSIC), Steinbuch Centre for Computing at the Karlsruhe Institute of Technology (KIT), Ustav Informatiky, Slovenska Akademia Vied (IISAS), Universitat Politecnica De Valencia (UPV), Predictia Intelligent Data Solutions Sl, Laboratorio De Instrumentacao E Fisica Experimental De Particulas (LIP), Istituto Nazionale Di Fisica Nucleare (INFN), Instytut Chemii Bioorganicznej Polskiej Akademii Nauk (PSNC), Microstep-Mis Spol Sro, Wielkopolski Osrodek Doradztwa Rolniczego W Poznaniu (WODR)

Funding: European Union (EU)

Duration: 2022 – 2025

The AI4EOSC project aims to deliver an enhanced set of services for the development of Artificial Intelligence (AI), Machine Learning (ML) and Deep Learning (DL) models and applications. These services will allow for advanced features such as distributed, federated and split learning; provenance metadata; event-driven data processing services or provisioning of services based on serverless computing.

The project will focus on tools to provide AI, ML and DL services by integrating real life use cases to aid in the design process and showcase the afore-mentioned functionalities. AI4EOSC bases its activities on the technological framework delivered by the DEEP-Hybrid-DataCloud H2020 project. The DEEP platform is a production-ready system that is being effectively used by researchers in the EU to train and develop ML and DL models.

The AI4EOSC consortium has been assembled to ensure a balanced and complementary set of partners with backgrounds in research, development, technology and innovation.

The IIP joins this endeavour by providing a use case on automatic, unmanned aerial system (UAS)-based thermography, centered around thermal images of city infrastructure, such as buildings and the district heating systems (DHSs). These will form a basis to test the platform's functionality and proficiency in incorporating new AI-based models to – in this case – detect thermal bridges on rooftops ("TBBRDet" model) and identify a list of DHS leak candidates through the segmentation of thermal anomalies ("TASeg" model) and common urban features ("TUFSeg" model). If possible, new platform services such as federated learning can be showcased using the provided data and AI-models.

The project kick-off took place in October 2022 at the coordinating university in Santander, Spain. The event introduced the project and discussed how the pre-existing DEEP platform will be improved. The workload was divided into seven work packages, each presenting key aims and current status, including IIP's use case in automatic thermal image analysis (work package 6). Since then, regular meetings defined user stories, epics, and requirements for the first deliverable. Further work focused on setting up a pipeline for training AI models for the use case and integrating them into the AI4EOSC platform, starting with TBBRDet.

The challenges of this integration, among other things, were discussed at a user workshop in November 2023, held in Bratislava, Slovakia.

To promote both the platform and IIP's thermography use case, a social media video was shot and webinar talk held in "ANERIS Workshops on AI Basics for Image Processing" in November and December 2023, respectively. The first version of the AI4EOSC platform was released in March 2024, alongside the software stack powering it.

Regarding the IIP's thermography-based use case, one of AI models - focused on thermal urban feature segmentation (TUFSeg) - was showcased at the Helsinki conference "AI in Architecture, Engineering

and Construction conference" in March 2024. Various experiments with this model were presented via poster at the "HaiCon24" conference in June in Düsseldorf. Aside from this, a paper titled "Detecting District Heating Leaks in Thermal Imagery: Comparison of Anomaly Detection Methods" was published in the journal "Automation in Construction" in October with accompanying code and datasets on Zenodo.

The previously mentioned experiments centered around the TUFSeg model were published in February in the paper "Enhancing UAS-Based Multispectral Semantic Segmentation Through Feature Engineering" in the IEEE's "Journal of Selected Topics in Applied Earth Observations and Remote Sensing". Both code and dataset were made available alongside on GitHub and Zenodo. Previously presented approaches on federated learning for that same application were published at the 25th "Computational Science and Its Applications" conference in June, spear-headed by the SCC partners. A presentation focusing on the energy efficiency of federated learning approaches was also held at the 2025 "EGI" conference in June.

In addition to all the afore-mentioned, the platform itself was further developed. An open call for use cases meant an additional four research groups joined the existing three use cases. In terms of the IIP use case, the new drift detection functionality was made use of for the TUFSeg model to detect the presence of data drift using "Frouros", a library developed by the CSIC project partners. A third AI model – specifically for thermal anomaly segmentation (TASeg) – was integrated into the platform and made available for training and inference. A publication describing this model and its uses for leak detection in DHSs was published in the "ISPRS Journal of Photogrammetry and Remote Sensing" under the title "Leak detection using thermal imagery: Deep learning versus traditional computer vision state-of-the-art". Again, both the dataset for model training and code were made publicly available. Tools such as MLFlow were also implemented for this application.

In addition to the listed publications, further dissemination work included the participation in the KIT-hosted German podcast "Nachgefragt – wissen wie's läuft" in February and presentation in the AI4EOSC webinar series "Exploring the Future of AI, Machine Learning, and Federated Learning" in May.

After a final project meeting in June at CSIC in Santander, Spain, AI4EOSC officially ended in August 2025. With its use case on automated thermography, the IIP contributed to three deliverables (D6.1, D6.2, and D6.3) throughout the project lifetime, discussing the planned and achieved progress. In the end, the use case was able to successfully showcase numerous platform features such as continuous integration and development (CI/CD), experiment tracking, federating learning, privacy-enabled inference, and drift detection. It also exceeded the originally planned integration of only the TBBRDet model by developing a total of three applications and publicly providing just as many datasets.

IEA EBC - Annex 89 - Ways to Implement Net-zero Whole Life Carbon Buildings

Theresa Kaya, PD Dr. Rebekka Volk

Funding: International Energy Agency (IEA), Federal Ministry for Economic Affairs and Climate Action (BMWK)

Duration: 2023-2027

In light of the critical need to align the building and real estate sector with the goals of the Paris Agreement, this research project explores the pathways and actions required to implement net-zero whole life carbon (NetZ-WLC) buildings in both policy and practice. The project addresses the necessity of considering greenhouse gas (GHG) emissions holistically, encompassing both embodied and operational emissions across all life cycle stages of buildings to achieve climate neutrality by 2050 at the latest. The overarching goal is to contribute to the limitation of global warming to well below 2°C, preferably 1.5°C, above pre-industrial levels.

The project's objectives are pursued through a multi-stage approach:

1. **Development of Guidelines and Carbon Targets**
   The project establishes whole life carbon targets and budgets for the building sector, identifying pathways and actions to align practices with Paris-compatible goals.
2. **Paris-compatible Assessment Frameworks**
   It develops and evaluates frameworks to ensure Paris Agreement compatibility, guiding NetZ-WLC implementation at all scales.
3. **Tools, Aids, and Instruments for Decision-makers**
   The project maps and evaluates decision-making tools for stakeholders, focusing on their relevance and effectiveness in supporting NetZ-WLC outcomes.
4. **In-practice Uptake of Context-based Solutions**
   It examines factors that enable stakeholders to adopt NetZ-WLC approaches, including regulatory, financial, and social aspects.
5. **Stakeholder Engagement and Knowledge Exchange**
   The project promotes engagement and disseminates findings to bridge research and practice, ensuring outputs are globally applicable.

2024 saw significant progress in Subtasks 1 and 2. Subtask 1, focusing on science-based approaches for setting and allocating Mitigation Pathways based on GHG budgets in the building and construction sector, began with an online meeting on April 22 to clarify the work program and align participant contributions. Concrete steps were outlined for the June 20–21 Berlin meeting, organized by Rebekka Volk, Thomas Lützkendorf, and Theresa Kaya. This event emphasized tools and instruments for implementing NetZ-WLC initiatives and Paris-compatible assessment methods. The meeting concluded with task coordination and planning. An additional online meeting on October 7 provided updates and prepared for the Melbourne meeting on November 18–21.

Subtask 2, focused on defining Paris-compatible decarbonization methods and aligning international climate policies with the Paris Agreement, reached key milestones.

Meetings on May 13 and October 30 reviewed progress and introduced a Danish assessment method. The Melbourne meeting (November 18–22) accelerated work on all subtasks, emphasized draft guidelines based on background reports and papers, fostered expert exchange, clarified contributions, and engaged Australian stakeholders and ExCo members to enhance the global impact of Annex 89.

In 2025, two key Annex 89 meetings structured the development of the national contributions and the methodological foundations for Subtask 1 through Subtask 4.

On 26–27 June 2025, the meeting at ETH Zurich focused on preparing the **ST1 Background Report** on national mitigation pathway starting points and

basic concepts. The work aimed to establish a coherent terminology, shared definitions and a common conceptual framework for the building and construction sector across all participating countries, ensuring comparability of national approaches. In this context, a multi-part survey was developed. The first component is a **morphological matrix** to classify methodological characteristics of national studies. The second component examines the **cross-sectoral perspective**, analysing how studies and statistics are structured and whether they link to other sectors. The third component provides **examples of how mitigation pathways can be categorised**, such as distinguishing between budget-based and policy-driven trajectories or assessing whether pathways account for all greenhouse gases or only CO_2.

The meeting on 27–28 November 2025 in Trondheim included a full status update from all participating countries for Subtask 1 through Subtask 4. Germany presented the **draft report on GHG accounting approaches in the German housing sector**, which compiles tools and methods and serves as a key contribution to Subtask 4. The Background Report for Subtask 1 was also presented, and the submission deadline was set for February 2026. The deadline for the survey responses was fixed for 15 January 2026. Germany is involved in all subtasks, contributing primarily to Subtasks 2–4 and taking full responsibility for the Background Report in Subtask.

EBC
Energy in Building and Communities Programme

CEDIM – Center for Disaster Management and Risk Reduction Technology

Resilient Systems and Risk Management group, Dr. Sonja Rosenberg

Partner: Geophysical Institute (GPI), Institute of Applied Geosciences (AGW), Institute for Industrial Production (IIP), Institute for Nuclear and Energy Technologies, Resilient and Smart Infrastructure Systems (IKET, RESIS), Institute of Meteorology and Climate Research (IMK-TRO/IFU), Institute of Photogrammetry and Remote Sensing (IPF), Institute of Regional Science (IfR), Institute for Technology Assessment and Systems Analysis (ITAS), Institute of Economics (ECON), Institute for Water and Environment (IWU)

Funding: Karlsruhe Institute of Technology

Duration: since 01/2006 (ongoing)

The Center for Disaster Management and Risk Reduction Technology (CEDIM) is an interdisciplinary research center of the Karlsruhe Institute of Technology (KIT) in the field of disaster management. The main goal of CEDIM is to advance our scientific understanding of natural and man-made hazards, and to develop disaster management solutions for the early detection and reduction of the related risks.

Facing the increasing probability of extreme events and their tremendous possible impacts on societies, it is inevitable to investigate their impacts on current and future energy, mobility and information systems. This is also more than valid, facing the aspect that through the network character of those systems, extreme events lead to cascading effects along its system parts. That is why, natural disasters can have also severe impacts far away from their place of origin. The current globalization and strong interconnectedness around the world is also increasing this aspect.

The ongoing work of the interdisciplinary CEDIM Team is to report and evaluate immediately after the occurrence of natural disaster in form of Forensic Disaster Analysis (FDA) reports. In FDA methods and findings of the different involved research disciplines are merged to reconstruct the disaster.

Furthermore, in 2025 CEDIM organized – in cooperation with the DKKV – a series of online lunch talks that showed the great variety of research conducted by CEDIM research institute. The resilient systems and risk management group participated and held a talk about current results of the LandWandel project. The talk was recorded and can be accessed online.

CARE-o-SENE – Catalyst Research for Sustainable Kerosene

Work package 4 : Impact assessment from a techno-economic and ecological perspective

Alexander Schneider, Paul Heinzmann, Dr. Andreas Rudi

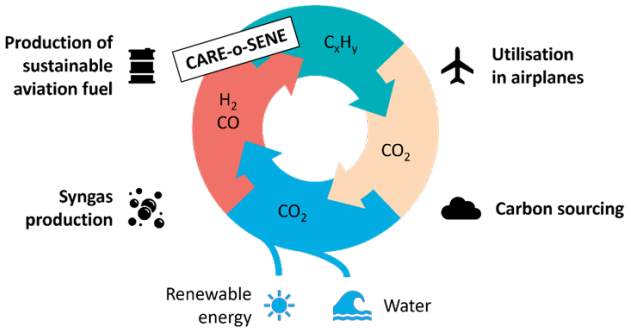
Partner: Sasol Germany GmbH; Helmholtz Centre Berlin for Materials and Energy (HZB); University of Cape Town, Department of Chemical Engineering (UCT); Fraunhofer Institute for Ceramic Technologies and Systems (IKTS); INERATEC GmbH; Karlsruher Institute for Technology (KIT), Institute for Catalysis Research and Technology (IKFT)

Funding: Federal Ministry of Education and Research (BMBF)

Duration: 09/2022 – 09/2026

The energy transition requires the substitution of fossil fuels with carbon-neutral alternatives. Power-to-Liquid (PtL) processes might be the future key to a sustainable decarbonization of hard to abate sectors, such as the aviation sector. The CARE-o-SENE project focuses on the process of converting renewable hydrogen and CO_2 to sustainable aviation fuels (SAF) by utilizing Fischer-Tropsch (FT) processes. FT process derived synthetic paraffinic kerosene (FTSPK) show well demonstrated benefits and high greenhouse gas emissions reduction potential.

To achieve the expected rapidly growing medium to long term demand of SAF, a competitive, reliable FT catalyst with high conversion efficiencies and yields to the desired kerosene product fraction are key success factors.



Therefore, the goal of CARE-o-SENE is the accelerated and knowledge-based development of Fischer-Tropsch catalysts for the highly efficient and sustainable production of green SAFs in relevant volumes for the transformation of the aviation sector. The project aims at the scale-up of a promising catalyst (TRL 4) targeting a reduced usage of metals, a higher activity, selectivity and longer lifetime, leading to economic and environmental benefits. Additionally, new FT catalysts (TRL0/1) will be developed and analyzed, based on the combined knowledge and skills of the involved partners.

For future application, development and improvement, understanding and quantifying the overall benefits that the improved catalysts, could have on the production of Sustainable Aviation Fuels (SAF), will be analyzed in an impact analysis in work package 4. This will include life cycle assessment as well as techno-economic evaluations to assess the feasibility of the whole production, application and recycling.

The overall goal of the project strongly complements the German "Hydrogen Strategy". The project will have significant benefits in establishing new, long lasting strategic partnerships and foster existing ones between the various German and South African companies and institutes.

NaWo-Collab – Transdisziplinäre Kollaboration für nachhaltiges Wohnen und Bauen

PD Dr.-Ing. Rebekka Volk

Partner: KIT/IfR (Prof. Dr. Michael Janoschka), Universität Freiburg (apl. Prof. Dr. Philipp Späth)

Funding: Innovation campus Sustainability, Baden-Württemberg Ministerium of Science, Research and Arts

Duration: 09/2024 - 08/2025

The provision of safe, permanently affordable and climate-neutral housing requires comprehensive transformation processes, and in particular a huge acceleration of energy-efficient, climate-friendly and adaptive building renovations. To ensure broad social acceptance and support for this sustainability transition, these measures must be integrated into existing and new housing concepts.

The NaWo-Collab links stakeholders from politics, business and society in order to change regional housing policy in such a way that sustainable living, building and renovation is strongly promoted. This includes:

- Developing, demonstrating and linking pioneering system innovations for affordable, climate-adapted housing, with the aim of significantly increasing the rate, quality and depth of renovation (climate neutrality) while also ensuring a high degree of neutrality in terms of rent and heating costs;
- Networking of stakeholders and innovations in the field of building renovation, with a focus on overcoming the renovation deficit and promoting social justice in the housing market. It serves as a platform for the exchange of best practices and the development of strategies to reduce socio-spatial inequalities.

The Upper Rhine region, one of the areas in Germany most affected by climate change, faces particular challenges. In the face of longer and more intense heat waves, the region urgently needs innovative solutions for adapting the building stock to changing climatic conditions, particularly with regard to insulation, ventilation and cooling. At the same time, high real estate prices and rents, especially in the 'swarm cities' around Freiburg and Karlsruhe, emphasize the urgency of socially just reconstruction and new construction.

The **NaWo-Collab** therefore uses regional resources and potential, such as geothermal and solar energy sources or possibly forest residual wood from the Black Forest and biogenic waste, to develop innovative, sustainable housing solutions. These approaches allow for a sustainable transformation of the housing stock, strengthen the regional economy, particularly in the skilled crafts sector, and promote the connection between urban and rural areas. The Upper Rhine region is thus becoming a model for climate-adapted housing concepts, with transregional relevance.

BioCyclesRN – Bioeconomy in the Rhine-Neckar metropolitan region: circular use of biogenic residues

Raphael Heck, Dr. Andreas Rudi

Partner: City of Mannheim

Funding: State Ministry of Rural Affairs, Food and Consumer Protection (MLR)

Duration: 12/2024 – 11/2026

The BioCyclesRN project aims to promote the circular economy in the Rhine-Neckar metropolitan region (MRN) by systematically collecting biogenic residues from agriculture and industry and integrating them into sustainable value chains. Under the leadership of the city of Mannheim, in close cooperation with the Karlsruhe Institute of Technology and other regional partners, the project is establishing a new network that brings together relevant stakeholders from industry, agriculture, and science. Together, they are investigating innovative approaches that aim to achieve both circular use and cascading utilization of biogenic residues and raw materials. The aim is to work with companies to identify practical utilization concepts in order to make effective use of residues and develop sustainable business models. A central element of the project is the identification of recyclable utilization options, the "BioCycles," based on selected potential studies. Workshops and specialist events will be used to bring together relevant stakeholders. An innovative matching process makes it possible to link specific material flows with suitable recycling options so that companies can track their implementation in flagship projects.

In this way, "BiocyclesRN" contributes to the state's sustainable bioeconomy strategy and builds on the areas of action identified in the MRN's bioeconomy strategy. With the help of already identified residual biomass potential and relevant stakeholders, this project promotes the development of innovative bioeconomy projects. This contributes to ecological sustainability and strengthens the economic resilience of the region. In the long term, BioCyclesRN aims to be a driving force for a sustainable, resource-efficient economic structure that offers both ecological and economic benefits for stakeholders in the region.

BioSMART– Bio-based fuels and sustainable materials from advanced renewable technologies

Dr. Andreas Rudi

Partner: TUE, TERI, PERSEO, NIC, CSIC-ITQ, WUR, Johnson Matthey, Avantium, Fibenol, TNO

Funding: EU-HORIZON Action Grant

Duration: 2025 - 2029

BioSMART develops a fully integrated, zero-waste biorefinery that converts all lignocellulosic biomass fractions into sustainable aviation and marine fuels, high-value chemicals, and biomaterials. By combining advanced fermentation, catalytic upgrading, and process intensification, the project increases resource efficiency, lowers environmental impacts, and improves cost-competitiveness, validating its technologies with real TRL5 streams.

To enable large-scale deployment, WP5 provides the system-level integration that the broader bio-based fuels field currently lacks, uniting feedstock, technical, environmental, economic, and social dimensions into actionable guidance for researchers, industry, and policymakers. It quantifies feedstock supply, models techno-economic feasibility, evaluates environmental footprints, and assesses social implications, merging all results through multi-criteria decision analysis (MCDA) to determine feasible and scalable deployment paths.

WP5 includes five core activities: feedstock mobilisation (GIS and MLbased assessments), technoeconomic analysis, environmental LCA, social LCA, and integrated MCDA based system analysis. Supported by data from pilots, process models, catalyst testing, fermentation runs, market studies, and logistics modelling, WP5 reflects realistic industrial conditions. Led by KIT, it provides essential insights into resource availability, process performance, sustainability, and system integration, forming a central decisionmaking hub that enables BioSMART's contribution to climatealigned, scalable biobased fuel and material production.

The work programme consists of five main tasks:

- **Feedstock mobilisation (T5.1)** – GIS- and machine-learning–based quantification of lignocellulosic biomass potentials, delivered-cost curves, supply-shed definitions, and mobilisation pathways.
- **Techno-economic assessment (T5.2)** – Cost and performance analysis of BioSMART process routes using CAPEX/OPEX modelling, LCOx calculations, scale-up factors, and benchmarking against fossil pathways.
- **Environmental life-cycle assessment (T5.3)** – ISO-compliant cradle-to-gate LCAs covering GHG, energy, water, land, circularity and uncertainty analyses for prioritized TRL-5 configurations.
- **Social implications (T5.4)** – Stakeholder interviews, surveys, and social LCA evaluating regional welfare, job creation, H&S aspects, and acceptance.
- **System analysis via MCDA (T5.5)** – Integration of TEA, LCA, and S-LCA results into a decision-support tool defining optimal deployment scenarios and guiding process development.

FINEST – Use and management of finest particulate anthropogenic material flows in a sustainable circular economy

Rafael Bischof, PD Dr. Rebekka Volk

Partner: Helmholtz-Zentrum Dresden-Rossendorf (HZDR), KIT-ITC Helmholtz Centre for Environmental Research (UFZ), Helmholtz-Zentrum Berlin für Materialien und Energie (HZB), TU Bergakademie Freiberg, Universität Greifswald

Funding: Helmholtz Association of German Research Centres under the "Helmholtz Sustainability Challenge"

Duration: 07/2022 – 07/2027

FINEST aims to develop a combined pyrolysis- and rotary-kiln based recycling process for creating high value products from the waste of external thermal insulation composite systems (ETICS) based on expanded polystyrene (EPS) and its mineral adhesions. Recycled cement clinker bricks and styrene are potential products of the FINEST project. These products are expected to partially replace their virgin counterparts, reducing construction and other sectors' environmental impact.

ETICS are multilayer insulation systems applied to building facades, walls, and roofs to reduce heat transmission and exchange, lowering energy demand and costs. They consist of a base coat, EPS insulation (such as EPS), anchors, a base coat, a reinforcement mesh, and a finishing coat. The layers are held together with adhesive. ETICS have been in use since the 1960s and have an approximate lifespan of 60 years. To improve buildings' energy efficiency, ETICS are being increasingly installed and the amount of waste from ETICS will increase.

One of the common insulating materials included in ETICS is EPS, a low-density fossil-fuel-based plastic. Its production has a large environmental footprint but, installed as an insulating material, it reduces energy consumption during building operation. Currently, waste EPS is typically burned for heat recovery and the material value is lost. The layers contain valuable minerals, metals and plastics bound together. The exact composition and quantity of each component varies from building to building. ETICS are difficult to separate mechanically and contain diverse, high-value materials that can be used in a circular economy.

The FINEST project is structured into three sub-projects which address plastic, mineral and metal fine particulates. In sub-project 1, UFZ, UG and HZB focus on developing processes for recovering microplastics whereas the focus of sub-project 3 (TU BAF) is on recovering metal fines. The mineral components of EPS-based ETICS are KIT's focus (sub-project 2). KIT IIP is responsible for the life cycle assessment and techno-economic assessment of the new recycling process with respect to minerals. Our emphasis is on demonstrating the potential for sustainability and avoiding risks to the environment. In addition, the optimum number and location of decentralized treatment facilities in Germany will be evaluated.

FINEST will establish and maintain a research school for training 28 postgraduate students. This includes the provision of internships to build connections with industry. PhDs will be prepared for leadership roles in industry and academia through a tailored doctoral program. Knowledge will be transferred to industry through careers, which will be achieved through a central transfer desk at HZDR which is connected to industry clusters and organizations.

Industrial Transformation 2050 – Technological and geographical redesign of the raw materials industry for a climate-neutral circular economy

Lena Fuhg, Dr. Justus Steins, PD Dr. Rebekka Volk

Partner: KIT-IAI, KIT-IKFT, KIT-ITC, Forschungszentrum Jülich (FZJ) ICE-1, FZJ-ICE-2, FZJ-IET-1, Helmholtz-Zentrum Dresden-Rossendorf, Helmholtz-Institut Freiberg für Ressourcentechnologie

Funding: Helmholtz program Energy System Design

Duration: 2025 - 2027

Industrial production has long depended on fossil raw materials and centralized energy systems. However, the dual transformation toward a circular economy and CO_2-neutral energy supply is reshaping the fundamental location factors of the raw materials industry. Achieving climate neutrality by 2050 demands a systemic redesign of infrastructures and production technologies.

Two structural trends define this transformation. First, decentralization of production arises from the need to process locally available secondary resources and to reduce transport-related emissions. This shift coincides with the decentralized generation of renewable electricity, requiring an integrated design of material and energy networks. Second, decarbonization through electrification and hydrogen-based processes is accelerating, particularly in energy-intensive sectors. Industrial heat pumps for high-temperature applications will play a central role, though their technological maturity remains limited.

This Innovation Pool project looks at "Industrial Transformation 2050" from the perspective of the infrastructural and technological redesign of energy-intensive basic materials and manufacturing industries. It examines the interactions between the distribution networks for energy, materials, and CO2. To this end, methods and models are being developed that link future material cycles (base metals, cement, carbon carriers) and their necessary infrastructures into an overall system. With regard to energy requirements, an analysis of the expected increase in electrical energy due to technological change and its potential for flexibility in prototypical processes is being developed. Based on techno-economic analyses, scenarios are being developed and evaluated with regard to the geographical location of future energy-intensive industrial sites.

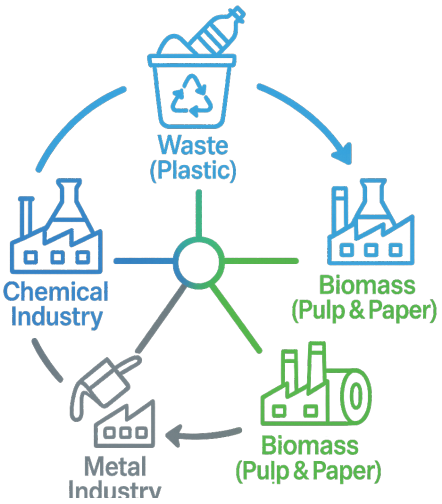


Figure: Focus industries for transformation

Innobeton – Innovative Technologien zur Entwicklung eines neuartigen reaktiven Betonzusatzstoffs aus feinem Betonabbruch (Brechsand) – Ressourceneffizienz im Baustoffrecycling

Antonia Frank, PD Dr. Rebekka Volk

Partner: KIT-IMB/MPA, TBS Transportbeton Rhein-Neckar GmbH & Co. KG, mbl Mineral- und Betonlabor GmbH, peterbeton Rudolf Peter GmbH & Co. KG, Heinrich Feess GmbH & Co. KG, Scherer + Kohl GmbH, Gebr. Pfeiffer SE

Funding: BMBF - funding code: 03EN2102A

Duration: 2023 - 2026

The research project is developing an innovative process for the production of a new type of concrete additive from recycled fine concrete rubble as a substitute for cement clinker, fly ash and granulated blast furnace slag, as well as its overall characterization over the product life cycle (development, production, properties, application and recycling options). This initially involves analysing regional and supra-regional material flows to identify potential raw material sources for thermomechanical processing.

The figure illustrates the interactions and overall structure of all project partners involved in the project.

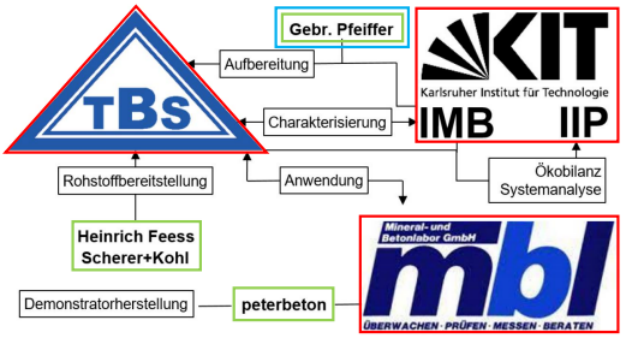


Figure: Composite structure of the project partners

The Institute for Industrial Production (IIP) carried out the analyses of the concrete material flows in south-west Germany to evaluate the future potential of post-demolition concrete as a secondary material. Currently, the work focuses on a life cycle assessment of a potential cement substitution material to evaluate which recycling process configurations perform best ecologically in the recycling process. In addition to that, site and capacity planning as well as logistics optimization for the collection of the secondary raw material and transport to suitable processing and production plants for the new concrete additive will also be carried out. Closely linked to this is the profitability analysis of the new value chain.

The basis for achieving resource efficiency in the recycling of building materials is to estimate the potential of post-demolition as accurately as possible. This makes it possible to calculate how much post-demolition is available to go back into the cycle of concrete production and thus, in the best case, save CO_2 and conserve primary resources.

For the first time, the project aims to pursue a holistic approach to evaluating the use of a new type of reactive concrete additive for concrete based on recycled concrete demolition material.

Due to the generally strong regional nature of concrete production, the focus of the research is on south-western Germany. As the basic composition of concrete - cement, water and aggregate - does not depend on local characteristics, the results can be applied throughout Germany and worldwide with little effort thanks to the cooperation of the applicant companies.

InnoFuels – Networking, further development and framework conditions for the scale-up of electricity-based fuels and advanced biofuels

Alexander Schneider, Paul Heinzmann, Dr. Andreas Rudi

Partner: Institute of Reciprocating Engines (IFKM), Institute for Catalysis Research and Technology (IKFT) and numerous industry partners

Funding: Federal Ministry for Digital and Transport

Duration: 2022 - 2026

Currently, activities, advancements in technologies, and the framework for the synthesis of renewable fuels are being addressed in numerous research and development projects, each focusing on specific aspects of production, application, and evaluation of these fuels. However, a comprehensive networking and intensive exchange to leverage synergies at the federal and EU levels have not taken place so far, thereby impeding their further development, implementation, and scale-up.

The InnoFuels platform aims to bridge this gap by bringing together relevant activities into a consortium comprising industry, application, and research.

The existing information is intended to be consolidated, processed into guidelines and policy recommendations, and utilized in events such as innovation workshops to promote innovation. Within the framework of InnoFuels, partially "regional" or isolated approaches/solutions will be merged, creating a platform for the exchange of knowledge and experiences, as well as the conceptualization of comprehensive solutions.

The InnoFuels platform is divided into eight innovations focuses: *production*, *supply chain*, *application aviation*, *application maritime traffic*, *application road & rail*, *sustainability*, *market & regulation* and *subject matter experts*. The IIP supports the platform with system analyses applying environmental and economic methodologies to assess business cases and to show potentials and opportunities regarding the market launch of renewable fuels.

The project results provide detailed information regarding existing works and projects, further development and technical and regulative challenges in the field of renewable fuels. Therefore, the innovation platform serves as a knowledge tool to facilitate a more sustainable development of the mobility sector, ultimately contributing to the achievement of the stated climate goals.

IntWertL – Intelligent value creation networks for lightweight vehicles produced in small quantities

Nina Treml, Dr. Andreas Rudi

Partner: KIT-IMI, Fraunhofer IPA, DLR, bwcon, many small SME from BW, further associated partners (cities)

Funding: Federal Ministry for Economic Affairs and Climate Action (BMWK)

Duration: 2022 - 2026

The mobility sector is currently undergoing a transformation, which must be evaluated in terms of the economic, ecological and social dimensions of sustainability. Global competitive pressure is increasing sharply, and sustainability and climate protection are transforming from an additional benefit to an obligatory goal. Classic individual mobility is increasingly being questioned by society. Concept lightweight construction offers new forms of mobility. Vehicles can be optimized for a specific application (use case) and be resource-saving alternatives compared to the classic series-produced vehicle. While there are numerous prototypes of such use-case specific mobility, the introduction into the market often fails due to the high costs associated with pre-series and small series production.

The project therefore aims to build a digital engineering and production platform for small and medium-sized enterprises that enables manufacturing companies and engineering service providers in cooperative approaches to offer complex products in small quantities to increase their global competitiveness. Distributed engineering and production lowers barriers to launch such lightweight vehicles. Small companies can thus become integrators/OEMs themselves. The engineering and production platform is initially designed for specific use cases of lightweight vehicles. To ensure that the developed platform can withstand the challenges of practical use, the commitment of potential users is of particular interest. That is why the active participation of more than twenty SMEs from Baden-Württemberg is not only encouraging for the project work, but also shows that the industry sees strong economic potential in the development of the platform. Bwcon research is responsible for the overall project coordination and lead the knowledge transfer. In addition to the industry partners, KIT, represented by IMI (Institute for Information Management in Engineering) and IIP, Fraunhofer IPA and DLR are involved in the project as scientific partners. The project is rounded off by associated municipalities, which contribute their knowledge about the future mobility behavior of end customers to the project.

The IIP carries out the ecological evaluation within the project. Among other aspects, this includes the development of a concept to derive the ecological impacts of the lightweight vehicles as case studies.

KommMa – Dynamic database of measures for municipal climate protection

Katharina Eberhardt, Moritz Fierke, Amelie Schwärzel (left in 2025), Dr. Sonja Rosenberg

Partner: Institute of Meteorology and Climate Research Troposphere Research (KIT- IMKTRO), represented by the South German Climate Office; Institute for Technology Assessment and Systems Analysis (KIT- ITAS), Institute for Transport Studies (KIT- IFV)

Funding: Federal Ministry of Education and Research

Duration: 2024-2027

In light of the increasingly evident effects of climate change in Germany and the undeniable urgency for action, municipalities are implementing concrete and effective measures to protect our planet. Decisions made at the municipal level have a direct impact on energy consumption, mobility organization, environmental pollution, and the quality of life of citizens.

Municipalities have the potential to initiate sustainable changes in areas such as urban planning, transportation, energy supply, waste management, and green space design, thereby ensuring equitable living conditions across society.

However, municipals are faced with a variety of burdens that hinder their decision-making process. For instance, the information available for selecting and implementing climate protection measures is often confusing and of varying quality. Additionally, financial and human resources are frequently limited.

Currently, there is a lack of scientifically sound decision-making support for German municipalities that is tailored to local situations in Germany. Communities as decision-makers lack also options for time- and cost-efficient comparisons with similar communities.

To overcome these limitations, the goal of KommMa is to set up a dynamic database of measures that are scientifically and transparently evaluated but also prioritized according to different output indicators. This pragmatic approach provides municipalities with a concrete tool to achieve their climate protection goals as efficiently and effectively as possible. Within the joined project of four KIT institutes, the IIP is mainly responsible for the set-up of the database and the functioning as a decision-support tool.

KommMa

KoRPSA – Carbon management for climate neutrality: regional potentials and systemic analysis

Moritz Fierke, Dr. Sonja Rosenberg

Partner: University of Freiburg - Department for Sustainable Systems Engineering (INATECH), University of Freiburg - Chair of Sustainability Governance; Fraunhofer Institute for Systems and Innovation Research (ISI), Chair of Energy Economics (KIT-IIP)

Funding: Innovation campus Sustainability, Baden-Württemberg Ministerium of Science, Research and Arts

Duration: 2025-2026

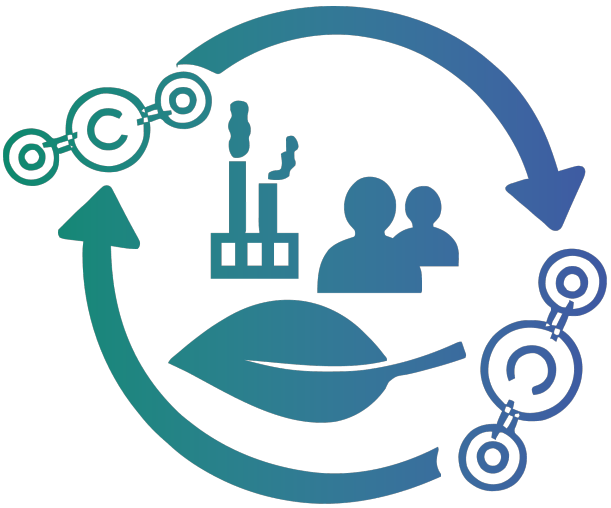
The goal of reducing carbon dioxide emissions in Germany to net zero by 2045 at the latest, as outlinked in the Federal Climate Protection Act, requires a fundamental transformation of carbon flows. The wide range of options and their different effects and sustainability implications raise important questions regarding assessment, strategy and implementation.

The KoRPSA project clarifies the significance of regional carbon management strategies including negative emissions using the Upper Rhine region as an example, creates the necessary knowledge from a systemic perspective, identifies options for action, promotes networking between stakeholders and thereby supports the sustainable transformation towards climate neutrality in the Upper Rhine region.

This transdisciplinary research project longs to combine qualitative and quantitative research methods from the participating institutes. At the Institute for Industrial Production, two key areas of focus are planned:

1. Empirical Social Research: The design and implementation of a study to assess public acceptance and perception of carbon management.

2. Modeling of Logistical Networks: The development and analysis of essential transport and infrastructure networks for the implementation of carbon management strategies.



LandWandel – Innovative Climate Parameters for Adaptation Measures in Rural Areas

Ines Hofmann, Dr. Sonja Rosenberg

Partner: Stadtwerke Freudenstadt GmbH & Co. KG, Institute of Meteorology and Climate Research Troposphere Research (IMKTRO), South German Climate Office

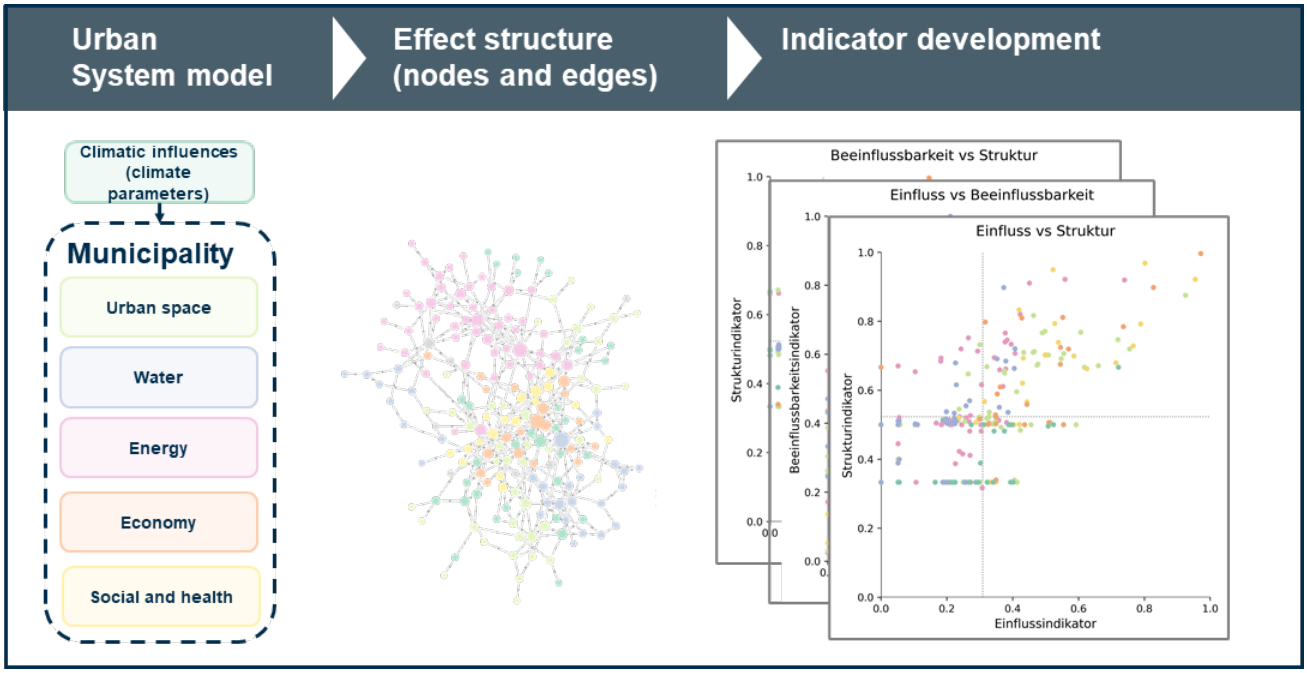
Funding: Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection

Duration: 2023 - 2026

The LandWandel research project addresses the urgent need for climate adaptation strategies in rural communities. Its primary goal is to provide decision support for municipalities by developing effective and sustainable approaches that consider both environmental and socio-economic dimensions. The project emphasizes the interaction between climate parameters and local socio-economic systems to ensure that adaptation measures are practical and region-specific.

One of the key expected outcomes is the creation of the "AnLand" online catalog, which represents region-specific and within the project defined innovative climate parameters. This catalog will serve as a foundation for municipalities to develop tailored adaptation strategies that are both environmentally sustainable and economically viable.

This years' IIP work focused on developing a graph-based municipality system that implies a causal and effect structure and can be analyzed using graph metrics. These allow to identify vulnerabilities within the community network and can give hints what actions should be prioritized. In the upcoming year the current analysis will be extended to include for instance socio-economic data.



NEWood – a 100% bio-based, climate-friendly, and circular material alternative for the construction industry

Xin Ying Chan, Dr. Justus Steins, PD Dr. Rebekka Volk

Partner: KIT-IEB, Agriinnovationen Hahnennest (AIH) GmbH, Fiber Engineering GmbH and König+Neurath AG

Funding: Klimaschutzstiftung Baden Württemberg

Duration: 2024-2026

Global raw material consumption exceeded 90 billion tons in 2020, while the share of greenhouse gas emissions from material production reached 23% in 2015. In Europe, the construction sector alone accounts for 42% of total energy use, 38% of greenhouse gas emissions, 50% of extracted materials, and 30% of water consumption. To achieve the EU's 2050 climate neutrality target and transition toward a circular economy, innovative material solutions are essential.

One promising approach is the development of bio-based composites derived from agricultural and forestry by-products. These materials can reduce dependence on fossil-based or slow-renewing natural resources and allow a sustainable return to nature or reintegration into new life cycles at the end of their use.

NEWood has been developed as novel class of bio-based, environmentally consistent, and circular materials. It is made exclusively from wood and agricultural biogenic waste, using fungal mycelium, which is the root network of fungi, as a natural binder. This innovation eliminates the need for synthetic or petroleum-based adhesives and freshly extracted wood fibres, offering a sustainable alternative for material-intensive industries such as construction and furniture manufacturing. This project builds on these results and utilizes Germany's abundant natural fibres, including hemp, rapeseed, and miscanthus, to enhance the performance of mycelium-based composites. These fast-growing fibres combine excellent mechanical properties with reduced environmental impacts, supporting the development of regional, high-performance, and climate-friendly materials.

The current project aims to scale up production of mycelium materials and demonstrate their technical and economic feasibility through 1:1 prototypes and comprehensive data-driven guidelines for design and manufacturing. Life cycle assessments, profitability analyses, and GHG quantifications will be conducted on the products and associated processes, particularly in production and transport. The overarching goal is to establish a fully bio-based, circular system that leverages regional resources, minimizes waste, and reduces CO_2 emissions, advancing sustainable, climate-friendly solutions for the construction industry and beyond.

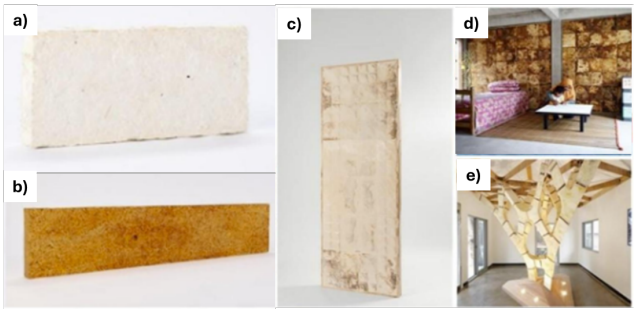


Figure. (a) Lightweight mycelium material, (b) Dense NEWood panel (c) lightweight acoustic mycelium wall for the pop-up campus of Zukunftbau, Aachen, Germany, (d) NEWood panels for the interior cladding of an affordable housing project in Batam, Indonesia, (c) (d) mycelium-based sculpture exhibited at Kunsthalle Basel, Switzerland, (e) MycoTree, exhibited at the Seoul Architecture Biennale, South Korea

ReBioBW – Potentials of agricultural residues for the bioeconomy in Baden-Wuerttemberg

Raphael Heck, Dr. Andreas Rudi

Partner: Universität Hohenheim, the Departments of Bioeconomy, Production Theory and Resource Economics, Biobased Resources in the Bioeconomy

Funding: State Ministry of Rural Affairs, Food and Consumer Protection (MLR)

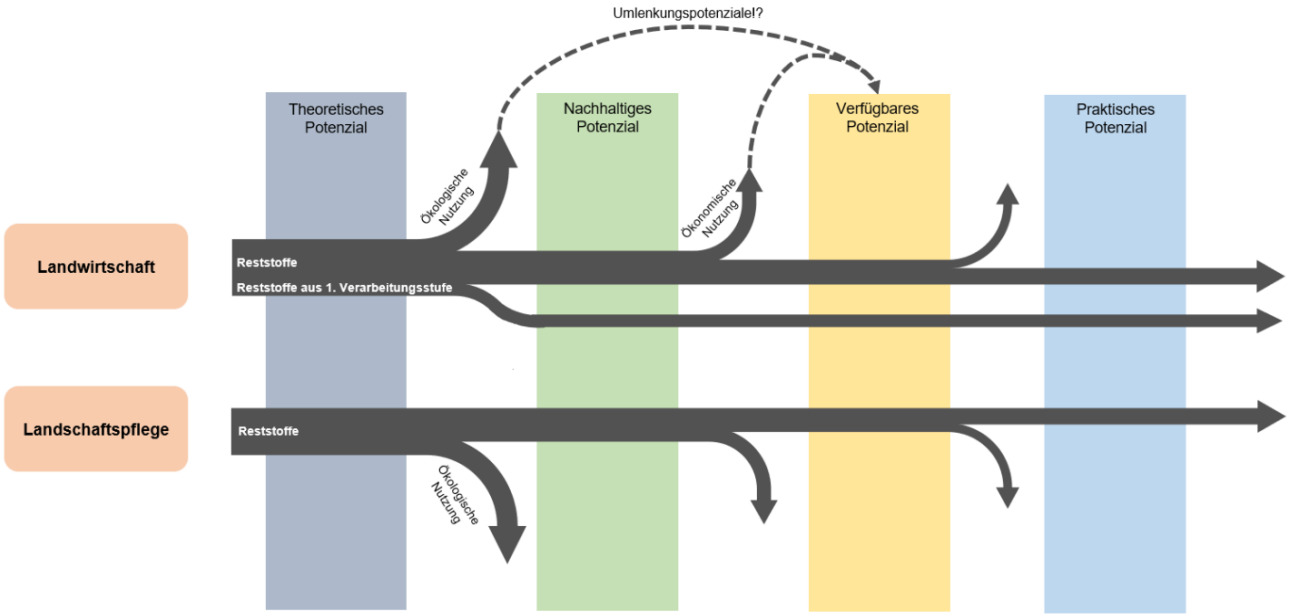
Duration: 09/2022 – 08/2025

By substituting fossil resources with renewable resources, the bioeconomy in Baden-Württemberg supports a climate-neutral economy. In order to avoid conflicting goals with food security, the focus is on agricultural residues. However, increased use of residues can cause conflicts of interest with existing use or climate protection if humus build-up and carbon storage in the soil are at risk. At the same time, the use of the residues offers opportunities for new regional value chains in rural areas. Realizing these opportunities and avoiding conflicting goals therefore requires a holistic evaluation of the residual material potential.

The aim of the ReBioBW project is to record the current and future potential of residues from agriculture and landscape conservation for the bioeconomy in Baden-Württemberg.

Using statistical data, the theoretical potential is calculated as the absolute volume of residues and minus the quantities for humus build-up, the sustainable potential. A representative survey among farmers is intended to provide information on the current use of the residues to determine the economically available potential. Qualitative surveys among companies and farmers show hurdles and framework conditions for calculating the practical potential. By developing a regional bioeconomy sector model and coupling it with an agricultural operating model, the knowledge gained is used to estimate the economic and ecological effects of residue use and future residue potential against the background of economic, social and political drivers. The surveys are accompanied by knowledge transfer along the value chain of agricultural residues aiming to close knowledge gaps regarding the nature, demand and supply of biomass and to increase the practical potential.

The project is being carried out in close coordination with the Baden-Württemberg Ministry of Food, Rural Areas and Consumer Protection and is based on the state strategy for sustainable bioeconomy.



Ref4Fu – Refineries for Future: Renewable fuels from green refineries of the future

Work package 4: Techno-economic and ecological assessment of renewable fuels

Diana Temnova Deguy, Paul Heinzmann, Dr. Andreas Rudi

Partner: Institute of Piston Machine research (IFKM), Institute of Catalysis Research and Technology (IKFT), Institute for Micro Process Engineering (IMVT), Engler-Bunte-Institute (EBI)

Funding: Förderprogramm Nachwachsende Rohstoffe (FNR), Federal Minsitry of Food and Agriculture (BMEL)

Duration: 2022 - 2025

The REF4FU project, in cooperation with 5 researchers and 6 industrial partners, aims to develop, validate, and evaluate sustainable refinery concepts with which the future demand for liquid fuels can be generated based on sustainable raw materials. From green methanol, Fischer-Tropsch hydrocarbons, and pyrolysis oil, the fuels that are customary in road, air, and ship traffic today and that are likely to be required in the future are to be produced, tested, and evaluated using scalable technologies. The technologies required for this should be verified in TRL 5 at least. The refinery concepts derived from this are evaluated concerning technical, ecological, and economic characteristics, and their flexibility for future fuel requirements and possible synergy and optimization potentials are determined. Finally, an overall assessment is made against the background of the regulatory framework and the feasibility of the refinery concepts developed.

The results of the analyzes and models shall demonstrate the potential of synthetic, green fuels. For this purpose, the system mentioned must first be implemented and tested on a pilot plant scale. Furthermore, the cost and profitability analysis results are used to support the decision-making process regarding the optimization of the system constellations, the usefulness of the planned synergies, and the profitability of the overall concept. The developed supply concepts and calculated GHG reduction potentials scientifically represent the possible contribution of synthetic fuels/biogenic fuels in sustainable road, air, and shipping traffic.

In work package 4, a techno-economic and ecological evaluation of the fuels is carried out. The work focuses on the flow chart simulation, the economic assessment, and the derivation of synergy and optimization potentials.

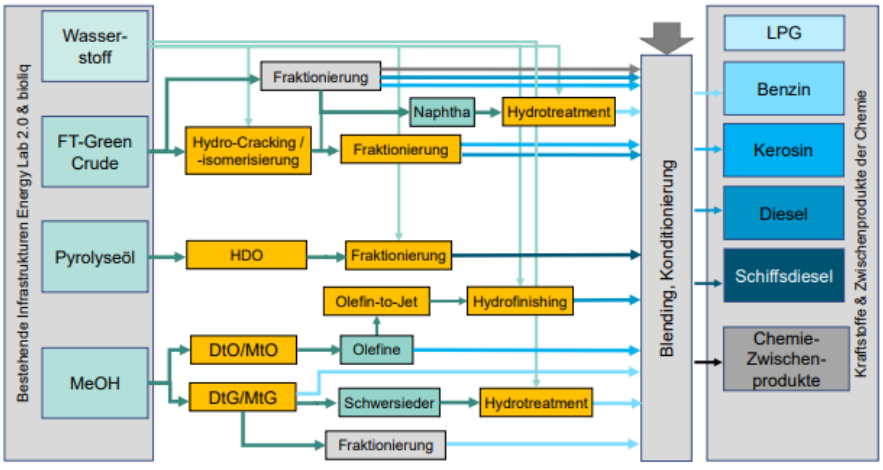


Figure: Diagram of the planned process network. Fuel fractions are produced from the input materials depicted on the left through the yellow-highlighted process stages, and these are further processed into various types of fuels.

reFuels Demo

Alexander Schneider, Paul Heinzmann, Dr. Andreas Rudi

Partner: Institute of Reciprocating Engines (IFKM), Institute for Catalysis Research and Technology (IKFT), Institute of Micro Process Engineering (IMVT), Engler-Bunte Institute (EBI), Institute for Technology Assessment and Systems Analysis (ITAS) and numerous industry partners.

Funding: Ministry of Transport Baden-Württemberg

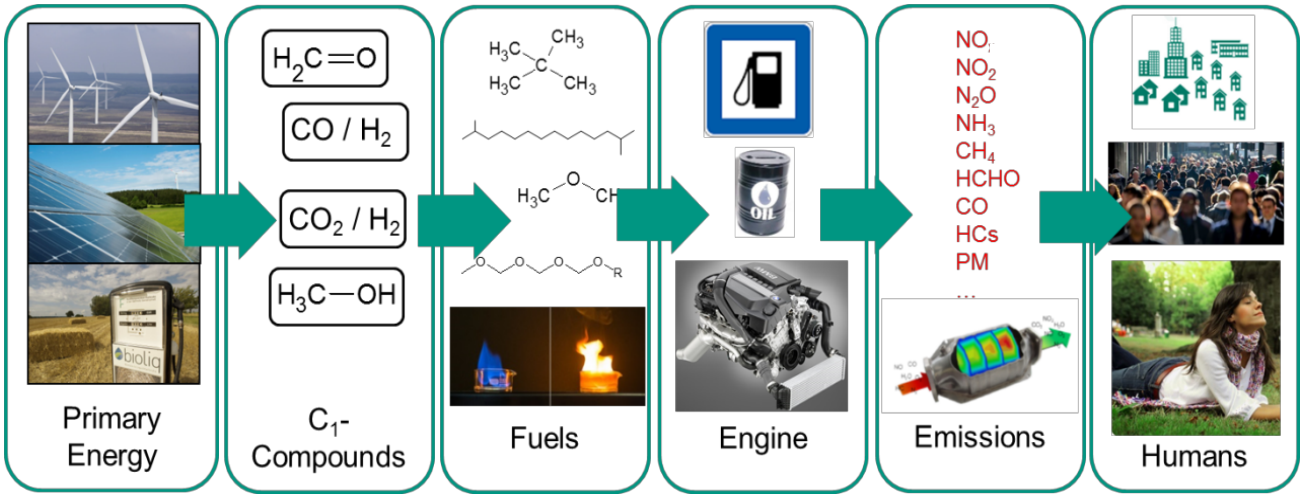
Duration: 2023 - 2025

The utilization of renewable produced fuels (reFuels) is one of the main actions beside electric mobility on the way to a CO2 neutral transportation sector. These fuels use carbon-containing residues of agriculture and forestry, as well as industry and municipality waste in combination with hydrogen produced from the electrolysis process for chemical synthesis.

The project consortium comprises several institutes of the KIT and other partners from the industry. Compared to the preliminary project *"reFuels"*, *"reFuels Demo"* has a closer scope and sets the focus on production processes for reFuels based on methanol. The aim of the project is the further development of the technology and the assessment of the scalability of Methanol-to-X (MtX) processes on an industrial scale. Therefore, a variable model of a pilot plant on the refinery site of the Mineralölraffinerie Oberrhein (MiRO) should be developed to enable flexible plant and operation configurations and the creation of optimal scenarios by applying economic and environmental assessment methods

The Institute for Industrial Production evaluates current developments, different business cases and cost scenarios by conducting a techno-economic analysis. This task aims to deliver deeper understanding of cost structure of different process constellations and to support decision making regarding the optimal configuration of the MtX processes.

The project results deliver insights on the feasibility of a MtX pilot plant, their integrability in an existing refinery site (MiRO), existing challenges and configuration potentials. These technical and scientific findings can serve as recommendation for the industry and the development of plants and new processes. This progress would help to reduce greenhouse gas emissions caused by the mobility sector and to achieve claimed climate goals.



ReSidence – Regionally Regrowing, Recyclable and Reconfigurable Modular Housing

Simon Steffl, PD Dr. Rebekka Volk

Partner: KIT Professorships Digital Design and Fabrication, KIT Professorships Wood Engineering and Building Construction, Construction and Building Physics and Technical Building Services, Design of Structures, KIT Professorship Building Materials and Concrete Construction, FibR GmbH, Nature Conservation Foundation Pfrunger-Burgweiler Ried

Funding: BIPL-Innovation Ministry for Nutrition, Rural Areas and Consumer Protection Baden-Württemberg

Duration: 2023 - 2025

The ReSidence project is researching digital construction technologies for rapidly renewable resources and combining these into a modular construction method for temporary, completely recyclable and waste-free living space extensions. To this end, a constructio method developed at FibR GmbH for load-bearing structures made of natural fiber composite is being further developed and research is being conducted into how this can be transferred to façade constructions. At the same time, research is being carried out into how a hybrid material system of willow/clay/wood composite developed jointly at KIT can be used for load-bearing wall and ceiling components. In a synergetic development of both construction methods, their interfaces are being researched and combined into a holistic, digitally prefabricated construction system made of natural building materials. The project maps the complete material cycle of the raw materials used and researches the extraction of natural raw materials, their combined use as hybrid components in the construction industry, their reusability and the recycling of such components. This requires coordinated innovations in the following areas: Agricultural management of wetlands, material characterization of natural hybrid material systems, digital process technology for processing inhomogeneous grown materials, integrative computer-based design processes, as well as the development of structural models and test procedures for the dimensioning and approval of such building systems. Following on from the ecological and climatic necessity of rewetting peatlands to bind Co2, agricultural methods are being tested to extract building materials from these peatlands and thus use them both ecologically and economically.

The modular reusability of the robotically prefabricated flax fiber facade structure and the willow-clay-wood wall and ceiling construction system will be tested in the overall system using the demonstrator construction at the Wangen State Garden Show. As part of the project, the IIP's Project and Resource Management in the Built Environment research team will holistically record the resulting material flows in order to carry out a comprehensive LCA analysis on this basis. In addition to ecological considerations, economic factors of the construction method are also recorded in order to evaluate its transfer and market potential.

SeRoZen BW - Regional secondary raw material centres in Baden-Württemberg

Lena Fuhg, Sebastian Rauscher, Dr. Justus Steins, PD Dr. Rebekka Volk

Partner: Landesanstalt für Umwelt Baden-Württemberg

Funding: Ministry for Regional Development and Housing Baden-Württemberg

Duration: 2024 - 2025

Urban areas and metropolitan regions are the sources of a variety of construction waste and waste streams. Local or regional secondary raw material centres (SRCs) are urgently needed in order to treat these material flows in the future in line with a circular economy and use them to the highest possible quality with minimal transport and handling costs. This need has also been recognised at EU level and initial examples of best practice have been collected.

The project was structured in four work packages. WP1 develops a definition for SRC tiers with specific material-flow and technology requirements. WP2 assesses the environmental impacts of alternative recovery pathways using life cycle analysis. WP3 identifies current and emerging technology routes and assesses the techno-economic performance of the SRC tiers. WP4 outlines an optimised spatial and network configuration for Baden-Württemberg, targeting minimal costs and greenhouse gas emissions. The results indicate that regionally differentiated SRCs (tiers 1–3) can substantially increase the share of high-quality recycled construction materials, reduce greenhouse gas emissions and deliver positive economic margins. Investment viability is particularly strong for larger SRC1 and SRC2 facilities, while SRC3 modules depend more heavily on regulatory conditions and technological maturity. The optimisation of locations and network structures reveals a trade-off between economic efficiency and environmental performance, suggesting that future planning should incorporate multi-criteria decision-making. Overall, a resilient transition of the construction sector requires coordinated measures: economically sound investments in SRC infrastructure, supportive policy instruments, technology-open innovation strategies and an institutional framework to strengthen reuse practices.

The results were presented and discussed at the annual event of the strategy dialogue 'Affordable Housing and Innovative Construction' organised by the state of Baden-Württemberg.

TFTEI – Technical Secretariat of the Task Force on Techno-Economic Issues

Diana Temnova Deguy, Dr. Andreas Rudi

Partner: Interprofessional Technical Centre for Studies on Air Pollution (CITEPA), Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA)

Funding: French Environment and Energy Management Agency (ADEME)

Duration: since 2002 (ongoing)

Since 2002, DFIU and CITEPA (France) form the Technical Secretariat of the former Expert Group on Techno-Economic Issues (EGTEI), now Task Force on Techno-Economic Issues (TFTEI). The work is primarily funded by the French environmental agency ADEME under the UNECE Convention on Long-Range Transboundary Air Pollution (CLRTAP). Between 2002 and 2008 several sector specific background documents with techno-economic information about air emission abatement techniques have been developed and revised. This information is considered in the Integrated Assessment Models (IAM) RAINS and GAINS, developed by the International Institute for Applied Systems Analysis (IIASA) in Luxembourg, Austria. Both models have been applied for the derivation of emission abatement strategies on UNECE and EU level.

After EGTEI focused on technical background documents for the revision of the Gothenburg Protocol and investment and cost calculation for emission abatement in large combustion plants in recent years, the work has been honoured in December 2014 by promoting the former Expert Group into a Task Force that is a constant part of the Working Group on Strategies and Review (WGSR). The current work focuses on VOC abatement in order to support the revision of the BREF STS and on emission abatement in the aluminium and cement sector. Furthermore, an information platform (the so-called Clearing House on Abatement Techniques) is built up and hosted by TFTEI. The results of the TFTEI activities shall be of use for the convention and its members, but particularly for the EECCA-region, where mission abatement strategies are developed.

THINKTANK "Industrial Resource Strategies": Kreislaufwirtschaft für Kunststoffe

Teresa Oehlcke, PD Rebekka Volk

Partner: Institute for Technical Chemistry (ITC), German Chemical Industry Association, Baden-Württemberg (VCI BW), National Advisory Board for Chemical Recycling (NBKCR)

Duration: 2024 - 2025

Building on the THINKTANK's work on resource efficiency and circular economy strategies, the project period 09/2024–10/2025 further advanced the methodological and empirical basis for a climate-neutral plastics circular economy in Germany. The overarching objective was to derive robust, actionable recommendations for policy and industry by combining technology-based systems modelling with targeted analyses of quality- and contamination-related constraints in recycling networks.

The work in this final period concentrated on three complementary research areas.

First, an existing spatially explicit optimization model for Germany's plastic waste management network was substantially extended. In addition to the previously modelled utilization of pyrolysis oil via steam cracking, an additional chemical recycling pathway - entrained-flow gasification of pyrolysis oil - was integrated to better represent complementary valorisation routes for different pyrolysis oil qualities. The extended model explicitly links infrastructure deployment decisions (e.g., placement and capacity of treatment technologies) with policy instruments, in particular CO_2 pricing, enabling quantitative assessment of system-wide cost and emission implications under varying CO_2 prices.

Second, the project developed a conceptual and model-supported framework to assess the behaviour and removal potential of relevant contaminants (e.g., PVC-related halogens and flame retardants) in current and future recycling systems. Using sector- and polymer-specific characterisation of post-consumer waste streams and process-chain representations for sorting and mechanical recycling, the work provides a consistent basis to analyse (i) contaminant partitioning along treatment routes, (ii) removal efficiencies, and (iii) potential accumulation effects across multiple product life cycles under different open-loop vs. closed-loop recycling configurations.

Third, the project quantified the technically accessible circular carbon potentials from plastic waste for the chemical industry in a scenario-based manner, explicitly considering both recycling rate targets and contaminant constraints. By linking sectoral waste generation, collection and sorting performance across several sectors, and downstream recycling routes, the analyses indicate that under ambitious but plausible system configurations plastic waste-derived carbon can contribute to defossilising the chemical sector's feedstock base.

Results were integrated into THINKTANK exchange formats and the scientific support of the Nationaler Begleitkreis Chemisches Recycling (NBKCR), contributing to evidence-based discussion across stakeholders.

With the completion of the reporting period (09/2024–10/2025), the project was successfully concluded.

THINKTANK
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SUSCI: SUStainable feedstocks for Chemical Industry

Teresa Oehlcke, Frank Schultmann

Partner: Institute for Technical Chemistry (ITC), Linde GmbH

Duration: 2025 - 2028

SUSCI addresses a key technological barrier for defossilising the chemical industry's feedstock base: although pyrolysis oils from mixed plastic waste and low-value biomass residues can, in principle, serve as steam-cracker feedstocks, their broader utilisation is currently constrained by heteroatoms and trace contaminants (e.g., halogens, silicon species, metals) and by the potentially high effort required for conditioning, and upgrading. The overarching objective is therefore to develop an integrated and industrially relevant process chain from waste/residue streams to high-value chemicals, while explicitly minimising the necessary conditioning effort. In contrast to approaches targeting a full naphtha-equivalent product, SUSCI pursues to upgrade the oils only to the extent required to meet steam cracker specifications and to exploit properties that deviate from conventional fossil feedstocks where advantageous.

Methodologically, SUSCI is designed as an iterative optimisation across the entire value chain. Upstream process choices (feedstock selection, pyrolysis conditions, fractionation) are developed in deliberate interplay with downstream requirements and constraints of steam cracking, and with the performance of targeted conditioning steps. This integrated perspective builds on prior insights and analytical foundations from preceding work (notably PYCRA for plastic-waste pyrolysis oils), while closing remaining research gaps needed for technically robust, economically viable, and higher-volume industrial application beyond minor blending ratios.

In Q4 2025, work primarily focused on project initiation and methodological setup. In particular, IIP began structuring the work on (i) quantifying and spatially characterizing future plastic-waste and biomass potentials and (ii) defining the framework for the economic and environmental evaluation (techno-economic assessment and life cycle assessment) to be populated with mass- and energy-balance data generated by the upstream experimental work packages.

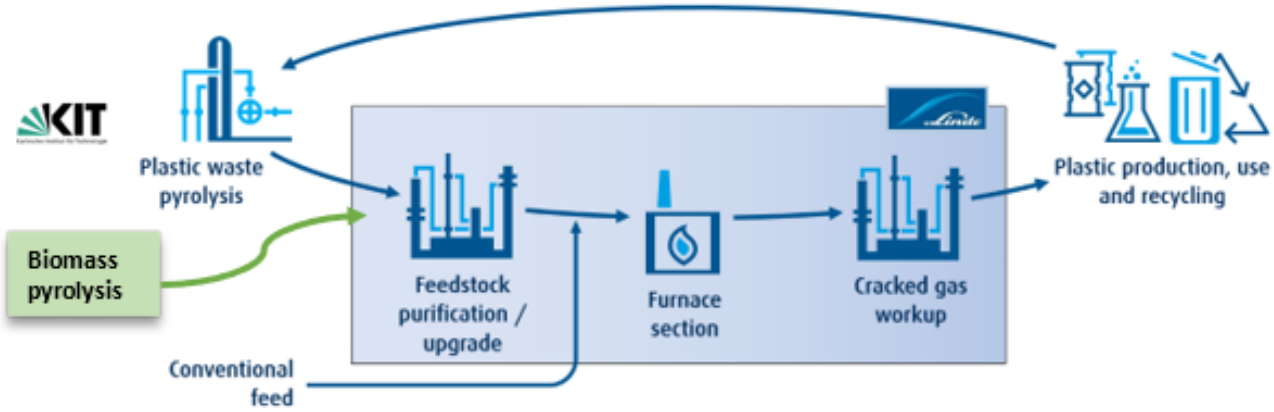

Figure: Integration of renewable and recycled feedstock streams into the chemical value chain.

URBAN – CO2-reduced concrete by upcycling residues from concrete preparation and CCU

Antonia Frank, Sebastian Rauscher, PD Dr. Rebekka Volk

Partner: KIT - Institute for Technical Chemistry (ITC), KIT –Institute of Concrete Structures and Building Materials (IMB), Leibniz University Hannover (LUH) - Institute for building materials (IfB), Sika Deutschland GmbH, Holcim (Deutschland) GmbH

Funding: BMBF - funding code: 03EE5130C

Duration: 2023 - 2026

The aim of the project is to develop a highly CO2-reduced, high-quality and resource-efficient concrete cycle for old, post-demolition concrete. For this purpose, a belite-based Portland cement clinker (RC clinker) with a low CO2 footprint will be produced from concrete crushed sand for the first time. Released CO2 can be separated in a concentrated manner and used for the technical carbonation of either mechanically processed concrete crushed sand as a substitute in cement or for carbonation hardening of coarse RC rock formation (CCU) using a new process based on a pressure autoclave.

Recycled cements with a greatly reduced CO2 footprint are formulated from recycled bricks, Portland cement clinker and technically carbonated crushed sands as well as other substitutes. In order to enable its use in production, recipes for recycled concretes based on adapted superplasticizers and accelerator systems are developed from recycled cement and recycled aggregate (RC2). The planned circular flow is shown in the figure. At the end of the project, plant tests will be conducted to demonstrate the high-quality concrete cycle using the example of concrete products and precast concrete elements. In order to produce this new type of cement, it is essential to estimate the future potential of post-demolition.

The newly developed technical process is assessed and evaluated technically, economically and ecologically for different plant sizes and locations throughout its entire life cycle and compared with the state of the art. The aim is to reduce the cumulative CO2 emissions of RC2 concrete by at least 40% compared to conventional recycled concrete. Different compositions of concrete with 15 and 30% recycled concrete are currently being tested.

In addition, regulatory boundary conditions are examined (e.g. Recycling Building Materials Ordinance, DIN-EN 197-1, legal classification of a plant for clinker production) in order to identify obstacles in the implementation of centralized or decentralized concepts.

First, the quantification of post-demolition concrete was assessed to determine the amount of material available for RC clinker production in the future. This was followed by a detailed analysis of the RC clinker manufacturing process, in which the CCU of post-demolition concrete is used as input material. A comprehensive process description is essential for conducting an economic assessment of the production route and for calculating the actual CO2 emissions associated with it. All material flows are therefore systematically examined and evaluated. The next step will focus on network optimization for concrete recycling in Germany in order to develop a strategy for establishing an efficient recycling network for demolition concrete in Germany.

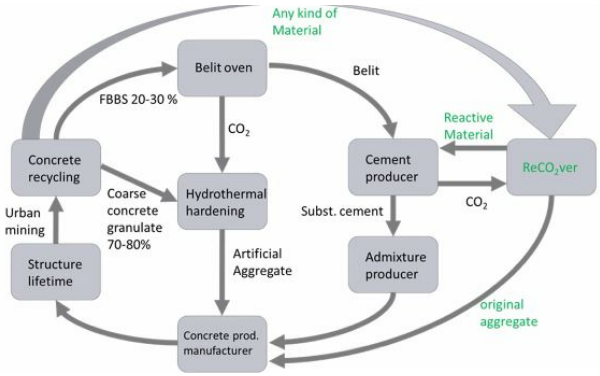

Figure: Circular flows (URBAN), supplemented with the material flows of the Sika project RECO2VER (green)

UT-UBGI – Urban Transformations towards Blue-Green Infrastructures

Niklas Braun, Janik Unterlöhner, Dr. Justus Steins

Partner: Institution(s) Helmholtz Centre for Environmental Research (UFZ), Leipzig; Karlsruhe Institute of Technology (KIT), Karlsruhe; Helmholtz Center Hereon, Geesthacht. The project is coordinated by UFZ.

Funding: Initiative and Networking Fund (INF) of the Helmholtz Association within the framework of the Helmholtz Sustainability Challenge

Duration: 2024-2027

The UT-UBGI project aims to drive tangible urban change by developing, planning, and assessing blue-green infrastructure (BGI). The entire initiative operates through an inter- and transdisciplinary approach, closely integrating academic partners with municipal practitioners. The core task involves defining the scope of sustainable BGI strategies, quantifying their inherent functions, and analyzing the public narratives and potential conflicts tied to their practical implementation.

The overarching objectives of the research include the development of data-scalable UBGI scenarios and modeling approaches, and the application of techniques for the attribution of urban climate extremes to facilitate adaptation. Furthermore, the project seeks to apply sustainable UBGI limits across Germany, ranging from medium-sized municipalities to data-rich cities, and integrate conflict analysis, negotiation strategies, and narratives into the broader context of UBGI transformation research.

The expected outcome of the consortium's work will be modeling tools that directly support urban planning processes for German municipalities. Using scenario-based infrastructure planning, the project will combine the expertise and specific methodological approaches of the partners. The three Helmholtz Centers (UFZ, KIT, and Hereon) enable this strong and robust co-creation process, which is aimed at establishing a joint Helmholtz research and innovation platform for urban systems.

For 2026, the comprehensive application and validation of the developed tools are scheduled across the partner municipalities.

Completed Dissertations

PhD Dissertation:

**Strengthening Resilience for Critical Supply Chain Networks:
Strategic Optimization and Decision Support**

Katharina Eberhardt

As global supply chains become more interconnected and complex, strengthening their ability to anticipate, manage, and recover from disruptions presents a growing challenge, particularly in critical sectors such as food and pharmaceuticals, where disruptions can have severe consequences. In these industries, resilience requires strategic planning approaches that strengthen network reliability, enhance visibility, and improve responsiveness, enabling public authorities and companies to manage operations more effectively, monitor performance, and maintain continuity of supply. While interest in supply chain resilience is rising, there is still considerable potential for deeper evaluations of network strategies, data-driven decisions, and incorporating insights derived from real-world case studies.

Given these challenges, this dissertation presents six research studies that develop strategic optimization and decision support methodologies, contributing to increased resilience in critical supply chains. Study A focuses on optimizing facility placement and the distribution of critical goods, accounting for disruptions related to warehouse operability, infrastructure and logistics failures, coverage limitations, and demand variability. Study B addresses the strategic challenges of network design for the location and distribution of critical goods under varying impact scenarios. The study integrates location-allocation decisions to minimize shortages and leverage economies of scale in storage, using stochastic modeling to assess crisis intensity, facility size, capacity limits, and cost-weighting strategies. Both models are applied to Germany's national food stockpiling system, demonstrating their applicability and practical relevance.

Study C analyzes national food stockpiling strategies through a comparative analysis of different countries, highlighting their benefits and limitations. Study D introduces a routing model that optimizes fleet composition by balancing the strengths of different vehicle types, such as trucks and drones, and considers the specific requirements of humanitarian logistics. A case study based on the COVID-19 pandemic assesses the model's applicability and sensitivity. Study E develops a knowledge graph to systematically structure, link, and integrate heterogeneous data sources, enabling a comprehensive analysis of drug shortages and supporting complex queries to uncover key contributing factors and enhance strategic planning. Study F deepens the understanding of supply chain resilience in the pharmaceutical sector, emphasizing its strategic role in building capabilities and linking them to vulnerabilities through a structured approach.

Beyond the specific findings of the individual studies, the overarching implications of this dissertation, comprising network design, disruption management, data analytics, and the development of strategic insights for decision-makers, collectively offer valuable contributions to strengthening the resilience of critical supply chains.

PhD Dissertation:

Modeling the Demand and Supply of Reconditioned Electric Vehicle Batteries under Consideration of Stakeholder Interests

Sandra Huster

The transition to electric mobility is expected to significantly increase the number of electric vehicle batteries (EVBs) reaching end of life (EoL). As EVBs contain critical raw materials and their production is associated with significant environmental impacts, it is essential to manage them in a sustainable manner. Circular EoL strategies include recycling EVBs at the material level, reconditioning them for reuse as spare parts in electric vehicles, and repurposing them for use in non-automotive applications. While recycling and repurposing have received considerable attention in both academia and industry, reconditioning remains insufficiently understood, particularly in terms of its economic and regulatory viability and its acceptance among key stakeholders. The objective of this thesis is to support EoL decision-making by developing a tool that evaluates how stakeholder decisions and technical developments influence the supply and demand of reconditioned EVBs.

To this end, four studies (A–D) were conducted. Study A presents a simulation model estimating the volume of reusable EVBs as well as the number of electric vehicles requiring battery replacement, based on the lifetime mismatch between batteries and vehicles and considering constraints such as battery quality and the age of the host vehicle. Study B investigates consumer demand through a discrete choice experiment, analyzing how product attributes, such as price, life expectancy, and environmental footprint, affect preferences for replacing a failed EVB with either a new or reconditioned battery, or for retiring the vehicle entirely. Study C integrates the findings from Studies A and B and incorporates additional insights from stakeholder interviews to develop a comprehensive simulation model. The model includes 49 parameters, reflecting trends in recycling, repurposing, and reconditioning costs, battery technology developments, consumer and workshop preferences, and legal requirements such as recycled content targets. The model outputs projections of reconditioned EVB supply and demand up to 2050. Study D addresses the complexity and computational burden of the integrated model by using machine learning methods to approximate its input-output relationships. It shows that different key performance indicators can be predicted with varying accuracy depending on the machine learning approach applied.

The results underscore that reconditioning can be a valuable component of a circular battery economy, provided that key technical, economic, and collaborative conditions are met. The simulation approach developed in this thesis serves as a flexible tool for exploring future scenarios and supporting strategic decisions by manufacturers and policymakers. Future research could examine additional stakeholder dynamics and technical challenges of reconditioning and analyze its ecological impacts in greater detail.

Staff 2025

Head of the Chair of Business Administration, Production and Operations Management

Prof. Dr. Frank Schultmann

Administrative Staff

Liana Blecker (also working for the Chair of Energy Economics)

Corinna Feiler (also working for the Chair of Energy Economics)

Josiane Folk (also working for the Chair of Energy Economics)

Katrin Grauer

Heads of Research Groups

Dr. Sonja Rosenberg – Resilient Systems and Risk Management

Dr. Andreas Rudi – Sustainable Value Chains

Dr. Justus Steins – Resource Management in the Built Environment from June 2025

PD Dr. Rebekka Volk – Resource Management in the Built Environment until end of May 2025

Research Associates and their PhD-topics

Sonia Alikhah: Optimal solutions for sustainable value chains, production and distribution systems in the food sector

Raphael Bischof: Towards a Circular Economy: Techno-Economic and Ecological Evaluation of ETICS End-of-Life Management

Niklas Braun: Dynamic Layout Routing - Development of a new optimization model for merging layout and route planning with dynamic spaces

Xin Ying Chan: Life Cycle Optimization of Mycelium Composites as a Circular Alternative to Conventional Engineered Wood Products

Katharina Eberhardt: Strengthening Resilience for Critical Supply Chain Networks: Strategic Optimization and Decision Support

Moritz Fierke: Model-Based Risk Analysis for Resilient Infrastructure Systems

Antonia Frank: Sustainability in Concrete Construction: Potentials and Design of a Circular Economy System within Concrete Production

Lena Fuhg: Resource-Efficient and Low-Carbon Industrial Networks

Raphael Heck: Cooperation and Competition in Bioeconomy Value Networks – Analysing the Techno-Economic and Socio-Economic Potentials of Innovative Biorefinery Concepts

Paul Heinzmann*: Techno-economic optimization of e-fuel and hydrocarbon production taking into account plant flexibility and storage systems

Ines Hofmann: Socio-Technical Systems under Climate Stress: Implications for Resilience

Sandra Huster: Forecasting core supply and demand for reconditioned electric vehicle batteries under consideration of stakeholder preferences

Theresa Kaya: National mitigation pathway for the German construction and real estate sector

Elias Naber*: Socio-Technical Modeling and Agent-based Simulation of Deep Energy Retrofits in the German Building Stock - Mitigating Emissions Caused by Cooling and Heating of Buildings

Sebastian Rauscher: Sustainable use of mineral secondary raw materials in Germany

Teresa Oehlcke: The role of chemical recycling in meeting the carbon supply demands of the chemical industry through waste system integration

Alexander Schneider: Integrated life cycle sustainability assessment of Power-to-Liquid value chains

Simon Steffl: Composites in a circular economy

Diana Temnova Deguy: Superstructure Optimization of a newly developed green refinery concept

Nina Treml: Evaluating sustainability in pork production in Germany

Janik Unterlöhner: Nature-Based Solutions under Urban Climate Stress: Effectiveness and Net Carbon Balance

Elena Vollmer: Towards automatic thermography-based leak detection in district heating systems

Tobias Zimmer*: Model-based assessment of mobile pre-treatment technologies in bioenergy value chains

*external researcher

(International) Collaboration and Exchange

The Chair of Business Administration, Production and Operations Management is engaged in various national and international (exchange) activities.

Among others, these include:

- Prof. Schultmann is deputy spokesman of the topic “Circular Economy and Environmental Technologies” within the KIT Climate and Environment Center.
- Prof. Schultmann is scientific spokesman of the topic “Sustainable Material and Energetic Use of Biomass” of the Chilean-German Institute of Eco-Industrial Development (IECO).
- German-Australian cooperation and research exchanges, in 2025 with A/Prof. Larissa Statsenko from University of Adelaide visiting the IIP to engage network and identifying joined research interests.
- Visit of Navodi Wijayarathne, PhD candidate form Adelaide University to exchange research interests in September 2025.
- Simon Steffl spent a research stay at the Ecological System Design Chair at the ETH Zürich to exchange about Materials & Product Assessment for Sustainable Systems in the Bioeconomy
- In May the first DFIU day took place at the institute to strength the academic dialogue on cross-border environmental issues

Teaching Activities

The Chair of Business Administration, Production and Operations Management offers several modules in the fields of Production and Operations Management, Risk Management, Project Management, Supply Chain Management and Logistics, and Sustainability. During 2025 around 530 student exams were completed and the chair has supervised 65 bachelor and master theses.

Circular Economy – Challenges and Potentials

Prof. Dr. F. Schultmann, Dr. Andreas Rudi, Dr. Sonja Rosenberg, Dr. Justus Steins, Rafael Bischof, Xin Ying Chan, Sandra Huster, Teresa Oehlcke, Sebastian Rauscher

Circular Economy (CE) is an economic system that, on the one hand, aims to minimize waste, emissions and resource consumption and on the other hand increase resource efficiency by keeping products and materials in use for as long as possible. Based on basic ideas and principles of CE this lecture tackles potentials and challenges for the design and operations of circular value chains and systems. Different research-oriented case studies reveal and illustrate the potential implementation as well as the limits and future needs of CE as a key element of sustainable industrial development.

Design and Operation of Industrial Plants and Processes

Prof. Dr. F. Schultmann, Dr. Andreas Rudi, Raphael Heck, Paul Heinzmann, Alexander Schneider, Diana Temnova-Deguy

This course familiarizes students with industrial plant management along the entire life cycle, starting with the initiation and erection up to operating and dismantling. Students learn how to deal with important methods to plan, realize and supervise the supply, start-up, maintenance, optimization and shut-down of industrial plants. A focus is also given to specific characteristics of plant engineering, commissioning and investment.

Fundamentals of Production Management

Prof. Dr. F. Schultmann, Lena Fuhg, Antonia Frank

This course aims to make students familiar with basic concepts of industrial production economics and logistics. The main contents are the different strategic, tactical and operational production strategies and layouts, as well as planning and management methods. The terms and tasks of industrial production are defined and described by interdisciplinary and system approaches. Furthermore, warehouse location problems, operational site planning and production design problems as well as decision making are in the focus. Qualification aims are to enable students to describe the field, to reproduce and analyse decisive aspects and decisions in industrial production contexts, to know, model and solve key planning tasks of strategic production management and logistics.

Life Cycle Assessment - Basics and Application Possibilities in an Industrial Context

Prof. Dr. F. Schultmann, Nina Treml, Alexander Schneider

The lecture focuses on the analysis of the environmental impact of products using Life Cycle Assessment (LCA). Structure and steps are conveyed in detail and selected further developments are shown. In order to record the methodology and classify potential environmental impacts, the practical development of what has been learned is also focused on using LCA software and interactive formats.

Logistics and Supply Chain Management

Dr. Sonja Rosenberg, Katharina Eberhardt

Students learn the central tasks and challenges of modern logistics and supply chain management. They learn and apply methods of risk evaluation and risk management in supply chains like market forecasts, the Bullwhip effect and the difference between a lean and a robust supply chain. Further aspects comprise the analysis and development of efficient incentive-schemes and planning-tools relevant to procurement decisions, optimal location decisions, order management and supplier relationship management.

Production and Logistics

Prof. Dr. F. Schultmann, Rafael Bischof

This course introduces students to the key concepts and methods of production management and logistics. It covers the role of production in value chains, the main strategic, tactical and operational planning tasks, and practical approaches to material requirements planning, inventory control, procurement and supplier evaluation. Students learn how production systems are structured, how planning decisions are made, and how uncertainties such as demand fluctuations or supply disruptions affect operations. The course also provides an introduction to sustainable production and circular economy ideas. By the end, students are able to describe important elements of production and logistics, analyze basic planning problems, and apply essential methods for production program planning, materials management and supplier assessment in industrial settings.

Production and Logistics Management

Dr. Andreas Rudi, Sonia Alikhah

This course covers central tasks and challenges of operational production and logistics management. Systems analytically, central planning tasks are discussed. Exemplary solution approaches for these tasks are presented. Further practical approaches are explained. Students get to know the set-up and mode of operation of planning systems such as PPS, ERP and APS to cope with the accompanying planning tasks. Alongside to MRP II, students are introduced to integrated supply chain management approaches in Supply Chain Management.

Production Economics and Sustainability

PD Dr. Rebekka Volk, Dr. Justus Steins, Rafael Bischof

This course offers an introduction to the basics of sustainability and the linkage of sustainability to production and logistics. Main methods of lifecycle assessment (LCA), material flow analysis, and ecological accounting are presented. Examples of sustainability assessments and sustainable production systems illustrate actual challenges for the transformation of current production environments into sustainable structures. Also, integrated assessment models, environmental legislation, environmental management approaches, and circular economy principles are presented. The students get an overview of different sustainability topics, methods, databases, software, and legal backgrounds in relation to sustainable consumption and production.

Project Management

Prof. Dr. F. Schultmann, Theresa Kaya, Teresa Oehlke, Ines Hofmann, external experts

This lecture introduces the basics of project management starting with a general introduction on projects and standards in the field. Then, scope management as well as time, cost, and resource management principles are addressed and emphasised. Furthermore, aspects of risk, stakeholder, and quality management are described and considered and communication, negotiation, leadership, and controlling in the project management context is examined. The lecture is deepened with practical exercises and complemented by a business game and a software tutorial. Furthermore, we are happy to include two invited talks from employees of Campana & Schott (international management and technology consultancy) and VSE AG (German power supplier). The talks cover the topics "The Role of the Project Manager", "Communication, Negotiation and Leadership" and "Agile Methods of Project Management" from a practical perspective.

Risk Management in Industrial Supply Networks

Dr. Sonja Rosenberg, Ines Hofmann, Amelie Schwärzel

Students learn methods and tools to manage risks in complex and dynamically evolving supply chain networks. Students learn the characteristics of modern logistics and supply chain management and learn to identify and analyse the arising risks. On the basis of this overview on supply chain management, the students gain knowledge about approaches and methods of industrial risk management. Key aspects include the identification of major risks, which provide the basis for the development of robust networks, together with risk reduction techniques like risk diversification, risk pooling and risk transfer. This provides the students profound knowledge for supply chain risk analysis and for the design of strategic and tactic risk prevention and mitigation measures for supply networks.

Teaching by external lecturers

Emissions into the Environment

Prof. Dr. Ute Karl

The lecture gives an overview of relevant emissions of air pollutants and greenhouse gases, emission monitoring and pollutant abatement options together with relevant legal regulations at national and international level. In addition, the fundamentals of circular economy, waste management and recycling are explained.

Global Manufacturing

Dr. Henning Sasse

This course deals with questions of international management in engineering and production. Advanced knowledge in the field of international production and the internationalization strategies of engineering companies is presented. Basic understanding of international production companies the relevant business and economic models and schools of thought on the subject are provided. Different approaches of the design of internationalization strategies and production networks are presented and relevant location factors for their particular design are investigated. Risks of internationalization and methods of risk minimization as well as issues of supply chain management are discussed in the context of different approaches to the discrete manufacturing and the process industry. The course concludes with selected case studies from the process and discrete manufacturing industry.

Supply Chain Management with Advanced Planning Systems

Dr. Mathias Göbelt, Claus Bosch

This lecture deals with supply chain management from a practitioner's perspective with a special emphasis Advanced Planning Systems (APS) and the planning domain. The software solution SAP SCM, one of the most widely used Advanced Planning Systems, is used as an example to show functionality and application of an APS in practice.

Teaching at the Chair for Business Administration, Production and Operations Management	
BSc-Module „Production Management" • Fundamentals of Production Management • Production Economics and Sustainability • Logistics and Supply Chain Management	
MSc-Module "Industrial Plants and Processes" • Design and Operation of Industrial Plants and Processes • Emissions into the Environment • Life Cycle Assessment – Basics and Application Possibilities in an Industrial Context • Global Manufacturing	**MSc-Module "Production and Logistics Management"** • Production and Logistics Management • Supply Chain Management with Advanced Planning Systems • Project Management • Risk Management in Industrial Supply Networks • Circular Economy – Challenges and Potentials

Publications

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