Karlsruhe Institute of Technology

Institute for Industrial Production

Annual Report 2020

Chair of Business Administration, Production and Operations Management




Sources of cover page images:
N3PO

Stahlinstitut VDEh

Fotolia

Karlsruhe Institute of Technology (KIT)
Institute for Industrial Production (IIP)
Chair of Business Administration, Production and Operations Management
Building 06.33
Hertzstraße 16
D-76187 Karlsruhe
phone +49 721 608 44460/44569
fax +49 721 608 44682
info@iip.kit.edu
www.iip.kit.edu

Preface

This annual report from the Chair of Business Administration, Production and Operations Management at the Institute for Industrial Production (IIP), Karlsruhe Institute of Technology (KIT) highlights our main activities during the year 2020. Our three research groups "Sustainable Value Chains", "Risk Management", and "Project and Resource Management in the Built Environment" have conducted numerous projects on a regional, national and international level covering a broad range of topics. The team of the Chair consists of about 26 researchers, 4 administrative staff and a several student assistants.

During 2020, we worked on 23 third party funded research projects. We published 8 peer-reviewed journal papers, numerous articles in conference proceedings and book chapters. 2 PhDs were completed. Teaching activities resulted in around 800 exams and about 140 bachelor and master theses were supervised. Though, due to the Corona pandemic our international collaborations were limited in 2020, we managed to deepen 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,

Chair of Business Administration, Production and Operations Management

Sustainable Value Chains

Head of research group: Dr. Simon Glöser-Chahoud

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 parallel 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. Methods and models are developed based on the regarded problems and transferred to specific applications.

A focus task is the development of computational planning models that enable an integrated analysis, assessment and optimization of material streams, complex interconnected plants or complete production networks. Other considered aspects 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 metal, energy, chemical and automotive industry as well as on the utilization of biomass.

Typical methods in use are:

- investment and production cost estimation, investment decision making
- operations research based modelling (optimization and simulation)
- empirical social studies (especially questionnaire-based surveys and statistics)
- Life Cycle Assessment (LCA), Life Cycle Costing (LCC), environmental impact assessment

Members of the research group (from l. to r.): Paul Heinzmann, Raphael Heck, Tobias Zimmer, Simon Glöser-Chahoud, (Marina Maier), Andreas Rudi, Sonja Rosenberg, Sandra Huster.

Risk Management

Head of research group: Dr. Marcus Wiens

The Risk Management Research Group works on scientific research questions and practice-relevant problems in the area of Risk Management with a special focus on systemic risks, behavioral risks, critical infrastructure and supply chains. The applied methods comprise economic modelling (in particular, OR and game theory), empirical approaches (e.g. surveys) and simulation studies (e.g. agent-based simulations).

Also, in the Risk Management Group, the Corona year 2020 was characterized by more difficult project work, virtual project meetings, and cancelled conference trips. However, in February of the year, the second expert workshop of the PREVIEW project could still take place. At this meeting, the project consortium presented and discussed the interim results of the project together with the associated partners of the project as well as one representative each of the Federal Ministry of Transport and the project sponsor VDI. At the same time, the milestone meeting of the PREVIEW project was successfully completed during the February meeting.

Despite the same constraints, the Corona crisis proved to be an unexpected boost for the NOLAN project. A number of intermediate solutions to public-private partnerships in crisis management, such as the goods transport pact or state protection of supplier credits, which had previously been merely hypothetical or theoretical, suddenly had a real counterpart and were launched by authorities and companies, in some cases within a few weeks. Against this background, the consortium was given the opportunity to extend the project for one year with full funding. PPEC remains the main topic in the extension phase with increased consideration of the experience gained in the Corona context.

With regard to the KASTEL project, everything in 2020 was dominated by the planned continuation as a Helmholtz institute from 2021. In the first half of the year in particular, a large number of preparatory workshops were held in order to prepare the joint work in 2021. In addition, Florian Kaiser was able to obtain a scholarship (HIDA Summer School), which gave Florian the opportunity to cooperate with the Ben-Gurion University in Israel for almost a quarter of a year. Thanks to this very valuable cooperation with the Complex Networks Analysis Lab, a great progress was made in the area of game theory-based anomaly detection. Furthermore, the work with the other KASTEL partners continued and was extended by experimental research in the KASTEL-research group Human & Societal Factors.

In the DFG-ANR project INCA, the track planned for the ISCRAM-conference in 2020 could not take place due to Corona. In the meantime, the INCA consortium has established contacts with two Swedish researchers and will make up with them for the cancelled track at ISCRAM 2021. Planning and execution of the jointly organized call for papers for the Journal of Homeland Security continued in 2020 and is expected to be completed as planned in 2021. The INCA project was successfully completed in August 2020. The project partners will continue their cooperation on the topic of transboundary resilience.

The year 2020 was also successful in terms of PhDs. At the end of May, Heike Schmidt-Bäumler successfully completed her PhD with a thesis on "Multicriteria decision support in risk-based infrastructure management". At the end of the year in December 2020, Farnaz Mahdavian, who was an external PhD student in the Risk Group and funded by KHYS during this time, also successfully completed her PhD with a thesis on "Emergency Decision Making and Disaster Recovery". The Risk Management Research Group warmly congratulates Heike and Farnaz for this great achievement!

Members of the research group (from l. to r.): Rebecca Wehrle, Francois Nyobeu, Markus Lüttenberg, Marcus Wiens, Florian-Klaus Kaiser, Miriam Klein, Florian Diehlmann, Farnaz Mahdavian.

Project and Resource Management in the Built Environment

Head of research group: Dr. Rebekka Volk

The Project and Resource Management in the Built Environment (PRM) group carries out technical, economic and environmental model-based analysis of energy-efficient, resource-efficient and renewable policies and technologies, as well as their potentials regarding the built environment. Especially in the fields of deconstruction and circular economy, decommissioning and dismantling of nuclear facilities, sustainable urban development, energy and resource efficiency and the use of renewable energies in buildings, research projects are currently being worked on.

To offer decision support for different planning activities on consumer/user perspective, building level, district, regional or national level, several optimization models have been developed and are employed, among others the AWOHM model, the ECCO models for greenhouse gas quantification on value chains and the ResourceApp and MogaMaR/NukPlaRStoR models for optimized (nuclear) decommissioning project planning. AWOHM is a simulation model for the German residential building stock, the building stock's energetic quality and technical equipment as well as its owners and residents. AWOHM is used to identify economically feasible retrofit options and the resulting national greenhouse gas emissions. This is a transferable model for national-scale energy systems, which mainly employs publicly available data and census data. The ResourceApp, MogaMaR and NukPlaRStoR models are linear optimization models for robust project planning under uncertainty particularly for deconstruction and decommissioning of buildings and structures. While the ResourceApp model is focusing on residential and non-residential buildings, MogaMaR and NukPlaStoR are addressing nuclear power plants and facilities. And, the MogaMaR model was transferred to an innovation as new software product called openZELOS.

Furthermore, we work on the planning and decision support of sustainable urban development on district level with the city administration Karlsruhe. Key aspects are the sustainable and efficient resource usage and management focusing on land use, water and materials. Another project is identifying heat losses in buildings and infrastructures of urban districts via automated processing of drone images.

As well, we analyse current and emerging technologies and supply chains with respect to more resource efficient (recyclable and/or CO_2-reduced) building materials and products, ranging from steel, aluminium, aerated concrete and cement to different types of plastics. In these projects, we analyse production methods, new production technologies and assess the whole supply chains and material flow systems for decision support.

Typical methods used in the PRM group are:

- agent-based modelling to identify cost-efficient renewable energies' potentials in residential building stocks and municipalities,
- model-based material stock/flow and life cycle analyses and
- automated image processing to identify potential cost savings of heat and cooling losses,
- techno-economic assessments and scenario analyses,
- project management optimization methods.

Members of the research group (from l. to r.): Mihir Rambhia, Christoph Stallkamp, Marco Gehring, Rebekka Volk, Zoe Mayer, Elias Naber, Justus Steins.

Research Projects

CEDIM Center for Disaster Management and Risk Reduction Technology

Marcus Wiens & group members

Partner: Geodetic Institute (GIK), Geophysical Institute (GPI), Institute of Applied Geosciences, Institut für Finanzwirtschaft, Banken und Versicherungen (FBV), Institute for Hydromechanics (IfH), Institute for Industrial Production (IIP), Institute for Nuclear and Energy Technologies (IKET), Institute of Concrete Structures and Building Materials - Materials Testing and Research Institute (MPA Karlsruhe), Institute of Meteorology and Climate Research, Institute of Photogrammetry and Remote Sensing (IPF), Institute of Regional Science (IfR), Institute for Technology Assessment and Systems Analysis (ITAS), Institute of Technology and Management in Construction, Institute of Economics (ECON), Institut für Wasser und Gewässerentwicklung

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. To assess the indirect impacts of natural events, two subprojects were implemented, dealing with supply chain vulnerability under consideration of global interconnectedness (IIP) and changed consumer mobility requests in the aftermath of a disaster (ECON).

CoBiVal – Cooperation in Bioeconomy Value Chains

Raphael Heck, Simon Glöser-Chahoud, Tobias Zimmer

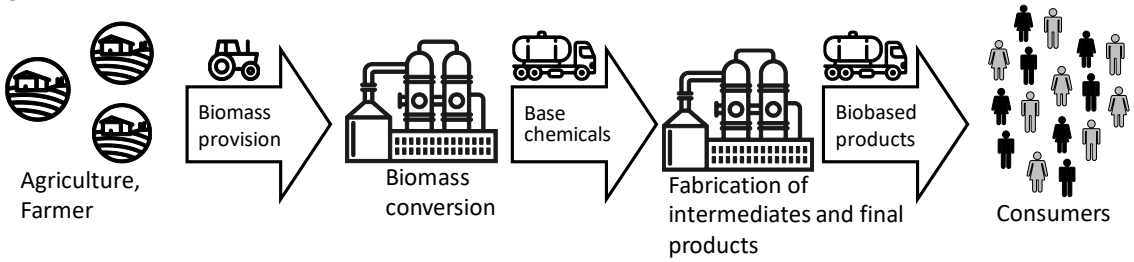
Funding: Federal Ministry of Education and Research

Duration: 2019 - 2022

Despite technical feasibility and, in some cases, a positive assessment of economic viability, bio-based processes and value chains are only implemented very slowly or not at all in practice. Classical obstacles are a lack of incentives for all actors involved in the value chain such as unequal distribution of risk or profit, high entry costs or path dependencies and a lack of flexibility. Social acceptance and general public perception of new bio-based products and technologies are also of central importance with regard to the practical implementation of innovations in a bioeconomy. Last but not least, every process, every renewable resource or raw material and every potential value chain has technical, economic and social specifics that have to be taken into account when performing a holistic evaluation.

The present research project aims at a systematic investigation and evaluation of bio-based value chains taking into account the incentives and obstacles of all actors involved. In particular, the availability of suitable biomass in sufficient quantity and quality is of central importance when establishing innovative utilization pathways. This requires new forms of cooperation and business models between agriculture and industry, which are systematically examined in this project. For this purpose, empirical studies will be carried out through expert interviews and surveys. Based on the gathered insights, optimization and simulations approaches taking into account the decision of individual actors in the value chain will be developed in order to enable a quantitative assessment of potential value creation in alternative bioeconomy value chains.

The aim of the project is primarily to identify and evaluate measures, concepts and business models with which actors can be motivated to participate in bio-based value chains in order to establish the bioeconomy as an integral element of a sustainable industrial society.



	Problem	Research question
I	Distribution of investment, risk and outcome among supply chain partners	Which share of risk and reward is acceptable for all partners in the value chain?
II	Coordination and cooperation in bioeconomy supply chains	How can transaction costs in value chains be reduced by cooperation and exchange of information?
III	Integration and implementation of bioeconomy value chains	How can the implementation and market entrance of bio-based technologies be facilitated and accelerated?
→	**Increase the participation of agents and potential partners in bioeconomy value chains**	

DeMoBat – Industrielle Demontage von Batteriemodulen und E-Motoren zur Sicherung wirtschaftsstrategischer Rohstoffe für die E-Mobilität

Sandra Huster, Sonja Rosenberg, Simon Glöser-Chahoud

Partner: Fraunhofer Institut für Produktionstechnik und Automatisierung (IPA), Clausthal Research Center for Environmental Technologies (CUTEC), KIT Institut für Produktionstechnik (wbk), Hochschule Esslingen, BTU Cottbus – Fachgebiet Physikalische Chemie , Mercedes Benz AG, Siemens AG, Silberland Sondermaschinenbau GmbH, Greening GmbH & Co. KG, Erlos GmbH, acp systems AG, CTC battery technology GmbH

Funding: Ministry of the Environment, Climate Protection and Energy Sector Baden-Württemberg

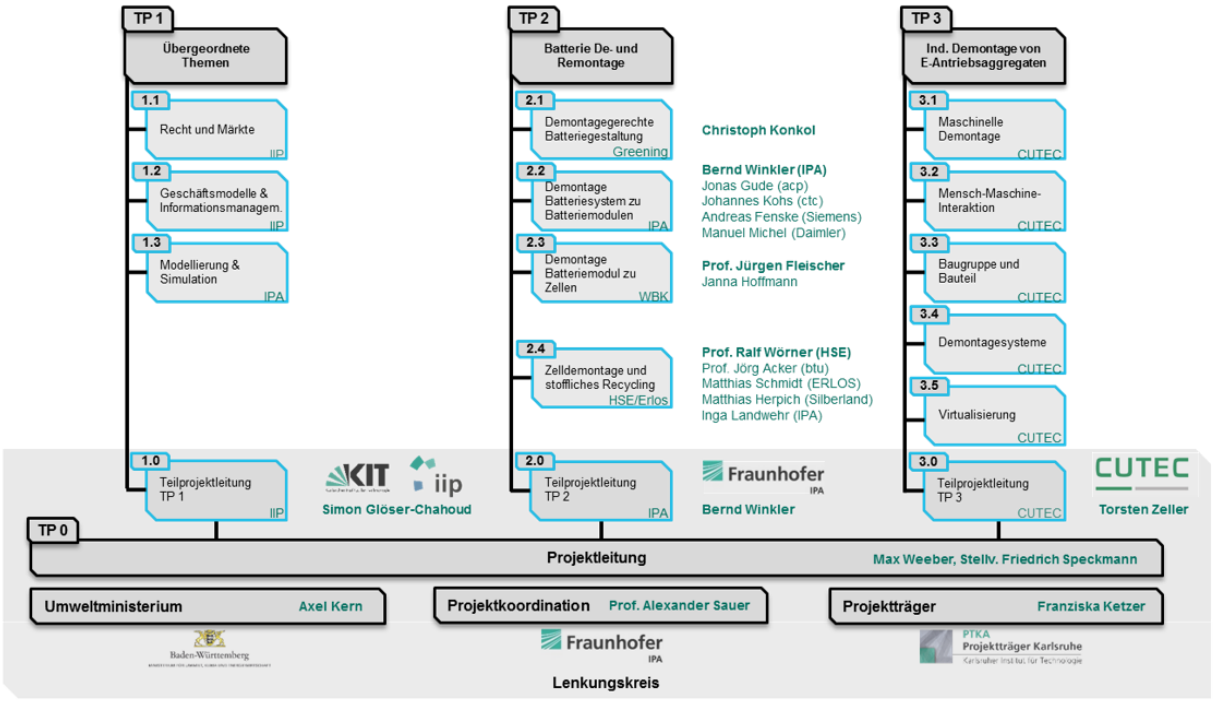
Duration: 12/2019 - 2022

The joint project DeMoBat aims to develop industrial disassembling processes for traction batteries and drive trains of electric vehicles. These processes are considered as a prerequisite for a resource-efficient and sustainable design of closed-loop supply chains for electro-mobility.

Traction batteries represent a key cost factor of electro-mobility and cause significant environmental impacts during production, which is why their most efficient and long-term use is a crucial element of the sustainable design of electro-mobility.

The targeted disassembly of battery packs into individual modules and subsequent cell level enables condition-specific uses of the battery modules or cells. A disassembling allows on the one side reassembling for second use applications, such as energy storages or automotive spare parts. On the other side, high-quality recycling of the electrode active material can be reached. The same applies to electric motors, where the rare-earth permanent magnets and copper coils are valuable components.

While the other research partners are primarily working on technical solutions for disassembling, IIP is responsible for coordinating sub-project 1. In this context, IIP evaluates raw material markets, business models, legal framework conditions, and logistics concepts, as well as capacity and sequence planning of the disassembling processes from a techno-economic perspective.



Development and evaluation of biobased value chains for Baden-Wuerttemberg

Andreas Rudi, Raphael Heck

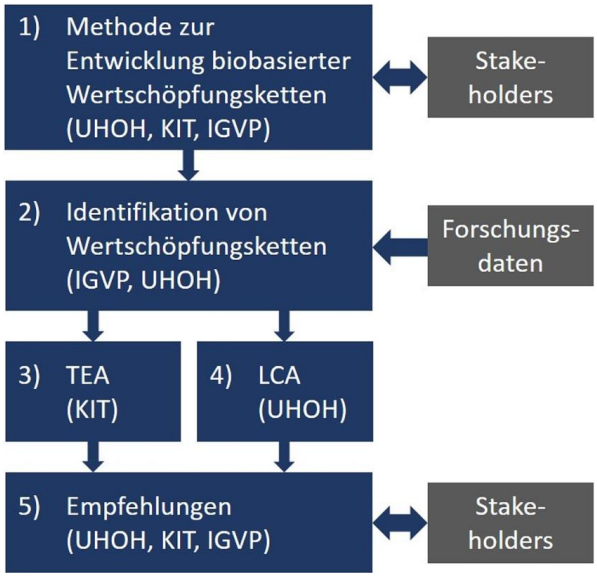
Partner: University of Hohenheim, University of Stuttgart

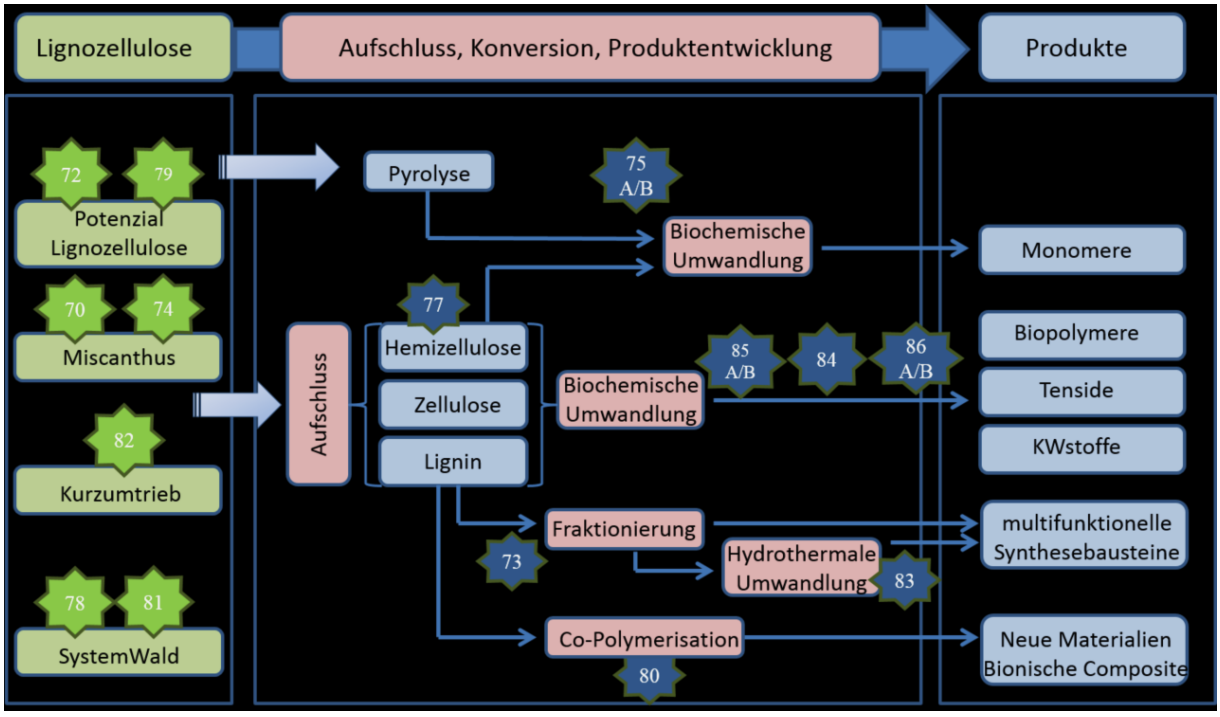
Funding: Ministry of Science, Research and the Arts

Ministerium für Wissenschaft, Forschung und Kunst Baden-Württemberg

Duration: 10/2018 - 09/2020

For the development of new bio-based products, a large number of possible process steps are available. The combination and evaluation of these possibilities is a complex undertaking, especially if process steps are to be taken into account in the trial phase. In addition to the technical feasibility, the ecological evaluation and the economic realization possibilities have to be considered with regard to the overriding goals of the bioeconomy. This project aims to develop a methodological approach that is suitable for creating bio-based value chains and analyzing them from a techno-economic and ecological perspective. Five steps are undertaken:





Development of an economic approach for decision support in a circular economy orientated production

Sonja Rosenberg, Marina Maier

Partner: AUDI AG, UMICORE, Scholz Recycling GmbH

Funding: THINKTANK
Industrielle Ressourcenstrategien

Duration: 05/2018 - 03/2019

Up to today, Original Equipment Manufacturers (OEM) have hardly any incentive to invest in recycling and dismantling friendly products. One of many reasons is that expected earnings through recovery in the future cannot be allocated directly to higher costs in the early stages of a products life cycle, such as development and production. Thus, it is common practice for OEM business models to focus solely on producing and selling while achieving a profit based on a margin. If performed, other companies execute the dismantling and recovery processes and receive the earnings.

With the increasing digitalization and changing consumer behavior OEM rethink their business models and tend to focus more on product service systems. Furthermore, increasing technology allows new forms of cooperation along supply chains and lifecycles of products. These developments create the possibility of new circular economy based business models.

In order to evaluate and identify which circular economy-based business models should be chosen for a specific product, decision support is needed.

Thus, the aim of this project is to develop an evaluation tool that allows the economical investigation of alternative business models and recovery options. The developed method is tested for specific use cases in the automotive industry. Afterwards, further use cases in other industries are implemented to show the general applicability.

Emergency Management and Evacuation

Farnaz Mahdavian

Funding: Graduate Funding from the German States

Duration: 2017 - 2020

The first objective of the research project is to gain a deeper understanding of the chain of events during a disaster and to improve human behaviour and reactions particularly regarding evacuation. To this end, extensive research on different natural disasters in several countries has been carried out to outline the key lessons concerning evacuation from various hurricanes and floods in major worldwide events. The analysis revealed both successes and failures in warning and evacuation.

The evacuation process can be viewed from two perspectives. The first is related to government decision-making, to early warning systems and to the relevant authorities' protocols for issuing an evacuation order. The second is whether people in the affected area decide to evacuate or not depending on whether or not they have received an evacuation order. In principle, evacuation needs to be carried out in an immediate and urgent manner, which requires fast decision-making on all levels. However, crises are characterized by a high degree of uncertainty and delay and the need to evacuate is often only realized after the disaster has escalated.

For the government reaction part, a decision model for disaster evacuation was designed using the Bayesian Updating method, which captures government decision-making during the event of a flash flood. In this scenario, the government receives a noisy signal (a disaster warning) about an upcoming extreme weather event and faces a choice between announcing an evacuation order, either severe or extreme, or keeping silent. The objective of the dynamic model is to analytically compare the outcomes and various costs of different decisions based on different levels of information and identify the optimal decision paths. "Cost" in this context is defined as adverse consequences for life and health as well as a loss of trust or credibility in governmental announcements.

The second part of the research analyses society's perception and attitude towards crisis events based on a questionnaire. To this end, a set of hypotheses about the influence of risk attitudes, disaster experience and trust is established. A special focus is on country comparisons.

The target sample includes people who were living or working in the affected area in Germany and the United Kingdom. The study analyses the levels of risk awareness, knowledge, attitude to disaster and preparedness in different countries as well as the role of trust among people and between people and government in emergency reaction. The objective is to learn which factors influence people's decisions and reactions immediately following a disaster. The insights out of this survey can help the government to improve preparedness, warning and evacuation policies.

Entwicklung von Rückbau- und Recyclingstandards für Rotorblätter

Dr. Rebekka Volk, Christoph Stallkamp

Partner: THINKTANK Industrielle Ressourcenstrategien, Institut für Technische Chemie (ITC) am KIT, Fraunhofer-Institut für Chemische Technologie (ICT), Baumeister Rechtsanwälte, Composites United e.V.

Funding: Umweltbundesamt (UBA)/
Federal Environment Agency (UBA)

Duration: 2020 - 2021

Wind turbines are a decisive component in achieving the goals of the energy turnaround in Germany. The number of onshore wind turbines has more than tripled in the last 20 years. In addition to the numerical development, their continuous increase in size and, closely related to this, the increasing complexity of the material composition, is of great importance. The height of wind turbines and their rotor diameters influence the possibility of a uniform energy yield and allow the development of new areas for energy conversion. This leads to the expectation that, within the scope of technical possibilities, the height and especially the rotor diameter will continue to increase in the future.

Due to their operating life and the reduction in EEG payments, wind turbines are increasingly being dismantled due to decommissioning or repowering, and this trend is expected to continue. The possibility of rebuilding disused plants in emerging markets will be made more difficult in future by their increasing size. It can therefore be assumed that new generation turbines will have to be recycled mainly in Germany. The pressure and the necessity to develop conclusive dismantling and recycling concepts for Germany's wind power plants will therefore increase considerably.

In a previous study commissioned by the Federal Environment Agency (UBA) a first, conclusive and complete dismantling and recycling concept was developed. Conceptual proposals for high-quality and complete plant recycling were developed and organisational obligations were assigned to manufacturers, operators and owners.

Figure 1: Wind park

From the perspective of high-quality recycling, composite materials - carbon fibre reinforced (CFRP) or glass fibre reinforced (GRP) plastics - are a particular challenge. The composite materials are mainly found in the rotor blades, making them a key component in the dismantling of wind turbines. In the case of the rotor blades, it is often unclear which materials were used because of the large number of makes. Especially with longer rotor blades, one must always expect to find layers of CFRP. In the UBA study mentioned above, these composite materials play only a minor role. In the next few years, however, the increasing proportion of CFRP-containing waste will pose a particular challenge for health and environmental protection reasons during dismantling, shredding and processing, and as a disruptive factor for the established recycling of CFRP and due to the ultimate lack of safe disposal. Here, too, the organisational responsibility for the highest possible quality recycling plays an important role.

EU-Tender

" Technical assistance to assess the potential of renewable liquid and gaseous transport fuels of non-biological origin (RFNBOs) as well as recycled carbon fuels (RCFs), to establish a methodology to determine the share of renewable energy from RFNBOs as well as to develop a framework on additionality in the transport sector."

Simon Glöser-Chahoud, Manuel Ruppert, Paul Heinzmann, Uwe Langenmayr

Partner: Guidehouse, Fraunhofer ISI, ESA², TU Wien

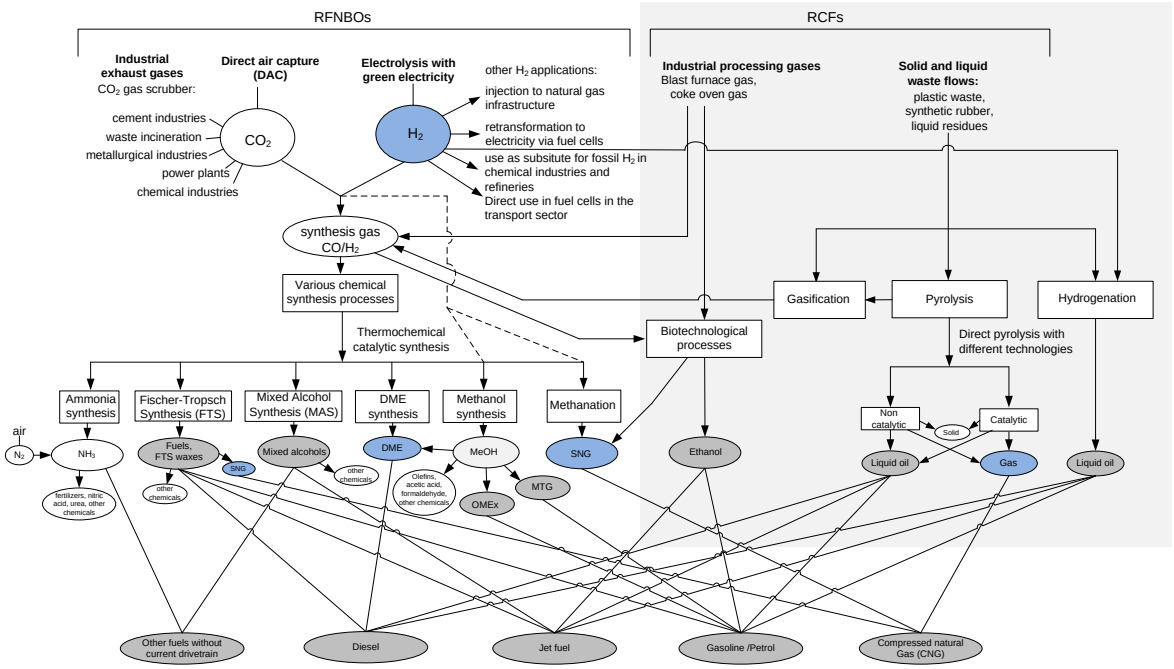
Funding: European Commission, DG ENER

Duration: 07/2020 – 07/2021

The general objective of the contract research is to obtain detailed information on the potentials of renewable fuels of non-biological origin (RFNBOs) and recycled carbon fuels (RCFs) in the EU from 2021 onwards. Producers of RFNBOs need a framework enabling to provide evidence that the renewable electricity used in the production of their fuel is of renewable origin. Subsequently the project develops a general framework to measure the additionally of electricity in the EU transport sector, which is required in the revised version of the Renewable Energy Directive (RED II).

The specific objectives of this contract research are to assist the Commission in:

- Assessing the potential of renewable liquid and gaseous transport fuels of non-biological origin as well as recycled carbon fuels, as defined in REDII, over the period 2020 to 2050 in the transport sector in the EU (task 1).
- Development of detailed rules by which producers of renewable liquid and gaseous transport fuels of non-biological origin can provide evidence that they are using renewable electricity in the production of their fuel in order to establish the methodology under Article 27, paragraph 3, subparagraph 7 of REDII (task 2).
- Developing a framework on additionality in the transport sector and the identification of different options to determine the baseline for EU Member States in accordance with Article 27, paragraph 3, subparagraph 3 of REDII



INCA Project

Miriam Klein, Marcus Wiens

Partner: University of Wuppertal, ARMINES - Mines Paris Tech, University of Paris-Dauphine

Funding: German Research Foundation (DFG), French National Research Agency (ANR).

Duration: 03/2017 - 08/2020

The INCA project was successfully completed in 2020 after a project extension of six months. In the INCA project, the crisis scenario of a long-term power blackout in the German-French border region was investigated with the objective to enhance cross-border resilience. First, direct and indirect consequences of a power failure for the population were mapped by scenarios. One key finding was that the efficient identification and treatment of casualties by an optimal distribution of available medical resources can be achieved by the integration of cross-border capacities. Hence, a strong project focus is on the cross-border cooperation of authorities who are responsible for crisis management as well as the forces involved in crisis management. A second focus of the project is on volunteer management in the cross-border context since their different backgrounds, experiences and motivations are seen as a huge potential for an improved disaster resilience. During past crises, it was observed that volunteer helpers not just act as members in voluntary aid organizations, but spontaneously come together and offer their know-how. As a result, the usual coordination is limited or even completely eliminated which makes this field of research highly relevant.

To achieve these goals, an agent-based model was developed, as this method is suitable for mapping the complex interplay of the individuals and the dynamics of their behavior. Agent-based modelling is particularly well-suited for depicting a crisis scenario, as each actor has limited information that he gains by sharing with other agents. Additionally, not all alternative courses of action are known and not all resulting effects are predictable due to the complexity. Nevertheless, decisions must be taken under uncertainty and the project supported this process from a scientific point of view. Here, special features of the cross-border region as culture and language, which may facilitate or complicate crisis cooperation, were considered. Therefore, in the modelling of the communication process, there has been inserted an additional trust variable between sender and receiver of a message. Depending on the relationship of trust between the two agents, the incoming information was evaluated and processed. Using a scenario-based approach, the impact of trust in the dynamic process of crisis management was measured and compared with other factors of influence such as different languages. It turned out that a common language as well as trust between the cooperating agents is necessary in order to increase the efficiency of the cooperation, whereby in the examined scenario the language barrier had greater influence.

In addition to the simulated framework a set of empirical studies was conducted. By interviewing disaster control experts from different border areas and observing joint crisis management exercises, it became clear that there is no comprehensive cross-border solution between two neighboring countries around Germany or France in the area of crisis management. Rather, different actors who are strongly dependent on the different administrative levels of the countries have worked out different local solutions. The forms of cooperation range from no cooperation to informal cooperation to partly institutionalized cooperation within a framework of committees such as the Upper Rhine Conference. In the context of a representative nationwide population survey in Germany and France, however, a higher willingness to volunteer as spontaneous helper across borders was found for people who live in the border area compared to people who live in the respective countries. This can be attributed to increased social capital and regional ties in the

border region and also allows conclusions to be drawn about a possibly common cultural identity within the border region. A scenario experiment provided insights into the behavior of affected people with and without health restrictions and showed that the authorities should timely warn in the event of a crisis but it should also communicate with the population in peace time to prepare for such events, last but not least across borders.

KASTEL

Florian Kaiser, Marcus Wiens

Partner: Institute for Applied Computer Science and Formal Description Methods (KIT), Institute for Anthropomatics and Robotics (KIT), Institute for Automation and Applied Computer Science (KIT), Institute for Program Structures and Data Organization (KIT), Institute for Theoretical Computer Science (KIT), Institute for Telematics (KIT), Research Center for Computer Science (KIT), Center for Applied Law (KIT), Institute for Public Law (Goethe University Frankfurt a.M.)

Funding: Federal Ministry of Education and Research (BMBF)

Duration: 05/2018 - 12/2020

The Competence Center for Applied Security Technology (KASTEL) is one of three nationwide competence centers for cyber security. The aim is to bring together expert knowledge from various scientific fields (e.g. information science, sociology and legal studies) to engineer secure systems and to develop a comprehensive approach for IT-security instead of isolated partial solutions.

With its approaches to techno-economic risk management, KASTEL contributes to making IT-security quantifiable and scalable, thus ensuring its economic feasibility and creating a basis on which secure systems can be developed.

KASTEL as a project was successfully completed in 2020. From 2021, KASTEL continues in the form of a new interdisciplinary Helmholtz Institute of KIT. This consolidation has significantly shortened the duration of the project, which was initially funded until 2022, and brought forward work that was planned for later dates. The goals of the project will continue to be pursued by the Risk Management Research Group at the KASTEL Institute.

Within KASTEL, the Risk Management research group keeps its focus on economic risk management. Risk management generally includes the systematic analysis of internal organizational risks and the development of measures to reduce risks for the purpose of long-term protection of the organization and the society. The handling and control of IT risks requires not only that organizations have the necessary technologies and processes, but also that these are economically sensible and feasible. Economically oriented risk management is therefore becoming increasingly important due to the ever-stronger linkage of industrial value chains in terms of information technology and the associated growing effort required to protect these structures from attacks and technical errors. Economic risk management refers not only to the economic efficiency of IT risk management, but also to the economic consequences of a failure of IT systems (e.g. business interruption). With a view to the development of scalable and quantifiable safety concepts, it is possible to consider material and immaterial consequences in the risk assessment. In addition, an economic risk analysis also considers the behavior of the actors as well as the opportunity costs of risk-reducing measures and thus the conflicting objectives of security investments.

In 2020, the research group developed an approach for value- and process-oriented quantification of cyber risks based on game theoretical methodology and process value analysis. Within this approach, the quantification of the impact of a cyberattack was based on process value analysis and combined with defender attacker game modelling for estimating the probability of an attack. The approach leverages on Cyber Threat Intelligence. This work was done in close cooperation with the Complex Networks Analysis Lab of the Ben-Gurion University in Israel.

Furthermore, in 2020, the group worked intensively with international and national cooperation partners, advanced research, especially in the areas of cyber security in the automotive sector, the health care sector and network markets and successfully

published first results. Unfortunately, the research work was also affected by the restrictions resulting from the COVID-19 pandemic. Especially international cooperations in 2020 could only take place in a limited form.

Leuchtturmprojekt Kreislauf für Kunststoffe

Dr. Rebekka Volk, Christoph Stallkamp

Partner: Institut für Technische Chemie (ITC) am KIT, Audi AG, VW Originalteilelogistik (OTLG)

Funding: THINKTANK Industrielle Ressourcenstrategien, Land Baden-Württemberg

Duration: 01/2020 - 12/2021

Worldwide, the production of plastics is increasing and with that the dependence on crude oil and secondary plastics. The amount of plastic waste has also increased in recent years - in Germany, especially in the packaging sector. The German recycling figures remain at a constantly low level. In contrast, there have been considerable changes in the market for plastic waste: Changed import regulations in China influence the price, supply and demand structure, and Germany and the EU are calling for further steps towards a circular economy by tightening the political framework conditions. This is reflected in an increase in recycling quotas for plastic packaging.

The establishment of a closed-loop economy for plastics offers the opportunity to improve competitiveness and resource efficiency. The finite nature of primary raw materials is countered and a reduction in energy consumption contributes to climate protection.

The aim of the project is to map the German plastics cycle in its current status and dynamics. The focus is on the waste fraction of light packaging and the standard thermoplastics used there, as well as the automotive sector with its technical plastics.

Current political framework conditions and potential changes will be examined and the resulting options for action and effects will be mapped in the system. In particular, the options for action avoidance, material recovery (increase in the recycling quota through improved sorting) and raw material recovery (use of currently unused plastic waste fractions as chemical raw materials including potential assessment) are to be investigated. The different recycling paths will be assessed and compared using techno-economic and ecological indicators.

Figure 2: Sorting of lightweight plastic packaging waste

On the basis of the planned national model for Germany, the following desired effects of options for action should be investigated: (1) the reduction of the use of fossil raw materials, (2) the reduction of greenhouse gas emissions, and (3) economic advantages compared to the current status quo.

Figure 3: Pyrolysis condensate from different plastic waste fractions

The project is based in the THINKTANK Industrial Resource Strategies at KIT, which was established by the state government of Baden-Württemberg in cooperation with industry and science. Its focus is the holistic view on technological-strategic questions of resource efficiency, resource use, and resource policy.

The assessment of chemical recycling options is performed in cooperation with the Institute of

Technical Chemistry (ITC) at KIT. At the ITC, the selected material flows are investigated, experiments are performed on chemical recycling options, and thus the technical feasibility is demonstrated.

Audi and Volkswagen OTLG support the subproject "Chemical recycling of plastics from automotive engineering" by providing plastic components that are no longer needed and also data for the assessment.

Lignocellulose Biorefinery for the Bioeconomy in Baden-Wuerttemberg

Andreas Rudi, Raphael Heck, Simon Glöser-Chahoud

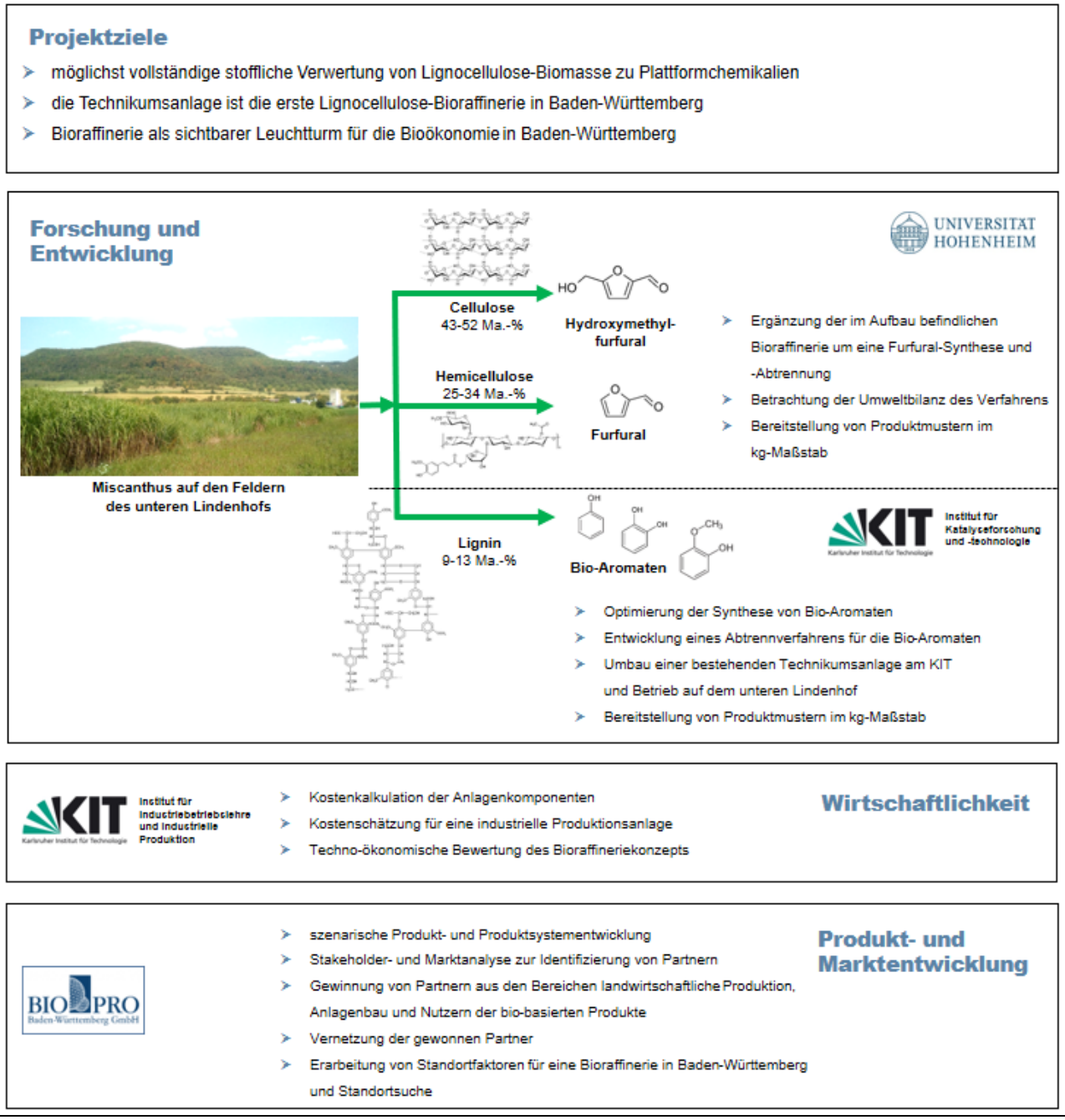
Partner: Institut für Katalyseforschung und -technologie (IKFT-KIT), University of Hohenheim, BIOPRO GmbH

Funding: Ministry of Science, Research and the Arts

Ministerium für Wissenschaft, Forschung und Kunst Baden-Württemberg

Duration: 10/2018 - 09/2020

The aim of the project is to set up and operate a complete lignocellulose utilisation chain in the biorefinery pilot plant "Bioraffinerie-Technikum" on the site of the "Unterer Lindenhof" experimental station at the University of Hohenheim. Within the framework of a modular plant, the complete recycling of lignocellulosic biomass into platform chemicals will be demonstrated.



namares
– Resource management in urban districts in the context of sustainable urban development

Dr. Rebekka Volk, Sophia Schambelon, Elias Naber

Partner: Karlsruhe city administration (Stadtplanungsamt und Amt für Umwelt- und Arbeitsschutz der Stadt Karlsruhe), Smart Geomatics Informationssysteme GmbH, Netzwerk für Planung und Kommunikation Sippel.Buff, KIT – Lehrstuhl Ökologie und Ökonomie im Wohnungsbau (ÖÖW), KIT - Institut für Angewandte Geowissenschaften (AGW), KIT - Kompetenzzentrum für Materialfeuchte (CMM)

Funding: BMBF - funding code: 033W111A

Duration: 04/2019 - 03/2022

The project aims at developing a support tool for urban resource management, which enables city administrations and other actors to monitor the use of natural resources (here: land, water, materials) at district level and to establish active resource management. To manage (natural) resources efficiently, their use must be measured and evaluated. On this basis, the need for action can be identified, measures can be designed and targeted goals can be monitored. For this purpose, an assessment scheme with relevant fields of interest and subordinate indicators will first be developed. Subsequently, interrelationships and effects of resource use in the urban district are modelled and consequences and conflicting goals for different actors are examined. With the base of this scientific knowledge a GIS-based software tool will be developed, implemented and tested in an urban case study district in the city of Karlsruhe. This will be accompanied by transdisciplinary approaches and a guideline enabling the transfer of project results.

The desired project result is a capable GIS-based web tool for accounting and monitoring resource consumption in urban districts, which is aimed at municipal decision makers and interested citizens. The tool and an accompanying guideline should enable the transfer of the results and support sustainable decision-making processes in district management and sustainable urban transition processes.

In 2020, namares project completed data capturing and analysis of district data for the Innenstadt-Ost district in Karlsruhe. In particular, 12 seminar students undertook the effort to assess roof and facade areas, waste containers, window surfaces and residential units. Also, in the Stadtökologisches Praktikum students assessed the ecological quality of the private yards. This data was analyzed and first results could be developed for the sample district in Karlsruhe. The first case study aims at desealing the private yards to reduce urban heat island effects, to increase irrigation and reduce rain water runoff as well as to improve air quality. For this, a method was developed and applied to the sample district. Further works aim at greening of roof and façade surfaces and decision support regarding the tradeoff between related cost and benefits. Due to the corona pandemic, the project faced some delays.

Figure 4: Exemplary yard sealing (© City of Karlsruhe)

The project is accompanied by working groups within the research program RES:Z funded by the Federal Ministry of Education and Research. We particularly contributed to the working groups "digitalisation" and "indicator development".

NOLAN

Florian Diehlmann, Markus Lüttenberg, Marcus Wiens

Partner: 4flow AG, TU Dresden

Funding: Federal Ministry of Education and Research – BMBF.

Duration: 2018 - 2021

Emergency care falls within the remit of the public sector. Nevertheless, private companies have a large number of resources (including skills) at their disposal, which can be very helpful in providing emergency support to the suffering population in the event of a crisis. In the NOLAN project, the option of a public-private partnership in crisis management is being systematically investigated for the first time.

The project partners are experts in the areas of risk and crisis management, emergency logistics, supply chain management and public law. Together with dialogue partners from the private and public sectors, the partners investigate the possibilities for the effective and practical design of a "Public Private Emergency Collaboration" (PPEC).

The overall objective of the project is to improve the supply security of an urban population with essential goods in crises. The aim is to develop concepts for efficient cooperation between private actors in commercial supply chains (i.e. retail, logistics, CI-operators) and state actors (i.e. public response agencies). For an escalating crisis event in urban areas, a holistic concept of emergency logistics – scalable in escalation stages – is developed which focuses on the cooperation of private actors in commercial supply chains and on state actors in emergency supply, taking into account the findings from humanitarian supply chains.

The focus is on the supply of vital, discrete goods such as food, medicines and bottled drinking water. Methodologically, a distinction can be made between two different approaches. On the one hand, the supply chains of public authorities and private companies are modelled and the interaction of the supply chains simulated and optimized. Parallel to this, a game theoretical analysis of the cooperation is carried out with the objective to determine factors of a stable cooperation together with an efficient and fair division of risk and responsibility in a PPEC.

NOLAN activities of the year 2020 were affected by the unprecedented developments, and many events, workshops, and conferences had to take place digitally or had to be cancelled entirely.

The year started with the storm "Sabine" forcing the KIT-project team to cancel the third expert workshop, which would have been hosted by the Ministry of the Interior of the state of Baden-Wuerttemberg in Stuttgart. Due to the Covid-19-pandemic the workshop had to be cancelled twice. In addition, the associated project partners were not available as those were heavily involved in their organizations' disaster response. In February 2021, the project consortium holds a virtual expert workshop. The aim is to collect, reflect and discuss the experiences and key learnings from the experts and to apply these insights to the concept of PPEC. Against the background of the Covid-19-pandemic, the project sponsor officially regarded the NOLAN-project as a "project with Corona-relevance" which provided the consortium with the unique occasion of a fully funded project extension of one year. During this year, the key topic will still be the public-private emergency collaboration, however, the scenarios and applications put more emphasis on the specificities of a pandemic.

Due to the evolving pandemic, the project meetings with the partners from Berlin and Dresden took place digitally. Moreover, the NOLAN team participated in various digital conferences, including the World Food Convention (in June), focusing on the acute challenges to global food systems, the Health & Humanitarian Logistics Conference (in September) focusing on coping with current public health challenges, or the Humanitarian Congress (in October) with the focus on existing power imbalances in the humanitarian sector and how social inequalities shape the global response to crises. Moreover, the KIT-project-team participated at the INFORMS conference in November. During the INFORMS conference, Marcus Wiens gave a talk

on the COVID-19 response of selected German companies, sharing some experiences from the NOLAN-project with a large audience.

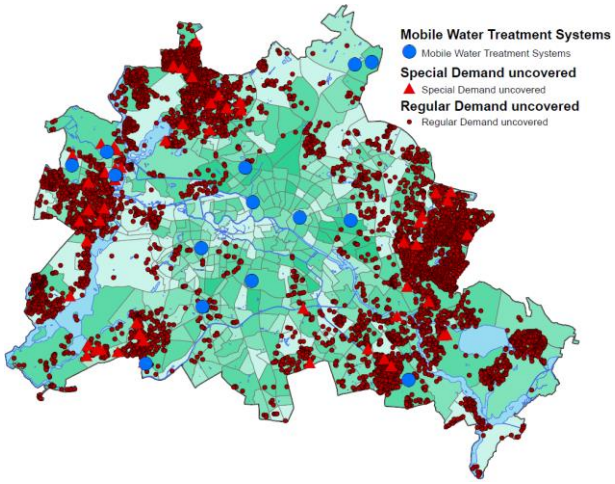


Figure 5: Selected locations of mobile treatment plants (blue dots) in case of a failure scenario of the Berlin water supply (Stallkamp et al., 2020)

In collaboration with the project partners and international colleagues, publications in the context of crisis management were continuously promoted.

NukPlaRSTOR – Development of a user-friendly cost-optimizing planning tools for nuclear dismantling projects taking into account material flows for resource planning

Dr. Rebekka Volk, Marco Gehring

Partners: RODIAS GmbH; VPC GmbH

Funding: BMBF - funding code: 15S9414A

Duration: 07/2019 - 06/2022

International organisations expect that the dismantling of nuclear plants is becoming a national and international focus of the energy and dismantling industries. Completed and still ongoing dismantling projects of nuclear plants show that dismantling is technically safe. However, the nuclear facilities operators and responsible dismantling companies state a still considerable potential for optimisation and cost savings in the project management of nuclear dismantling. This is particularly evident with regard to the extreme time and cost deviations from the original planning of some current nuclear decommissioning projects. A major reason for these deviations is that the planning of nuclear dismantling projects represents a major challenge due to low empirical values and the large scope (many dismantling steps, many actors involved, long project duration, complex permits, complex material and waste flows, etc.). Currently, existing project planning tools do not completely cover the requirements of nuclear dismantling projects.

The aim of the NukPlaRStoR joint project is to develop a user-friendly planning tool that is specifically tailored to the needs of nuclear dismantling projects. The planning of nuclear dismantling projects is thus considerably simplified. The planning tool should enable the calculation of an optimized plan (with regard to costs and in compliance with safety regulations) containing all tasks to be performed as well as all material flows occurring during the decommissioning. Based on the material flows, the planning tool should support logistical planning (e.g. transport and processing within the plant, conditioning) as well as container planning including final disposal documentation. Furthermore, the planning tool should be interfaced with other programs (e.g. for the visualisation of the calculated plan or for residual material tracking).

The joint project started in June 2019 with a kick-off meeting of the participating project partners in Karlsruhe. Subsequently, we began reviewing and analysing the work breakdown structure of a real nuclear dismantling project in close cooperation with our industry partner VPC GmbH. Based on the retrieved data, a previously at IIP developed optimization method for cost-minimized project planning was tested. The underlying optimization method is suitable for practical application, as the evaluation of the results considering various criteria has shown. In 2020, this prototype was further developed into a user-friendly and commercially available software product called openZELOS. The planning tool is now launched in cooperation with our partner RODIAS GmbH.

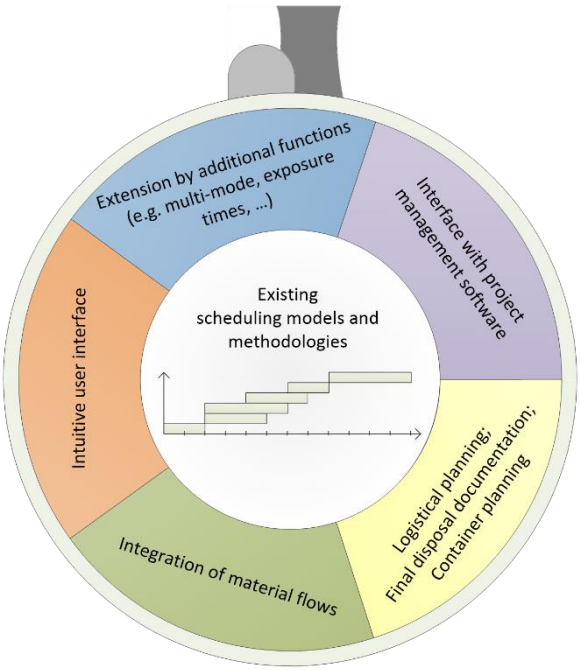


Figure 6: Planned extensions of the NukPlaRStoR project

Piloting the native ethanolic extraction of rapeseed (EthaNa); Subprojects 5: Economic and ecological accompanying research in the joint project (EthaNa)

Andreas Rudi, Simon Glöser-Chahoud

Partner: Fraunhofer-Zentrum für Chemisch-Biotechnologische Prozesse CBP, Fraunhofer-Institut für Grenzflächen und Bioverfahrenstechnik IGB, Fraunhofer-Institut für Verfahrenstechnik und Verpackung IVV, Forschungsinstitut Futtermitteltechnik IFF, B+B Engineering GmbH, Thywissen GmbH, AVA Anhaltinische Verfahrens- und Anlagentechnik GmbH, Miccra GmbH, VetterTec GmbH, tti Magdeburg GmbH

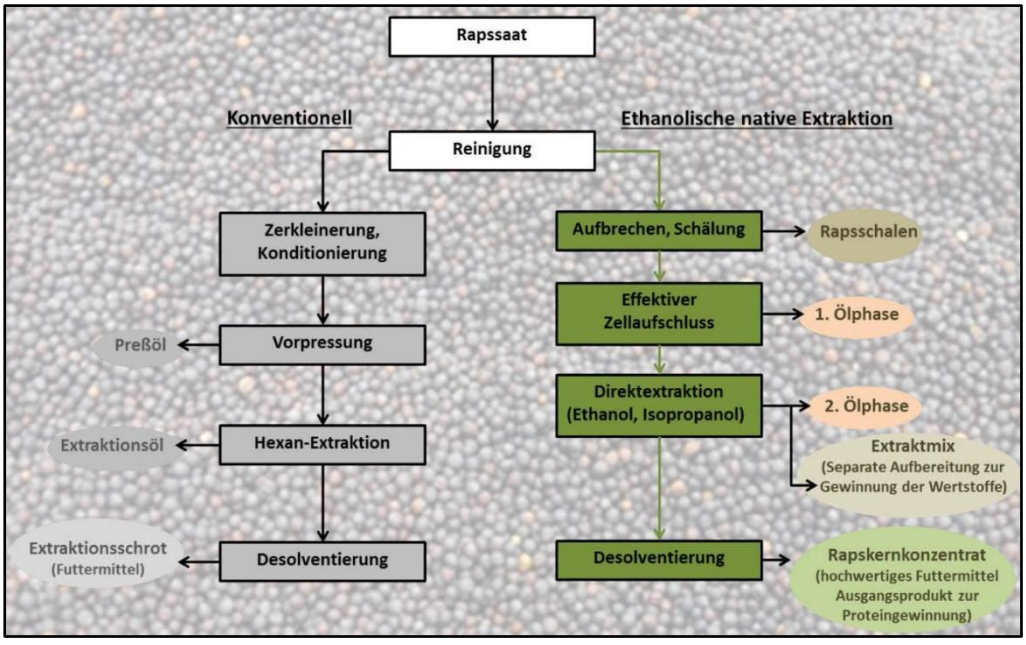
Funding: German Federal Ministry of Food and Agriculture (BMEL)

Federal Ministry of Food and Agriculture

Duration: 09/2017 - 08/2021

The aim of the project is to develop an innovative refining process of canola seed in order to obtain highly efficient, economical, high-quality products. Compared to extraction processes with the solvent hexane, which were customary up to now, the EthaNa-refining processes might enable a significant qualitative improvement of the products rape oil and rape kernel concentrate. In addition, new highly valuable substances which have not yet been derived from rape seed are isolated. This will open up further sales markets in future and increase overall sales revenues from the oleaginous seed. The EthaNa concept is a fully integrated process for rape seed refining. Direct extraction with alcohol makes it possible to obtain high-quality plant-oil and proteins as primary products. Within the framework of the overall project, the IIP is dedicated to the evaluation of the relevant economic and ecological aspects of the individual sub-processes as well as the overall process. It forms an essential basis for industrial application and marketing of the developed concept. Economic and ecological evaluation models for the concept are used and evaluations are carried out in parallel. For this purpose, methods from material and energy balancing (e. g. process engineering simulation), investment and operating cost estimation as well as life cycle assessment (e. g. Life Cycle Inventory of the entire value-added chain) are applied.

EthaNa Process



PREVIEW

Rebecca Wehrle, Marcus Wiens

Partner: 4flow AG, TU Dresden, Bundesanstalt für Wasserbau (BAW), antwortING

Funding: Federal Ministry of Education and Research – BMBF.

Duration: 2018 - 2021

Around 2.5 million containers are transported annually on the German waterways. On the one hand, the waterways are of outstanding importance for the functioning of the economy. On the other hand, the infrastructure of the artificial federal waterways, including canals and locks, is outdated. Floods or possible terrorist attacks also pose a threat to the waterway infrastructure. Furthermore, it is not known what consequences the failure of individual critical elements of this system may have for other transport infrastructures, the economy and the population in the affected regions.

The PREVIEW project investigates the possible consequences of the failure of critical water transport infrastructure structures for other transport infrastructures, logistics, neighbouring industries and the population of the regions concerned. The overall objective of the project is thus to increase the resilience of the waterway infrastructure in Germany. To this end, adverse consequences will be analysed and processed on the basis of three exposure scenarios as natural events, technical or human failure and hostile attacks. For the first time, the entirety of the hazards for the population as well as for transport logistics and the economy will be analysed. The resulting findings will be used to draw up contingency plans in order to effectively counter these hazards.

The results of the project will be incorporated into a simulation model, which illustrates possible hazardous situations using the example of the West German canal network. This enables end users to visualize the vulnerability of the infrastructure, the local communities and industries. Logistic models also make it possible to assess the economic impact of damage events in canals. The results benefit the end users and can then be transferred to the entire waterway infrastructure.

In February 2020, the milestone meeting took place in Karlsruhe. The results of the initial milestones were presented at half-time of the project duration to representatives of the VDI as the project's sponsor. The second PREVIEW expert workshop was held immediately afterwards. Dialogue partners from authorities, science and industry made a decisive contribution to the validation of the work concept developed in the project and other work results. In addition, a focus was placed on the requirements analysis of the demonstrator to be developed.

Further project meetings took place digitally and ensured the close cooperation with the project partners from Berlin, Cologne and Karlsruhe as well as the focus on the common goal of further work.

The continuous validation of the research results by further publications and conference participation within the framework of the joint project is also pursued. In 2020, for example, research results were published in the journal Bautechnik. Furthermore, Rebecca Wehrle attended the Hamburg International Conference of Logistics (HICL) in September 2020 with focus on new ways of creating value in supply chains and logistics. In cooperation with project partner Johannes Gast (4flow AG) the submission and presentation of a paper on the topic "Impact of notification time on risk mitigation in inland waterway transport" was accepted, presented and discussed with an interested audience.

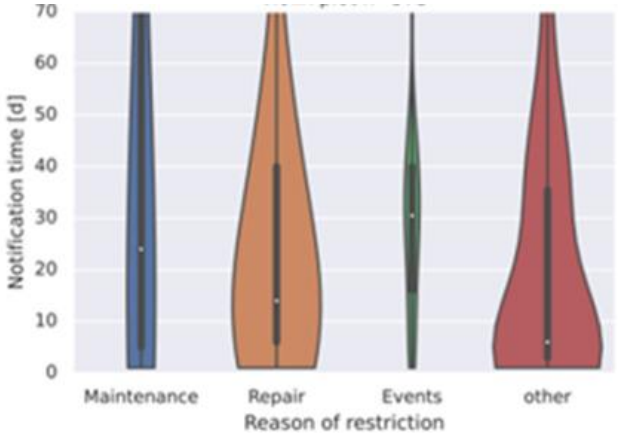


Figure 7: Distribution of warning time regarding the reason for closure of waterways based on Notification to Skippers at the West German Canal Network (n = 573)

Raw materials of strategic economic importance (r⁴)

Innovative technologies for resource efficiency – Provision of raw material of strategic economic importance

Sonja Rosenberg, Simon Glöser-Chahoud

Partner: Clausthal Research Center for Environmental Technologies (CUTEC), Fraunhofer Institute for Systems and Innovation Research (ISI), Federal Institute for Geosciences and Natural Resources (BGR), Pforzheim University (HS PF)

Funding: Federal Ministry of Education and Research (BMBF)

Duration: 2015 - 2019

Raw materials, such as indium, gallium, and rare earth elements are of strategic importance, while being scarce and thus, play a key role in future technologies and in Germany's transition to renewable energy. The started programme aims at increasing supplies for primary and secondary raw materials of strategic economic importance through research and development. Research areas cover primary and secondary resources comprised in 40 joint projects. Initiatives with focus on primary resource are associated to the exploration or the extraction and processing of raw materials. Meanwhile secondary resource projects deal either with recovery of raw materials or the recycling of end-of-life products.

Innovative Technologien für Ressourceneffizienz

Bereitstellung wirtschafts-strategischer Rohstoffe

The parties of the Germany-wide programme are interlinked by the research-supporting "r4-INTRA" integration and transfer project. "r4-INTRA" strengthens the innovation power of the projects by interconnecting parties and showing interdisciplinary synergies leading to a possible higher research efficiency. Performed potential analyses and evaluation of ecological and social benefits are used to derive recommended actions for future funding programmes.

reFuels – rethinking fuels

Simon Glöser-Chahoud, Paul Heinzmann, Uwe Langenmayr, David Pflegler

Partner: Institut für Kolbenmaschinen (IFKM), Institut für Katalyseforschung und -technologie (IKFT), Institut für Mikroverfahrenstechnik (IMVT), Engler-Bunte-Institut (EBI), Institut für Technikfolgenabschätzung und Systemanalyse (ITAS) and numerous industry partners

Funding: Ministry of Transport Baden-Württemberg

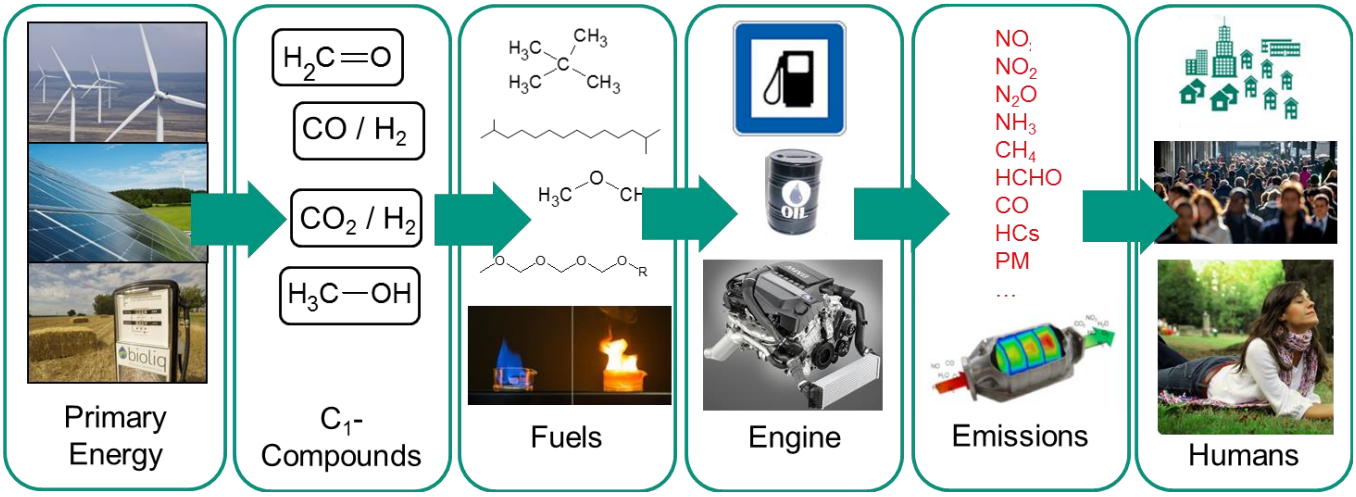
Duration: 2019 - 2021

The utilization of renewable produced fuels (reFuels) is one of the main actions beside electric mobility on the way to a CO_2 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. The aim of the project is to assess the complete value chain, from production of the fuels to the application of these fuels in vehicles.

The Institute for Industrial Production, on the one hand, examines the impact of the production processes on the energy system of Baden-Württemberg and Germany. The focus of this task is the assessment of the additional flexibility of these processes, the CO_2 savings in the mobility sector and the increasing integration of renewable energy sources. On the other hand, a techno-economic analysis of the different production processes is conducted. This task aims to deliver deeper understanding of investment volumes and the cost structure of different process constellations. This includes aspects of logistics and necessary infrastructure, which have an additional impact on the final integration costs of the processes. Finally, the implementation of a pilot plant at the facility of one project partner will be simulated and assessed.

The project results support deeper insights on reFuels, their production processes and useful applications. Furthermore, they help to further decrease the greenhouse gas emissions in the mobility sector.



REPOST
– Resource management in urban districts in the context of sustainable urban development

Dr. Rebekka Volk, Justus Steins

Partner: Xella Technologie- und Forschungs-gesellschaft mbH, Otto Dörner GmbH, KIT - Institut für Technische Chemie

Funding: BMBF - funding code: 033R249B

Duration: 06/2019 - 05/2022

"REPOST" has set itself the goal of creating the basis for a high-quality and economical recycling management of aerated concrete. New and competitive products for masonry construction are to be created from old aerated concrete. In addition to direct material recycling, alternative recycling methods - e.g., the production of clinker substitutes - are also being investigated. The project is funded within the framework of the funding measure "Resource-efficient recycling management - Innovative product cycles (ReziProK)" by the Federal Ministry of Education and Research (BMBF).

Aerated concrete is a building material that has been known and proven for almost 100 years. The recycling of aerated concrete fresh from production, which occurs as cuttings or breakage during production, has been practiced for decades. In contrast to this, aerated concrete demolition material often contains accompanying materials that make high-quality recycling difficult, which is why aerated concrete is usually deposited in landfill after use. Decreasing landfill capacities, legal obligations for the recyclability of products as well as the conservation of primary materials therefore make it essential to find recycling alternatives for this demolition material. REPOST aims at the reduction of primary raw materials in the production of aerated concrete by recycling old aerated concrete at the same or comparable quality level. This concept differs from conventional building material recycling. In the statistics, around 90 percent of mineral construction waste is recycled, but mostly as low-value and one-off downcycling in road construction.

Figure 8: Aereated concrete waste to be recycled

The REPOST work plan is based on the life cycle of a recycled aerated concrete block and begins with the dismantling and sorting/preparation of aerated concrete from the existing stock. The secondary raw material obtained is to be used directly as an additive for new masonry products. In 2020, we quantified the expected AAC waste in Germany until 2050.
Aerated concrete contains a large proportion of deacidified lime, which was produced using a high amount of energy and high CO_2 emissions. Where recycling within a closed cycle is not possible, a thermal conversion into dicalcium silicate, a main component of cement clinker, is investigated. The aim is to partially replace the primary raw materials cement or lime in the production of cellular concrete with a recycled product that causes lower CO_2 emissions and energy consumption during its manufacture. With the involvement of building owners, demolition companies and processing companies, business models are being developed for the new recycling options over the entire life cycle.

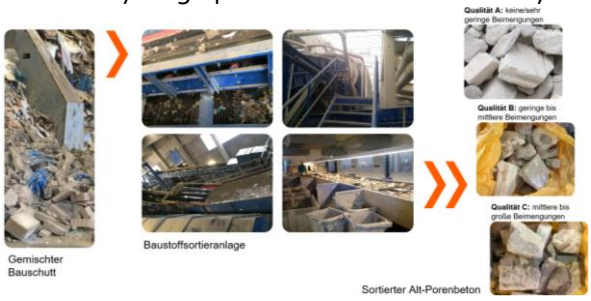


Figure 9: Provision of old aerated concrete in various grades of purity

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

Simon Glöser-Chahoud

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 currently developed.

THINKTANK "Industrial Resource Strategies"

Marina Maier, Rebekka Volk, Simon Glöser-Chahoud, Frank Schultmann

Partner: AUDI AG, Badische Stahlwerke GmbH, Carl Zeiss AG, Daimler AG, Robert Bosch GmbH, Scholz Recycling GmbH, SchwörerHaus KG, Umicore AG & Co. KG, German Chemical Industries Association (VCI) Baden Württemberg, Zeller+Gmelin GmbH & Co. KG.

Duration: 01/2018 - 12/2021

In February 2018 the THINKTANK "Industrial Resource Strategies" was set up at the Karlsruhe Institute of Technology (KIT). This THINKTANK is a pioneer institution between policy, industry, and science to develop ideas and answers on questions concerning resource and raw material efficiency. The efficient usage, as well as the recycling and reuse of (raw) materials, have a high priority, especially in a Federal State like Baden Württemberg that only has a few natural resources, but is at the other hand a well-developed production location. Therefore, ideas and concepts to reduce its dependency on raw material imports and geopolitical crises should be developed within the THINKTANK.

Four institutes of the KIT are involved in the THINKTANK, among others the Institute for Industrial Production (IIP). Within the THINKTANK, we will work on topics such as circular economy, resource efficiency alongside the entire supply chain. The circular economy framework will be applied holistically to achieve a more efficient material selection, to increase the collection and recycling rate, and to decrease the resource input. Furthermore, the impacts of important technical and social trends and transformation processes on resource demand and efficiency will be analysed.

Five pilot projects have been defined to set up the work of the THINKTANK. Those projects deal with questions in trending areas such as blockchains and digitalization, closed loops supply chains, circular economy and the 2nd life cycle of products.

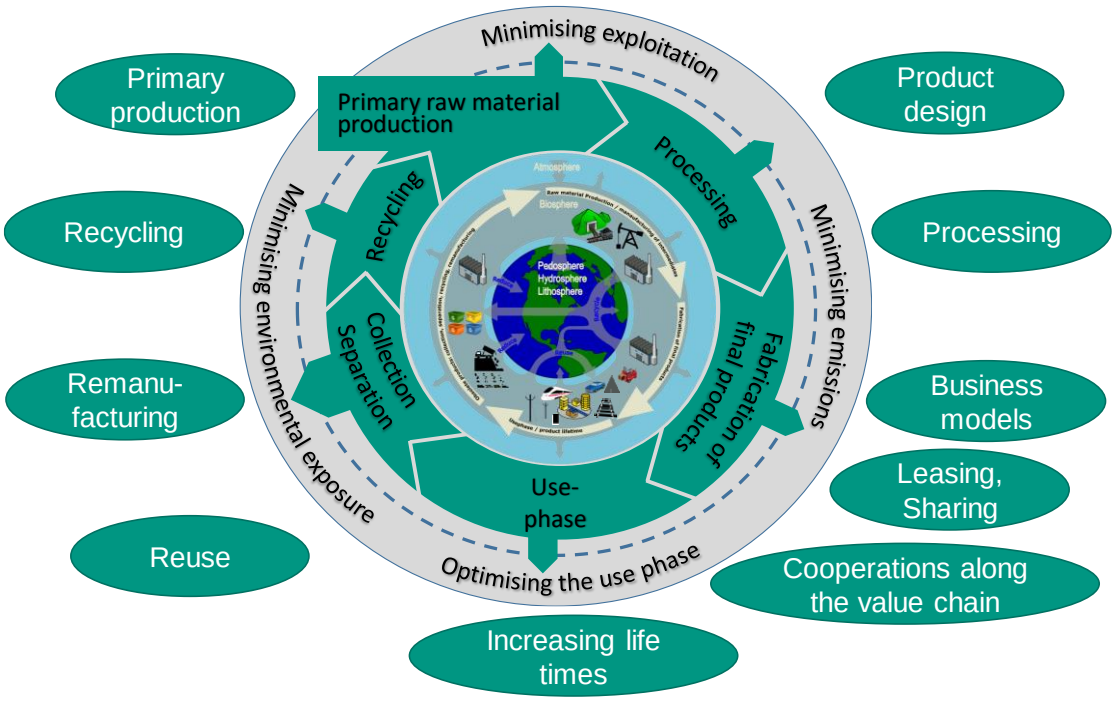


Figure 10: Circular Economy from a systemic perspective as a key element of research activities within the ThinkTank Industrial Resource Strategies

Urban heat losses

Dr. Rebekka Volk, Zoe Mayer, Yu Hou

Partner: University of Southern California, Air Bavarian GmbH

Funding: DAAD, Landesgraduiertenförderung Baden-Württemberg

Duration: 03/2018 - 12/2022

Figure 11: Drone experiments at KIT campus north and in the city area Karlsruhe (© KIT, Rebekka Volk)

The main objective of this project is the data collection and processing of drone data with the aim to identify urban heat losses – both in buildings and infrastructures.

For this, we collected thermal data of buildings and heat distribution networks in Karlsruhe at Campus North, Campus South and in the inner city area in 2018 and 2019. The data collection was scheduled in January and March 2019 and accompanied by research fellow Yu Hou from the university of Southern California. During the experiments, we successfully completed day and night drone flights in Karlsruhe at several heights, with different flight paths, camera angles and flight patterns. Furthermore, further experiments were undertaken to calibrate the different thermal cameras in use and to measure indoor temperatures and temperature distributions.

The processing of the data revealed significant heat losses especially from non-retrofitted buildings (windows, facades, chimneys, roofs) but also visualized heat losses in the infrastructural network (see Figure). The research group deals within this project with the identification of heat losses in buildings and district heating networks to design and assess change measures from a technical, economic and ecological point of view.

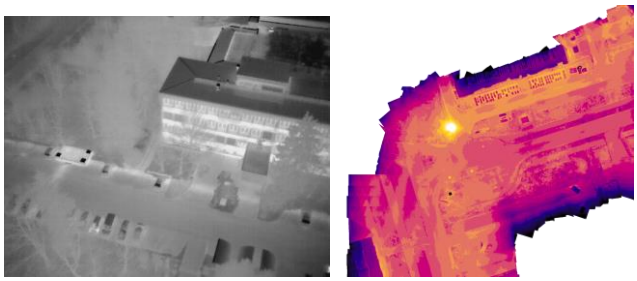


Figure 12: Thermal images with visible damages (©Rebekka Volk)

Most recent developments were presented both in conferences (ISARC conference in May 2019, Banff, Canada) and in several submitted manuscripts to scientific journals.

Awards

In 2020, M.Sc. Mihir Rambhia won the Copernicus Hackathon in the thematic area of "Urban areas". The WHO recommends that "everyone should be able to access 0,5 to 1 ha of green spaces within 300m of their homes". Thus, Mihir Rambhia developed a tool to analyse the distribution and accessibility of green spaces within a city. With this, city administrators can plan greening and prioritize the management. For further details, please click here.

IIP congratulates PhD Felix Hübner for receiving the Science Award of the KIT Faculty of Economics in the category "Interdisciplinary Work". Mr. Hübner received the award for his doctoral thesis on "Planning and Modeling of the Decommissioning of Nuclear Facilities under Consideration of Uncertainties - An Example for the Planning of Large Projects".

Completed PhD Dissertations and Habilitations

PhD Dissertation: "Risk-Based Maintenance Management System for Waterways Infrastructures"

Heike Schmidt-Bäumler

The age structure and condition of the traffic water structures on federal waterways make the targeted use of resources imperative. The number of high-priority structures and the maintenance backlog are constantly increasing. Also, the forward-looking maintenance planning that considers long-term developments for a large stock of structures is becoming increasingly complex.

In this dissertation, a planning tool for the maintenance of traffic water structures was developed, which integrates a risk-based prioritisation of measures into the maintenance planning and quantifies current and future resource requirements as well as developments in the maintenance backlog.

Since a functional failure or structural failure is increasingly to be expected due to the development of the condition of the traffic water structures, possible failure consequences for this extreme event were recorded for each structure investigated. For this purpose, geoinformation data and data from various statistical offices were evaluated. Using an adapted hydraulic approach, the height of a surge wave after a sudden structural failure was calculated. The new data determined in the ex-ante damage analysis were used as criteria for the risk-based multi-criteria decision analysis. Based on an outranking method, the results from pairwise comparisons between the structures were converted into preference values. With the help of the aggregation of the preference values, a risk-based priority value was finally determined for each structure.

For maintenance planning in the form of a long-term forecast, ageing processes and maintenance measures were modelled (life cycle simulation) so that it can be determined for each structure when the end of its useful life will be reached, which maintenance measure is necessary and how high the investment requirement is. Since several structures in a large building stock always reach the end of their useful life at the same time, structures with higher priority values are given priority in maintenance planning. The planning tool can be adapted to different framework conditions, such as the useful life of the structures or the annually available budget. In the scenario analysis, long-term trends in the building stock and the future development of the maintenance backlog are shown for the different maintenance plans with the help of simulations.

PhD Dissertation: "Emergency Decision Making and Disaster Recovery"

Farnaz Mahdavian

The objective of the PhD is to understand how to increase the resilience and reduce the vulnerability for future disasters. The initial step for this research was to understand society decision making in the disaster context, in particular about how people and authorities cope and react to different chain of events during a disaster and what factors influence these decisions. The analysis of evacuation behavior and the reaction to early warning were the core part of the PhD-project.

To this end, an extensive research about the societal reaction during the past natural disasters such as hurricanes and floods in major worldwide events in several countries has been carried out. Afterwards, empirical surveys analysed society's risk awareness, risk perception and attitude, the level of preparedness, as well as the importance of trust in government on people's reaction during the emergency. The surveys were conducted in different flood prone regions and the respondents were either flood affected people or people living a flood-prone area. A special focus has been on comparing two regions in Germany and the UK.

The evacuation process can be viewed from two perspectives. The first is related to government decision-making, to early warning systems and to the relevant authorities' protocols for issuing an evacuation order. The second is whether people in the affected area decide to evacuate or not depending on whether or not they have received an evacuation order. In principle, evacuation needs to be carried out in an immediate and urgent manner, which requires fast decision-making on all levels. However, crises are characterized by a high degree of uncertainty and delay and the need to evacuate is often only realized after the disaster has escalated.

For the government reaction part, a decision model for disaster evacuation was designed using a Hidden-Markov-Model, which incorporates a Bayesian approach capturing government and people's decision-making during the event of a flash flood. In this scenario, both the government and the public receive a noisy signal (a disaster warning) about an upcoming extreme weather event. The government then faces a choice between announcing an evacuation order, either severe or extreme, or keeping silent. The objective of the dynamic model is to analytically compare the outcomes and various costs of different decisions based on different levels of information and to identify the effect of people's evacuation compliance. "Cost" in this context is defined as adverse consequences for life and health as well as a loss of trust or credibility in governmental announcements.

Finally, the impact of floods in UK (2007) and Germany (2013) have been analyzed in a comparative study. In particular, the flood impact as well as the speed and quality of recovery in different sectors of housing, economy, employment, population, infrastructure, and non-domestic buildings were the focus. The survey was carried out with two groups of flood experts in Germany and the UK as well as residents of flooded areas.

The insights out of both, the insights of the compliance model as well as the findings from the empirical study can help the government to improve preparedness, early warning and evacuation orders.

Staff 2020

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. Simon Glöser-Chahoud – Sustainable Value Chains

Dr. Rebekka Volk – Project and Resource Management in the built environment

Dr. Marcus Wiens – Risk Management

Postdoctorial Researchers

Dr. Marina Maier

Research Associates and their PhD-topics

Florian Diehlmann: Facility Location Planning in Relief Logistics: Decision Support for (German) Authorities

Marco Gehring: Mathematical project optimization in nuclear dismantling

Raphael Heck: Cooperation and Competition in Bioeconomy Value Chains

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

Sandra Huster: Application of Lean Production Principles in Remanufacturing Operations

Florian Kaiser: Holistisches Riskomanagement für quantifizierbare und skalierbare IT-Sicherheit

Miriam Klein: Social resilience and cooperation in cross-border crisis management

Markus Lüttenberg: Public-Private Emergency Collaborations from a game-theoretical perspective

Zoe Mayer: Energy retrofits of single buildings and identification of heat losses on district scale

Richard Müller: Planning and modelling of costs and CO_2-emissions along industrial supply chains – using the automotive industry as an example

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

Mihir Rambhia: Urban Green Management

Sonja Rosenberg: Optimization of Closed-Loop Supply Chains with innovative Business Models for Traction Batteries of Electric Vehicles

Andreas Rudi: Modelling regional biomass-based value chains

Sophia Schambelon: Sustainable urban resource management

Andreas Schießl*: Techno-economic impact assessment of steel and aluminium production sites and supplier selection in the automotive industry

Christoph Stallkamp: Circular Economy of Plastics in the case studies of lightweight packaging and automotive plastic waste

Justus Steins: Techno-economic assessment of new aerated concrete recycling options and supply chain implications

Kira Schumacher: Social acceptance of renewable energy installations in different national contexts – a comparative approach

Rebecca Wehrle: Criticality assessment of transport infrastructure networks

Alexander Zienau*: Public-Private Emergency Collaboration in Logistics from a Business Perspective

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

*external researcher

International Collaboration and Exchange

Due to the Corona pandemic, several international research stays and further international activities of IIP staff were cancelled. However, IIP remains engaged in different international exchange activities.

This includes:

- Participation to the KIT China Round Table
- Topic lead within the virtual German-Chilean Institute for Eco-Industrial Development (IECO)
- German-Australian Cooperation

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 2020 more than 800 student exams were completed and the chair has supervised 140 bachelor and master theses.

Anlagenwirtschaft / Planning and Management of Industrial Plants

Dr. Simon Glöser-Chahoud, Raphael Heck, Paul Heinzmann, Sonja Rosenberg

~120 students

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.

Grundlagen der Produktionswirtschaft / Introduction to Production Management

Prof. Dr. F. Schultmann, Dr. Rebekka Volk, Justus Steins, Christoph Stallkamp

~180 students

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

Prof. Dr. F. Schultmann, Dr. Marina Maier

~30 students

This course is a short introduction into the methodical field of Life Cycle Assessment (LCA). Within this course, the method itself is explained from different perspectives. Most of the course concentrates on the environmental aspect of LCA, however an overview of Life Cycle Costing Analysis and Social Life Cycle Assessment is included. At the end of the course, the research area of dynamic LCA is presented.

Logistics & Supply Chain Management

Dr. Marcus Wiens , Florian Diehlmann, Markus Lüttenberg

~70 students

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.

Produktions- und Logistikmanagement / Production and Logistics Management

Dr. Simon Glöser-Chahoud, Sandra Huster, Tobias Zimmer

~120 students

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.

Project Management

Prof. Dr. F. Schultmann, Dr. Rebekka Volk, Dr. Felix Hübner, Dr. Marcus Wiens, Marco Gehring, Sonja Rosenberg

~60 students

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. Furthermore, we are happy to have two invited talks this semester from employees of Campana & Schott (https://www.campana-schott.com/de/de/), an international management and technology consultancy with more than 300 employees in Europe, the US and Canada. The talks will cover the topics "The role of the project manager" and "Agile Methods of Project Management" from a practical perspective.

Risk Management in Industrial Supply Networks

Dr. Marcus Wiens, Miriam Klein

~50 students

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.

Supply Chain Management in the Automotive Industry

Prof. Dr. Frank Schultmann, Dr. Tilman Heupel (BMW AG), Hendrik Lang (BMW AG), Florian Kaiser

~100 students

Students learn concepts, methods and tools on various aspects of automotive supply chain management. Through concrete application examples of a globally operating automobile manufacturer, the students recognize challenges that are connected with the implementation of these solutions. The students learn theoretical concepts as well as their practical implementation in the context of value chains, procurement logistics, risk management, quality engineering, cost engineering and purchasing, and they can identify, analyse, and evaluate problems in these areas as well as design adequate solutions. At the end of the lecture, students are able to identify links in these fields and to classify them into the overall context of the value chain and the product development process of an automobile manufacturer.

Sustainable Production

Dr. Rebekka Volk, Dr. Julian Stengel (EnergieSüdwest AG)

~50 students

This course offers an introduction into the basics of sustainability and the linkage of sustainability to production and logistics. Main methods of lifecycle assessment (LCA), social 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 industrial ecology principles are presented. The students get an overview on different sustainability topics, methods, databases, software and legal background in relation to a sustainable consumption and production.

Teaching at the Chair for Business Administration, Production and Operations Management

BSc-Module
„Production Management"

- Introduction to Production Management (SS, 5,5 ECTS)
- Sustainable Production (WS, 3,5 ECTS)
- Logistics and Supply Chain Management (SS, 3,5 ECTS)

MSc-Module
"Planning and Management of Industrial Plants"

- Planning and Management of Industrial Plants (WS, 5,5 ECTS)
- Emissions and Environment (WS, 3,5 ECTS)
- Life Cycle Assessment (WS, 3,5 ECTS)
- International Management in Engineering and Production (WS, 3,5 ECTS)

MSc-Module
"Production and Logistics Management"

- Production and Logistics Management (SS, 5,5 ECTS)
- Supply Chain Management with Advanced Planning Systems (SS, 3,5 ECTS)
- Project Management (WS, 3,5 ECTS)
- Supply Chain Management in the Automotive Industry (WS, 3,5 ECTS)
- Risk Management in Industrial Supply Networks (WS, 3,5 ECTS)

Publications

Peer-Reviewed Journals

Mahdavian, F.; Wiens, M.; Platt, S. & Schultmann, F. (2020): Risk behaviour and people's attitude towards public authorities – a survey of 2007 UK and 2013 German floods. International Journal of Disaster Risk Reduction, 49(2020).

Mahdavian, F.; Platt, S.; Wiens, M.; Klein, M. & Schultmann, F. (2020): Communication blackouts in power outages: Findings from scenario exercises in Germany and France. International Journal of Disaster Risk Reduction, 46(2020).

Platt, S.; Mahdavian, F.; Carpenter, O.; Wiens, M. & Schultmann, F. (2020). Were the floods in the UK 2007 and Germany 2013 game-changers? Philosophical Transactions of the Royal Society A, 378: 20190372.

Loibl, A.; Marscheider-Weidemann, F.; Ostertag, K.; Rosenberg, S.; Tercero Espinoza, L.; Pfaff, M.; Sartorius, C. (2020). Potenziale und Grenzen der Sekundärrohstoffgewinnung – Ergebnisse der r4-Begleitforschung. Chemie Ingenieur Technik, 92 (4), do:10.1002/cite.201900132

Schiessl, A.; Müller, R.; Volk, R.; Zimmer, K.; Breun, P.; Schultmann, F. (2020): Integrating site-specific environmental impact assessment in supplier selection: exemplary application to steel procurement. 2020. Journal of Business Economics. doi:10.1007/s11573-020-00967-1

Stallkamp, C.; Diehlmann, F.; Lüttenberg, M.; Wiens, M.; Volk, R.; Schultmann, F. (2020): On the combination of water emergency wells and mobile treatment systems: a case study of the city of Berlin. 2020. Annals of Operations Research. doi:10.1007/s10479-020-03800-8

Wehrle, R., Wiens, M., Schultmann, F., Akkermann, J., Bödefeld, J. (2020): Ebenensystem zur Resilienzbewertung kritischer Verkehrsinfrastrukturen am Beispiel der Wasserstraßen. *Bautechnik,* 97(6), 395-403, https://doi.org/10.1002/bate.202000006.

Zander, T.; Birnstill, P.; Kaiser, F.; Wiens, M.; Beyerer, J. & Schultmann, F. (2020): IT-Sicherheit im Wettstreit um die erste autonome Fahrzeugflotte – Ein Diffusionsmodell. TATuP – Zeitschrift für Technikfolgenabschätzung in Theorie und Praxis. 29. 16-22. 10.14512/tatup.29.1.16.

Conference Proceedings and Working Papers

Diehlmann, F.; Hiemsch, P. S.; Wiens, M.; Lüttenberg, M.; Schultmann, F. (2020). A Novel Approach to Include Social Costs in Humanitarian Objective Functions. Karlsruher Institut für Technologie (KIT). doi:10.5445/IR/1000127134

Diehlmann, F.; Klein, M.; Wiens, M.; Lüttenberg, M.; Schultmann, F. (2020). On the Value of Accurate Demand Information in Public-Private Emergency Collaborations. Karlsruher Institut für Technologie (KIT). doi:10.5445/IR/1000127133

Diehlmann, F.; Lüttenberg, M.; Verdonck, L.; Wiens, M.; Zienau, A.; Schultmann, F. (2020). Public-Private Collaborations in Emergency Logistics: A Framework based on Logistical and Game-Theoretical Concepts. Karlsruher Institut für Technologie (KIT). doi:10.5445/IR/1000127135

Gast, J., Wehrle, R., Wiens, M., Schultmann, F. (2020): Impact of notification time on risk mitigation in inland waterway transport. Hamburg International Conference of Logistics (HICL) 29: 247-278 (2020). TUHH Universitätsbibliothek. Doi: 10.15480/882.3115 (peer-reviewed).

Glöser-Chahoud S, Pfaff M, Schultmann, F (2020): The role of unused storage phases (hiberna-tion) in the overall lifetime of a mobile phone – an evaluation of simulation-based scenarios including their environmental impacts. Proceedings of the 3rd Product Lifetimes and the Environment (PLATE) Conference Sept. 2019, Berlin, Germany

Heinzmann, P.; Langenmayr, U.; Pflegler, D.; Schultmann, F. (2020): Technische und wirtschaftliche Analyse von PtL-Verfahren und deren Interaktion mit dem deutschen Energiesystem im Projekt reFuels. Jahrestreffen der ProcessNet-Fachgruppe Energieverfahrenstechnik DECHEMA, Frankfurt am Main, Germany

Rudi, A. et al. (2020); A methodology for evaluating regional biobased value chains on the ex-ample of Baden-Wuerttemberg. 3rd International Bioeconomy Congress (21./22.09.2020), University of Hohenheim, Germany

Schulte, Y.; Klein, M.; Wiens, M.; Fiedrich, F. & Schultmann, F. (2020): Spontaneous Volunteers Across National Borders: An Agent-Based Comparison. Proceedings of the 17th International Conference on Information Systems for Crisis Response and Management, ISCRAM 2020, Blacksburg, Virginia, USA.

Volk, R.; Lützkendorf, T.; Schambelon, S.; Naber, E.; Mörmann, K.; Böhnke, D.; Norra, S.; Schuhmann, R.; Ehbrecht, A.; Balouktsi, M.; Schultmann, F. (2020): Stakeholder-specific assessment of environmental, economic and social effects of resource-efficiency measures in urban districts - first results. 2020. IOP conference series / Earth and environmental science, 588, Art.-Nr.: 052036. doi:10.1088/1755-1315/588/5/052036

Volk, R.; Lützkendorf, T.; Schambelon, S.; Naber, E.; Mörmann, K.; Böhnke, D.; Norra, S.; Schuhmann, R.; Ehrbecht, A.; Baloutski, M.; Schultmann, F. (2020): NaMaRes: Stakeholder-specific assessment of resource-efficiency measures in urban districts - first results. 2020, Juni. Beyond - World Sustainable Built Environment Conference (2020), online, 9.–11. Juni 2020

Volk, R.; Kern, C.; Schultmann, F. (2020): Secondary raw material markets in the C&D sector: Study on user acceptance in southwest Germany. 2020. KIT, Karlsruhe. doi:10.5445/IR/1000105958

Wiens, M.; Diehlmann, F.; Lüttenberg, M.; Joussen, K.; Schultmann, F. (2020). Helping Others to Help Yourself? The potential of humanitarian oriented production conversions of companies during the Covid-19 pandemic. INFORMS Annual Meeting (2020), online, 7.–13. November 2020.

Wiens, M.; Mahdavian, F.; Platt, S.; Schultmann, F. (2020). Optimal Evacuation-Decisions Facing the Trade-Off between Early-Warning Precision, Evacuation-Cost and Trust – the Warning Compliance Model (WCM). Working Paper Series in Production and Energy, no. 47(2020), Karlsruhe Institute of Technology.

Books and Book Chapters

Wiens, M.; Breitbarth, E.; Diehlmann, F.; Gromitsaris, A.; Gross, W.; Lüttenberg, M.; Michalk, K.; Schulte, M.; Schultmann, F.; Zienau, A. (2020). Intakte Versorgungsketten in Krisenzeiten mit Hilfe öffentlich-privater Partnerschaften - Das Projekt NOLAN. OR News, (69), 39–40.

Wiens, M. (2020): The Economic Sector. In: Science for DRM 2020 Super Case Study "Fukushima Daiichi Nuclear Disaster"; Raskob, W. (lead author), Disaster Risk Management Knowledge Center, European Commission.

Hertzstraße 16 | D-76187 Karlsruhe | phone +49 721 608 44460/44569 | fax +49 721 608 44682 | iip.kit.edu | info@iip.kit.edu