Annual Report 2017

Institute of Systems Sciences, Innovation and Sustainability Research

University of Graz, Merangasse 18/1, A-8010 Graz
Tel: +43 (0) 316/380-3238, Fax: +43 (0) 316/380-9585
E-Mail: sis@uni-graz.at, Web: http://sis.uni-graz.at/de/

Institute of Systems Sciences,
Innovation & Sustainability Research
University of Graz

Merangasse 18/I,
8010 Graz, AUSTRIA

Editorial

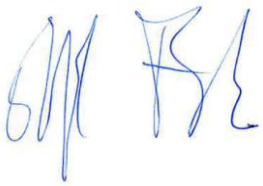
Dear Reader!

We are happy to share the results of our work with you, summarized in this annual report for 2017. Perhaps most remarkable – and therefore mentioned right at the beginning - is the high number of 36 publications in scientific journals that we achieved. This number is now increasing for five years, which shows that the redefinition of our publication strategy, i.e. to publish in high quality journals in order to share our research results with the international scientific community, was the right decision. This success was possible because we were able to maintain our high number of externally funded research projects allowing us to carry out up-to-date and internationally relevant research. An excellent example for this success is the involvement of Prof. Stern in two new Comet-K projects (WoodC.A.R. and Flippr^2 - Future Lignin and Pulp Processing Research). We are also happy to be involved in the doctoral program "Climate Change – Uncertainties, Thresholds and Coping Strategies", which is conducted together with colleagues from five different faculties of the University of Graz, in regard to which the Austrian Science Fund agreed to fund the second phase of this program. We are also looking forward to the new profile building research area formed by the University of Graz called "Climate Change and Sustainable Transformation" where Prof. Posch and Prof. Baumgartner participate. In terms of teaching we again have been able to attract highly qualified international students for our joint master programs "Sustainable Development" and "Industrial Ecology".

The success in publications, research and teaching activities is also reflected in national and international awards. Prof. Rupert Baumgartner was recognized as DuPont Young Professor for his research on circular economy and product lifecycle management; he was also awarded with the Seraphine-Puchleitner-Award as best PhD supervisor of the University of Graz. Dr. Ulrike Gelbmann received the lifetime achievement award as sustainable designer and entrepreneur by the Businessart Magazine. In addition, she won together with her colleagues Thomas Winkler, PhD and Mag. Martina Friesenbichler the University´s Teaching Award "Lehre: Ausgezeichnet!". The e-learning teaching award ELCH (E-Learning Champion) was awarded to Dr. Georg Jäger and Prof. Manfred Füllsack. Congratulations to all our successful colleagues!

We also congratulate two former colleagues for the successful finalization of their doctoral studies: Josef-Peter Schöggl, PhD researched the topic "Sustainability assessment in supply chains and product development - providing a full life cycle perspective with methods, tools and indicators" and Morgane Fritz, PhD worked about "Sustainability Management in Supply Chains: Developing a Supply Chain View to operationalize sustainability among multiple supply chain stakeholders".

We wish them all the best for their future careers!



Univ.-Prof. Dr. Rupert Baumgartner

Univ.-Prof. Dr. Manfred Füllsack

Contents

1 THE INSTITUTE

1.1 Mission statement

The Institute of Systems Sciences, Innovation and Sustainability Research is investigating possibilities for the transition towards a more sustainable world. Therefore, we study transition, innovation, and adaptation processes within human-environment systems, with a focus on firms and regions. We base our research on systems sciences, innovation and transition sciences as well as on sustainability science, and develop inter- and transdisciplinary methods to analyse and model human-environment systems, develop scenarios and transition pathways, and assess regulatory strategies.

The institute is characterized by the disciplinary diversity of its members. Highly motivated researchers originating from diverse fields of natural, social and formal sciences collaborate along real-world problems.

Figure 1: Our team

The institute is unique in several ways:

- Scientific work focuses on three central topics: systems sciences, innovation and transition sciences, as well as sustainability science and management.
- It is open to external collaboration with scientists from social as well as natural sciences.
- The transdisciplinary research focus facilitates high quality research and leads to strong collaborative ties with regional stakeholders and with business and industry.
- Research projects apply a mix of both qualitative and quantitative approaches.
- Offering one of the few curricula on Environmental Systems Sciences, the institute grew into additionally coordinating two international joint master's programmes.
- The institute is well embedded in international networks in both teaching and research.

The institute is a part of the Faculty of Environmental, Regional and Educational Sciences and features a broad interface within the faculty as well as beyond. Together with the “Wegener Center” it plays a central role within the university’s research core area “Environment and Global Change” and in the new profile-building area "Climate Change and Sustainable Transformation".

1.2 The Institute’s Website

The institute’s website with an up-to-date news section and plenty of information can be accessed via http://sis.uni-graz.at/ (English version: http://sis.uni-graz.at/en/).
While central information items like contact information, opening hours, news as well as important links can be found already on the start page, the rest of the website is organised in four categories:

- *Institute*: This category includes a mission statement, venue information including trip advisor and public transport planning tool, the annual reports since 2010 as well as further up-to date information.
- *Studying*: This category involves information for both current and potential future students of our study programmes: Environmental Systems Sciences, Joint Degree Sustainable Development, Master Industrial Ecology (MIND) and the recently founded doctoral school. A list of master theses and links to the alumni clubs can also be found there.
- *Research*: This section gives an overview on research aims and activities, ongoing projects, recent publications as well as existing co-operations with national and international partners. There is also a sub-category dedicated to the ISIS science talk, which is forum for invited (international) guests to present their research.
- *People*: Finally, one category is dedicated to introduce people who work (or worked) at the institute, including their research interests and publications. Open positions are also announced there.

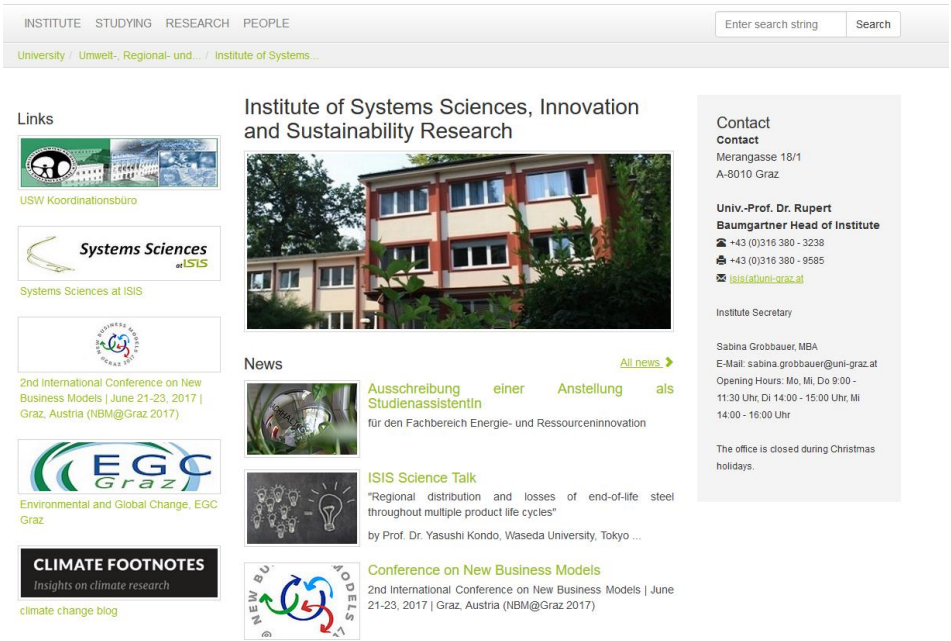


Figure 2: Website http://sis.uni-graz.at/

1.3 Faculty and Staff members

Professors:

Univ.-Prof. Dr. **Rupert Baumgartner**
Phone: 3237 Email: rupert.baumgartner@uni-graz.at

Director of the Institute, Vice Dean at the URBi Faculty
Professor for Sustainability Management

Research Interests: Corporate Sustainability, CSR, Strategic Management, Life Cycle Assessment, Industrial Ecology/Circular Economy, Management systems, Sustainable Supply Chain Management, New Business Models

Univ.-Prof. Dr. **Manfred Füllsack**
Phone: 3235 Email: manfred.fuellsack@uni-graz.at

Vice Director of the Institute
Professor for Systems Sciences

Research Interests: Systems, Complexity, Networks, Games and Computational Theory, Work (History, Sociology, Economy, Philosophy), Computer-Based Modelling and Simulation

Univ.-Prof. Dr. **Tobias Stern**
Phone: 7344 Email: tobias.stern@uni-graz.at

Professor for Energy and Resource Innovation

Research Interests: Energy and Resource Innovation, Transition towards Bio-economy, Technology Valuation and Impact Assessment, Innovation Barriers and Diffusion Processes, Harvested Wood Products and Climate Policy

Ao. Univ.-Prof. Mag. Dr. **Alfred Posch**
Phone: 3234 Email: alfred.posch@uni-graz.at

Dean for studies at the URBi Faculty

Research Interests: Environmental and Innovation Management, Eco-Controlling, Industrial Ecology, Inter- and Transdisciplinary Learning for Sustainable Development

Research and Teaching Staff:

Mag. **Raphael Asada**, BA
Phone: 7343 Email: raphael.asada@uni-graz.at

Research Interests: Transitions towards Bioeconomy, Social Metabolism, Integrated socio-ecological Modelling

Dipl.-Ing. Dr. **Ralf Aschemann**
Phone: 3232 Email: ralf.aschemann@uni-graz.at

Academic coordinator of the "Erasmus Mundus Master's Programme in Industrial Ecology"; coordinator of transdisciplinary case-study teaching; Erasmus advisor.
Research Interests: Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA), Env. Effects of Transport, Industrial Ecology, Higher Education and Env. Assessment and Management, Health Impact Assessment (HIA)

Ass.-Prof. Dr. **Thomas Brudermann**
Phone: 7336 Email: thomas.brudermann@uni-graz.at
Academic coordinator Joint International Master's Programme in Sustainable Development

Research Interests: Human Decision Making, Choice Architecture and Nudges, Sustainable Development, Energy Transition, Complex Adaptive Systems, Diffusion of Green Technology, Collective Dynamics and Mass Psychology

Mag. Dr. **Ulrike Gelbmann**
Phone: 7333 Email: ulrike.gelbmann@uni-graz.at

Research Interests: Strategic Sustainability Management, Corporate Social Responsibility, Stakeholder Management, Sustainability Reporting, Social Sustainability, Resilience, Waste Management

Christian Hofer, Bakk. BSc. MSc.
Phone: 7347 Email: christian.hofer@uni-graz.at

Research Interests: Systems Sciences, Machine Learning, Systems Modeling

Dr. **Georg Jäger**, BSc. MSc.
Phone: 7348 Email: georg.jaeger@uni-graz.at

Research Interests: Computational Systems Science, Systems Modelling, Simulation of Complex Systems, Network Science, Optimization

Aisma Linda Kiesnere, BSc. MSc.
Phone: 7337 Email: aisma.kiesnere@uni-graz.at

Research Interests: Sustainable Business Models, Transformations of Organizations for Sustainability, Sustainable Entrepreneurship, Decision Making and Change Management

Claudia Mair, BSc. MSc.
Phone: 7346 Email: claudia.mair@uni-graz.at

Research Interests: Environmental Assessment and Management, Sustainable Development, Sustainable Resource and Waste Management, Innovations towards Bioeconomy

Ass.-Prof. Mag. Dr. **Romana Rauter**
Phone: 3236 Email: romana.rauter@uni-graz.at

Research Interests: Sustainability Innovation, Open Innovation, Innovation Management and Performance, New and Sustainable Business Models, Strategic Sustainability Management, Knowledge Transfer and Knowledge Management

Mag. **Andreas Schober**, Bakk.
Phone: 7341 Email: andreas.schober@uni-graz.at

Research Interests: Systems Sciences, Data Mining, Text Mining, Green Economy

Martina Zimek, BSc. MSc.
Phone: 7330 Email: martina.zimek@uni-graz.at

Research Interests: Corporate Social Responsibility, Sustainability Performance, Sustainability Assessment, Life Cycle Assessment, Sustainability and Supply Chain Management, Waste Management, Strategic Management

Project Staff:

Eva Fleiß, MA
Phone: 1521 Email: eva.fleiss@uni-graz.at

Research Interests: Empirical Social Research, Validity of Survey Questions, Environmental Sociology/Sustainability, Renewable Energy, Photovoltaics

Morgane Fritz, MIM (until December 2017)
Phone: 1525 Email: morgane.fritz@uni-graz.at

Research Interests: Sustainability and Supply Chain Management, Stakeholder Management, Bottom-up Approaches, Resources Policy, Waste Management, Corporate Social Responsibility, electronics/automotive/raw Materials Industries

Patrick Hart, BA
Phone: 1520 Email: patrick.hart@uni-graz.at

Research Interests: Modelling Social Interactions, Gamification Approaches to Energy Savings, Renewable Energy Uses in Urban Environments

Mag. **Stefanie Hatzl**
Phone: 1521 Email: stefanie.hatzl@uni-graz.at

Research Interests: Energy Transition, Renewable Energy Technologies (PV), Empirical Social Research, Environmental Behaviour

Josef-Peter Schöggl, Bakk. MSc.
Phone: 1525 Email: josef.schoeggl@uni-graz.at

Research Interests: Design for Sustainability, Life Cycle Assessment, Corporate Social Responsibility, Sustainable Supply Chain Management

Julia Wenger, BSc MSc. MSc.
Phone: 7331 Email: julia.wenger@uni-graz.at

Research Interests: Transitions towards Bio-Economy, Lignocellulosic Biorefineries, Techno-economic and Environmental Assessment

Thomas Winkler, MSc. PhD (until March 2017)
Email: thomas.winkler@uni-graz.at

Research Interests: GHG Emission Scenarios, Climate Change, Ecotourism

Doctoral Programme DK Climate Change:

Matthias Damert, MSc.
Phone: 7348 Email: matthias.damert@uni-graz.at

Research Interests: Corporate Social Responsibility (CSR), Corporate Climate Change Strategies, Sustainability Management in the Automotive Industry, Environmental Policy and Management

Sajeev Erangu Purath Mohankumar, MSc. Eng.
Phone: 7403 Email: em.sajeev@uni-graz.at

Research Interests: Climate Change Adaptation and Mitigation, Renewable Fuels, Low Carbon Scenarios

Michael Kriechbaum, MSc.
Phone: 7348 Email: michael.kriechbaum@uni-graz.at

Research Interests: Environmental Innovation, Environmental Policy, Renewable Energy

Arijit Paul, MSc.
Phone: 7348 Email: arijit.paul@uni-graz.at

Research Interests: Corporate Sustainability and Climate Strategy and Sustainable Energy Strategies and Policies

Administration:

Sabina Grobbauer, MBA
Phone: 3238 Email: sabina.grobbauer@uni-graz.at

Klaudia Kramer
Phone: 1037 Email: klaudia.kramer@uni-graz.at

USW Coordination Office

Student Assistants:

Victoria Allmer	**Yannick Oswald**	**Bernhard Schrempf**
Gerald Bruckner	**Michael Peer**	**Bianca Steiner**
Gregor Fallmann	**Simon Pieber**	**Angelika Meißl**
Julia Graf	**Daniel Pröll**	
Alexandra Horvath	**Magdalena Rusch**	

1.4 Seminars and "SIS Science Talk"

For the "SIS Science Talk", the institute is inviting external experts to give a presentation on core research topics (i.e., systems sciences, innovation and sustainability research). These presentations are followed by a discussion and a small buffet. This event is held in English and open for the entire URBI Faculty, other interested colleagues and students and any friends of the institute.

The following talks were held in 2017:

- Prof. Dr. Bo **Weidema** (Aalborg University, Denmark), "The end of LCA: Unleashing the consumer power with decentralised network technology", April 25, 2017.
- Prof. Dr. Peter **Schwarzbauer** (University of Natural Resources and Life Sciences), "Advantages and limits of a simulation model for the analysis of sustainable forest management and forest-product markets: The case of FOHOW", May 2, 2017.
- Urška **Fric**, Ph.D. Fellow (Faculty of Information Studies in Novo mesto and School of Advanced Social Studies in Nova Gorica, Slovenia), "Socio-cultural factors and their influence on the structuring of industrial symbiosis networks", May 16, 2017.
- Prof. Dr. **Visvanathan** (Asian Institute of Technology), "Global Economic Transition and Next Evolutionary Acts: Progress of Circular Economy in ASEAN", June 13, 2017.
- Prof. Dr. Sanjay **Patnaik** (George Washington University, Washington DC), "Analyzing Firm Responses to Transnational Climate Change Regulations: Evidence on Rent-Capturing Behavior by Multinational Companies", November 21, 2017.
- Prof. Dr. Verena **Winiwarter** (University of Klagenfurt), "Sustainable Development in Historical Perspective", December 12, 2017.

Up-to-date information and the whole list of speakers can be found on our website at http://sis.uni-graz.at/en/forschen/science-talk.

In addition to these talks, the following events were organized by the Coordination Office for Environmental Systems Sciences (USW Koordinationsbüro):

- Environmental System Sciences Application Check, May and December 2017
- How to write a Bachelor Thesis, March 2017
- ESS Event with master thesis awards, May 2017
- ESS Orientation Event, September, October and November 2017
- Evaluation of ESS Master: Sustainable Management
- Evaluation of IPs

Up-to-date information on events organized by the Coordination Office for Environmental Systems Sciences can be found at http://umweltsystemwissenschaften.uni-graz.at/.

1.5 Material flow analysis of SIS

For the course "Introduction to Industrial Ecology" in winter term 2017/18, taught by Ralf Aschemann, a sub-group of six engaged and motivated students (namely Laura Huemer; Philipp Lerch; Raphaela Maier; Isabella Melbinger; Julia Neumann and Bianca Steiner) did an additional task by identifying, analyzing and calculating essential material and energy flows, caused by its employees and students. This method is called "material flow analysis" (MFA) and one of the key tools of "industrial ecology". MFA is an analytical method in order to evaluate flows and stocks of materials quantitatively in a properly defined system in terms of space and time.
For this assignment, the students' group collected various secondary data, did some expert interviews with the university's facility management and developed and interpreted an online questionnaire for the SIS staff mobility. The main MFA key results are presented in the following. First, some relevant key inflows are depicted in Table 1 for the building Merangasse 18 in 2016.

Merangasse 18, input flows (2016)	
Heat	150,740 kWh
Electricity	47,480 kWh
Water	488 m^3
Copying paper	548 kg
Paper towels	536 kg
Toilet paper	368 kg

Table 1: Selected input flows of the building Merangasse 18 in the year 2016

A follow-up task might be the analysis of the reduction potential concerning the building's consumption for heating and electricity.
Second, an amount of 9.4 tons was reported as residual waste for the year 2016. Here, the biggest contribution is from the fraction of residual waste with a weight of 9.4 tons.
Third, the mobility was subject to the MFA. In this context, only the SIS staff and students were taken into account (cf. Table 2 below), i.e., the employees of the Dean's Office and the Center for Inter-American Studies and its students, which are also accommodated in the building Merangasse 18, were not considered.

Energy demand for mobility of SIS staff and students (2016)	
SIS staff trips to work	38,867 MJ
SIS staff business trips (conferences etc.)	338,880 MJ
SIS students' trips to SIS	110,794 MJ

Table 2: Energy flows regarding transport of SIS staff and students in the year 2016

Table 2 shows that the business trips of the SIS employees require approximately nearly nine times more energy than their daily journeys to the institute and three times more energy than the students' trips to the SIS lecture rooms in the building Merangasse 18.

2 RESEARCH PROJECTS AND ACTIVITIES

2.1 Research profile

Our research is based on **three pillars**: systems sciences, innovation and transition research and sustainability research. By combining these three science fields, we seek to enhance the ability of human-environment systems to deal with global change.

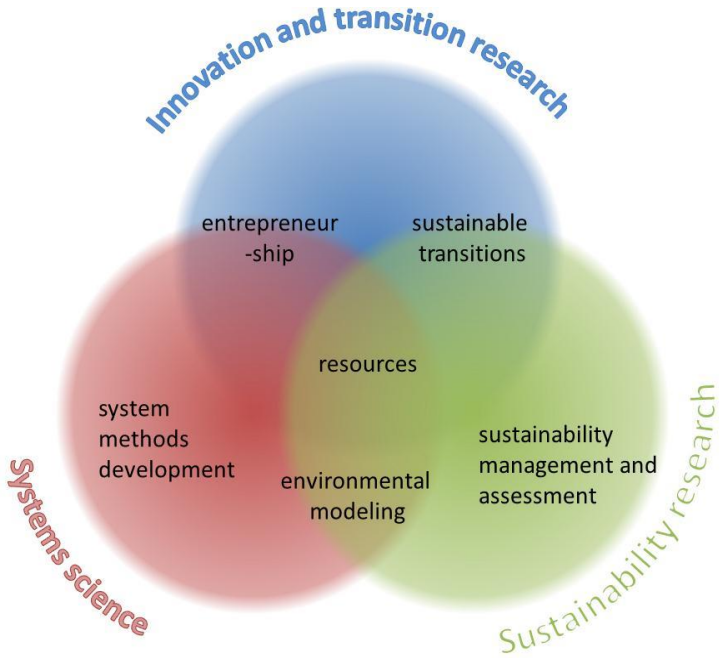


Figure 3: Science fields of the institute

Systems sciences. Systems modelling (e.g. agent-based modelling or system dynamics) and environmental systems assessment provide a better understanding of different kinds of human-environment systems and their adaptation processes to challenges of global change. We are engaged in system methods development, improving computer-based (multi-agent) simulations of systems, in particular of complex adaptive systems. Special emphasis is put on the interaction between physical and social systems in order to develop concepts and strategies for sustainable development.

Innovation and Transition research. Management of innovations at different levels is a significant challenge for the transition towards sustainable development. It is our goal to gain insight into innovation processes for new products, services, and technologies, but also into transition processes in society, organizations, and sectors, like the energy sector. Therefore, it is necessary to generate an understanding of logics and patterns of human decision making and action. On this basis, we can develop inter- and transdisciplinary concepts for supporting decisions that influence sustainability, and we can help initiate sustainability-oriented transition, innovation and adaptation processes in a variety of human-environment systems.

Sustainability research. Regions and corporations are important actors and entities for sustainable transitions. Thus, we investigate systems and processes for sustainability management and corporate social responsibility (CSR) initiatives at corporate level including the value chains and the regional level. Key topics include life-cycle-assessment (LCA), strategic management, corporate sustainability management and strategies, industrial ecology/circular economy, integrated management systems, and management of resources (like waste or energy).

2.2 Research Projects

2.2.1 FLIPPR - Future Lignin and Pulp Processing Research

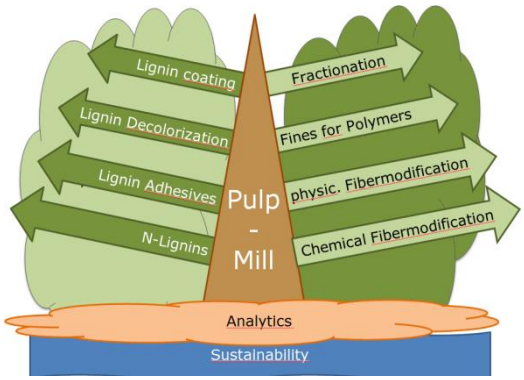


Figure 4: Integration of FLIPPR Areas

In this COMET K-Project, the efforts are focused on establishing structural know-how to make more efficient use of major raw materials streams of the paper and pulp industry - cellulose and lignin. The project focusses on applications in the pulp and paper value chain but also in areas outside the classical product chain. The goal of FLIPPR is to transform this empirical domain into a science-based endeavour and to give the current product and process development approaches in the field of lignin and fibre usage a new direction.

Together with the Wegener Center, the Institute of Systems Sciences, Innovation and Sustainability Research is responsible for the area of sustainability. The institute will conduct a life cycle sustainability assessment (LCSA) of "high potential" biorefinery-products, based on the innovations from other project partners. Besides the ecological assessment, additional emphasis is placed on social impacts, sustainability and life cycle costs. Thus an integrated system for life cycle sustainability assessment (LCSA) is developed and applied.

The Institute of Systems Sciences, Innovation and Sustainability Research is specifically responsible for the following tasks:

- Environmental LCA for standard industrial feedstock of project partners from the paper and pulp industry
- Environmental LCA of state of the art products, which may be substituted by innovations coming from the pulping industry
- Life cycle sustainability assessment (including environmental LCA, social LCA and life cycle costing) of bio-refinery products based on the results of other project parts

The purpose of these tasks is to find the critical issues (hotspots) for the three pillars of LCSA - environmental LCA (E-LCA), social LCA (S-LCA) and life cycle costing (LCC) - that really determine the contribution of the lignin and cellulose-derived products to the emergence of sustainable low carbon systems. Link: www.flippr.at

Project team:	Ao.Univ.-Prof. Dr. Alfred Posch, Univ.-Prof. Dr. Tobias Stern, Josef-Peter Schöggl, MSc.
Lead Institution:	Future Lignin and Pulp Processing Research Project GmbH
Company Partners:	Sappi Gratkorn-Produktions GmbH, Mondi Frantschach GmbH, Norske Skog Bruck GmbH, Zellstoff Pöls AG
Scientific Partners:	University of Natural Resources and Life Science, Graz University of Technology, University of Graz (Wegener Center)
Duration:	April 2013 - March 2017
Funding:	FFG, COMET K1-Project

2.2.2 IN-BEE - Assessing the intangibles: the socio-economic benefits of Energy Efficiency

While there is abundant research in the field of energy efficiency (EE) and the related energy savings expected from EE measures, the socio-economic impacts of EE are underestimated. In this context, the overall benefits of EE improvements cannot be fully assessed. IN-BEE addresses this issue by focussing on the intangible benefits (or "multiple benefits") of EE (i.e. all benefits related to EE except energy savings).

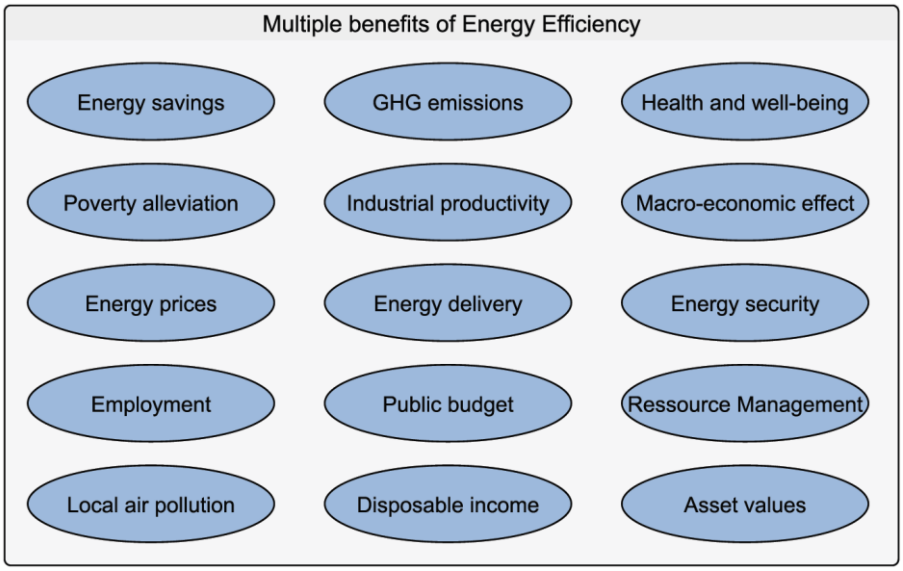


Figure 5: Categorisation of multiple benefits of EE according to OECD/IEA (2014)

The main goal of the project is to identify the intangible benefits of EE and non-EE projects, programmes or policies in country-specific case-studies involving regional and local stakeholders. The overall outcome is a consolidated set of policy recommendations for the EU and public/private institutions that promote EE and sustainability. The role of our institute is to contribute to the definition of intangible benefits, to analyse the social, environmental and economic benefits or negative impacts of EE in Austrian cases (e.g. in Energy Regions) and support the development of a framework to measure the intangible benefits of EE and derive best practice recommendations.

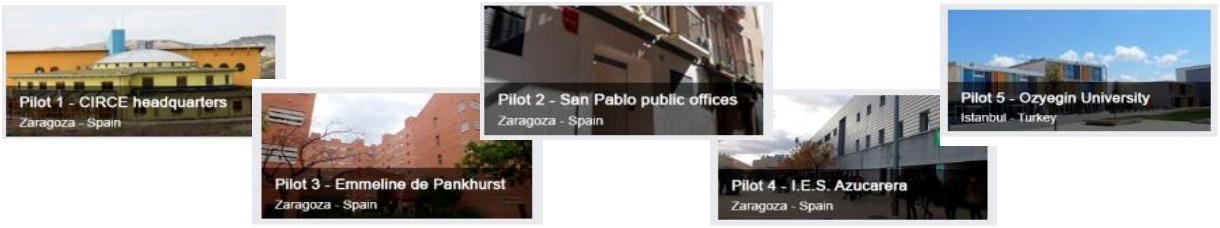
Project team:	Univ.-Prof. Dr. Rupert Baumgartner, Morgane Fritz, MIM, Josef-Peter Schöggl, Msc.
Project partners:	Universita Degli Studi Del Piemonte Orientale Amedeo Avogadro (IT), Deloitte Advisory SL (ES), Environmental Change Institute - University of Oxford (UK), Teknologian Tutkimuskeskus VTT Oy (FI), Instytut Energetyki (PL), Sofia Energy Centre Ltd (BG)
Duration:	March 2015 - April 2017
Funding:	Horizon 2020 "EE–12–2014: Socioeconomic research on energy efficiency"

2.2.3 TRIBE - Training Behaviours Towards Energy Efficiency - Play it!

The general objective of TRIBE is to contribute to a citizens' behaviour change towards energy efficiency in public buildings, through their engagement in the experience of playing a social game, linked by ICT to real time data collected from 5 pilot buildings including three different environments: residential, workplace and academic.
The achievement of TRIBE objectives allows the development of:

1. The TRIBE game: A serious game providing the possibility to engage public buildings users in a behavioural change towards energy efficiency,
2. The TRIBE pack: A package including a number of tools and guidelines for public building owners and operators, providing the opportunity to implement the project solutions in their buildings, addressing their particular challenges.

TRIBE project is based on real time as well as empirical data collected in 5 public pilot facilities:



Scientific & technical objectives:

- Development of public building users' behaviour profiles in relation to energy-related behaviours, identification of different conduct patterns and drivers towards behaviour change based on different psycho-social behavioural theories.
- Collection of real time comparable and reliable data about the energy performance of the pilots and their users' behaviour.
- Modeling and simulating the effects of the set of energy efficiency actions on the building and on the users' behaviour.
- Assessment of the evolution of the players' behaviour towards energy efficiency at individual and building level.
- Development of an EU-wide virtual community for exchanging knowledge and positive attitudes towards energy efficiency.

The goal is to foster the spread of the public building users' behaviour change as well as to support the deployment of ICTs for energy efficiency among public building owners and operators. (see also under: http://tribe-h2020.eu/)

Project team:	Ao. Univ.-Prof. Dr. Alfred Posch, Ass.-Prof. Dr. Thomas Brudermann, Eva Fleiß, MA, Patrick Hart, BA, Mag. Stefanie Hatzl
Project partners:	CIRCE Foundation, Spain, ACCIONA Infraestructuras, Spain, Zaragoza Vivienda, Spain, Özyeğin University, Turkey, bio by Deloitte, France, Interactive Institute - Swedish ICT, Sweden
Duration:	March 2015 - March 2018
Funding:	European Union's Horizon 2020 research and innovation programme, grant agreement No 649770

2.2.4 AKRoSA – Processing of critical raw materials from special waste streams

The European Commission defined a number of elements and raw materials (e.g., REE, gallium, germanium, PGE and tantalum) as critical raw materials (CRMs) because of their limited resource availability in Europe and the EU dependency on imports. To tackle this challenge an increased recycling and the use of these CRMs as secondary raw material in the sense of a circular economy is promising but not readily available. Therefore, a consortium of medium-sized and large enterprises and the Universities of Leoben and Graz was formed to develop new innovative approaches for processing and recovering certain critical raw materials.

The objective of AKRoSA is to investigate the following three waste streams with respect to processability and suitability for critical raw material recovery:

- Residue and waste streams of waste treatment plants
- Waste from special industrial processes, including e.g. mixed waste and by-product streams of the industry
- Landfilled waste

The project includes the identification of waste and residue streams and the improvement and adaption of current processing and recycling technologies. In order to conduct an appropriate recycling in the field of critical raw materials, besides the registration and collection and technological aspects, also the economic evaluation plays a crucial role.

The role of ISIS is to complement the technical research with the analysis of material flows and the subsequent development of a system dynamics model based on the results. This aims at providing a comprehensive understanding of the underlying causal relationships with regards to the three analyzed waste streams which can facilitate the decision-making of relevant stakeholders.

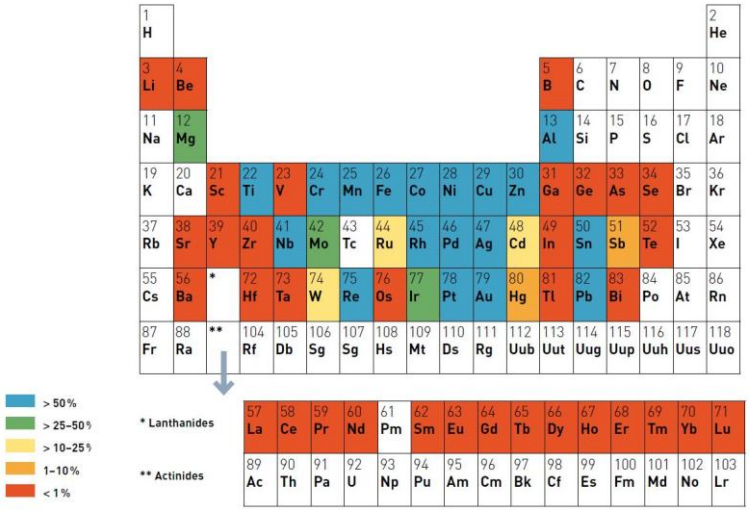


Figure 6: Recycling rate of different metals (Gradel et al. 2011)

Project team: Univ.-Prof. Dr. Rupert Baumgartner, Morgane Fritz, MIM, Mag. Andreas Schober, Josef-Peter Schöggl, Bakk. Msc.

Duration: April 2015 - March 2018

Funding: Austrian Research Promotion Agency (FFG)

2.2.5 Endowment Chair: Energy and Resource Innovation

Bioresources constitute an uncontested key pillar of European 21st century economies. Whether in regards to wood for power plants, rapeseeds as biofuels or corn-based packaging material, renewable bio-based fuels and materials are crucial for a transition to a petroleum-free economy. However, the application of such resources is not free of technical, ecological, economic and societal conflicts. The adherent causes, dynamics and consequences are in the focus of the 2016 newly introduced chair for energy and resource innovation at the Institute of Systems Sciences, Innovation and Sustainability Research.

Having his academic background in the field of forestry, Professor Tobias Stern is especially interested in examining the diffusion processes of future-oriented technologies. In particular he works on decisive questions like, how to overcome the gap between technical maturity and practical implementation, what broader implications might derive from an intensified use of bio-processing technologies or which transition pathways are most feasible for a sustainable use of bio-based materials. Hence, the centre of his research activity can be summarized by focusing on a facilitation and development of a bio-based economy and the further anchoring of this emerging topic in the Austrian research landscape.

In assessing the abovementioned questions, the research is uderpinned by analysing the transition, (eco-)innovation and adaption processes between the three key systems of sustainability. Only through a holistic aproach to the manifold interrelations between environmental, societal and economical dimensions of bio-based economies, long-lasting and feasible solutions can be generated. However, not every material is applicable in the same context under altered circumstances in different regions.

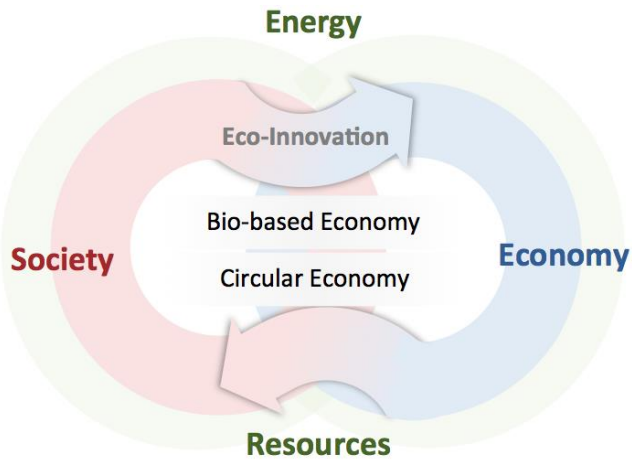


Figure 7: Energy and Resource Innovation

With the institutes focus on innovation, environment and global change, this new chair features a promising link and extension to the already existing research activities. The chair for energy and resource innovation is conceptualized as endowment chair and is funded by the Land Steiermark (Province of Styrian) for the next three years. At the moment, the faculty is in search of further collaboration partners.

Project team:	Univ.-Prof. Dr. Tobias Stern, Mag.rer.nat. Raphael Asada, BA, Claudia Mair, Bsc. Msc.
Duration:	January 2016 – December 2020
Funding:	Land Steiermark

2.2.6 Joint Program for Sustainability Leadership

The major aim of this Erasmus+ partnership project is to jointly develop a study program for sustainability leadership. The study program aims to enhance the ability of leaders to innovate, collaborate and catalyze change, eventually creating sustainable organizations and societies. The program is being developed based on the needs of managers and leaders, research evidence and principles of sustainability leadership, sustainability standards and SDGs requirements. The study program has been implemented in Lithuania, Slovenia and Macedonia and the first cohort started their studies in October 2017; the project team from Graz is contributing to the development of the program by providing expertise in the field of sustainability management and curriculum development; furthermore, lecturers from the institute will offer courses at University of Ljubljana, Ss. Cyril and Methodius University in Skopje and Vytautas Magnus University in Kaunas during a teaching mobility. Selected students of the program have the chance for a short study exchange in March 2018.

The wider objective of the project is to improve manager's and leader's performance and sustainability actions through enhancing their leadership skills and abilities to innovate, collaborate and manage change. The target group consists of managers working in local, national and governmental bodies, as well as in the private and non-profit sector; managers who are willing to make a difference and integrate strategies for sustainability in their organizations are very welcome to the program. Another target group are interested students who plan to work as key players in project management and organizational development, where broader issues of societal development are important.

First project meeting in Skopje on September 30, 2016

Project team:	Ass.-Prof. Dr. Thomas Brudermann, Dr. Thomas Winkler, Mag. Andreas Schober, Ass.-Prof. Dr. Romana Rauter, Dr. Ralf Aschemann, Ao. Univ.-Prof. Dr. Alfred Posch
Project partners:	Ss. Cyril and Methodius University (Macedonia), Institute for Research in Environment, Civil Engineering and Energy (Macedonia), Vytautas Magnus University (Lithuania), University of Ljubljana (Slovenia)
Duration:	September 2016 – August 2018
Funding:	Erasmus+, Key action 2 (Strategic Partnerships), grant agreement No 2016-1-MK01-KA203-021670

Funded by the Erasmus+ Programme of the European Union

2.2.7 Wood for Automotive Applications – WoodC.A.R.

WoodC.A.R. COMPUTER AIDED RESEARCH

This COMET K-Project aims at gaining a more thorough and comprehensive understanding of wood as load-bearing and energy absorbing (crash and vibration) material in advanced applications is needed. WoodC.A.R. (Wood - **C**omputer **A**ided **R**esearch) will establish the knowledge and the requisites for integrating wood in virtual engineering and the industrial design process (e.g. vehicle design) in general. The Project will establish the needed knowledge base on the mechanical properties, the grading, the processing, the integration and the recycling of numerous wood species and wood composites in vehicle design. Moreover, WoodC.A.R. will evaluate and improve existing and develop advanced material models for use in computer aided engineering (CAE). State-of-the-art production, joining and bonding technologies will be reviewed, analyzed, evaluated and integrated in the virtual engineering process. Application cases, not only from the automotive sector, will be selected. Based on meticulous specification sheets, the application cases will be developed by applying the initial virtual engineering process. In continuous feedback-loops, the process will be refined such that it is applicable in an industrial development process. Eventually, demonstrators will be built and tested, proofing the reliability of the virtual engineering process.

Photo: Mattro

The Institute of Systems Sciences, Innovation and Sustainability Research is responsible for assessing the environmental and socio-economic impacts of wood in an automotive application. More precisely the institute will perform a Life Cycle Assessment (LCA) of the defined application cases in order to identify environmental Hot Spots on a Meta level. Moreover, the socio-economic impacts of an increasing wood demand will be assessed by applying the system dynamics model FOHOW.

Photo: MAGNA

Further Information: http://www.woodcar.eu/index_de.html#

Project team: Univ.-Prof. Dr. Tobias Stern, Claudia Mair, MSc.
Lead Institution: Innovationszentrum W.E.I.Z.
Company Partners: MAGNA, MAN, MATTRO, Weitzer Parkett, DOKA, DYNAmore, EJOT, FHP – Forst Holz Papier, Holzcluster Steiermark, IB Steiner, LEAN MC
Scientific Partners: University of Natural Resources and Life Science, University of Graz (SIS), Graz University of Technology (VSI), Virtual Vehicle (Vif), University of Applied Science FH Joanneum
Duration: March 2017 - March 2021
Funding: FFG, COMET K-Project

2.2.8 Flippr² - Future Lignin and Pulp Processing Research PROCESS INTEGRATION

This COMET K-Project is the follow-up project to FLIPPR⁰ (April 2013 – March 2017), where University of Graz was already responsible for the area of sustainability research (e.g. LCA).

The efforts of the project are focused on integrated solutions to efficiently manufacture products from wood, specifically from spent liquor derived technical lignin and pulp derived specific short fibre fractions (fines). By tackling process integration issues associated with separation, fractionation and modification of bio-based materials in the pulp and paper industry, resulting products are expected to contribute towards a more sustainable knowledge-based bioeconomy, partly replacing fossil resources and increasing value added.

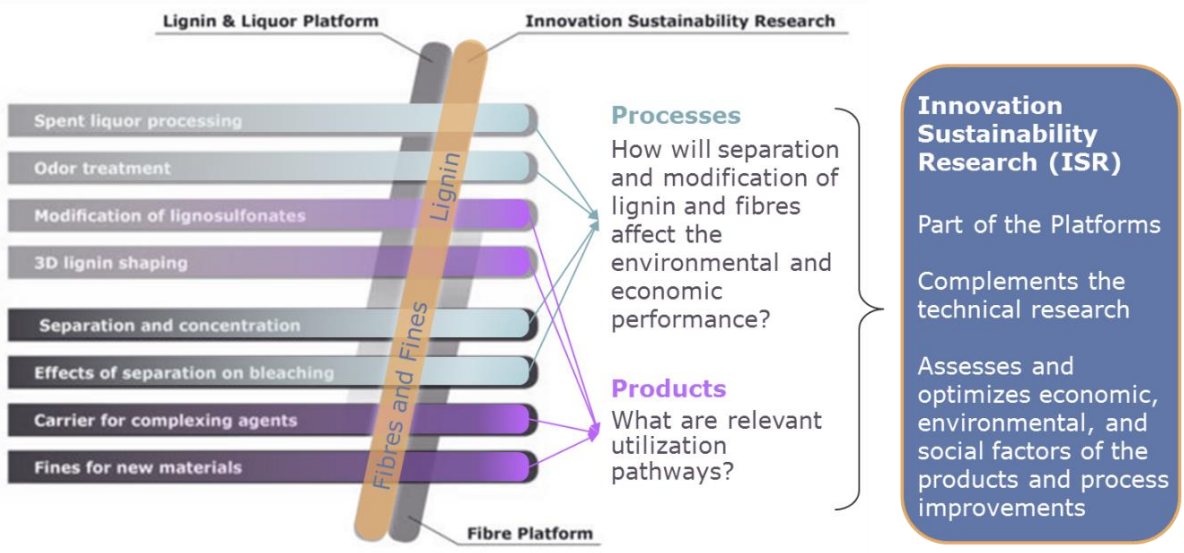


Figure 8: Flippr² sub-projects and the innovation sustainability task

As illustrated in Figure 8, SIS is responsible for the innovation and sustainability task.
On the one hand, the respective technical sub-projects are complemented by (techno)-economic and environmental research: with a spectrum of methods at hand, tailor-made solutions are applied to support the decision making process.
On the other hand, issues in a broader context such as bio-based innovations, (lignocellulosic) biorefinery developments and bioeconomy impacts are investigated.

Project Team:	Univ.-Prof. Dr. Tobias Stern, Ao. Univ.-Prof. Dr. Alfred Posch, Julia Wenger, MSc., Josef-Peter Schöggl, MSc.
Lead Institution:	Papierholz Austria GmbH
Company Partners:	Sappi Gratkorn-Produktions GmbH & Co KG, Mondi Frantschach GmbH, Zellstoff Pöls AG
Scientific Partners:	University of Natural Resources and Life Sciences Vienna, Graz University of Technology, University of Graz
Duration:	April 2017 - March 2021
Funding:	FFG COMET K-Project (6th Call): BMDW, BMVIT, KWF, SFG

2.3 Research cooperations and networks

2.3.1 Visiting researchers

Name	from	until	University	Host
Prof. Dr. Sanjay Patnaik	21.11.2017	21.11.2017	George Washington University, Washington DC, USA	Rupert Baumgartner
Viktorija Illieva, MBA	15.09.2017	15.12.2017	Ss. Cyril and Methodius University of Skopje	Thomas Brudermann
Rafia Zaman, MBA	01.09.2017	31.05.2018	Kuhlna University, Bangladesh	Thomas Brudermann
Prof. Dr. Visnavathan	07.06.2017	14.06.2017	Asian Institute of Technology, Thailand	Ralf Aschemann
Urška Fric, MSc	08.05.2017	19.05.2017	Faculty of Information Studies in Novo mesto, Slovenia	Ralf Aschemann
Prof. Dr. Bo Weidema	22.04.2017	28.04.2017	Alborg University, Denmark	Ralf Aschemann
Ass.-Prof. Warangkana Jutidamrongphan	08.04.2017	07.05.2017	Prince of Songkla University, Thailand	Thomas Brudermann

2.3.2 EGC - Environment and Global Change

The University of Graz has defined seven “research core areas”, four of them with inter-university-cooperation. One of them is the research core area „Environment and Global Change“. Within this core area, global and regional climate and environmental changes are investigated and monitored. The role of humans contributing to this change, as well as possible ways for transformation towards a sustainable society through innovation, is the central theme of EGC. Researchers from climate and environmental physics, environmental chemistry, hydro-geology, environmental biology, environmental economics, sociology, geography and regional sciences, systems sciences and sustainability research and management, environmental ethics and law collaborate cooperate interdisciplinary in this research core area.

There are main research areas:

- GlobEOS (Global Earth Observation and Stewardship)
- RegIMOS (Regional and Local Integrated Modelling System and Studies)
- EnviSYS (Changing Ecosystems and Earth-external Environmental Systems)
- GreenPROTEC (Green Processes and Technologies)
- RegiKNOWS (Regional Changes and Knowledge Transfer for Sustainability)
- HDChange (Human Dimensions of Climate and Global Change)

Figure 9: EGC Logo

2.3.3 ISDRS - International Sustainable Development Research Society

The International Sustainable Development Research Society (www.isdrs.org) was formally founded in 2006 and builds upon a 20 year history of the International Sustainable Development Research Conferences. The vision is to establish a forum where diverse research communities can come together creating a transparent dialogue on key problems, issues, initiatives, policies and strategies needed to make sustainable development a reality. It aims to foster and communicate the importance of sustainable development in a global society, to promote high quality dialogue and collaboration and to build bridges between different research communities and also between research and its applications in society. In 2017, the 23nd annual International Sustainable Development Research Conference was held in Bogota/Columbia. Rupert Baumgartner is board member and executive secretary of the ISDR-Society.

2.3.4 Early Career Researchers Network of Networks

Early Career Researchers Network of Networks (ECR NoN) is uniting early career researcher organisations from all over the world to facilitate cooperation, to break silos across disciplinary backgrounds and engage with interdisciplinary issues. ECR NoN also addresses science-policy translation issues and provides early career researcher opinion in initiatives like Future Earth, the International Social Science Council (ISSC) and other relevant groups and organisations.

Institute of Systems Sciences, Innovation and Sustainability Research (SIS) is part of this ECR NoN since mid-2016, with another 25 international networks involved. Each of the member organizations have freedom to create working groups for certain topics of interest. SIS, represented by Arijit Paul and Aisma Linda Kiesnere, together with 16 other networks/organizations has joined the Future Earth Working Group (FE WG), which concentrates specifically on sustainability and interdisciplinary research. Additionally, in the last FE WG meeting in London (22-24 January 2018) Aisma Linda Kiesnere took over the team lead of Structure, Governance and Communication Team of the FE WG, letting the institute plant its sustainability research ideas straight into this global early career researcher community.

More information on the latest meeting is available here: http://futureearth.org/news/early-career-researcher-networks-meet-london

2.4 PhD projects (ongoing)

2.4.1 Corporate strategies in response to climate change - an empirical analysis of characteristics, drivers and outcomes with a focus on the global automotive industry

Businesses play a crucial role in climate change mitigation efforts, since most emissions are caused by industrial activities. Although there has been plenty of research on other sustainability and environmental issues, corporate action on climate change remains poorly understood. This especially applies to the dynamics of strategies employed in specific industries and supply chains.

This dissertation aims at closing these knowledge gaps through four empirical studies that address (i) the characteristics of companies' strategic responses to climate change; (ii) their intra-organizational and external drivers; and (iii) the impact of strategies in terms of GHG reductions and financial performance. An empirical focus is on the global automotive industry because of the need for combatting CO2 emissions from road transport. For comparison purposes, the global cement and steel industries and suppliers of multinational corporations were also considered.

Based on strategic management literature, novel definitions of and conceptual frameworks for climate change strategies are developed. In contrast to previous research, the conceptualizations proposed in this dissertation adopt an integrated perspective by including both market (e.g. development of low-carbon products and processes) and non-market aspects (e.g. political lobbying) and by distinguishing between several underlying strategic objectives. Stakeholder, institutional and legitimacy theory and the resource-based view of a firm, in turn, serve to derive theoretical propositions about internal and external drivers of corporate climate change strategies. For the empirical analyses, secondary data was sourced from company documents, financial databases, trade associations and international institutions. A mixed-method approach was employed to analyze the data, including content analysis techniques and statistical methods.

The findings show that climate action in the automotive industry is particularly dependent on effective corporate governance, the position of a company in the supply chain and its size. Moreover, suppliers (regardless of industry affiliation) are more likely to implement low-carbon initiatives when perceiving climate-related risks and opportunities. Having said that, results concerning external factors are rather ambiguous. In general, regulatory pressures to reduce GHG emissions are not associated with a greater extent of action among automotive firms. The opposite applies, however, when looking at the largest companies in the automotive, steel and cement industries and suppliers of multinational corporations. Interestingly, empirical evidence cannot be provided for a positive relationship between companies' emission reduction initiatives and environmental performance. Yet, climate change strategies are partly associated with financial gains in the long run.

PhD student: Matthias Damert, MSc.
Duration: 2014 - 2018
Reference: Doctoral Programme DK Climate Change

2.4.2 Scenarios for a Low Carbon Society: Sector Agriculture

Accumulation of greenhouse gases (GHGs) in the atmosphere has led to rising temperatures, variable precipitation, and other extreme events like droughts and floods. In order to limit negative impacts to climate, the environment, and human livelihoods in general, emissions of these compounds need to be strongly reduced. International agreements have not been effective, in part due to missing concepts of realistic "low carbon" situations. Hence there is a need to devise scenarios for a low carbon society that is technically and economically viable.

The agricultural sector is a source of food and is indispensable to society. However, it is associated with significant GHG emissions. The Intergovernmental Panel on Climate Change's (IPCC) 5th assessment report, identifies the agricultural sector as one of the major GHG emitting sectors, responsible for almost a quarter of GHG emissions (~10–12 $GtCO_2$ eq./yr) mainly from deforestation and agricultural emissions from livestock, soil and nutrient management. Reports have also shown that agricultural yields are vulnerable to climate impacts, as seen by a decreasing rate in production increase over recent years. Hence agriculture is not only a major source of GHG emissions but is also affected by the accumulation of the GHG's in the atmosphere and subsequent changes in climate. The economic mitigation potential in the supply-side is estimated to be around 7.2 to 11 $GtCO_2$ eq./yr in 2030 consistent with carbon prices (IPCC 5th Assessment Report, 2014). Although it is characterized by a high level of GHG emissions, the agricultural sector is indispensable for society. Understanding the negative impacts of climate change due to GHG accumulation and accounting for the potential that exists to mitigate emissions, it is necessary to devise low carbon scenarios to reduce GHG emissions in the agricultural sector.

This study, using international emission inventories, country specific reports and the International Institute for Applied Systems Analysis's (IIASA) Greenhouse Gas and Air Pollution Interactions and Synergies (GAINS) model will assess the policies and measures undertaken by the European Union (EU) countries to mitigate GHG emissions in the agricultural sector. Additionally, the study will also identify and evaluate other novel mitigation options and estimate their subsequent costs using the GAINS model. Overall, the results would identify and describe low carbon scenarios in the agricultural sector to mitigate climate change. This holistic framework analyzing the mitigation potential of current and proposed measures is more complete than previous research. The results are helpful for farmers, crop advisors, and policy makers struggling to identify economically viable mitigation strategies and understand the impact of a changing climate on commodity agriculture.

PhD student: Sajeev Erangu Purath Mohankumar, MSc. Eng.
Duration: 2014 - 2018
Reference: Doctoral Programme DK Climate Change

2.4.3 I Shine, Not Burn. Empirical studies on citizen participation initiatives in the field of photovoltaics

During the last decades, citizen participation initiatives in renewables spread across Europe in various forms and shapes – including 'small' or 'large' initiatives with respect to capacity and/or number of members involved; 'strong' or 'weak' ones regarding the level of community engagement and the amount of resources available to operate the initiative, 'idealistic' or 'market-oriented' ones regarding their goal, etc. One overarching benefit of such initiatives is, however, that they provide the opportunity for different actors (e.g. energy supply companies, private companies or individuals, etc.) to aid the transition towards a more sustainable energy system, to reduce greenhouse gas (GHG) emissions and to foster the diffusion of renewable energy technologies, and thereby contribute to meeting the current goals defined by several policy agreements on national, European and international level.

To cope with the variety of energy community projects, the term 'citizen participation initiatives' (CPI) will be used in the PhD thesis at hand to underline the importance of individual citizens for implementing renewable energy projects – more specifically: projects in the field of photovoltaics (PV). This broad definition also allows for considering different possibilities of participation (e.g. financial investment, active contribution to operating the initiative, etc.), as well as for recognizing the involvement of a broad variety of actors who may found and operate such initiatives, including not only individual citizens but also external firms, energy supply companies, municipalities, etc.

CPIs in renewables received attention from researchers of various disciplines. Owing the complexity and diversity of such initiatives in respective national contexts, research questions address different dimensions, most importantly: (1) the overall goal of such initiatives from initiators' perspectives, (2) relevance and impact of framework conditions (e.g. legal, acceptance, etc.) as well as the development potential of such initiatives, and (3) motives to participate in an initiative. However, results are still rather fragmented, owing (not only but heavily) to methodological weaknesses.

The PhD thesis at hand aims to make a contribution to this field of research by innovating regarding the methods applied as well as content wise by providing rather comprehensive information about PV-CPIs in Austria. Therefore, all three of the above-mentioned dimensions are addressed, as indicated by the following research questions:

1. What kind of niche processes operate within CPI social innovation? How do market-based and grassroots PV-CPIs perform in these processes, how do both types of PV-CPIs evolve towards a global niche, and what is their potential success at the regime level?
2. Why do people participate in PV-CPIs?
3. What factors foster or hinder the development of CPIs for PV diffusion I Austria?
4. Which resources are necessary to successfully implement a PV-CPI?

The PhD thesis was embedded in the project RESHAPE.

PhD student: Eva Fleiß, MA
Duration: 2013 - 2018

2.4.4 Behaviour and Behaviour Change in the context of the transition towards a sustainable energy system

The problem of climate change is closely related to globally increasing energy consumption which is at the moment by 80% covered by fossil fuels and thus producing 32.3 Gt of global energy-related CO_2 emissions in 2014 (IEA 2015). Consequently, international and European policy strategies aim at reducing carbon emissions, decreasing dependencies on fossil fuel imports, and achieving other ambitions for a transformation towards a sustainable energy system (WBGU 2011).

Various energy policies that are supported on the European level are implemented on national scales. Initiatives in this context involve technical measures (e.g. usage of energies from renewable resources), and non-technical measures like behavioural changes at the individual level. Thus any kind of successful transformation into low-carbon and sustainable societies requires beside a development of new technologies, especially the prompt and widespread diffusion of technical and social innovations.

Important input for policy-makers is the better understanding of factors affecting energy-relevant behaviour (e.g. investment decision for renewable energies) as well as the influence of initiatives on the currently prevailing socio-technical energy system in order to design and implement policies that will more effectively promote the diffusion of social and technical innovations the prevailing energy system. Therefore the purpose of the thesis is to gain an integrative perspective on factors (e.g. adoption decisions of renewable energies, characteristics of niche practices) influencing the diffusion of social and technological innovations in order to understand system change towards a sustainable energy future.

The main objective in this context is to get an understanding of (1) a widespread diffusion of "more or less commercially available" energy technologies, and (2) bottom-up "demand-side actors", their role (which may become the role of prosumers regarding the diffusion of renewable energies) and the effectiveness of diffusion. In order to reach this objective the focus lies on four different sub-aspects, from an individual up to a system perspective of behaviour change.

1. Do the aims of bottom-up initiative programmes of local agents get through to the citizens in respective regions to support a transformation towards a sustainable energy future?
2. How do bottom-up initiatives in the field of photovoltaics evolve towards a "global niche" and what is the transition potential to break through to the energy regime?
3. In which way do change agents as well as individual psychological factors influence household heating technology decisions?
4. How do desires and beliefs influence the decision to participate in bottom-up initiatives in the field of photovoltaics?

Results and findings of the four sub-questions provide an essential contribution to transition and behaviour theories in the energy context. Thus, different behavioural theoretical frameworks are considered, drawing an interface from the individual level, to the social context up to a system perspective.

The PhD-project is embedded in the projects RESHAPE, TRIBE - Play it! and HTD

PhD student: Mag. Stefanie Hatzl
Duration: 2014 - 2018

2.4.5 Social and Economic Uncertainties and Thresholds for the Diffusion and Adoption of Renewable Energy Systems

In my PhD thesis, I deal with diffusion processes of emerging low-carbon technologies in the energy sector. More specifically, I focus on radical innovations (i.e. innovations that do not fit well into current energy regimes) by using primarily the example of solar photovoltaics (PV), a promising technology, which may contribute substantially to the de-carbonization of our society. Based on the insights of evolutionary economics and innovation theory, I conceptualize the diffusion of technologies as a dynamic and non-linear process, which depends on a range of different factors, including financial, technical, institutional, political and cultural factors.

There are two thematic blocks within the thesis. The first block is about social and economic uncertainties for solar PV technology and the associated emergence of collective expectations. Based on the sociology of expectations, I analyse the patterns of expectations for this type of technology over time and examine the actual contents of these expectations. Furthermore, I try to shed light on the question of how expectations might influence actual innovation activities. In one of my key projects, I focus on expectations for photovoltaic technology in Germany and Spain by analysing newspaper articles.

The second block is about social and economic thresholds. Within this block, I seek to identify and explain relevant tipping points in the context of the emergence of low-carbon technologies such as, for instance, a point in time at which the diffusion of a technology becomes self-sustaining. Here, I draw mainly on the technological innovation system (TIS) framework, which suggest that the successful diffusion and development of novel technologies depend on seven key functions that strongly interrelate. While these functions may accelerate each other and eventually cause a technology to 'take-off', they also may block each other and prevent a technology's successful diffusion. To study the latter case, I, again focus on photovoltaic technology, but use the Western Cape Province of South Africa as a case study.

In the analyses, I primarily draw on the method of content analysis (qualitatively as well as quantitatively). I, however, also try to triangulate my data by conducting desk research or analysing secondary literature.

PhD student: Michael Kriechbaum, MSc.
Duration: 2014 - 2018
Reference: Doctoral Programme DK Climate Change

2.4.6 Strategic and ethical dimensions of business responses to climate change

Current understanding of business strategies and climate change is too fragmented to propose effective measures for achieving fossil fuel redundancies for business organizations at the collective level: a task that is of paramount importance to improve our chances of meeting the 20C global warming target of the Paris Agreement.

In my thesis I try to address this concern in three collaborative research papers. In the first paper we propose an integrated model of business strategy and climate change that combines climate strategy, climate performance and financial performance of companies. We operationalize the model using the statistical method of structural equation modelling. The results from the application of the model indicates: in the long run, internal greenhouse gas emission reduction efforts at companies are profitable and the combination of regulatory and stakeholder pressures are effective in pushing companies towards more action on climate change. A need for developing a deeper integrated view emerged from the first paper. We attempted to address this need in the second paper by trying to uncover the ontology of the interaction between business and climate change. Grounded in the philosophy of critical realism and supported by an extensive structured literature review, in the second paper we propose a multilevel ontology of the interaction between business and climate change. The ontology is captured in a multilevel framework, which shows that the organizational level strategic responses of business organizations to climate change are influenced by four other levels, comprising of individual, national, sectorial and transnational levels. The multilevel ontology of our framework makes the need for interdisciplinary research in developing integrated understanding of business strategies and climate change explicit. Using the statistical technique of multilevel modelling we show an empirical example of the operationalization procedure of our framework.

The empirical example is the first global study on corporate lobbying behavior on climate change. Our results show lobbying behavior of companies on climate change does not vary between developed and developing countries but instead are guided by their sector affiliations and organizational level characteristics. In the third paper we demonstrate a conceptual application of our framework by developing a novel interdisciplinary insight of business inaction on climate change. Focussing on business leaders as moral agents and by combining insights from climate ethics, psychology and ethical decision-making theories we provide a theoretical explanation for the collective level failure of business organizations in reducing their GHG emissions.

I end my thesis with a vision for an integrated understanding of business strategies and climate change and emphasise that such a vision can only be achieved through deep interdisciplinary research.

PhD student: Arijit Paul, MSc.
Duration: 2014 - 2018
Reference: Doctoral Programme DK Climate Change

2.4.7 Data Generation for Systems Scientific Approaches in Sustainability and Labor Market Research by Use of Text Mining

Economic growth and technological development induce a continuous transformation of the labor market. This transformation manifests for employees in altered labor conditions and education requirements. In labor market research these changes have been investigated on the microscopic and macroscopic scale separately. On the macroscopic scale the research is based on employment statistics, whereas on the microscopic scale questionnaires and interviews are employed. Combining these approaches is not appropriate to gain a labor market analysis with both wide coverage and high resolution. That is due to the huge effort questionnaires and interviews require especially for extensive investigations. However, data mining methods, which have been developed since the end of the twentieth century, provide capable instruments to describe the labor market. Such a representation can be created on both the macroscopic and microscopic scale by using an extensive collection of job announcements. Sources for suitable datasets are found on the internet and newspapers. While the internet allows real-time analysis, newspapers are appropriate to investigate historical developments and higher-level systemic correlations moreover. Those correlations are for example Job Polarization in the labor market context and Critical Transitions in general. Both concepts are part of current systems scientific research. The combination of information retrieved from newspapers and from the internet allows to analyze in particular rise, development, presence and quality of Green Jobs.

The research questions are:

1. Does the usage of Text Mining allow to generate data suitable for systems scientific investigations?
2. What can be revealed in the systems scientific context regarding the economic development?
   2.1. Can Text Mining in job announcements published via newspapers depict labor market parameters of past decades?
   2.2. Is it possible to determine indicators for Critical Transitions in these datasets?
3. Can real-time monitoring of the labor market be developed basing on the answers to the above questions? What can be concluded regarding the development of Green Jobs?
4. Based on the data provided by the use of Text Mining, is it possible to develop alternative economic indicators?

PhD student: Mag. Andreas Schober, Bakk.
Duration: 2014 - 2018

2.4.8 Resilience in decentralized infrastructure networks: Modeling dynamic systems

Infrastructures are a crucial requirement for working societies. Without basic infrastructures (e.g. electrical power, water, communication technology, …) growth in health, education and productivity is hindered. Therefore, establishing resilient infrastructures is one of the goals of the United Nations Sustainable Development Goals.
Smart Grid initiatives try to address the challenges of sustainable and reliable supply of energy. However, the integration of high shares of renewable energy, large scale demand management and the resilient control of energy networks still face major (technological) obstacles. In the thesis these aspects are addressed by combining network science and further systems scientific methods. The focus of the planned work is on deploying methods of modeling and simulation to develop and test options for building resilient and decentralized supply networks with the help of self-organizing dynamically adapting agents.

To approach this goal, various steps are foreseen. In a first step a general theoretical framework for robust infrastructures will be developed:

- Systems scientific concepts (for example adapted network processes, early-warning signals in network context, machine learning methods) will be screened in regard to recognition and prevention of breakdowns ("critical transitions") in dynamical infrastructure networks.
- Different methodological approaches will be compared and their resilience evaluated.
- After finding suitable methods the goal is to identify distinctive network properties of resilient and susceptible networks.
- In a second step the findings are then applied to the development of smart grids and the main research questions are:
- How do the results of the general framework compare to the applied case?
- Can the used concepts enrich traditional smart grid modeling approaches?
- Is it possible to derive recommendations for the development and improvement of smart grids?

PhD student: Christian Hofer, Bakk. BSc. MSc.
Duration: 2015 - 2018

2.4.9 URBAN-TRANSITIONS: Behaviour-Related Transition Management Approaches towards Urban Sustainability

At the beginning of the 21st century, half of the world's population lived in cities. In industrialized countries cities encompass over eighty percent of the population. These developments pose complex challenges for metropolitan policy-making such as technical and socio-economic ones as well as challenges related to the impact of urban life. Political and scientific discussions about metropolitan aggregation and its associated problems become more crucial in relation to climate change which is largely caused by greenhouse gas emissions that are the result of a continuously growing (especially in cities) population's demand for energy. Furthermore, cities are particularly challenged by climate change, for example in relation to heat burdens. Cities around the world are recognizing the potential danger of climate change to disrupt their social and economic fabric. Thus, they develop strategies for reducing greenhouse gas emissions, modify programs to adapt a warmer future, and engaging civil society in this effort. There is a commonly accepted scientific consensus that global sustainability is for an important part an issue of urban sustainability. In this sense, different concepts of cities, such as smart, sustainable and resilient ones, are a current matter of interest in relation to a sustainable urban future.

Urban sustainability requires the realization of sustainable urban places, which is the aim of sustainable urban transformation and thus, encompasses sustainable urban structures and environments as well as economic, social, cultural, organizational, governmental and physical change processes. The effective implementation of change processes in different contexts relies to a large part on human behaviour change. The resistance against behaviour change is a major challenge with regard to sustainable developments. Change is a source of stress for individuals and habits are a source of resistance.

Change processes on different societal levels can be described by transition theory which distinguishes three mutually interacting levels: landscape, regime and niches. Niche developments may break through to the regime level during so-called "windows of opportunity", leveraging irregular tensions and misalignments in the regime. The strategic preparation for taking the chance of a window of opportunity in different city as well as thematic contexts as reference points for the development of change strategies towards sustainable cities is the focus of this PhD thesis. Three different framing conditions, which are all related to the sustainable city subject area pose the basis for the investigation of different methods for strategically preparing windows of opportunity, which favour long-lasting change in cities. Within these framing conditions the investigation of the following research questions is the centre of the thesis:

1. What are key issues for the adaptation to climate change induced heatwaves in urban areas?
2. What are drivers for behaviour change of different types of energy consumers in urban public buildings?
3. How do current regime structures favour the niche breakthrough of renewable energy technologies in urban quarters?

This PhD project is embedded within the projects TRIBE - Play it! and URSOLAR

PhD student: Christiane Reischl, MA MSc.

Duration: 2015 – 2018

2.4.10 Operationalization of sustainability performance of first and second order

After the publication of the report "Our Common Future" by the World Commission on Environment and Development many milestones followed to define sustainability. Most studies focus on sustainable development on a macro-level, rather than linking all effected levels (e.g. the company, market, society and nature). It must be considered that a sustainable development cannot be achieved by thinking within a firms' boarder. Everything is interconnected and pollution doesn't stop at any (geographical or firms) boundary. A company is operating in a market system which is part of the society embedded in the nature. The focus on the performance of a sub-system might potentially decrease the sustainability performance of society and nature in total. This means that whole systems have to be studied, rather than focusing on single projects, processes and activities. Thus, the dissertation focuses on the topic of sustainability performance in a systemic view. The goals are to 1) find a definition of sustainability performance, by splitting this term into first- and second-order sustainability performance. And 2) to find feasible methods to measure the degree of sustainability performance in a systemic way. The goal of the dissertation is to develop a framework to operationalize sustainability performance of first- and second-order. The first part of the dissertation is the development of a conceptual framework which includes essential criteria to operationalize sustainability performance of first- and second-order. To test the applicability of this framework, case studies will be conducted and companies are being assessed based on their sustainability activities. The figure below shows the methodological approach of the dissertation.

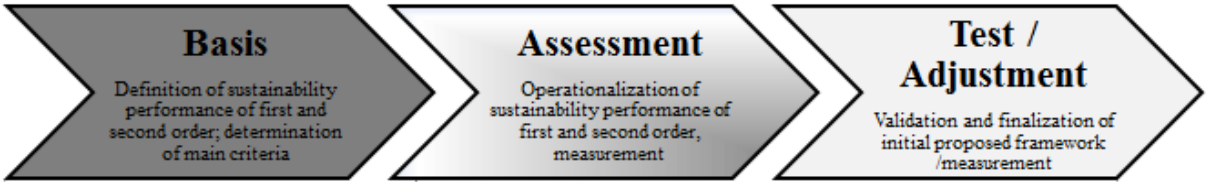


Figure 10 Methodological approach to operationalize first- and second-order sustainability performance

In the frame of the present dissertation the following main research questions will be studied:
Question 1: How can sustainability performance be operationalized if systemic impacts are integrated?
Question 2: Which criteria are needed to operationalize sustainability performance of first- and second-order?
Question 4: How can companies reduce negative impacts to lead to an improvement of sustainability performance?
Question 5: Which corporate activities can be counted as sustainable activities (voluntary and forced by law) to achieve sustainability performance of first and second order?
This dissertation is one of the first attempts to split sustainability performance into first- and second-order by identifying the degree of sustainability in a systemic way. This helps businesses to concentrate on major (sustainability management) activities to allow a sustainable development, according to the Brundtland report 1987, to meet the needs for generations nowadays and in the future. Through this approach companies can identify lack of sustainability performance. Based on this, improvements and targets can be set by implementing sustainable strategies. This is highly important as current situations show an urgent need to get companies to act in a more sustainable way.

PhD student: Martina Zimek, BSc. MSc.
Duration: 2016 - 2019

2.4.11 Eco-Innovations in Bioeconomy: The Role of Wood-based Composites in the Mobility Sector

The bioeconomy strategy promotes a transition away from using fossil-based resources towards the production of bio-based products (European Commission 2012). This transition towards a bioeconomy will certainly need knowledge creation, research & development and innovation in its major cornerstones (European Commission 2012; McCormick and Kautto 2013). Substituting fossil-based resources with bio-based resources in certain applications will not necessarily lead to a reduction of environmental impacts. The performance of bio-based products compared to other materials such as metals, carbon-fibres or aluminum also needs to be analyzed.

On the other side the automotive industry faces growing pressures to reduce the green-house gas emissions of their fleet (European Commission 2014a) and simultaneously increase the recyclability of its components (European Commission 2000). In order to cope with the emission targets, the mobility sector is in need to reduce the fuel consumption and the weight of their vehicles. Current used lightweight materials such as carbon- or glass-fibres do indeed reduce weight but have problems when it comes to recycling (Diener and Tillman 2016) and have therefore difficulties to reach the ELV targets (European Commission 2000). Bio-based materials have some advantages compared to traditional glass-fibres such as being renewable and available at a low cost, having a low weight, high strength and elasticity modulus. It is possible to incinerate natural fibres with no residues being left after the incineration or provide a safe handling with no skin irritation (Bismarck et al. 2006).

The work at hand aims to gain more insight into the issues of resources efficiency, environmental performance, end-of-life issues and general environmental aspects and impacts of newly developed material sand product innovations in the bioeconomy by

1) analyzing the differences and similarities between the different resource management concepts within the bio-based and non-bio-based economy, namely cascading utilization and circular economy;
2) critically discuss the environmental performance of bio-based lightweight material selection in the mobility sector;
3) analyzing the end-of-life possibilities and issues of bioeconomy innovations in terms of re-source efficiency; and
4) illustrating the sustainability effects of substituting fossil- or mineral-based resources with bio-based materials.

The PhD-project is partly embedded in the project WoodC.A.R.

PhD student: Claudia Mair, MSc
Duration: 2016 - 2020

2.4.12 Transition Towards Bioeconomy: Indicators, Determinants and Interventions from a Macro-level Perspective

The terms “bioeconomy” and “bio-based economy” are currently referring to one of the most prominent political-economic concepts in Europe focusing on ecological aspects i.e. climate change mitigation and reducing environmental impacts. Furthermore, a bio-based economy is intended to have socioeconomic benefits such as fostering economies’ competitiveness, meeting rising demand and counteract resource depletion. Measuring and monitoring bioeconomic developments are important for future social, political and economic decisions. Previous studies on the state of bioeconomy were based on an initial decision, what bioeconomy is, i.e. which sectors of an economy are considered as bioeconomic. However, literature shows that corresponding prioritization within bioeconomy strategies around the world differ considerably. Some countries rather focus on traditional biomass producing and transforming sectors (e.g. forestry sector, pulp and paper industry) while others concentrate on high-tech industry (e.g. chemical and pharmaceutical industry). On the other hand, there is a broad consensus regarding the possible outcomes of a bioeconomic transition. These are, among others, reduced dependency on fossil fuels, mitigated global warming as well as avoided environmental damages caused by petrochemistry.

In order to overcome the problem of a lacking definition of bioeconomy, this project refrains from measuring the economic performance of a set of “bioeconomy sectors”. Instead, it focuses on the potential outcome of bioeconomic transitions, i.e. to quantify fossil fuels and biomass consumed by countries. Applying such a material-based approach, explanatory and controlled key variables expected to determine the fossil fuels and biomass shares in economies’ material inputs must be taken into account. In this context, economic growth, affluence or final demand, as well as population density and domestic per-capita extraction of raw materials have been discussed in literature. However – at least for a subset of countries – models show unsatisfactory results, which leaves room for the inclusion of further/other explanations. Summarized, the question of raw material consumption determinants on macro level remains partly unresolved. To contribute to the discussion on measurability of bioeconomic transitions, this project is built upon four consecutive objectives.

(1) Comparing non-structural output growth of bio-based and non-biobased primary sectors across countries as a preparatory work and to get familiar with the data used in (2) (*constant market share decomposition*).
(2) Setting up a material-based indicator for bioeconomic transition that goes beyond the use of basic economic data; describing past developments and comparing the results with existing literature (*multi-regional input-output analysis*).
(3) To reassess (and add new) explanatory/controlling variables regarding the data from (2) in order to explain possible driving forces of bioeconomic transitions (*regression analysis*). Investigate, if model output is similar to the results of existing models based on other data sources.
(4) Conduct sensitivity analysis introducing variables from (3) as external factors, and observe resulting behavior of bioeconomy indicators (e.g. using *computable general equilibrium modelling*). Draw conclusions on possible interventions affecting the external factors investigated.

PhD student: Mag. Raphael Asada, BA
Duration: 2017–2020

2.4.13 Transition to Business Models for Sustainability: decision makers and decision-making systems supporting sustainable development of organizations

Many researchers have reached consensus that sustainable development of economy and society at large is not likely without the sustainable development of organizations. Companies should not only decrease the negative impacts from carrying out their business activities, but these should also aim at creating positive value for environment and society, while still creating sufficient economic value. Therefore, corporate management has an important role in contributing to sustainable development.

This dissertation explores *decision-making for sustainability* in companies in Austria. The focus of the research lies on identifying the (sustainability) decision makers and understanding the decision-making systems that are shaping corporate sustainability management strategies. The goal of the research is to find out, what type of decision-making processes enable more integrated approach to corporate sustainability management, thus, forming also more sustainable organizations/companies.

This research goal was further elaborated into the following questions of interest:

- Who is responsible for corporate sustainability management in companies in Austria, and where are these persons located in terms of the organizational structure?
- Which organization levels are involved in corporate sustainability management and in what form/to what extent?
- How companies/corporate sustainability managers reveal the sustainability topics of relevance for themselves?
- Which topics are reported as relevant for the companies in selected sample in Austria, and can any trends be observed?
- What is the influence on corporate sustainability management practices from stakeholder requirements, and various internal and external factors? Etc.

To reach the goal, mixed methods approach is used. First, corporate sustainability survey was carried out from October-December 2017, addressing medium-sized companies in Austria. The second step will be case studies in some of these companies to explore decision-making for sustainability in detail. Finally, there is a potential also for the international comparison with companies in Germany in future.

PhD student: Aisma Linda Kiesnere, MSc.

Duration: 2016-2019

2.5 PhD Projects (finalized)

2.5.1 Sustainability and supply chain management in a multiple stakeholder context

Sustainability and supply chain management are concepts that are still under development in the academic and business world. In contrast, the field of stakeholder management is well established but often limited to the company perspective only. Additionally, supply chains are networks that are today embedded in different institutional environments due to globalisation and the need for competitiveness. This PhD thesis combines theories from these three fields of research and shows the relevance of such combination for a better understanding of systems for both sustainability research and practice. The overall research question structuring this thesis is: how can a supply chain perspective support a more comprehensive understanding of sustainability issues in theory and practice?

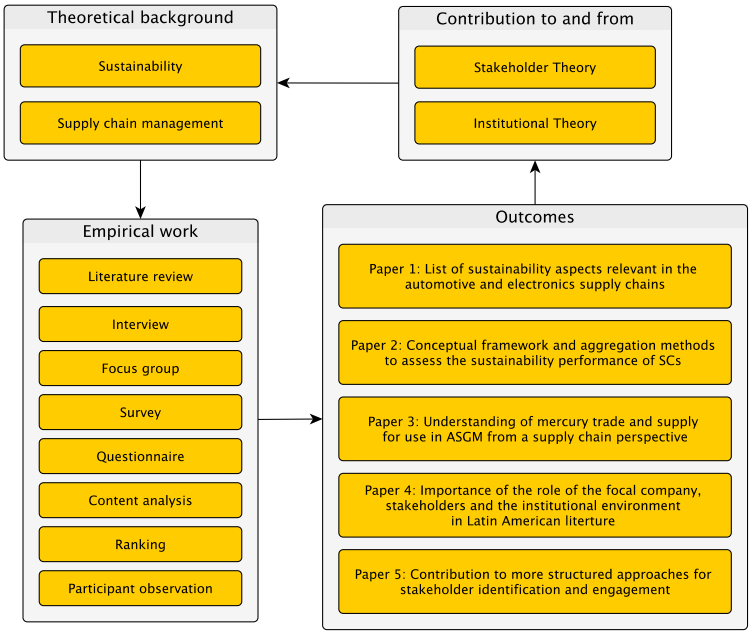


Figure 11: Thesis framework (ASGM: Artisanal and Small-scale Gold Mining)

First, it is examined which sustainability aspects are relevant for companies to be exchanged along the supply chain with the case of the automotive and electronics industry (1st paper). Second, the aspects defined in paper 1 serve the development of a conceptual framework and aggregation methods to assess the sustainability performance of supply chains (2nd paper). Third, a focus is set on the importance of chemicals management along the supply chain as a result of the outcomes from paper 1. In particular, the case of mercury trade and supply for use in Artisanal and Small-scale Gold Mining (ASGM) is explored (3rd paper). Fourth, a study is conducted that moves away from developed country approaches to explore the specificities of research elsewhere, i.e. in Latin America. This study shows the relevance of the institutional theory to address sustainability in supply chains more comprehensively (4th paper). Finally, based on paper 3, a process to identify stakeholders from a supply chain perspective is presented and shows that supply chain concepts are also relevant for decision and policy-making (5th paper).

PhD student: Morgane Fritz, MIM
Duration: 2012 - 2017

2.5.2 Measuring and Improving Sustainability in Global Supply Chains: An Example from the Electronics and Automotive Industries

During the last two decades the concept of sustainability has found consideration in different areas of business operations, from product design to post-consumer product management. Its consideration in supply chain management operations however is still lagging behind. The field of Sustainable Supply Chain Management (SSCM) intends to fill this gap. From a company's profit-oriented point of view SSCM makes sense, since it has the potential to decrease costs due to efficiency improvements. It also avoids non-compliance with increasingly stringent regulations and legislation, such as REACH, RoHS or the End of Life Vehicle Directive in the automotive industry. From an environmental and social perspective supply chain sustainability is of particular importance, because of the global impacts a product can have today. The depletion and the pollution of the environment and massive violations of human rights are just some of these challenges that have to be overcome. Thus the efficient management of natural and human resources at all supply chain stages, as well as the application of measures to minimize the negative impacts on people and the environment is a necessary and promising approach.

The objective of this dissertation is to facilitate sustainability assessment in supply chains and to shed light on important interdependencies between different supply chain actors and stakeholders. Therefore, firstly, a comprehensive set of supply chain sustainability indicators is suggested. Secondly, methods for checking the plausibility of suppliers' sustainability data as well as for aggregating sustainability information along an entire supply chain are developed. Thirdly drivers and barriers for the successful implementation of SSCM are investigated. As part of this research aim a case study with the company "Fairphone" on consumer perceptions of sustainability in supply chains is conducted.

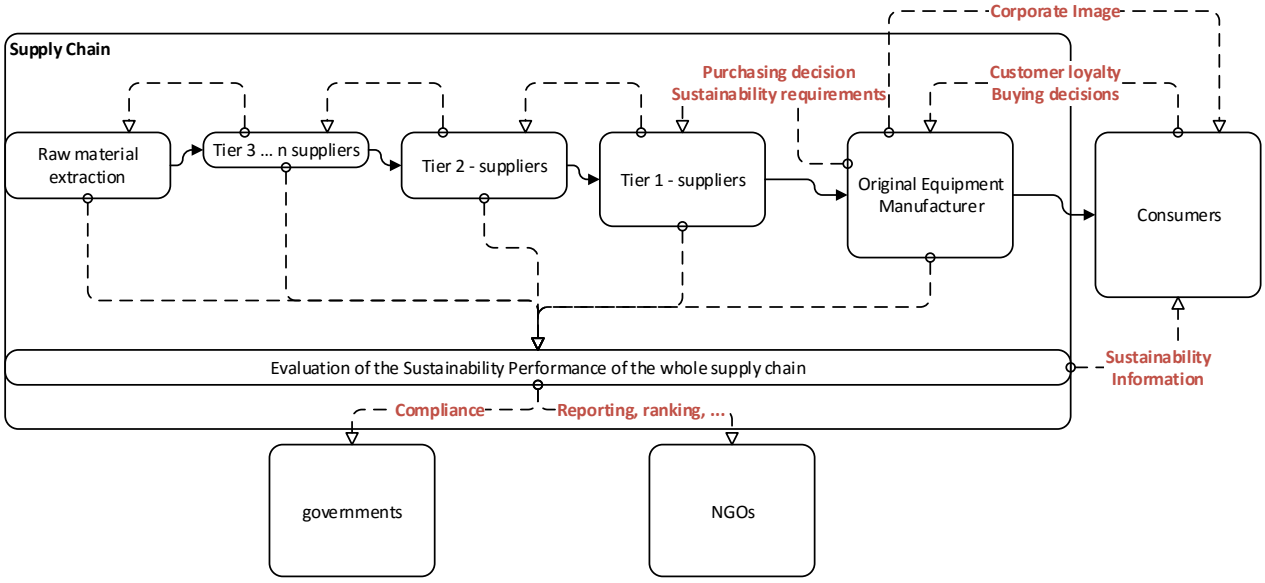


Figure 12: Sustainability related interdependencies in a supply chain

PhD student: Josef-Peter Schöggl, Bakk. MSc.
Duration: 2012 - 2017

3 PUBLICATIONS AND OTHER RESEARCH OUTPUT

In this section a detailed report on the institute's research output is presented. An overview is given in the following table:

Research activities and output	2013	2014	2015	2016	2017
Publications					
Publications in scientific journals	18	22	22	27	36
Contributions to an edited book or proceedings	29	19	16	22	12
Posters presented at scientific conferences	5	3	6	19	4
Projects					
Third-party funded projects	12	12	16	14	13
Networking activities					
Presentations at scientific conferences and seminars	42	26	44	48	47
Awards	5	4	4	1	5

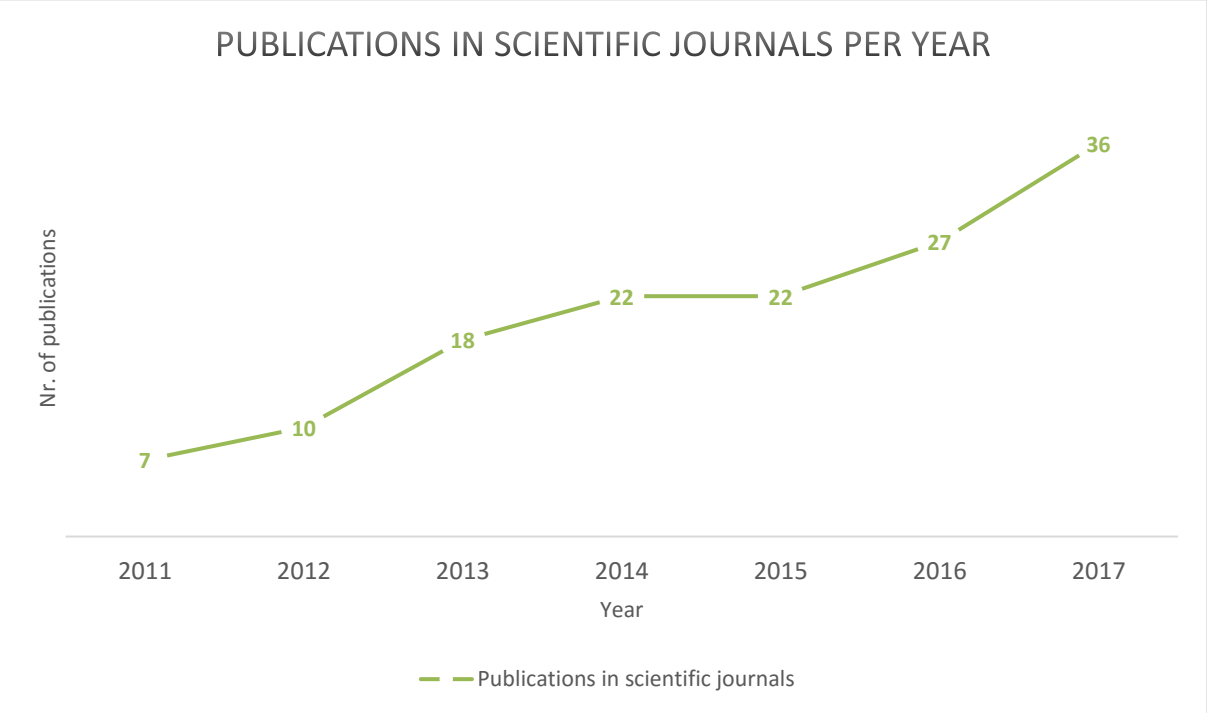


Figure 13: Number of publications in scientific journals over the last years

3.1 Publications

3.1.1 Edited book series/journal

Riegler, Alexander; Füllsack, Manfred (Ed.): Eigenbehavior. Brüssel: Special Issue of Constructivist Foundations 2017 - 2017.

3.1.2 Contribution to peer-reviewed journal

Aggestam, Vivianne; Fleiß, Eva; Posch, Alfred: *Scaling-up short food supply chains? A survey study on the driversbehind the intention of food producers,* in: Journal of Rural Studies 51 (2017), 64-72. DOI: http://dx.doi.org/10.1016/j.jrurstud.2017.02.003

Aschemann, Ralf; Neuhold, Bianca; Hofer, Kathrin; Amort, Frank; Bauer, Lisa: *Combining Public Health Issues and EIA – a Case Study of an Austrian Rural Road Traffic Project,* in: Journal of Transport & Health 5, Supplement (2017), S72. DOI: doi.org/10.1016/j.jth.2017.05.220

Baumgartner, Rupert J.; Rauter, Romana: *Strategic perspectives of corporate sustainability management to develop a sustainable organization,* in: Journal of Cleaner Production Vol. 140, Part 1 (online first 2016) (2017), pp. 81–92. DOI: doi.org/10.1016/j.jclepro.2016.04.146

Broman, Göran; Robèrt, Karl-Henrik; Collins, Terrence J.; Basile, George; Baumgartner, Rupert J.; Larsson, Tobias; Huisingh, Don: *Science in support of systematic leadership towards sustainability,* in: Journal of Cleaner Production Vol. 140, Part 1 (2017), pp. 1-9. DOI: 10.1016/j.jclepro.2016.09.085

Brudermann, Thomas; Holländer, Robert; Pastres, Roberto; Posch, Alfred; Schot, Paul: *Integrating Interdisciplinarity and Internationality in Sustainable Development Education.* in: Gaia: oekologische Perspektiven in Natur-, Geistes- und Wirtschaftswissenschaften 26,4 (2017), 360-362. DOI: doi.org/10.14512/gaia.26.4.16

Brudermann, Thomas; Sangkakool, Tachaya: *Green roofs in temperate climate cities in Europe – an analysis of key decision factors,* in: Urban Forestry & Urban Greening 21 (2017), 224-234. DOI: 10.1016/j.ufug.2016.12.008

Damert, Matthias; Baumgartner, Rupert J.: *External Pressures or Internal Governance – What Determines the Extent of Corporate Responses to Climate Change?* in: Corporate Social Responsibility and Environmental Management 0 (2017), 0. DOI: 10.1002/csr.1473

Damert, Matthias; Baumgartner, Rupert J.: *Intra-Sectoral Differences in Climate Change Strategies: Evidence from the Global Automotive Industry,* in: Business Strategy and the Environment 0 (2017), 0. DOI: 10.1002/bse.1968

Damert, Matthias; Paul, Arijit; Baumgartner, Rupert J.: *Exploring the determinants and long-term performance outcomes of corporate carbon strategies,* in: Journal of Cleaner Production 160 (2017), pp. 123-138. DOI: 10.1016/j.jclepro.2017.03.206

Ettwein, Frederike; Rohrer-Vanzo, Valentina; Langthaler, Georg; Werner, Andrea; Stern, Tobias; Moser, Olivia; Leitner, Raimund; Regenfelder, Katja: *Consumer's perception of high gloss furniture: instrumental gloss measurement versus visual gloss evaluation,* in: European Journal of Wood and Wood Products 75,6 (2017), 1009-1016. DOI: 10.1007/s00107-017-1197-4

Fritz, M.M.C.; Schöggl, J.-P.; Baumgartner, R.J.: *Selected sustainability aspects for supply chain data exchange: Towards a supply chain-wide sustainability assessment,* in: Journal of Cleaner Production 141 (2017), pp. 587-607. DOI: doi.org/10.1016/j.jclepro.2016.09.080

Füllsack, Manfred; Riegler, Alexander: *Thinking in Eigenbehaviors as a Transdisciplinary Approach,* in: Constructivist Foundations 12,3 (2017), 239–245.

Gabriel, Magdalena; Schöggl Josef-Peter; Posch, Alfred: *Early Front-End Innovation Decisions forSelf-Organized Industrial SymbiosisDynamics—A Case Study on Lignin Utilization,* in: Sustainability 9 (2017), 1-17. DOI: doi:10.3390/su9040515

Hecher, Maria; Hatzl, Stefanie; Knoeri, Christof; Posch, Alfred: *The trigger matters: The decision-making process for heating systems in the residential building sector,* in: Energy Policy 102 (2017), 288-306. DOI: http://dx.doi.org/10.1016/j.enpol.2016.12.004

Hesser, Franziska; Wohner, Bernhard; Meints, Tillmann; Stern, Tobias; Windsperger, Andreas: *Integration of LCA in R&D by applying the concept of payback period: case study of a modified multilayer wood parquet,* in: International Journal of Life Cycle Assessment 22,3 (2017), 307-316. DOI: 10.1007/s11367-016-1173-y

Hofer, Christian; Lechner, Gernot; Brudermann, Thomas; Füllsack, Manfred: *Adapting Axelrod's cultural dissemination model for simulating peer effects,* in: MethodsX 4 (2017), 1-10. DOI: 10.1016/j.mex.2016.11.003

Huber, J., Ranacher, L., Stern, T., Schwarzbauer, P.: *Forest management or greed of gain?—An information experiment on peri-urban forest visitors' attitudes regarding harvesting operations,* in: Urban Forestry & Urban Greening 27 (2017), 214-220. DOI: 10.1016/j.ufug.2017.08.005

Jäger, Georg; Hofer, Christian; Kapeller, Marie; Füllsack, Manfred: *Hidden early-warning signals in scale-free networks,* in: PLoS One 12 (2017), 1-14.

Karutz, Raphael; Riedner, Lukas; Robles Vega, Luisa; Stumpf, Lukas; Damert, Matthias: *Compromise or complement? Exploring the interactions between sustainable and resilient supply chain management,* in: International Journal of Supply Chain and Operations Resilience 0 (2017), 0. DOI: 10.1504/IJSCOR.2017.10010519

Kriechbaum, Michael; López Prol, Javier; Posch, Alfred: *Looking back at the future: Dynamics of collective expectations about photovoltaic technology in Germany & Spain,* in: Technological Forecasting and Social Change n.a. (2017), n.a. DOI: https://doi.org/10.1016/j.techfore.2017.12.003 (in print)

Lähtinen, Katja; Toppinen, Anne; Suojanen, Hannele; Stern, Tobias; Ranacher, Lea; Burnard, Michael; Manja, Kuzman Kitek: *Forest Sector Sustainability Communication in Europe: a Systematic Literature Review on the Contents and Gaps,* in: Current Forestry Reports 3 (2017), 173-187.

Lettner, M.; Schöggl, J.-P.; Stern, T.: *Factors influencing the market diffusion of bio-based plastics: Results of four comparative scenario analyses,* in: Journal of Cleaner Production 157 (2017), 289-298. DOI: 10.1016/j.jclepro.2017.04.077

Mair, Claudia; Stern, Tobias: *Cascading Utilization of Wood: a Matter of Circular Economy?* in: Current Forestry Reports 3,4 (2017), 281–295. DOI: 10.1007/s40725-017-0067-y

Paul, Arijit; Lang, Jonas WB; Baumgartner, Rupert J.: *A multilevel approach for assessing business strategies on climate change,* in: Journal of Cleaner Production Vol. 160 (2017), pp. 50-70.

Ranacher, L.; Stern, T.; Schwarzbauer, P.: *Do wood products protect the climate? Public perception of the forestbased sector's contribution to climate change mitigation,* in: Austrian Journal of Forest Science 3 (2017), 281-298.

Rauter, Romana; Jonker, Jan; Baumgartner, Rupert J.: *Going One's Own Way: Drivers in Developing Business Models for Sustainability,* in: Journal of Cleaner Production Vol. 140, Part 1 (online first 2015) (2017), pp. 144-154. DOI: 10.1016/j.jclepro.2015.04.104

Rauter, Romana; Perl-Vorbach, Elke; Baumgartner, Rupert: *Is open innovation supporting sustainable innovation? Findings based on a systematic, explorative analysis of existing literature,* in: International Journal of Innovation and Sustainable Development 11,2/3 (2017), pp. 249-270.

Saari, Ulla A.; Baumgartner, Rupert J.; Mäkinen, Saku J. : *Eco-Friendly Brands to Drive Sustainable Development: Replication and Extension of the Brand Experience Scale in a Cross-National Context,* in: Sustainability 9,7 (2017), 1286. DOI: 10.3390/su9071286

Schober, Andreas; Füllsack, Manfred: *Text Mining in Stellenanzeigen – eine Methode zur Arbeitsmarktforschung am Beispiel nachhaltiger Berufe in Österreich,* in: S W S - Rundschau 57. Jg.,4 (2017), 426–442.

Schöggl, Josef-Peter; Baumgartner, Rupert J.; Hofer, Dietmar: *Improving sustainability performance in early phases of product design: a checklist for sustainable product development tested in the automotive industry,* in: Journal of Cleaner Production 140 (2017), pp. 1602-1617. DOI: doi.org/10.1016/j.jclepro.2016.09.195

Silva, M.E.; Fritz, M.M.C.; Nunes, B.: *Scanning Insights on Sustainability and Supply Chain Management in Brazil,* in: Journal of Operations and Supply Chain Management 10,1 (2017), 33-54. DOI: http://dx.doi.org/10.12660/joscmv10n1p33-54

Sutterlüty, A.; Hesser, F.; Schwarzbauer, P.; Schuster, K.C.; Windsperger, A.; Stern, T.: *A Delphi Approach to Understanding Varying Expert Viewpoints in Sustainability Communication: The Case of Water Footprints of Bio-Based Fiber Resources,* in: Journal of Industrial Ecology 21,2 (2017), 412-422. DOI: 10.1111/jiec.12427

Zaman, Rafia; Brudermann, Thomas: *Energy governance in resource-poor settings: the case of Bangladesh,* in: Energy Procedia 142 (2017), 2384-2390. DOI: doi.org/10.1016/j.egypro.2017.12.171

3.1.3 Contribution to non-peer-reviewed journal

Fritz, M.M.C.: *Women in ASGM: What Does the Research Literature Tell Us?* in: Women & Environments International Magazine 98-99 (2017), 24-28.

Füllsack, Manfred: *Die digitale Rationalisierung und ihre Voraussetzungen,* in: Talente Zeitschrift für Bildung und Berufsorientierung 13,28 (2017), 14-24.

Rauter, Romana; Globocnik, Dietfried; Perl-Vorbach, Elke; Baumgartner, Rupert: *Open Innovation und Nachhaltigkeit. Empirische Befunde zur Bedeutung von Kooperationen für den nachhaltigkeitsorientierten und ökonomischen Unternehmenserfolg.* in: WING-Business 50,2/17 (2017), pp. 36-43.

3.1.4 Contribution to an edited book or proceedings

Gelbmann, Ulrike-Maria: *Bildung für Nachhaltigen Konsum - Vom Denken zum Handeln,* in: Hübner, Renate et al. (Ed.), Symposium Konsum neu denken. Klagenfurt: Universität Klagenfurt 2017, online Beitrag.

Globocnik, Dietfried; Rauter, Romana; Baumgartner, Rupert: *Synergy or conflict? Sustainability vs. economic innovation performance, and the role of organizational culture,* in: Innovation and Product Development Management Conference (Ed.), Proceedings of the 24th Innovation and Product Development Management Conference, Reykjavik, Iceland. Reykjavik, Iceland: ISSN 1998-7374 2017, 1-25.

Jank, Merle-Hendrikje; O'Reilly, Ciarán J; Göransson, Peter ; Baumgartner, Rupert J ; Schöggl, Josef-Peter ; Potting, José: *Advancing energy efficient early-stage vehicle design through inclusion of end-of-life phase in the life cycle energy optimisation methodology,* in: IEEE (Ed.), Twelfth International Conference on Ecological Vehicles and Renewable Energies (EVER). Monte Carlo: IEEE 2017, pp. 1-9.

Kriechbaum, Michael; Lopez-Prol, Javier; Posch, Alfred: *The dynamics of collective expectations about photovoltaics: a comparative analysis of Germany and Spain,* in: 8th International Conference on Sustainability Transitions (Ed.), International Sustainability Transitions Conference 2017 “Taking the lead in real world transitions”. Stockholm: 2017, 1-2.

Kriechbaum, Michael; Posch, Alfred; Brent, Alan C.: *Why is distributed photovoltaic technology diffusing so slowly in South Africa?* in: 8th International Conference on Sustainability Transitions (Ed.), International Sustainability Transitions Conference 2017 “Taking the lead in real world transitions”. Stockholm: 2017, 1.

Lackner, Bettina Christina; Matthias Damert; Sajeev Erangu Purath Mohankumar; Diah Kusumaningrum; Silke Carmen Lutzmann; Arijit Paul; Daniel Petz; Katharina Schröer; Christian Unterberger: *Ausstellungskatalog KliMacht | CliMatters,* in: Meyer, Lukas; Reiter, Barbara (Ed.), Wem gehört das Klima? Graz: Leykam 2017, 75-184.

Mautz, Rüdiger; Fleiß, Eva; Hatzl, Stefanie; Reinsberger, Kathrin; Posch, Alfred: *Bottom-up Initiativen im Bereich Photovoltaik in Deutschland und Österreich: Rahmenbedingungen und Handlungsressourcen,* in: Lars Holstenkamp; Jörg Radtke (Ed.), Handbuch Energiewende & Partizipation. Wiesbaden: Springer VS 2017, xxxx. (in print)

Rauter, Romana; Zimek, Martina; Kiesnere, Aisma L.; Baumgartner, Rupert J.: *Exploring a changing view on organizing value creation: Developing New Business Models. Contributions to the 2nd International Conference on New Business Models.* Graz: Creative Commons Copyright Licence 3.0, Austria Creative Commons Copyright Licence 3.0, Austria 2017.

Schober, Andreas; Füllsack, Manfred: *Computergestützte Echtzeitanalyse der Entwicklung des österreichischen Arbeitsmarktes und damit einhergehender regionsspezifischer Konsequenzen für ArbeitnehmerInnen,* in: Filipič Ursula (Ed.), Sozialpolitik in Diskussion: Zur Zukunft von Arbeit und Wohlfahrtsstaat. Wien: ÖGB-Verlag 2017.

Vorbach, Stefan; Rauter, Romana; Müller, Christiana; Baumgartner, Rupert J.: *Technologie als Enabler nachhaltiger Geschäftsmodelle,* in: Biedermann, Hubert; Vorbach, Stefan; Posch, Wolfgang (Ed.), Transformationen. Neue Wege zu industrieller Nachhaltigkeit. Augsburg, München: Rainer Hampp Verlag 2017, pp. 19-30.

Winkler, Thomas; Aschemann, Ralf: *Decreasing Greenhouse Gas Emissions of Meat Products Through Food Waste Reduction - A Framework for a Sustainability Assessment Approach,* in: Morone, P.; Papendiek, F.; Tartiu V.E. (Ed.), Food Waste Reduction and Valorisation – Sustainability Assessment and Policy Analysis. Cham (Switzerland): Springer 2017, 43-68.

Zimek, Martina: *Corporate sustainability activities and sustainability performance of first and second order.* Greece, Skiathos: Proceedings - 18th European Roundtable on Sustainable Consumption, Proceedings - 18th European Roundtable on Sustainable Consumption 2017.

3.2 Presentations

Aschemann, Ralf: *Combining Public Health Issues and EIA - A Case Study Approach of an Austrian Rural Road Traffic Project,* 3. International Conference on Transport and Health, Int. Professional Association for Transport & Health, Barcelona (Portugal), 27.06.2017.

Aschemann, Ralf; Brudermann, Thomas: *Komplexe Systeme und Nachhaltigkeit - Einführung in die Umweltsystemwissenschaften,* Tag der offenen Tür, Universität Graz, (Austria), 20.04.2017.

Aschemann, Ralf; Rauter, Romana: *Probevorlesung Umweltsystemwissenschaften: Systemwissenschaften - Innovation - Nachhaltigkeit,* Schnupperuni Graz 2017, Uni Graz, Graz (Austria), 25.08.2017.

Baumgartner, Rupert J.: *Circular Economy,* iPoint Customer Day, iPoint GmbH, Reutlingen (Germany), 18.05.2017.

Baumgartner, Rupert J.: *Circular Economy,* for: iPoint OEM Customer Day, iPoint GmbH, Reutlingen (Germany), 16.05.2017.

Baumgartner, Rupert J.: *Management challenges of a circular economy,* International Waste Management Day, Saubermacher AG, Graz (Austria), 05.07.2017.

Baumgartner, Rupert J.: *Management challenges of a sustainable circular economy from a corporate perspective,* 23th Annual International Sustainable Development Research Conference 2017, International Sustainable Development Research Society (ISDRS), Bogota (Colombia), 15.06.2017.

Baumgartner, Rupert J.: *Strategic perspectives of corporate sustainability management,* 22nd International Summer University, Köszeg, Institute of Advanced Studies Köszeg (IASK), Köszeg/Ungarn (Hungary), 29.08.2017.

Baumgartner, Rupert J.: *Sustainability Management: sustainable and circular along the lifecycle,* DuPont Young Professor Programme Presentation, DuPont, Genf (Switzerland), 27.06.2017.

Baumgartner, Rupert J.; Schöggl, Josef-Peter: *Sustainable Product Management by integrating physical and digital lifecycles,* 2nd Conference on Product Lifetimes and the Environment (PLATE), TU Delft, Faculty of Industrial Design Engineering, Delft (Netherlands), 09.11.2017.

Brudermann, Thomas: *Challenges for Sustainable Development,* Invited Lecture, Songkhla Rajabhat University, Songkhla (Thailand), 07.07.2017.

Brudermann, Thomas: *Controversies in Sustainable Development,* Invited lecture, Rajamangala University, Bangkok (Thailand), 13.07.2017.

Brudermann, Thomas: *Energy governance in resource-poor settings: the case of Bangladesh.,* 9th International Conference on Applied Energy (ICAE 2017), Cardiff University, Cardiff, UK (United Kingdom), 23.08.2017.

Brudermann, Thomas: *Sustainability Research @Uni-Graz,* Plenary Meeting, ASEA Uninet, Graz (Austria), 18.07.2017.

Brudermann, Thomas; Hofer, Christian; Jäger, Georg: *The break-down of synchronization,* SSC 2017, European Social Simulation Association (ESSA), Dublin (Ireland), 29.09.2017.

Friesenbichler, Martina: *Mediennutzung an der Universität Graz,* Graz (Austria), 14.12.2017.
Fritz, Morgane M.C.; Schöggl, Josef-Peter: *Environmental protection and social justice in global supply chains – research perspectives and practical solutions,* 7th Austrian Development Conference: SOCIO-ECOLOGICAL TRANSFORMATIONS NOW!, Paulo Freire Zentrum, Graz (Austria), 18.11.2017.

Fritz, Morgane: *The role of regional/community-based business models in the transition towards mercury-free artisanal gold mining,* New Business Model Conference 2017, University of Graz, Graz (Austria), 22.06.2017.

Fritz, Morgane; Rauter Romana: *How to identify and engage stakeholders to build sustainable business models?,* New Business Model Conference 2017, University of Graz, Graz (Austria), 21.06.2017.

Füllsack, Manfred: *Arbeit und Digitalisierung,* Digitalisierung, WU Wien, Wien (Austria), 08.11.2017.

Füllsack, Manfred: *Modeling options,* Agent-based modeling workshop, Austrian Institute of Technology, Wien (Austria), 17.02.2017.

Gelbmann, Ulrike-Maria: *Frauen an vorderster Front: warum nachhaltige Entwicklung von Gendergerechtigkeit abhängt. Teilnahme an der Paneldiskussion/Panelvortrag,* 7. Österreichische Entwicklungstagung, Paullo Freire Zentrum WienUniversität GrazLand SteiermarkAGEZ et al., Graz (Austria), 18.11.2017.

Gelbmann, Ulrike-Maria: *Obsoleszenz als Makel der Konsumgesellschaft,* Vortragsreihe Gesundheit und Wohlbefinden, Uania Graz, Graz (Austria), 17.01.2017.

Hart, Patrick: *Hate-Crimes als emergentes Phänomen,* Jahreskongress der österreichischen Gesellschaft für Soziologie, Österreichische Gesellschaft für Soziologie, Graz (Oman), 08.12.2017.

Hart, Patrick; Hatzl, Stefanie; Fleiß, Eva; Posch, Alfred: *Achieving curtailment behavior via gamification,* World Sustainable Energy Days, Wels (Austria), 01.03.2017.

Hart, Patrick; Hatzl, Stefanie; Fleiß, Eva; Posch, Alfred; Brudermann Thomas: *New business models for urban solar energy,* New business model conference, Graz (Austria), 22.06.2017.

Hofer, Christian; Jäger, Georg; Füllsack, Manfred: *A new Approach to Large Scale Traffic Simulations,* F & E Round Table mit AVL, Uni Graz, Graz (Austria), 10.10.2017.

Hofer, Christian; Jäger, Georg; Füllsack, Manfred: *ABM-driven optimization of EV charging stations placement,* (Austria), 17.02.2017.

Hofer, Christian; Jäger, Georg; Füllsack, Manfred: *Generating realistic road usage information and origin-destination data for traffic simulations: augmenting agent-based models with network techniques,* The 6th International Conference on Complex Networks and Their Applications, Lyon (France), 01.12.2017.

Hofer, Christian; Jäger, Georg; Füllsack, Manfred: *Large scale simulation of emissions caused by urban car traffic: an agent-based network approach,* (Austria), 06.07.2017.

Jäger, Georg: *Agent-based risk assessment of crowdworking,* (Austria), 06.07.2017.

Jäger, Georg: *Crowdworking - ein agentenbasiertes Modell,* ÖGS-Kongress 2017: „Soziologie zwischen Theorie und Praxis“, Österreichische Gesellschaft für Soziologie, Graz (Austria), 08.12.2017.

Kapeller, Marie; Füllsack, Manfred: *Smooth and cascading transitions in cooperation on scale-free networks,* SSC-2017, European Social Simulation Association (ESSA), Dublin (Ireland), 28.09.2017.

Kiesnere, Aisma Linda: *Creating Business Models for Sustainability: exploring the link between the sustainability awareness of decision-maker and business model innovation.,* 18th European Roundtable on Sustainable Consumption and Production Conference, National Technical University of Athens; School of Mechanical Engineering; Sector of Industrial Management & Operations Research, Skiathos, Greece (Greece), 02.10.2017.

Kiesnere, Aisma Linda: *Transition to Business Models for Sustainability: Link between decision-making in the context of sustainability management to changes in business models.,* 2nd International Conference on New Business Models, Universtiy of Graz, Institut of Systems Sciences, Innovation and Sustainability Research, Graz, Austria (Austria), 23.06.2017.

Kriechbaum, Michael: *Institutional aspects of the implementation of photovoltaics,* Open Dialogue, Innovation and Technology for Development Centre, Technical University of Madrid, Madrid (Spain), 29.06.2017.

Kriechbaum, Michael: *Interaction patterns of systemic problems in sustainable energy diffusion: A case study of distributed photovoltaic technology in South Africa,* PhD in Transitions Conference, École polytechnique fédérale de Lausanne, Lausanne (Switzerland), 27.04.2017.

Kriechbaum, Michael: *The dynamics of collective expectations about photovoltaics: a comparative analysis of Germany and Spain,* International Sustainability Transitions Conference 2017 “Taking the lead in real world transitions”, Chalmers University of Technology, Stockholm (Sweden), 20.06.2017.

Lackner, Bettina Christina; Erangu Purath Mohankumar, Sajeev; Damert, Matthias; Petz, Daniel; Meyer, Lukas; Klug, Roman; Reiter, Barbara; : *Communicating climate change in a museum setting–a case study ,* World Symposium on Climate Change Communication, Research and Transfer Centre “Applications of Life Sciences” of the Hamburg University of Applied Sciences (Germany), Manchester Metropolitan University, University of Manchester and the International Climate Change Information Programme (ICCIP) , Manchester (United Kingdom), 24.02.2017.

Paul, Arijit; Baumgartner, Rupert.J: *Ethical decision making in an intergenerational context: The case of climate change,* 4th Workshop on Business Ethics, European Institute for Advanced Studies in Management, Brussels (Belgium), 09.11.2017.

Schober, Andreas; Füllsack, Manfred: *Computergestützte Analyse des österreichischen Arbeitsmarktes zur Abschätzung von Automatisierungsfolgen,* Zur Zukunft von Arbeit und Wohlfahrtsstaat, AK-Wien, Wien (Austria), 01.06.2017.

Schober, Andreas; Füllsack, Manfred: *Verteilung, Rahmenbedinungen und Zukunftschancen nachhaltiger Berufe in Österreich,* Denkwerkstätte 2017, Centrum für Sozialforschung/ Institut für Soziologie an der Universität Graz, Graz (Austria), 23.05.2017.

Schober, Andreas: *Computergestützte Echtzeitanalyse der Entwicklung des österreichischen Arbeitsmarktes und damit einhergehender regionsspezifischer Konsequenzen für ArbeitnehmerInnen,* Zur Zukunft von Arbeit und Wohlfahrtsstaat. Perspektiven aus der Sozialforschung, Arbeiterkammer/SOZNET/Forba, Wien (Austria), 01.06.2017.

Schober, Andreas; Stern, Tobias: *Anwendung von Text Mining Tools für Literaturanalysen im Bereich des Sustainable Forest Management,* Nachhaltigkeitstag 2017, UNI Graz, Graz (Austria), 31.05.2017.
Stern, Tobias: *Das Innovationssystem Holz-Bioraffinerie oder……wie Biomasse unsere Welt verändern könnte!,* Biomasse in Österreich - QUO VADIS?, Akademie der Wissenschaften, Wien (Austria), 09.11.2017.

Stern, Tobias: *The Biorefinery Innovation System: Lessons to be learned and Questions to be asked,* CEBC 2017, Biomasseverband/LK, Graz (Austria), 19.01.2017.

Stern, Tobias: *WHAT WE WOOD BELIEVE: Societal Perceptions of the forest-based sector,* Wood Wisdom Seminar, Wood Wisdom Era Net/Forestry Commission, Edinburgh (United Kingdom), 04.04.2017.

Zimek, Martina: *Corporate sustainability activities and sustainability performance of first and second order,* 18th European Roundtable on Sustainable Consumption and Production Conference, National Technical University of Athens; School of Mechanical Engineering; Sector of Industrial Management & Operations Research, Skiathos, Greece (Greece), 02.10.2017.

3.3 Posters

Baumgartner Rupert J.; Schöggl: *Is Circular Economy supporting the Sustainable Development Goals? - Drivers, pressures and implications for an operationalization,* World Symposium on Sustainability Science and Research - Implementing the 2030 United Nations Agenda for Sustainable Development, Hamburg University, Manchester (United Kingdom), 2017.

Gelbmann, Ulrike; Zimek, Martina: *Bildung für Nachhaltigen Konsum - Vom Denken zum Handeln,* 3. Symposium "Konsum neu denken", Alpen-Adria-Universität Klagenfurt, Klagenfurt (Austria), 2017.

Kriechbaum, Michael: *Why is distributed photovoltaic technology diffusing so slowly in South Africa?,* International Sustainability Transitions Conference 2017 “Taking the lead in real world transitions”, Chalmers University of Technology, Stockholm (Sweden), 2017.

Rauter, Romana; Fritz, Morgane; Schöggl, Josef-Peter; Baumgartner, Rupert: *Education for Sustainable Development: How teaching might enable tomorrow’s decision makers to make a difference,* World Symposium on Sustainability Science and Research - Implementing the 2030 United Nations Agenda for Sustainable Development, Hamburg University, Manchester (United Kingdom), 2017.

3.4 Science to Public

3.4.1 Media article

Baumgartner, Rupert J.: *Wie nachhaltig ist unser Konsumverhalten?,* Kolping Kontakte, print , 01.12.2017.

Brudermann, Thomas; Moderation: Barbara Zeithammer: *Punkt eins: In der humanen Masse - ein neues, gefährliches Wesen? Gast: Dr. Thomas Brudermann, Wirtschaftspsychologe und Systemwissenschaftler, Institut für Systemwissenschaften, Innovations- und Nachhaltigkeitsforschung, Karl-Franzens-Universität Graz.,* Ö1, radio, 27.07.2017.

Damert, Matthias: *Cheese vs. Meat – Which Carbon Footprint Is Higher?,* ClimateFootnotes.com, internet, 17.05.2017.

Posch, Alfred: *Beitrag über Ölheizungen in: Servus am Abend,* Servus TV, television, 16.05.2017.

Füllsack, Manfred: *Podiumsdiskussion Grundeinkommen,* Radio Helsinki, radio, 27.04.2017.

Kriechbaum, Michael: *Will the energy transition unfold rapidly enough?,* Climate Footnotes: Insights on climate research, internet, 04.04.2017.

Füllsack, Manfred: *Interview zum Thema Arbeit,* brand eins 03/2017, print , 15.03.2017.

Füllsack, Manfred: *Interview zu "Neue Arbeit",* Radio FM4, radio, 07.03.2017.

3.4.2 Mentioned in media

Baumgartner, Rupert in: *Sollen Äpfel eher fliegen oder eher liegen?,* Die Presse, print , 11.03.2017.

Baumgartner, Rupert J. in: Beate Moosig, *Tag der Abrechnung,* Rohstoff (Zeitschrift der Fachgruppe Entsorgungs- und Ressourcenmanagement, WKO Steiermark), print , 02.11.2017.

Baumgartner, Rupert J. in: *Wie man Ökodesign zum Durchbruch verhelfen will,* trennt: Die Fachzeitung der ARA Servicegruppe, print, 01.03.2017.

Baumgartner, Rupert J.; Damert, Matthias in: Landtag Steiermark, *„Des einen Freud, des anderen Leid“ - Diskussionsveranstaltung im Landtag Steiermark,* Pressemitteilung Landtag Steiermark, internet, 24.01.2017.

Brudermann, Thomas in: *มรภ.สงขลา เทียบเชิญนักวิชาการต่างประเทศ บรรยายทางเศรษฐศาสตร์ เปิดซ่อง นศ. พัฒนาทักษะภาษาอังกฤษ-เตรียมต่อยอดเวทีสัมมนา (International Guest Lecture at Songkla Rajabat University on Economic Development and Sustainable Development),* Samilian Times, print, internet, 21.07.2017.

Gelbmann, Ulrike-Maria in: Günther Pilch, *Auswege aus der Klimakrise,* Kleine Zeitung, print , 16.11.2017.

Gelbmann, Ulrike-Maria in: Johanna Trummer, *Fairbessere dein Outfit!,* Aircampus Uni Graz, radio, 26.06.2017.

Gelbmann, Ulrike-Maria in: N.N., *Globales T-Shirt GrazInterdisziplinäres Praktikum im Masterstudium Global Studies der Universität Graz,* Website Land Steiermark, Nachhaltigkeitskoordination, internet, 05.06.2017.

Gelbmann, Ulrike-Maria in: Sigrid Hroch, *Fair Fashion Festl und das Globale T-Sirt,* Radio Steiermark, radio, 26.06.2017.

Universität Graz, Konferenz zu neuen Geschäftsmodellen in: Hannes Gaisch-Faustmann, *Die wackeren Lichtspender,* Kleine Zeitung, print, 28.06.2017.

3.5 External Scientific Functions

Reviews were undertaken for following journals:

- Biomass and Bioenergy
- Business Strategy and the Environment
- California Management Review
- Computational and Mathematical Organization Theory
- Corporate Social Responsibility and Environmental Management
- Ecological Indicators
- Energies
- Energy Efficiency
- Energy Policy
- European Journal of Forest Research
- European Journal of Wood and Wood Products
- Forest Products Journal
- Gaia: oekologische Perspektiven in Natur-, Geistes- und Wirtschaftswissenschaften
- International Journal of Transitions and Innovation Systems
- International Wood Products Journal
- Journal of Business Ethics
- Journal of Cleaner Production
- Journal of Computational Methods in Sciences and Engineering
- Journal of Economic Psychology
- Scandinavian Journal of Management
- Science and Public Policy
- Sustainability
- Sustainable Development
- Systems Research and Behavioral Science

3.6 Institute of Systems Sciences, Innovation, and Sustainability Research Report

In 2012 the institute decided to issue a report series of its own, called "Institute of Systems Sciences, Innovation, and Sustainability Research Report". The series is dedicated to disseminating interesting scientific results from institute members and their colleagues as well as from excellent students. The aim is to provide a means of publication that works more quickly than journals would and an opportunity to publish excellent research work that has not been published in other ways. This includes research reports, excellent master's or PhD theses as well as collections of papers from conferences (conference proceedings) or excellent reports from teaching projects. The series appears at irregular intervals. It bears an ISSN number and is available in the form of hard copies and especially as a pdf online on our website. The language of publication is German or English.

Published reports:

- SIS Report #1: Florian Hold, Informelle Abfallwirtschaft in Österreich – Chancen, Risiken und Praxis. Graz, October 2012 (in German).
- SIS Report #2: Maximilian Mrotzek, Andreas Kreuzeder, Walter Gössler (Eds): Phosphorus: Papers of an Interdisciplinary Practical Training at the University of Graz. Graz, January 2013 (in English).
- SIS Report #3: Manfred Füllsack (Ed.): Networking Networks. Graz, May 2013 (in English).
- SIS Report #4: Rauter, R., Gsodam, P., Nguyen, T. D., Stabauer, P., Baumgartner, R. J.: New Business Models in Austria -Forerunners in Sustainable Economics. Graz, October 2013 (in English).
- SIS Report #5: Gastinger, B.: Biologische Abfallbehandlung in der Steiermark und ihr Beitrag zum Klimaschutz. Graz, December 2013 (in German).
- SIS Report #6: Baumgartner, R.J., Gelbmann, U., Rauter, R. (eds.): Making the Number of Options Grow. Contributions to the Corporate Responsibility Research Conference 2013. Graz, January 2014 (in English).
- SIS Report #7: Rauter, R., Globocnik, D., Perl-Vorbach, E., Baumgartner, R. J.: Open Innovation und Nachhaltigkeit. Bedeutung von Kooperationen und formalen Managementpraktiken zur Steigerung des nachhaltigkeitsorientierten und wirtschaftlichen Innovationserfolgs. Graz, November 2015 (in German).
- SIS Report #8: Rauter, R., Zimek, M., Kiesnere, A. L., Baumgartner, R. J.: Exploring a changing view on organizing value creation: Developing New Business Models. Graz, June 2017.
- SIS Report #9: Baumgartner, R.J., Damert, M., Fritz, M.M.C., Schöggl, J.-P.: IP Sustainability in Global Supply Chains: A stakeholder perspective. Graz, September 2017.

3.7 Recollection: The 2nd International Conference on New Business Models

Nearly 120 researchers from more than 20 countries attended the 2nd International Conference on New Business Models, held from 20-23 June 2017 in Graz, Austria. They listened to – and of course intensively discussed – more than 70 presentations in eight sessions and had the opportunity to explore new business modelling tools in four hands-on workshops.

The International Conference on New Business Models series was founded by Prof. Jan Jonker, motivated by upcoming trends and by having cognizance of the fact that our societies are facing serious problems in various domains. Hence, a generation of new business models that foster *sustainability, social inclusion* and *circularity* could be one promising approach tackling such problems but also providing innovations in a pro-active way so that societal or ecological problems are not only diminished afterwards but prevented from the beginning. These three strands of business models are referred to as "new business models." Together they address various aspects of business modelling and in doing so they give substance to the economic transitions society desires since they are embedded in everyday transactions, be it between citizens or businesses or any other societal actor. However, in this light academic research as well as practical experience from various fields, like business modelling, entrepreneurship, innovation management, strategic management, business model design to name but a few, is necessary and required in order to provide a solid ground for future activities.

The conference series aims to bring together scholars, practitioners and others to share their experiences, exchange insights etc. to collectively reach a deeper understanding and improve the repertoire of contention available to implement the necessary changes for sustainable economic transitions.

This year's conference edition – organized by the Institute of Systems Sciences, Innovation and Sustainability Research – followed the inaugural conference held in 2016 in Toulouse, France, and prepared the ground for the third edition in 2018 in Sofia, Bulgaria. The fourth edition in 2019 in Berlin, and fifth editions are also under preparation.

Sources, further links and information:

Conference Proceedings:
https://static.uni-graz.at/fileadmin/veranstaltungen/new-business-models/2017-06-30-Proceedings_final_version.pdf

Conference Websites:
https://new-business-models.uni-graz.at/en/
http://www.nbmconference.eu/

Sustainable Business Model Blog:
https://blog.ssbmg.com/2017/07/14/retrospect-2nd-nbm-conference/

3.8 Prices and Awards

3.8.1 DuPont Young Professor

A highly endowed grant was awarded to Univ.-Prof. Dr. Rupert Baumgartner, Head of the Institute for System Science, Innovation and Sustainability Research at the University of Graz, from one of the world's largest companies in the chemical industry. DuPont, with a seat in the USA, has distinguished Professor Baumgartner as "DuPont Young Professor" for his innovative scientific work in the fields of Circular Economy and Product Management. The recognition was awarded to a total of eight researchers from different disciplines. As a "Class of DuPont Young Professors", together they received 350,000 US dollars.
With the "DuPont Young Professor" program, the group supports researchers in the early stages of their research careers. The award is not subject to any obligations, however, with the hope of initiating future co-operation.

3.8.2 Environmental Award of the City of Graz

The teaching team at the Institute of Systems Science, Innovation and Sustainability Research Karin Dullnig, DI Karl Reiter and Dr. med. Ulrike Seebacher was awarded the Environmental Award of the City of Graz 2016/2017 for the interdisciplinary lecture "Copenhagenize Graz - the streets are there for life".

3.8.3 Seraphine-Puchleitner-Award

Univ-Prof. Dr. Rupert Baumgartner was awarded the Seraphine-Puchleitner-Award.
The jury particularly emphasized Rupert Baumgartner's "supportive accompaniment, which aims to impart methodological competence and structured work". "He promotes the writing of scientific publications, participation in professional conferences and ensures that his doctoral students keep track of the major content of their dissertation projects." Rupert Baumgartner also cultivates a feedback culture that decisively contributes to the success of dissertation projects with factual criticism and suggestions for improvement contribute.

3.8.4 Teaching Award "Lehre: Ausgezeichnet!"

This year's Teaching Award "Lehre: Ausgezeichnet!" had the topic "Responsible University". It was awarded to Mag. Martina Friesenbichler of the Academy for New Media and Knowledge Transfer, Dr. Ulrike Gelbmann and Thomas Winkler, PhD, from the Institute of Systems Science, Innovation and Sustainability Research on November 9, 2017 for the course "The Global T-Shirt".

3.8.5 Businessart price for sustainable designers

The renowned Austrian magazine for sustainable business management "Businessart" annually awards prizes for "sustainable designers" - to entrepreneurs for their activities in the past three years. This year, for the first time, people from public administration, politics, science and research as well as NGOs were honored. Ulrike Gelbmann from the Institute of Systems Science, Innovation and Sustainability Research received a prize in the so-called "Lifetime Achievement" category. For years, the researcher has been concerned with the question of how our actions affect the environment and society.

3.8.6 ELCH Teaching Award

The Teaching award ELCH (E-Learning Champion) was awarded to Georg Jäger and Manfred Füllsack from the Institute of Systems Science, Innovation and Sustainability Research for their course "USW Computational Basics", which teaches students basics programming skills. All teaching and learning material is under a Creative Commons license, and is designed so that those interested can learn the programming language Python without the need for prior knowledge in the field of computation. The developed documents can be used and modified by teachers and students everywhere thanks to the used license.

4 TEACHING

4.1 Study Programmes

4.1.1 Environmental Systems Sciences

In teaching, our institute is the focal institute for the bachelor and master study programmes in **Environmental Systems Sciences (USW - Umweltsystemwissenschaften)** with its four subject foci: business administration (respectively sustainability oriented management), economics, geography, and NAWI-Tech.

Figure 14: USW logo

NAWI-Tech is the newest of all subject foci and was established in 2012. This unique study programme is provided by University Graz (KFUG) and Graz University of Technology (TUG) in their joint activity Natural Sciences. This study (USW Nawi-Tech) replaces the former subject foci physics and chemistry and is focussing predominantly on the aspects of natural sciences in the discussion of sustainability (for further information please see: http://www.nawigraz.at/).

The main idea of these study programmes is to generate interdisciplinary trained academics that are able to handle complex problems that are related to environmental protection and/or to the broader concept of sustainable development of different systems. Here, the capability to apply formal methods of systems sciences, in-depth knowledge in the respective subject focus and profound competences for working in interdisciplinary teams are the most important cornerstones of the profile of graduates in Environmental Systems Sciences.

The roots of the study programmes in Environmental Systems Sciences go back to 1991 when the first individual diploma studies were developed. Continuously increasing interests by students and high dedication of some professors finally led to the implementation of regular bachelor and master study programmes in October 2003 which are still unique in its conception in Europe. Now, about 1,300 students are enrolled in the bachelor and master programmes in Environmental Systems Sciences; the bachelor programmes comprise 180 ECTS credit points which equals a study period of six semesters, and the consecutive master programmes 120 ECTS credit points, or four semesters.

Our institute is responsible for the education in formal methods of systems sciences, mathematics and statistics, interdisciplinary education for basics in human-environment systems, for parts of the teaching subject business administration (bachelor level), for the teaching subject sustainability-oriented management (master level), and last but not least for the interdisciplinary practical courses. The latter is a special and unique course type where an interdisciplinary team of teachers and students with different subject foci work together on a complex real-world problem for sustainable development of a certain system. Interdisciplinarity and transdisciplinarity are part of the teaching concept, aiming at the integration of

stakeholders from outside the University in order to initiate a mutual learning process between academics and practitioners.

Comprehensive information on Environmental Systems Sciences can be found at http://umweltsystemwissenschaften.uni-graz.at or www.umweltsystemwissenschafen.at.

4.1.2 International Joint Master's Programme in Sustainable Development

In 2008, a curriculum for the International Joint Master's Programme in Sustainable Development was designed and approved by six partner universities, with the University of Graz (Austria) as co-ordinating university, Ca' Foscari University of Venice (Italy), Leipzig University (Germany), and Utrecht University (The Netherlands) as degree-awarding consortium members, and Basel University (Switzerland) and Hiroshima University (Japan) as associated mobility partners. In 2013, University of Stellenbosch (South Africa) and TERI University in New Delhi (India) joined the consortium as further mobility partners.

Figure 15: Welcome meeting for new students in September 2017. 18 students from 11 countries started the programme in Graz

In this master's programme sustainability issues are approached from an international as well as inter- and transdisciplinary perspective. The focus is set on applying the competences to the question of sustainable development and the needs and possibilities of societal transformation. It combines the strengths and specializations in teaching and top research of six partner universities, thereby offering the students a programme recognized in the countries of the consortium partners and the possibility of going on to PhD-studies as well as increasing the employability in the private, public and semi-public sector.

Admission to this Master's Programme is granted to students who have completed at least the equivalent of a Bachelor's or Diploma degree, and can demonstrate their research skills, their basic knowledge of the natural and/or social sciences, and a general insight in the subject of sustainable development and intervention strategies. The Master's Programme comprises 120 ECTS credits corresponding to a period of study of at least four semesters or two years. 60 ECTS credits have to be earned at the home university. Students are required to complete at least 30 ECTS credits at one of the partner universities. Besides the academic coordination, our institute offers courses for the first semester in basics in Sustainable Development, for the third integration semester, and one specialization track (second semester) in Sustainable Business Management. Master theses are generally supervised by two teachers of two different partner universities.

Comprehensive information on the International Joint Master's Programme in Sustainable Development can be found at www.jointdegree.eu/sd.

4.1.3 Erasmus Mundus Master's Programme in Industrial Ecology (MIND)

The European Commission's "Education, Audiovisual and Culture Executive Agency" (EACEA) has selected the "Erasmus Mundus Master's Programme in Industrial Ecology" (MIND) in July 2010. Beside the International Joint Master's Programme in Sustainable Development, this is the second Joint Master Programme coordinated by our institute.
MIND is a two-year programme with 120 ECTS, intending to train its students

- to conduct industrial ecology analyses of complex sustainability problems,
- to design industrial ecology solutions for these problems, and
- to develop implementation strategies for those solutions identified.

MIND has started with winter term 2011/12 and is co-ordinated by Dr. Ralf Aschemann as the academic co-ordinator and Dr. Anja Hoffmann from the Office for International Relations as administrative co-ordinator. Partners in the MIND consortium are Leiden University and Delft University of Technology (Netherlands); Chalmers University of Technology Gothenburg (Sweden); Asian Institute of Technology (Thailand); Rochester Institute of Technology (USA) and Waseda University (Japan).

The fifth generation of MIND students (which has started in September 2015) has been awarded with the double or joint degrees during the MIND graduation ceremony, organized from 17 to 18 August 2017 in Leiden, The Netherlands.

As the funding through the EACEA has come to an end with 31 August 2017, there is no granting of scholarships for the study year 2017/18. Thus, the Erasmus Mundus brand cannot be used anymore and consequently the new name of the programme is "International Master's Programme in Industrial Ecology".

The MIND consortium plans to submit a new proposal in 2018 in order to get a renewal of the funding through the European Commission for the study years 2019/20 to 2023/24.

More information on MIND can be found via the websites www.emmind.eu and https://www.jointdegree.eu/de/mind/.

4.1.4 Doctoral School for Environmental Systems Sciences

In October 2011, the new Doctoral School for Environmental Systems Sciences was founded. The main goal is to provide high-quality education for our PhD-students in the field of environmental systems sciences. The study programme is based either on the curriculum for interdisciplinary environmental systems sciences or on the curriculum for environmental systems sciences focused on natural science. The thesis has to be cumulative based on three peer reviewed journal publications instead of writing a monograph. This form of a dissertation complies with international scientific standards and ensures that the valuable results achieved by our PhD-students are presented to an international audience.

4.1.5 Doctoral Programme DK Climate Change

In the winter semester 2014 the interdisciplinary doctoral programme **DK Climate Change** has been launched. The program is a joint effort of researchers associated with University of Graz's research core area "Environment and Global Change". Univ.-Prof. Lukas Meyer (Department of Philosophy) serves as a speaker for the programme, and Univ.-Prof. Dr. Gottfried Kirchengast (Wegener Center for Climate and Global Change) serves as co-speaker. Three of the eleven board members are affiliated with our insitute: Univ.-Prof. Dr. Rupert Baumgartner, Ao.Univ.-Prof. Dr. Alfred Posch and Univ.-Prof. Dr. Wilfried Winiwarter. The programme is supported by Dr. Bettina Lackner and Mag. Regina Brunnhofer.

So far 13 postgraduate students have been selected for this highly competitive programme. Four of these students are affiliated with the Institute of Systems Sciences, Innovation and Sustainability Research. They will be employed for 3 years in pre-doc research positions with the option to extend their employment by half a year if they choose to spend at least 6 months at one of the programme's partner universities.

The programme is funded by the Austrian Science Fund (FWF). Detailed information on the aims of the programme, as well as information on all projects and involved researchers can be found on the following web site: http://dk-climate-change.uni-graz.at/en/

4.2 Systems Sciences E-Textbook

The rise of tablet computers and smartphones is accompanied by new possibilities for students as well as professors. It allows providing eBooks and especially electronic textbooks with interactive elements. Besides the incorporation of audio and video material, educational examples like dynamic models and simulations can be made accessible out of the text, giving the students the possibility to better understand and comprehend the teaching subject.

Figure 16: Screenshot Interactive E-Textbook

For these reasons, Manfred Füllsack, Professor for Systems Sciences, created an interactive electronic textbook for systems sciences based on software applications for tablet computers. This project is still in progress. A first version of the interactive textbook is available at http://systems-sciences.uni-graz.at/etextbook/. We are proud to announce that the E-Textbook had more than 20000 visitors in 2017.

The aims of the project are:

- To allow active learning with the help of significant examples where dynamics are not presented statically as graphics, but simulated directly via software applications.
- To give students the possibility to learn and try out the characteristic behaviour of specific impacts (for example the consequences of changing parameters) on their own, but at the same time under guidance of the text.

To test eBooks on their applicability for the special requirements of textbooks generally and to find a convenient, cross-platform and non-proprietary presentation method.

4.3 Completed theses (master and doctoral)

In 2017 38 master students completed their thesis within one of the study programs Environmental Systems Sciences, Global Studies, Sustainable Development and Industrial ecology. The list is ordered alphabetically; supervisors are named in brackets.

ALWARD, Florian; Evaluation of Smart City Business Models - Analysis of Business Models and the Value Generating Process within a Smart City Environment (Rupert Baumgartner)

BEGER, Julian; Co-creating knowledge for transitions toward low-carbon societies (Alfred Posch)

BERTH, Alexander; Cultural Sustainability: Understanding and Assessing the Sustainability of Cultural Initiatives based on a Case Study (Ulrike Gelbmann)

BILSHCHUK, Inna; Engaging local public actors in REDD+ implementation for conserving multi-use, biodiverse forests in developing countries - evidence from Indonesia (Alfred Posch)

CHEBAEVA, Natalia; Sustainability Assessment in Different Research Phases of Public-Private-Projects: Theoretical Deduction to Practical Implementation in a Comparative Case Study Approach (Tobias Stern)

DERLER, Hartmut; Analyzing the structure of sustainability grassroots initiatives with agent-based modelling (Manfred Füllsack)

DEUTSCH, Matthias; Analysis of the decision-making relevance of individual factors in the choice of turbines for small hydropower plants by using the Analytical Hierarchy Process (AHP) method (Tobias Stern)

ENGELMANN, Klaus Peter; Business models for the distribution of agriculturally produced local foods (Ulrike Gelbmann)

ENKE, Alexandra; Application of a corporate sustainability management framework to large sized logistics companies. A sustainability report analysis and action research (Rupert Baumgartner)

FINNERN, Freya; Drivers and barriers for energy cooperatives. An environmental analysis by the example of Georgia (Alfred Posch)

GARCIA LAVERDE, Laura; Water-Energy Nexus: Renewable energies for water supply in arid areas. A Technological Innovation System analysis for Renewable Energy Technologies diffusion in northern Colombia (Alfred Posch)

GEYIK, Özge; Climate change mitigation in food systems through life cycle sustainability: An assessment of olive oil production in Turkey (Ralf Aschemann)

GLAWAR, Astrid; Future prospects for access-based consuption: An analysis of influence factors for the case of commercial rental services for consumer durables (Tobias Stern)

HART, Patrick; Hate-crimes against homo-and transsexuals in Austria. Hate-crimes as an emergent phenomenon of vitim-perpetrator interaction. (Manfred Füllsack)

KALTENEGGER, Katrin; Opinion Change in Social Networks: Developing a Generic Agent-Based Model to Predict Opinion Change Influenced by Networks and Groups (Manfred Füllsack)

KOLLER, Stefan; Electricity Use in Different Consumption Areas in Austria - A Comprehensive Sectoral Decomposition and Allocation (Romana Rauter)

KORPAR, Mario; Transportation related energy use in different consumption areas in Austria - A comprehensive sectoral decomposition and allocation (Ralf Aschemann)

LEHNER, Christina; Closed-loop textile recycling - Analysis and modelling of material flows of the reverse textile supply chain for assessing the potential of chemical fibre recycling in Austria and Germany (Tobias Stern)

MESSERSCHMIDT, Markus; LEARNING: A Cybernetic Involvement in Life (Manfred Füllsack)

MÜNZER, Kathrin-Christina; Sustainability-oriented seals of quality in the food industry (Alfred Posch)

OLT, Elisabeth; An empirical study about the connection between coffee consumption and the personal environmental awareness (Tobias Stern)

ORZETEK, Guido Peter; Success measurement of the implementation of a 5S quality management system by using the example of a metalworking company in Graz. (Ulrike Gelbmann)

PETRITZ, Heidrun; Vegetarianism and Veganism from a Social Innovation Perspective (Tobias Stern)

PFUISI, Carina Maria; Energy management system according to EN ISO 50001:2011 between requirements and reality - An empirical study of the potentials and problems for upholding and improving the EnMS (Alfred Posch)

PLOLL, Ursula; Motives of Vegetarians and Vegans and their Behaivoural Expressions (Tobias Stern)

POJER, Elisabeth; Sustainability management in the packaging supply chain. Improvements towards sustainability in the e-commerce packaging supply chain. (Rupert Baumgartner, Ralf Aschemann)

PSENNER, Katharina Gerlinde; Development of Business Model Clusters for "Sustainable Fashion" in Graz (Ulrike Gelbmann)

QUIROZ GALVAN, Mayra del Pilar; Sustainability partnerships in the apparel industry: a multiple-case study of business-nonprofit collaborations (Tobias Stern)

RIEDNER, Lukas; E-Mobility in agriculture. Importance and performance of characteristics of e-mobility depending on user experience (Tobias Stern)

RINNHOFER, Heike; Driving Change? Mobility Behavior of Adolescents and Young Adults: A Qualitative Analysis of Drivers and Barriers for Sustainable Mobility (Alfred Posch)

RUMPL, Marion; Sustainable Open Innovation - How Open Innovation and Collaboration with External Partners Contribute to the Sustainability Innovation Performance (Rupert Baumgartner, Romana Rauter)

SCHOßWOHL, Stefan; Re-use as a contribution to regional added value while taking into account sustainability aspects (Ulrike Gelbmann)

STABAUER, Petra; Transition of business models towards business models for sustainability (Rupert Baumgartner, Romana Rauter)

STEINOCHER, Tomas; Characterizing markets and user requirements for fines from the pulp and paper industry (Tobias Stern)

SULIG, Andrea; Common Property Pastures: Will non-governmental organisations save them? Insights from Switzerland (Alfred Posch)

TESSMANN, Niklas; Transformation of mature business models through innovative startup- and acquisition systems (Rupert Baumgartner)

VACARESCU, Nadia; Influence factors affecting green roof diffusion in Austria (Thomas Brudermann)

ZU HOHENLOHE-OEHRINGEN, Philipp Frederik Kraft; How to measure the progress of the energy transition and make it internationally comparable (Alfred Posch)

In addition, four doctoral theses have been completed within the doctoral school for Environmental System Sciences which was founded in October 2011.

FRITZ, Morgane Marie Caroline; Sustainability Management in Supply Chains: Developing a Supply Chain View to operationalise sustainability among multiple supply chain stakeholders (Rupert Baumgartner)

LEOPOLD, Armin; Model based decision support for the energy transition in Germany (Manfred Füllsack)

MAIER, Stephan; Integrated resource and technology planning and optimisation in rural and urban areas (Rupert Baumgartner)

SCHÖGGL, Josef Peter; Sustainability assessment in supply chains and product development - providing a full life cycle perspective with methods, tools and indicators (Rupert Baumgartner)

4.4 Course list

Legend			
AG	Work group	**PV**	Privatissimum
DQ	Doctoral Colloquium	**SE**	Seminar
KS	Course	**UE**	Exercises
OL	Orientation lecture	**VO**	Lecture
PS	Introductory seminar	**VU**	Lecture with exercises

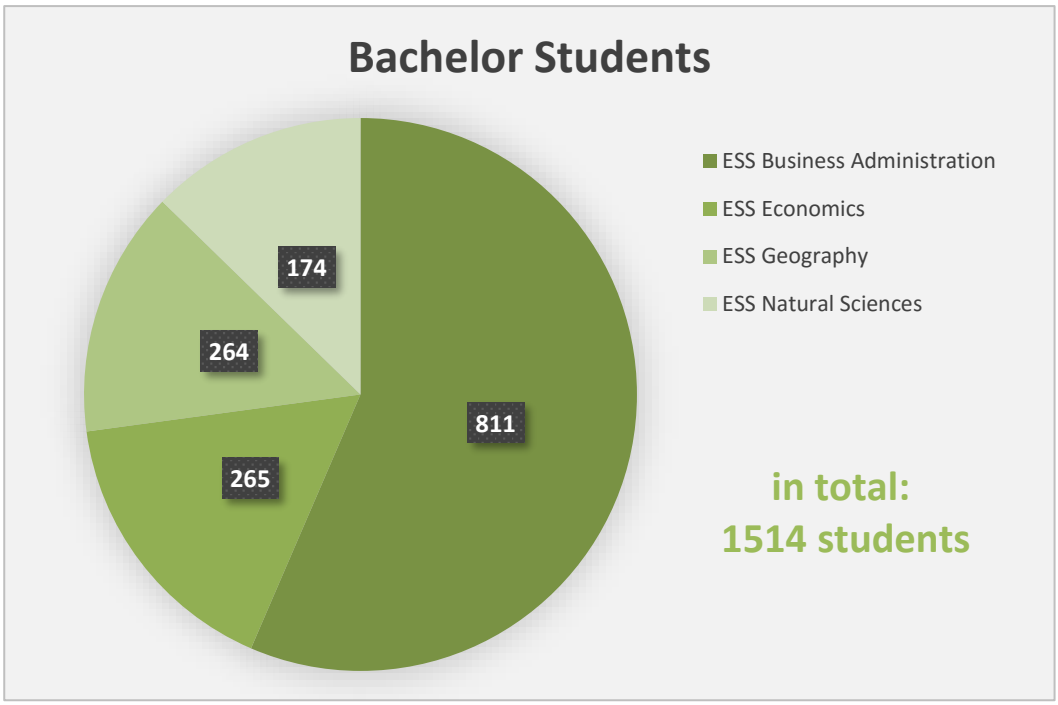
Summer Term 2017			
Type	**Course**	**Contact hours**	**Lecturers**
OL	Orientation Course Environmental Systems Sciences	1	Baumgartner R, Fischer W, Füllsack M, Huber A, Kramer K, Steininger K
VO	Human Beings and Environment: Biosphere and Eco-Systems	2	Raspotnig G, Tschernatsch M
VO	Systems Sciences 2	2	Desch G, Füllsack M
UE	Practical Approaches to Systems Sciences	2	Hintermüller S, Hofer C, Kupsa S, Schober A, Schröck A, Winkler T
VU	Systems Sciences 3	2	Granigg W
PS	Applied Systems Sciences	2	Hofer C, Jäger G, Maraun D, Schober A
VU	Calculus for Systems and Environment Sciences	4	Hötzl E, Keeling S, Prager W
VU	Vector Analysis for USW	3	Batzel J, Fripertinger H, Hötzl E, Prager W
PS	Introductory Seminar - Elementary Statistical Concepts and Methods, Examples and Practice	1	Feit T
AG	Interdisciplinary Practical Training	4	Aschemann R, Goritschnig A, Zettl R
AG	Interdisciplinary Practical Training	4	Gelbmann U, Hammerl B, Höflehner T, Peskoller A
AG	Interdisciplinary Practical Training	4	Bird D, Saccon P, Starz W
AG	Interdisciplinary Practical Training	4	Kozina C, Rauter R, Seebacher U
AG	Interdisciplinary Practical Training	4	Dullnig K, Reiter K, Seebacher U
VO	Modelling of Systems	2	Jäger G, Propst G
SE	Seminar for the Integration and Evaluation of Systems	2	Füllsack M
SE	Seminar for the Modelling of Systems	2	Füllsack M, Schmickl T
KS	Eco-Controlling	2	Baumgartner R, Mair C, Zimek M
AG	IP - Environmentally and socially friendly production of biofuels	6	Aschemann R, Friedrich A, Mittelbach M, Schweitzer S
AG	Interdisciplinary Practical Training	6	Brandl H, Frewein M, Vötsch G, Wolkinger B
AG	MIND Summer School	2	Aschemann R
PS	Management of Sustainable Development 2 Environmental Management	2	Baumgartner R

PS	Selected Topics of Sustainability and Innovation Management (Technology assessment)	2	Stern T
PS	MSD 2 Corporate Social Responsibility	2	Knechtl-Grabner E
PS	Selected Topics of Sustainability and Innovation Management (Bioeconomy)	2	Stern T
PS	Project Management	2	Posch A
KS	Strategic Sustainability Management	2	Gelbmann U
KS	Sustainability Entrepreneurship	2	Kiesnere A, Stern T
KS	Product and Service Development	2	Globocnik D
KS	Sustainable Innovation	2	Rauter R
KS	Value Chain Management	2	Aschemann R
KS	Waste and Recycling	2	Gelbmann U, Heigl M
KS	Environmental Decision Making	2	Brudermann T
AG	Research Project Sustainability Management	4	Crockett S, Brudermann T, Posch A
KS	Selected Topics of Sustainability and Innovation Management	2	Asada R, Stern T
SE	Seminar for Research Methods	2	Füllsack M, Hecher M
SE	Master Seminar	2	Baumgartner R, Füllsack M, Posch A, Stern T
SE	Sustainability and Environmental Management	2	Posch A
SE	Seminar for Postgraduates	2	Baumgartner R, Füllsack M, Posch A, Stern T
DQ	PhD Doctoral Colloquium II	2	Baumgartner R, Füllsack M, Posch A, Stern T
SE	Advanced Statistical Methods	2	Strunk G

Winter Term 2017/2018			
Type	**Course**	**Contact hours**	**Lecturers**
VO	Human Beings and Environment: Anthroposphere	2	Posch A, Steininger K
VO	Interdisciplinary Working Methods	2	Aschemann R
VO	Systems Sciences 1	2	Füllsack M, Jäger G
VU	Systems Sciences 3	2	Granigg W
PS	Applied Systems Sciences 1	2	Hofer C, Jäger G
PS	Applied Systems Sciences 2	2	Rieder H, Truhetz H
VO	USW Computational Basics	2	Füllsack M, Jäger G
UE	Practical Exercises: USW Computational Basics	1	Kapeller M, Kupsa S, Schröck A, Zilian L
VU	Calculus for Systems and Environment Sciences	3	Batzel J, Fripertinger H, Hötzl E, Keeling S
VO	Statistics	2	Feit T
PS	Introductory Seminar - Elementary Statistical Concepts and Methods, Examples and Practice	1	Ambros R, Feit T
VU	Linear Algebra for USW	2	Prager W
AG	Interdisciplinary Practical Training	4	Gelbmann U, Hammerl B,

			Peskoller A, Zimek M
AG	Interdisciplinary Practical Training	4	Bednar-Friedl B, Gössler W, Ledersteger A, Vorbach S
AG	Interdisciplinary Practical Training	4	Baumgartner R, Fritz M, Schöggl J
AG	Interdisciplinary Practical Training	4	Fischer W, Hasler A, Janitschek G
VO	Integration and Evaluation of Systems	2	Füllsack M
SE	Seminar for Integration and Evaluation of Systems	2	Füllsack M
SE	Seminar for Modelling of Systems (Equation Based Modeling)	2	Füllsack M, Schmickl T
KS	Eco-Controlling	2	Baumgartner R, Mair C, Paul A, Zimek M
AG	IP - Circular Economy - System change towards a sustainable future	6	König A, Saccon P, Schöggl J, Vötsch G
AG	IP - Ethical-ecological assessment of enterprises	6	Aschemann R, Baumgartner R, Paulesich R
KS	Methods for inter- and transdisciplinary problem-solving	2	Aschemann R
SE	Social Competences for Working in Inter- and Transdisciplinary Teams	2	Seebacher U
SE	Social competences for managing sustainable development	2	Seebacher U
VO	Environmentally Oriented Innovation and Technology Management	2	Rauter R, Stern T
VO	Sustainability and Environmental Management	2	Baumgartner R
PS	MSD 2 (Reportage of Sustainability)	2	Resel K
KS	Strategic Sustainability Management	2	Gelbmann U
KS	Sustainability Entrepreneurship	2	Kiesnere A, Stern T
KS	Product and Service Development	2	Globocnik D
KS	Sustainable Innovation	2	Rauter R
KS	Waste and Recycling	2	Gelbmann U, Schmidt G
KS	Environmental Decision Making	2	Brudermann T
KS	Integrated Management Systems	2	Dully S, Ulz A
AG	Research Project Innovation Management	4	Rauter R, Stern T
KS	Environmental and Technology Assessment	2	Aschemann R
SE	Introduction to Industrial Ecology	2	Aschemann R
SE	The Sustainability Challenge	2	Posch A
AG	Sustainable Development - Integrating Perspectives	6	Brudermann T, Posch A, Steiner A, Winkler T
SE	Seminar for Research Methods	2	Asada R, Stern T
SE	Master Seminar	2	Baumgartner R, Füllsack M, Posch A, Stern T
AG	Inter- and Transdisciplinary Case Study on Sustainable Development	6	Brudermann T, Crockett S, Posch A, Winkler T
PV	Tutorial for Postgraduates	2	Baumgartner R, Füllsack M, Posch A, Stern T

4.5 Student Statistics



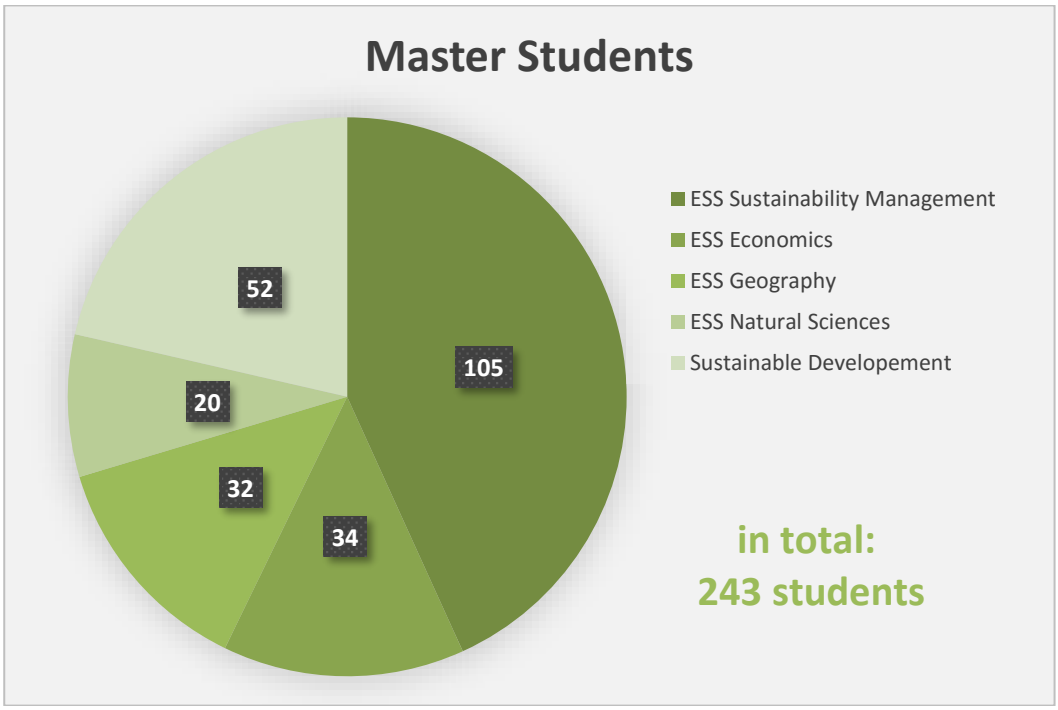


Figure 17 Number of registered students in 2017 (source: student statistics from UniGrazOnline)

Institute of Systems Sciences,
Innovation & Sustainability Research
University of Graz

Merangasse 18/I,
8010 Graz, AUSTRIA