



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

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Editorial

2016 was eventful for the world and for the Institute of Systems Sciences, Innovation and Sustainability Research. The year had a few unsightly moments and imposed challenges to be dealt with over the next coming years. But it also entailed quite some nice successes, which we will use to face whatever awaits us in future.

Among the less gratifying aspects is that we are considering to change our acronym, due to a misguided squad of religious firebrands in the Near East deciding to call themselves ISIS. The institute's long name of course is less handy, but in its bulkiness perhaps can be read as a sign of resilience in an atmosphere of growing skepticism against scientific expertise and political governance, recently expressing itself in terms like "alternative facts" or "fake news". Moreover, our primary goal, the sustainable development of our planet, became obscured by political developments that recently reached a high point in the results of the American presidential elections. As a consequence, the prospects for a sustainable environmental and social policy are not exactly edifying at the moment. But we shall not be discouraged. The challenge is there, and we will take it on.

Among the tasks for the institute in 2016 was the reorganization of the teaching curriculum for environmental system sciences. The mathematical-methodical parts of the curriculum had to be adjusted, in particular in anticipation of the reform targets for 2017 and the changing demands in respect to skills and knowledge of academics. The new design now provides a stronger orientation towards digital methodologies and data mining, hence it strives to adapt USW students to the demands of future labor markets. The accompanying strategy-building process that the institute conducted for its integrative orientation emphasized the desire that this reorientation and stronger emphasis on computer-assisted methods will be considered in all teaching and interactions with students.

The year also gave us a boost of young, enthusiastic staff, which will support the institute's agendas in the near future. Over the next six years, system sciences will profit from the profound knowledge and rapid perception of Dr. Georg Jäger, a trained physicist with great expertise in network research, systems modeling and computer science. The area of sustainability research will be supported by Aisma Kismere, a young scientist who travelled all the way from Latvia to join our team for research about sustainable business models. The field of innovation research will gain support from Claudia Mair and Raphael Asada in the future. While Claudia is alumni of environmental system sciences with a major in sustainability management, Raphael holds a master degree in social ecology. Dr. Ralf Aschemann, another long-serving and highly-profiled member of our institute, was able to successfully complete his goal and performance agreement procedure and thus will now provide his expertise to the institute for the remainder of his career.

Unfortunately, we also had to record some departures. Maria Hecher, an expert on empirical social research in the field of the adoption of renewable energy forms, was appointed Environment Commissioner in the city of Frohnleiten. Eva-Maria Knechtl-Grabner continues her career in the private sector. Anita Ulz left the Institute after the successful implementation of the EMAS environmental management system for the University of Graz. Christiane Reischl obtained a permanent position as a research assistant at CAMPUS 02, where she can continue her work on innovation management.

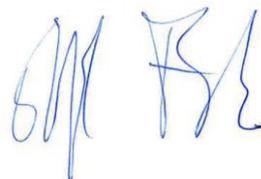
But not everything changed. Good things could be maintained. The doctoral program “Climate Change – Uncertainties, Thresholds and Coping Strategies”, funded by the Austrian Science Fund and conducted together with colleagues from four different faculties of the University of Graz, ranging from philosophy to physics, successfully went into its third year and brought about a couple of well-attended workshops, which further substantiated the interdisciplinary orientation of research and teaching activities. Once more, these activities aligned perfectly with other study programs and the externally funded research projects at the institute.

The successes with research projects enjoyed prolongation in 2016 as well. All together the institute managed to launch and to continue 14 third-party funded projects in the past year. Besides this, the institute managed to further expand its successful publication record, with 27 publications in scientific journals and 22 contributions to conference proceedings and edited books. Conference-activity saw 47 presentations at scientific conferences in 2016. Finally, the successful Science Talks-series at the institute continued to invite renown national and international experts to report on topics and issues of interest to research and teaching.

These achievements are the result of our strong commitment to sustainability and to high quality teaching and research that addresses complex real-world problems. Most importantly, it is the outcome of an excellent and highly motivated team, embedded in a supportive national and international network. We hope that this annual report contributes to foster this network and leads to additional collaborative links.

A handwritten signature in black ink, appearing to read "Rupert Baumgartner".

Univ.-Prof. Dipl.-Ing. Dr. Rupert Baumgartner

A handwritten signature in blue ink, appearing to read "Manfred Füllsack".

Univ.-Prof. Dr. Manfred Füllsack

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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”.

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://isis.uni-graz.at/> (English version: <http://isis.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.

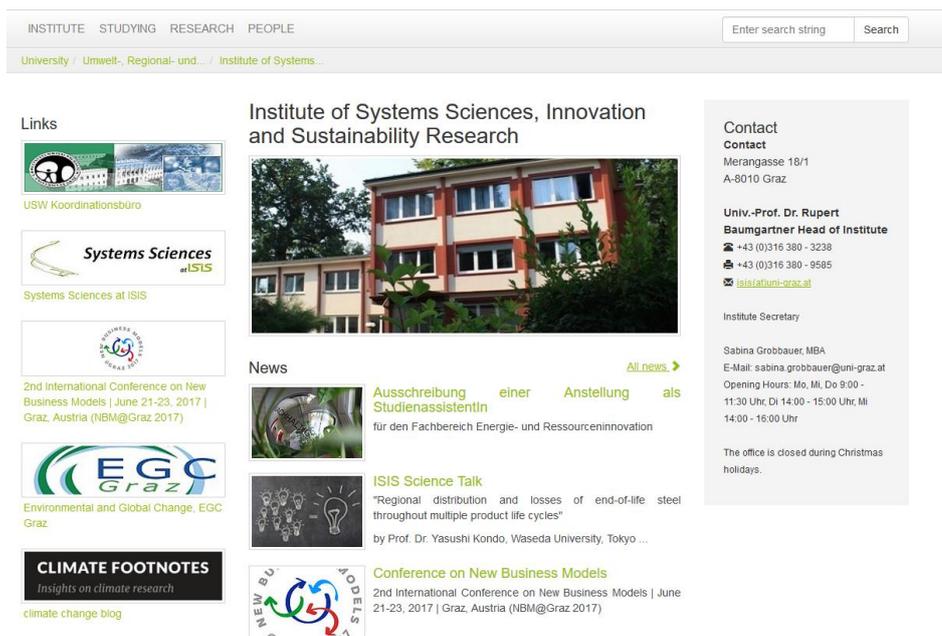


Figure 2: Website <http://isis.uni-graz.at/>

1.3 Faculty and Staff members

Professors:



Univ.-Prof. Dr. **Rupert Baumgartner**

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

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



Univ.-Prof. Dr. **Manfred Fußsack**

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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

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



Dipl.-Ing. Dr. Ralf Aschemann

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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

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Academic coordinator Joint International Master’s Programme in Sustainable Development

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Mag. Dr. Ulrike Gelbmann

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



Christian Hofer, Bakk. BSc. MSc.

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Research Interests: Systems Sciences, Machine Learning, Systems Modeling



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Claudia Mair, BSc. MSc.

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



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



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(until May 2016)

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Research Interests: Innovation and Transition Management, Smart Cities, Renewable Energy, Empirical Research



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Research Interests: (Environmental) Management Systems, Sustainability in higher Education, Renewable Energy, Photovoltaics



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Doctoral Programme DK Climate Change:



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



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Research Interests: Environmental Innovation, Environmental Policy, Renewable Energy



Arijit Paul, MSc.

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

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**Gerald Bruckner,
BSc.**



**Bernhard
Schrempf, BSc.**



**Gregor Fallmann,
BSc.**



Melanie Troppe



**Alexandra
Horvath, BSc.**



**Sandra Unger,
BSc.**



Angelika Meißl



**Sandra Viczek,
BSc. MSc.**

1.4 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 underpinned by analysing the transition, (eco-)innovation and adaption processes between the three key systems of sustainability. Only through a holistic approach 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.

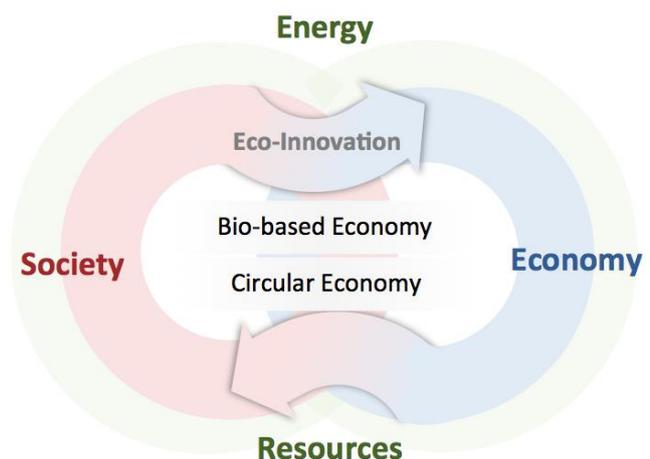


Figure 3: Energy and Resource Innovation

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

1.5 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 4: 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 2016.

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.



1.6 Seminars and “ISIS Science Talk”

For the “ISIS 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 2016:

- Dr. Hannes Klampfl-Pernold, SSI Schäfer Peem GmbH, *“Circularity - A closer look into Waste Management’s 6th Development Stage”*, January 19, 2016
- Dr. Pauline Deutz, University of Hull, *“Déjà vu: Managing resources in a Circular Economy”*, April 5, 2016
- Dr. Karl H. Müller, Univ. of Ljubljana/Steinbeis Transfer Center New Cybernetics, *“Second-Order Systems Science: An Overview”*, April 26, 2016
- Dr. Andreas Pölzl, Integrated Consulting Group, *“An Integrated Consulting Approach: Modernizing the Government of the City of Graz”*, June 7, 2016
- Prof. Dr. Nina Hampl, University of Klagenfurt, *“Interorganizational Network, Bottlenecks and Architectural Advantage in an Emerging Industry”*, June 21, 2016
- Prof. Dr. Bo Hu, Universität der Bundeswehr München, *“Small system dynamics models for economical and ecological evaluation of political options”*, November 22, 2016
- Prof. Dr. Yasushi Kondo, Waseda University, Tokyo, *“Regional distribution and losses of end-of-life steel throughout multiple product life cycles”*, December 13, 2016

Up-to-date information and the whole list of speakers can be found on our website at <http://isis.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):

- USW Applicationcheck, January 2016
- How to write a Bachelor Thesis, March 2016
- USW Practice-event, May 2016
- Introduction to scientific English, November 2016

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

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.

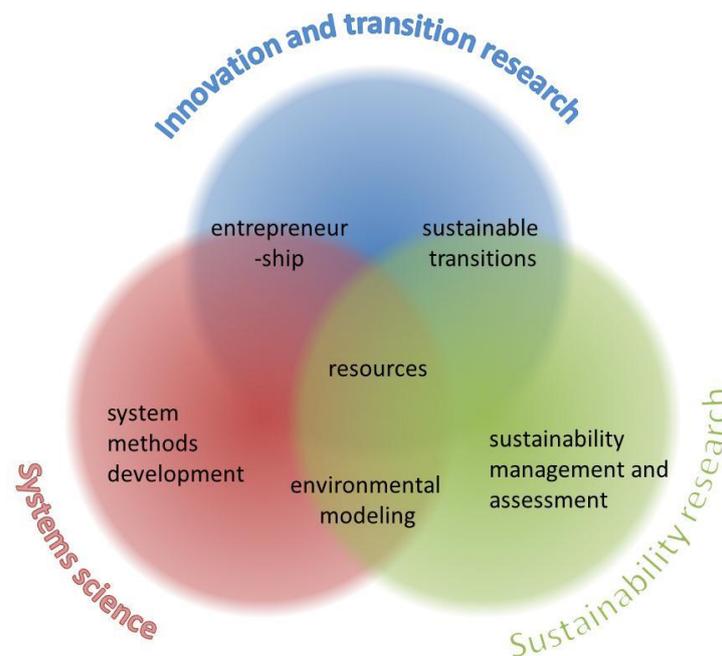


Figure 5: Science fields of the institute

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, 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

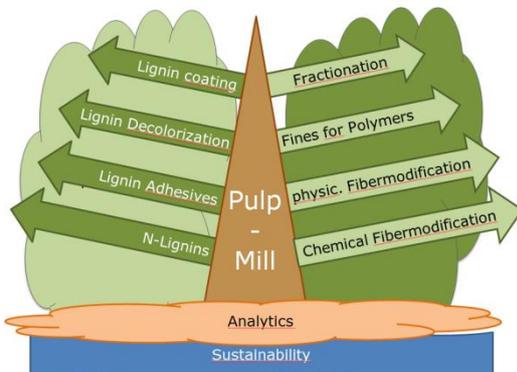


Figure 6: Integration of FLIPPR Areas

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 Schögl, 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 Energieschwamm Bruck

The development of energy supply systems in small and medium size urban regions with 10,000 to 20,000 inhabitants is usually slower than the urban development itself. The strategies developed by large cities concerning energy supply also differ from such urban regions but little research has been carried out to assess it in the energy field.

The research project “Energieschwamm Bruck” or “Energy-Sponge-Bruck” focusses on the urban region of Bruck an der Mur in Styria, Austria, where about 16,000 people live. The goal of this project is to assess the status quo of the urban region from a technical, economical, social and environmental perspective regarding energy supply to identify potentials for improvement. This is aimed at supporting the development of the energy system towards sustainable and renewable energy supplies.

Such an approach is based on the development of technical scenarios where current and possible technologies are assessed by collecting data on the needs for energy, the intensity of energy demand per “cell” (each cell representing one area of the urban region) and the current and possible infrastructure. The energy supply in Bruck for electricity, gas and district heating is in the hand of different local stakeholders (Stadtwerke Bruck, Brucker Biofernwärme, Energie Steiermark, private owners of PV and hydro-plants) who have different roles concerning the current and future energy supply of the region. The project team at ISIS focusses on the identification of stakeholders in place and the development of innovative business models that would make these scenarios feasible and support strategies for the sustainable development of the energy system.

This transdisciplinary approach is meant to deliver an energy development concept for the region of Bruck and a cadastre for short-term implementation measures. The outcome is expected to provide a solid and flexible framework to allow replicability of the method for urban regions with 10,000 to 20,000 inhabitants.

Further information: <http://www.hausderzukunft.at/results.html/id8155>

Project lead:	University of Leoben
Project team:	Univ.-Prof. Dr. Rupert Baumgartner, Ass.-Prof. Dr. Romana Rauter, Morgane Fritz, MIM
Project partners:	Stadtwerke Bruck an der Mur GmbH, Brucker BIO Fernwärme GesmbH, Stadtgemeinde Bruck an der Mur
Duration:	June 2015 - May 2016
Funding:	Austrian Research Promotion Agency (FFG)

2.2.3 Business Case for Corporate social responsibility (CSR) @ AT&S

This project aims to identify monetary effects and benefits related to CSR activities of the company AT&S in Leoben. CSR activities are known as the responsibility of businesses towards the community and environment (ecology and society). The activities have been analyzed based on the fifteen main topics of the company: Energy, Water, Raw materials, Investment Efficiency, Technological Innovation, Competence profile, Internal communication, Employee retention, Health & Balance, Diversity, Suppliers, Customers, Cooperation, Volunteering & Donating and Corporate Governance. Based on studies and research from scientific papers all fifteen CSR main topics of AT&S have been assessed showing potential environmental and social performance. CSR activities positively influence the environmental and social performance, hence increasing the productivity within the company. Finally this leads to the following monetary effects:

- Cost effect: costs can be saved as less input is needed for same output
- Revenue/output effect: revenue can be increased as more output can be generated with a given input

Additionally potential quantification methods are identified to support AT&S in performance measurement related to environmental and social aspects. Therefore key performance indicators (KPIs) for strategic sustainability topics have been developed to reflect the companies' goals and achievements. Preferences on KPIs can vary between different industries and therefore the proposed indicators focus on the priorities and performance criteria of AT&S.

Project team: Univ.-Prof. Dr. Rupert Baumgartner,
Ass.-Prof. Dr. Romana Rauter,
Martina Zimek, BSc. MSc., Aisma Kiesnere, BSc. MSc.

Project partner: AT & S Austria Technologie & Systemtechnik Aktiengesellschaft

Duration: August 2015 - March 2017

2.2.4 HTD - Heating Technology Decisions: Homeowners' decision-making process for heating system replacements and new installations

Energy demand from buildings is of particular importance as it accounts for a significant amount of the final energy use, offers massive savings in terms of environmental impacts, and restricts the speed of change through the long lifetime in our build environment. State-of-the-art technologies such as heating systems present a major opportunity to reduce buildings' energy demand and mitigate environmental impacts drastically in the next couple of decades. In this context, an important issue is to get a deeper understanding of homeowners' decision-making process identifying factors which foster or hinder heating system adoption decisions.

The purpose of this study is to empirically research private homeowners' decision-making process for heating system replacements and new installations identifying their motives to invest, information channels, actors and factors influencing the adoption to specific types of heating systems. In this context, a systematic literature analysis and four guided interviews with experts in the field of heating engineering were conducted (April 2015). These interviews aimed at validating and exploring the decision-making process of private homeowners. The results of the literature analysis and interviews served as a valuable basis to design a quantitative questionnaire. In an empirical survey (September - October 2015) data was

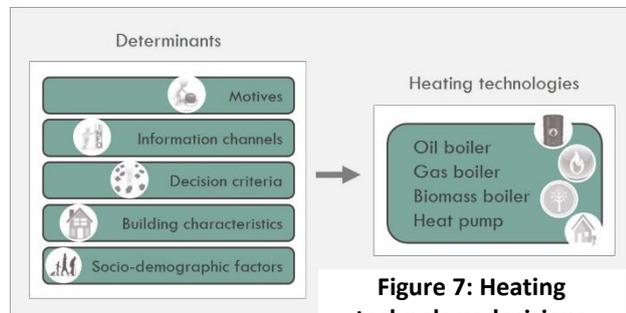


Figure 7: Heating technology decisions

collected from private Austrian homeowners of existing or newly build single and double-family houses. A representative sample of 1.000 homeowners was randomly selected by the professional research survey service provider Qualtrics, the world's leading panel survey software company (adopters with N = 560, non-adopters with N = 440).

The results of the empirical study show, that decisions for heating systems are not only dependent on building characteristics and economic factors, but are also determined by the (i) motives homeowners have to invest in a new system; (ii) type and quantity of information channels they use and suggestions by contacted actors; (iii) ecological factors and factors concerning supply security issues. To foster renewable energy technologies in the private building sector it is important to address homeowners who renovate their heating system and especially those who find themselves in a crisis or problem situation. Besides the information from the installer, it is essential to provide homeowners with more specialized information (magazines, fairs, etc.) raising their awareness for regional, ecological and/or independent fuel supply.

Project team: Ao. Univ.-Prof. Dr. Alfred Posch, Mag. Maria Hecher, Bakk., Mag. Stefanie Hatzl

Project partners: ETH Zurich, Department of Management, Technology and Economics

Duration: January 2015 - December 2016

Funding: Land Steiermark - Fachabteilung Energie und Wohnbau

2.2.5 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).

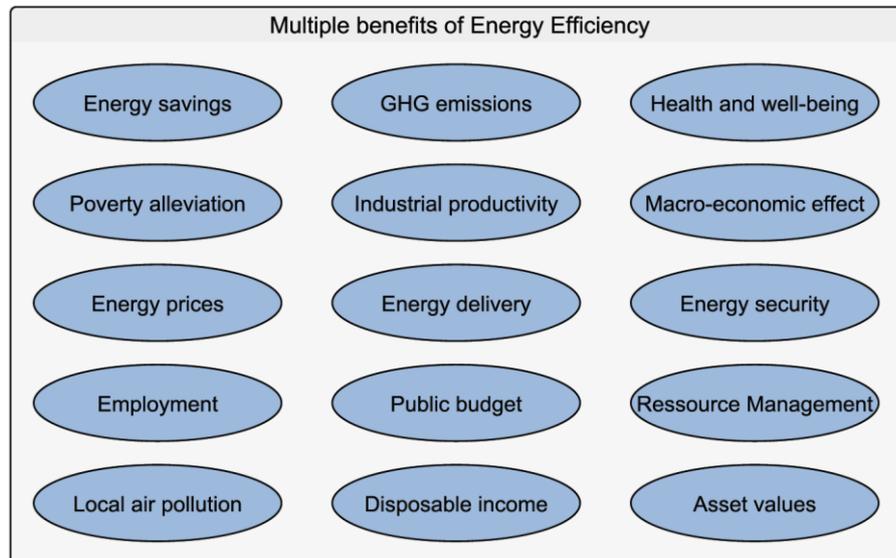


Figure 8: Categorisation of multiple benefits of EE according to OECD/IEA (2014)

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 Schöggel, 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”

2.2.6 URSOLAR – Optimization of SOLAR usage in URban energy systems



Solar energy technologies for heat and electricity still play a minor role in the urban energy system. Numerous benefits, such as zero emissions of noise, greenhouse gases and air pollutants or the general availability of the energy source, make these technologies attractive for urban regions. Therefore, a more important role of solar energy is desirable in the city of the future. The local usage of solar energy depends on different conditions, i.e. energy infrastructure, limited roof/facade areas as well as competition for space between technologies. Due to daily and seasonal output

fluctuations, the supply of energy often does not equal its demand. Moreover, the implementation of energy systems depends on interests and scopes of action of different stakeholders (i.e. acceptance factors, legal conditions) ranging from market actors to owners and tenants of houses, apartments, etc.

For the effective usage of solar energy, technical systems solutions have to be identified which are adjusted to specific city quarters and their infrastructural conditions as well as to avoid transformation losses and to relieve the variable load on the grid. To implement these technical system solutions successfully in city quarters, the following aspects have to be addressed:

1. What types of city quarters are well suited for the implementation of solar energy systems?
2. Which technical, legal or social barriers may emerge?
3. What types of business models are well suited for this purpose?
4. Which system solution performs best in an economic and sustainability assessment?

Based on the interdisciplinary analysis of three selected city quarters in Graz, the main outcome of this project will be a roadmap for urban decision makers. Therefore, urban characteristics in terms of city quarters' architectural attributes, current energy-related infrastructure, and social factors are considered. Moreover, an analysis of legal framework conditions together with identification of technical system solutions and adequate business models for the respective city quarters provide information for the roadmap-development.



Project team:	Ao. Univ.-Prof. Dr. Alfred Posch, Ass.-Prof. Dr. Thomas Bruderermann, Eva Fleiß, MA, Patrick Hart, BA, Mag. Stefanie Hatzl, Christiane Reischl, MA Msc., Dr. Sebastian Seebauer
Project partners:	Energy Agency Graz GmbH (GEA); Institute of Public Law and Political Science, University of Graz; University of Applied Sciences Graz
Duration:	November 2015 - November 2016
Funding:	FFG, Stadt der Zukunft (2nd Call)

2.2.7 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, Christiane Reischl, MA Msc., Dr. Sebastian Seebauer
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

2.2.8 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.

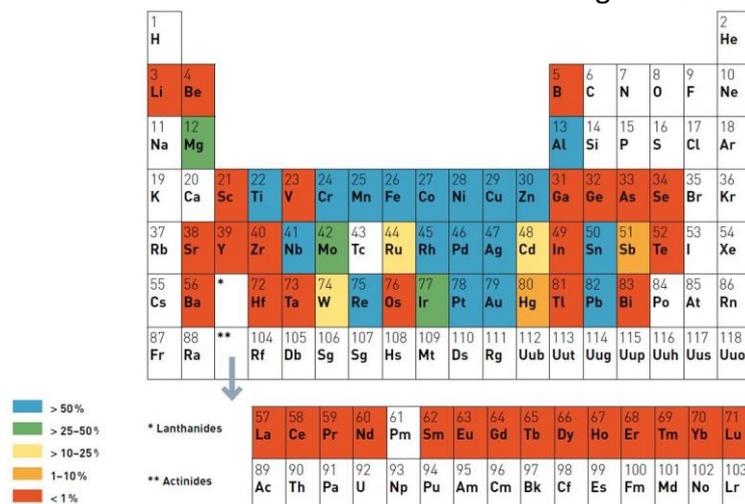


Figure 9: Recycling rate of different metals (Gradel et al. 2011)

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

Duration: April 2015 - March 2018

Funding: Austrian Research Promotion Agency (FFG)

2.2.9 Green Tech Valley – Integrated innovations for the heat- and power-transition

The EU has climate change mitigation goals of a 40 % reduction in CO₂ emissions and 27 % of energy from renewable sources by 2030. The climate and energy strategy of the province of Styria is targeting the expansion of renewable energy from the current 29.7 % to 40 % renewable by the same date. This requires an increased impetus on heat, power and mobility (the project is carried out in cooperation with the »Mobility Laboratory Graz«), but also the development of storage capacity for variable renewable sources and an intelligent network of consumers and producers (smart grid, predictive demand side management).

The aim of this exploratory project is to achieve the ambitious goal of 100 % renewable energy within the strategic boundaries (for example energy strategy of Styria). The technological strengths of this hotspot, which is internationally known as “Green Tech Valley”, will be bundled within an overall concept and a project cluster and therefore a comprehensive and large-scale demonstration – in the sense of the flagship region – will be prepared.

Ten global technology-leaders from Austria, four energy service companies with a high in willingness to innovate and invest, six specialized research institutions, and other partners of the cluster, all relevant policy institutions, are involved in this strong project consortium. New solutions to achieve the above stated renewable energy targets are the goals of this exploratory project. In the project, a structured **open innovation process** will bring together stakeholders and the needs and ideas of a 100 (inter-)national lead users. The project is also a test run for planned “innovation laboratories” in the implementation phase of the flagship region.

The vision and the overall concept will be stated economically and technologically viable with a clear long-term perspective. Using scenario analysis and feasibility studies, overall system solutions and not individual technologies will be developed. **The focus points** to be covered are at the intersection of the technology strengths of the companies within the cluster, the economic relevance and high benefits for the energy system such as:

- Flexible production and storage of electricity and heating/cooling
- Intelligent and energy-efficient networking of consumer and production
- Entanglement of heat, electricity and mobility through integrated hybrid networks

Pieces of the puzzle on the way to the flagship region will include, for example, solar district heating and storage at worldwide unprecedented scales, supply of balancing energy through innovative running power plants, large-scale use of photovoltaic (Grätzel cells) as well as new defined interfaces with mobility.

The result of this exploratory project is the development of a vision, the planning of the overall concept and the project cluster prior to the implementation phase in 2022. Throughout the energy value chain the new interaction between heating / cooling, power and mobility will be demonstrated by this internationally pioneering project.

Project team: Univ.-Prof. Dr. Tobias Stern,
Claudia Mair, BSc. MSc.

Project partners: AEE INTEC, Amt der Steiermärkischen Landesregierung - Abteilung 15
- FA Energie und Wohnbau, Andritz Hydro GmbH, Energie Steiermark
AG, FH JOANNEUM, Holding Graz, JOANNEUM RESEARCH,
Montanuniversität Leoben, Technische Universität Graz

Duration: July 2016 - March 2017

Funding: Austrian Research Promotion Agency (FFG)

2.2.10 Joint Program for Sustainability Leadership



The major aim of this Erasmus+ partnership project is to jointly develop a study program for sustainability leadership, which will address key issues in sustainability, and will enhance the ability of leaders to innovate, collaborate and catalyse change, creating sustainable organizations and societies. The program will be developed based on the needs of managers and leaders, research evidence and principles of sustainability leadership, sustainability standards and SDGs requirements. The study program will be implemented in Lithuania, Slovenia and Macedonia; our institute will contribute to these efforts by providing expertise in the field of sustainability management and curriculum development, and provide a mobility opportunity for selected students of the programme.

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, the private and non-profit sector, and are willing to make a difference and integrate strategies for sustainability in their organizations. Another target group are students who have interest and plans to work as key players in project management and organizational development environments, where broader issues of societal development are important.



First project meeting in Skopje on September 30, 2016

- Project team:** Ass.-Prof. Dr. Thomas Bruderemann, 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

2.3 Research cooperations and networks

2.3.1 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, hydrogeology, 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 10: EGC Logo

2.3.2 AIT Knowledge & Talent Development Programme: Innovation & Sustainability

The Foresight & Policy Development Department of the Austrian Institute of Technology (AIT) established the Knowledge & Talent Development Programme “Innovation & Sustainability” in order to meet the „grand societal challenges“, which are characterized by increasing dynamics and complexity of the involved and interacting systems. In the field of



Figure 11: Structure of Knowledge & Talent Development Programme

“Sustainable innovation oriented Infrastructure Policy” (SIIP) the Foresight & Policy Development Department cooperates with the Institute of Systems Science, Innovation &



Sustainability Research, University of Graz and the Institute of Transportation, Vienna University of Technology.

This programme provides selected master and PhD students with an excellent scientific environment that allows the flexibility to pursue in-depth research in a broad variety of critical areas related to sustainable innovation oriented infrastructure policy. PhD and master students are not only scientifically mentored; they are also financially supported with scholarships.

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 2016, the 22nd annual International Sustainable Development Research Conference was held in Lisbon, Portugal, from 13 to 15 July. Rupert Baumgartner is board member and executive secretary of the ISDR-Society.

2.3.4 ISIE - International Society for Industrial Ecology

ISIE (www.is4ie.org/) was founded in 2001 and promotes industrial ecology as a way of finding innovative solutions to complex environmental problems. Its mission is to promote the use of industrial ecology in research, education, policy, community development, and industrial practices. It facilitates communication among scientists, engineers, policymakers, and managers interested in better integrating environmental concerns with economic activities.

2.4 PhD projects (ongoing)

2.4.1 Individual Mobility as Climate Challenge - Climate Change Risks and Corporate Vulnerability in the Automotive Sector

The transportation sector accounts for 22% of global CO₂ emissions. It thus significantly contributes to human-induced global warming. Moreover, CO₂ emissions from global transport increased by 52% between 1990 and 2011. This rapid growth of emissions is mainly driven by road traffic, i.e. passenger and freight transport, being responsible for about three quarters of total sector emissions. In face of national and international GHG emission reduction targets, the transportation sector - and especially individual transport - is therefore a major area of concern for policy-makers.

On the assumption that there has to be a significant reduction of global GHG emissions, there will be an increasing pressure to reduce the emissions of car traffic in particular. These reductions will necessitate a different usage pattern of cars and the use of different technologies and services provided by the business sector. Hence, climate change contributes to the reshaping of both the regulatory and the societal environment of the automotive industry. This is of increasing relevance both from an environmental and an economic viewpoint as the classical business model of this sector is expected to undergo a fundamental change.

The main research objective of this dissertation is to develop a better understanding of business responses to climate change in the automotive industry by analysing the characteristics, drivers for and barriers to corporate climate change strategies.

The main research questions are:

- Which uncertainties, risks and thresholds in terms of climate change are identified by companies and how are they dealt with in the automotive industry?
- Which factors influence the development, adoption and avoidance of corporate climate change strategies?
- How does the implementation of climate change strategies affect companies' economic and environmental performance?

It is planned to implement a research methodology that becomes increasingly interactive over time. After a preliminary secondary data analysis of companies' annual and sustainability reports and newspaper articles, a survey among companies will be conducted, complemented by in-depth interviews with company representatives, NGOs, chambers of commerce, etc. at a later stage of research.

PhD student: Matthias Damert, MSc.
Duration: 2014 - 2017
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 GtCO₂ 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 GtCO₂ 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 - 2017

Reference: Doctoral Programme DK Climate Change

2.4.3 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?

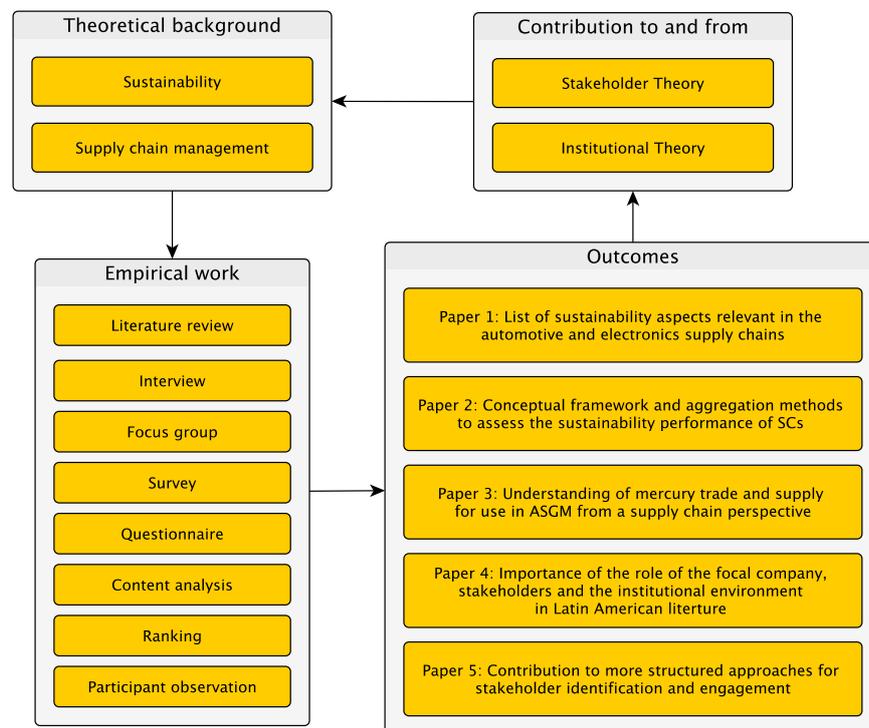


Figure 12: Thesis framework (ASGM: Artisanal and Small-scale Gold Mining)

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



2.4.4 I Shine, Not Burn. An Empirical Study on Actor's Decisions in the Field of Photovoltaic in Austria

Environmental issues became a central topic in sociology since the 1970s. Environmental sociology is concerned with societal causes of and reactions to ecological problems.

One of the most prominent problems is the need to reduce CO₂-emissions. This is especially important in light of the increase in global energy consumption today. One major contributor to global CO₂-emissions are private households: A total of 23% of the energy consumption in OECD-countries can be attributed to private households. Studies indicate that there is a large potential for reducing energy consumption in this area. If private households would adapt their behavior in different areas, a 20% reduction of CO₂-emissions could be possible. These examples depict the importance of understanding the factors influencing individuals' actions. A fitting theoretical framework often applied in environmental sociology and other disciplines - rational choice theory (RCT) - perceives ecological problems as being a (sometimes unintended) macro consequence of individuals' actions.

The work at hand aims at contributing to this field of research by analysing factors influencing individuals' actions in the field of photovoltaic (PV) in Austria using the example of Bottom-up initiatives (BUIs). Empirical results on motives of relevant actors - individuals who are involved in the founding-process or individuals who participate in already established BUIs - will be delivered by addressing the following research questions.

Research questions and studies:

- 1) Study 1, based on qualitative interviews: Which motives drive actors to initiate and/or implement a PV-BUI in Austria? Which motives/goals can be identified to be most important?
- 2) Study 2, based on a large-scale survey: Which motives drive actors when they decide to (not) be part in a BUI? Which motives can be identified to be most important?
- 3) Study 3, based on a laboratory experiment: How do people make trade-offs between themselves and benefits to the environment? How are these payoffs related to different survey measures on self-reported environmental behaviours and attitudes?

According to the research questions the goals are (study 1) to construct a typology of actors/initiatives based on motives to initiate a BUI, (study 2) to explain individuals' motives to (not) participate in a BUI according to an appropriate Rational Choice framework, and (study 3) to further investigate rational decision making by analyzing what role other-regarding preferences play in the decision making process.

The PhD-project is embedded in the project RESHAPE.

PhD student: Eva Fleiß, MA
Duration: 2013 - 2017

2.4.5 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 CO₂ 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 - 2017



2.4.6 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 - 2017
Reference: Doctoral Programme DK Climate Change

2.4.7 Sustainable Strategies of Companies in Energy Intensive Sectors to Cope with Climate Change

This PhD project focusses on corporate climate change strategy for energy-intensive industries and is being pursued at the Graz University and is being funded by the Austrian Science Foundation. The primary research focus of this PhD project is on understanding the mechanism behind strategic responses of business organizations to climate change. Methodologically in this PhD project, a multilevel approach is being applied to understand how business organisations as nested entities within sectors, countries and transnational context are influencing and are being influenced by climate change.

To carry out this task of multilevel assessment, a multilevel framework has been developed. The focus of this PhD research is on applying this framework for assessing corporate political strategies and corporate innovation strategies about climate change. The framework is operationalised by applying the statistical technique of multilevel modelling.

In addition, this PhD research is also assessing the normative implications of inter-generational justice for business organisations in the context of climate change. The research focus is to understand the nature of the ethical challenges faced by today's corporate managers in confronting the intergenerational impact of climate change.

PhD student: Arijit Paul, MSc.
Duration: 2014 - 2017
Reference: Doctoral Programme DK Climate Change

2.4.8 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.

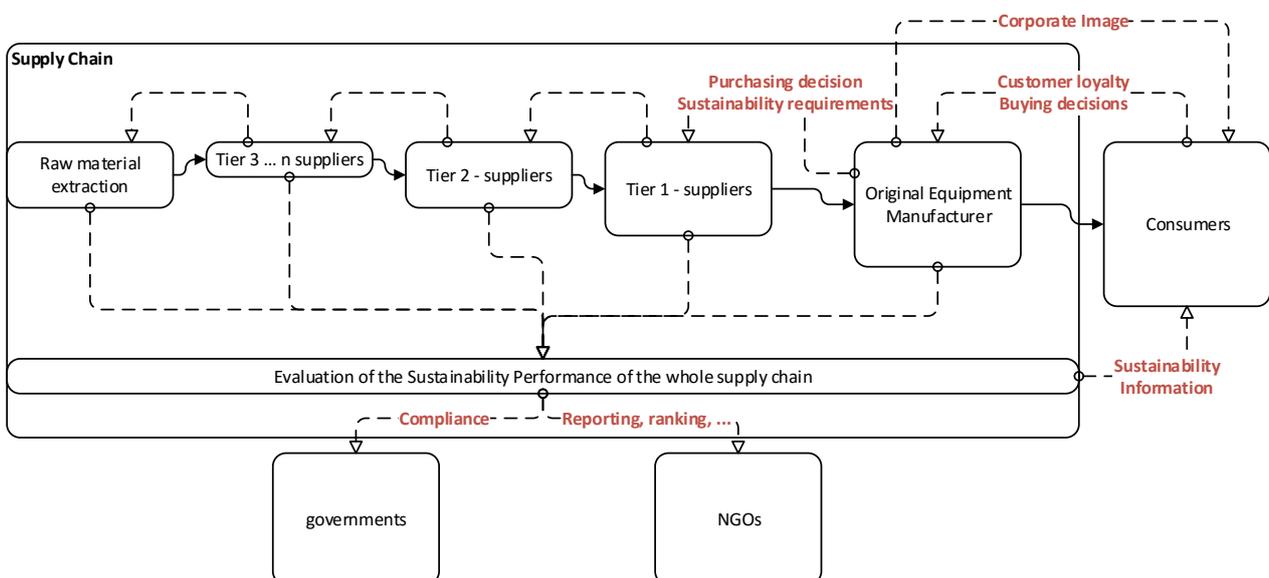


Figure 13: Sustainability related interdependencies in a supply chain

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

2.4.9 EMAS in Tertiary Education: The Case of the EMAS-System at the University of Graz

Environmental management system (EMS) standards are available since the 1990s. Different organizations developed standards defining the structure and content of such a system. In Europe, the European Union also carried out an own environmental management system called Eco-Management and Audit Scheme (EMAS) which is in focus of this dissertation. The main goal of environmental management systems is to reduce the organizations negative impact on the environment and to achieve continuous improvement of the organizations environmental performance.

In Austria there are more than 270 organizations certified according to EMAS but there are only two universities and one university of applied sciences certified. Although not many universities are certified according to EMAS, they play an important role in diffusion of this EMS. On the one hand, universities are often big organizations, with a high number of employees and even more “customers”, their students. As big organizations their demand of resources like energy, water or paper is comparably high. Especially as they not only provide infrastructure and resources for their employees but also for the students. On the other hand, at universities future managers and decision makers in companies as well as politicians are educated. As education is responsible for decisions, environmental awareness can be taught at this stage of education and influence future management style of the graduates. In addition, graduates can add valuable contributions to sustainability research, if the interest in this area is being drawn. But as mentioned above, only few research and teaching institutions in tertiary education (universities and universities of applied sciences) have already implemented an EMS according to the European Eco-Management and Audit Scheme.

Universities are organization meant to be pioneers in environmental responsible behaviour and spots where future managers and decision makers are educated. Therefore, the University of Graz decided to implement an EMS according to EMAS in cooperation with four other Austrian universities, starting the implementation process in the end of 2013. The University of Graz is a university with six faculties without a technical or a medical focus. With about 4,000 employees the University of Graz is one of the biggest employers in Styria, Austria. Around 31,500 students are studying at this institution. As the project is led by the author of this dissertation, a deep insight into the organizational structure, changes expected and achieved as well as different motives and barriers can be examined from an insider’s perspective.

Thus, the goal of this dissertation is threefold, namely (i) to identify which reasons motivate organizations in tertiary education to implement an environmental management system (EMS) according to EMAS, (ii) to point out the expected benefits and (iii) to investigate how the EMS changes the organization. In this sense, the particular case of University of Graz will be considered.

The PhD project is funded by the “Hochschulraum-Strukturmitteln” (HRSM).

PhD student: Anita Ulz, Bakk. MSc.
Duration: 2013 - 2017



2.4.10 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

2.4.11 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



2.4.12 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

2.4.13 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 (company, market, society and nature). It must be considered that sustainability cannot be achieved just within a company; on the market, society or environment. Everything is interconnected and pollution doesn’t stop at any (geographical or firms) boundary. So thinking in a systemic way is getting more important. The dissertation focuses on the topic of sustainability performance in a systemic view. The goals are to find a definition of sustainability performance, by trying to split this term into first and second order. This is needed to finally find feasible methods to measure the degree of sustainability performance on a corporate level and of the wider system.

The goal of this dissertation is to develop a framework to define sustainability performance of first and second order and to find a way to operationalize corporate sustainability management activities. To test the applicability, case studies will be conducted and companies are assessed based on their sustainability activities. The following main research questions will be studied

Question 1: Which corporate activities can be counted as sustainable activities (voluntary and forced by law) to achieve sustainability performance of first and second order?

Question 2: How can (corporate/holistic) sustainability performance be defined?

Question 3: Which possibilities to operationalize the term of sustainability performance already exist?

Question 4: What is the degree of companies to positively or negatively contribute influence the environment and society through their (sustainability management) actions?

This dissertation helps to get an overview of all discovered approaches and is one of the first attempts to split sustainability performance into first and second order by identifying the degree of sustainability in a holistic 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.

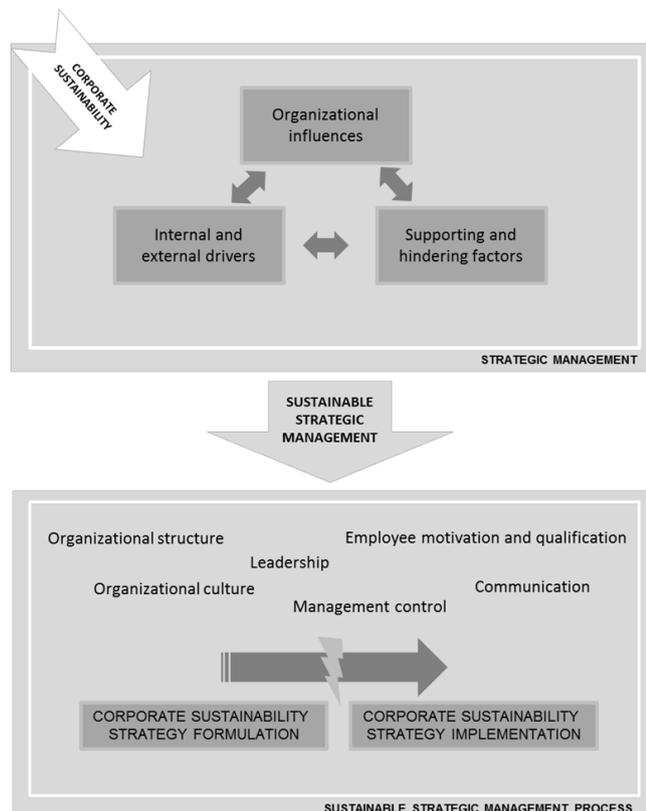
PhD student: Martina Zimek, BSc. MSc.

Duration: 2016 - 2019

2.5 PhD Projects (finalized)

2.5.1 Corporate Sustainability Strategies: An Analysis of the European Automotive Industry

Rising concerns about environmental and social issues and increasing stakeholder and regulatory demands force companies to adapt corporate sustainability, also at a strategic level. However, since decisions of incorporating sustainability aspects are taken at a strategic level, there has been increased scientific interest in the subject of strategic management as related to the integration of sustainability in a company's strategy, vision and culture. The central research conducted for this thesis is dealing with the question of 'how is corporate sustainability integrated into strategic management'. Thereby, three major research areas are identified: First, the general integration of corporate sustainability into strategic management from a theoretical point of view. Second, an analysis of the external perspective of corporate sustainability implementation using the example of the European automotive industry is conducted. And third, research on the internal perspective of corporate sustainability implementation. The result is a model which indicates how companies may overcome the two most crucial points in the field of sustainable strategic management: The challenge to integrate corporate sustainability into strategic management and therefore into the fundamental idea of a company and to bridge the gap between corporate sustainability strategy formulation and its implementation. The former shows that organizational influences (e.g. company size, industry type) internal and external drivers (e.g. legal compliance, cost reduction) as well as supporting and hindering factors (e.g. manager attitude, investments) must be considered in the integration process. The latter indicates identified success factors such as organizational structure, leadership and communication to overcome the challenge of turning strategy into action.



PhD student: Sabrina Engert
Duration: 2012 – 2016

2.5.2 Energy Transition in Energy Regions: An Analysis of Heating System Adoption Decisions and its Impact on the Environment

An important component in the shift towards a sustainable energy system is the transition from a mainly centralized, fossil-fuel system to a more localized, renewable one. ‘Energy regions’ address the issues of energy transition at the regional level and aim at promoting energy self-sufficiency through the use of local, renewable energy sources. It is of key interest to understand how energy supply and demand as well as institutional settings in these regions change over time. In this context, the energy demand from buildings is of particular importance as it accounts for a significant amount of the final energy use, offers massive savings in terms of environmental impacts, and restricts the speed of change through the long lifetime in our build environment. State-of-the-art technologies such as heating systems present a major opportunity to reduce buildings’ energy demand and mitigate environmental impacts drastically in the next couple of decades.

The main objective of this research is to understand the socio-technical transition in energy regions especially focusing on the adoption of heating systems and its environmental consequences. The specific objectives are:

- To analyse the transition dynamics in two Austrian energy regions from their establishment until today in terms of energy generation and consumption as well as key actors, milestones and factors supporting the energy transition (based on energy flow analysis combined with actor and institution analysis);
- To develop further an agent-based building-energy model which portrays the building stock’s energy demand with behavioural elements regarding heating system adoption decisions reflecting the interplay between policy interventions, technical and social structure, and individual behaviour (empirical operationalization of decision-making process based on systematic literature review, qualitative interviews, and quantitative survey);
- To assess the environmental impact of the building stock’s heat demand for different scenarios, where the results of the agent-based model are combined with life-cycle inventory data changing over time due to expected technology-driven dynamics (link of agent-based building-energy model with dynamic LCA).

The results of this research project provide important insights into the energy transition of energy regions engaged in promoting energy self-sufficiency from a socio-technical perspective. The combination of dynamic modelling and LCA allows for developing and assessing scenarios of the building stocks’ energy demand and heating system transition for an entire region capturing the complex socio-technical interrelations typically found when it comes to energy demand of buildings. The results shed light on what policy instruments could be most effective in reducing environmental impacts caused by energy demand from buildings.

The PhD project was funded by a doctorate scholarship from the URBI Faculty.

PhD student: Maria Hecher
Duration: 2013 – 2016

2.5.3 Scenarios for Future Greenhouse Gas Emissions in Austria

Future emissions and concentrations in Austria will be assessed with the help of the RCPs (Representative Concentration Pathways) and the SSPs (Shared Socioeconomic Pathways) published in the 5th Assessment Report of the IPCC. One of the main drivers at the beginning of the research project is the search for crossovers between the international scenarios and the national policies. This has to be seen as the main knowledge gap in this area as the Austrian's emission scenarios of the Austrian Environmental Agency are based on different methods and calculations than the RCPs.

The main objective of the dissertation is the analysis of future GHG in Austria in order to answer the main research question: "What are the main influences on future emissions in Austria till the end of the century?" The (theoretical) background for this analysis is based on the RCP scenarios as well as national and European emission scenarios. The main drivers for climate change and the increase in radiative forcing in Austria should be identified and qualified. The connection and similarities between the RCPs and Austria's climate policy shall be identified and, if possible, combined with adapted storylines specifically for Austria. Furthermore, it should be possible to use this method to create a framework which can be used by different single nations to assess their emissions and concentrations.

The first paper aims at comparing emission scenarios on a national, European and global level. It can be derived if the Austrian climate policy is in line with the EU climate goals and the, so called, 2°C target. The second paper is focusing on greenhouse gas emissions from livestock in Austria, comparing inventory emissions, emissions considering the whole life cycle and different emission scenarios.

The following figure gives a short overview of the thesis' framework:

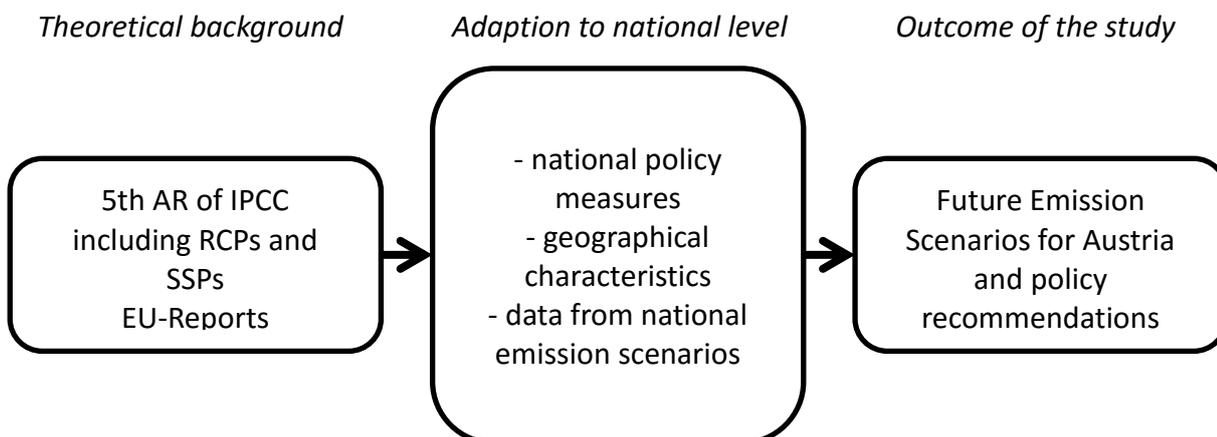


Figure 14: Thesis framework

The PhD project was funded by the PhD-scholarship from the Faculty of Environmental, Regional and Educational Sciences.

PhD student: Thomas Winkler

Duration: 2013 - 2016

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
Publications				
Publications in scientific journals	18	22	22	27
Contributions to an edited book or proceedings	29	19	16	22
Posters presented at scientific conferences	5	3	6	19
Other scientific publications	3	3	2	3
Projects				
Third-party funded projects	12	12	16	14
Functions				
External scientific functions and functions in external scientific committees	17	13	3	12
Functions in international journals	9	6	4	6
Networking activities				
Presentations at scientific conferences and seminars	42	26	44	48
Awards	5	4	4	1

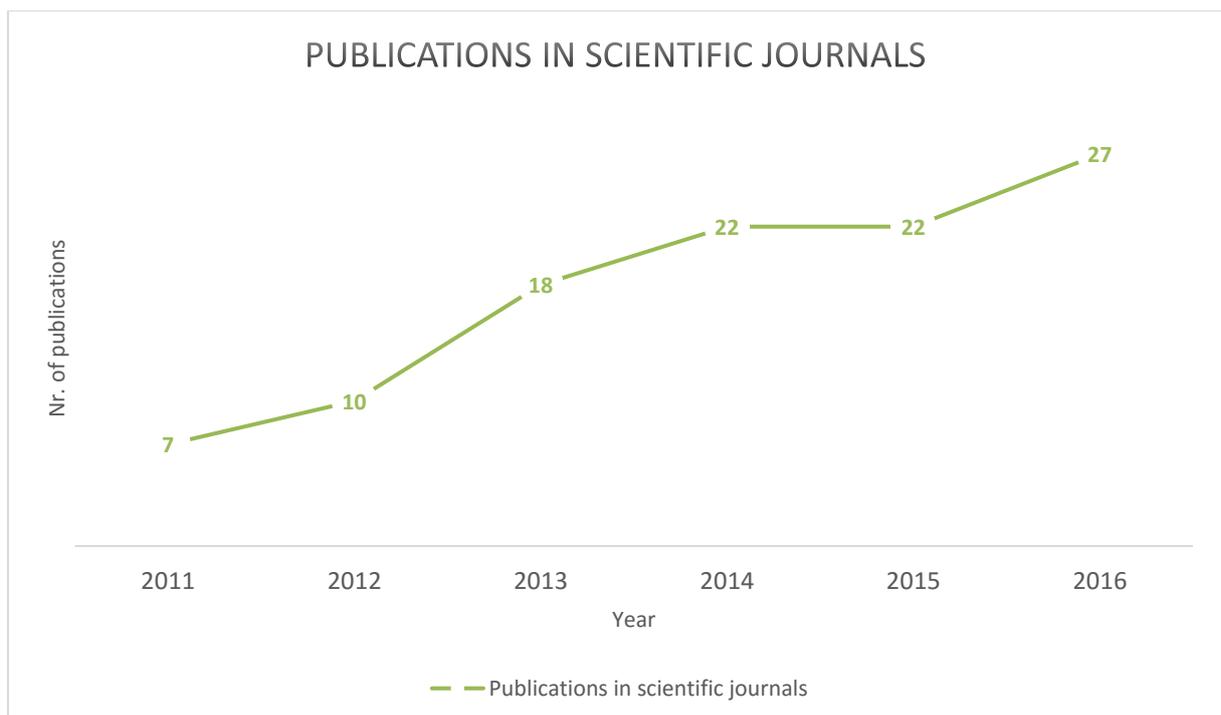


Figure 15: Number of publications in scientific journals over the last years



3.1 Publications

3.1.1 Edited volume

Rudolf Egger; Alfred Posch (Ed.): *Lebensentwürfe im ländlichen Raum. Ein prekärer Zusammenhang?* WiesbadenSpringer: Springer 2016.

3.1.2 Contribution to journal

Aschemann, Ralf: *Innovative internationale Bildungsidee*, in: Weiterbildung: Zeitschrift für Grundlagen, Praxis und Trends n.a.,4 (2016), 38-41.

Binder, Claudia; Knoeri, Christof; Hecher, Maria: *Modeling transition paths towards decentralized regional energy autonomy: the role of legislation, technology adoption, and resource availability*, in: Raumforschung und Raumordnung, 74,3 (2016), 273-284. DOI: DOI 10.1007/s13147-016-0396-5

Braun, M., Fritz, D., Weiss, P., (...), Schwarzbauer, P., Stern, T. : *A holistic assessment of greenhouse gas dynamics from forests to the effects of wood products use in Austria*, in: Carbon Management, 7,5/6 (2016), 271-283.

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Brudermann, Thomas; Sangkakool, Tachaya: *Green roofs in temperate climate cities in Europe – an analysis of key decision factors*, in: Urban Forestry & Urban Greening, 21 (2016), 224-234. DOI: 10.1016/j.ufug.2016.12.008

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Fritz, Morgane; Maxsons, Peter A.; Baumgartner, Rupert J.: *The mercury supply chain, stakeholders and their responsibilities in the quest for mercury-free gold*, in: *Resources Policy*, Vol. 50 (2016), pp. 177–192.

Füllsack, Manfred: *Circularity and the Micro-Macro-Difference*, in: *Constructivist Foundations*, 12,1 (2016), 1-10.

Füllsack, Manfred: *Recursivity, Anticipation, Mutual Referentiality, and the End of Human Analytics?* in: *Constructivist Foundations*, 12,1 (2016), 25-29.

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Reischl, Christiane; Rauter, Romana; Posch, Alfred: *Urban vulnerability and adaptation to heatwaves: a case study of Graz (Austria)* in: *Climate Policy* (2016), DOI: <http://dx.doi.org/10.1080/14693062.2016.1227953>

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Damert, Matthias; Schröer, Katharina in: *Karl-Franzens-Universität Graz - Klima und Wandel*, Kleine Zeitung, print , 15.12.2016.

Lackner, Bettina Christina; Damert, Matthias; Schröer, Katharina; Klug, Roman in: *„KliMacht/CliMatters“ an der KF-Uni Graz*, Die Digitale Tageszeitung, other media type, 03.03.2016.

Rauter, Romana: *„Internett“ oder digitales Teufelszeug?*, in: Rohstoff, Ausgabe November 2016, print, 01.11.2016



3.5 External Scientific Functions

Aschemann, Ralf: Member of the editorial board of the Journal of Environmental Assessment, Policy and Management

Baumgartner, Rupert J.: CERN Journal of Experimental Innovation, Member editorial board

Baumgartner, Rupert J.: Session Chair Depo&RecyTech 2016, 09.11.2016.

Baumgartner, Rupert J.: Trans-Atlantic Research and Development Interchange on Sustainability: Workshop on Growth and/or Sustainable Development, 19.10.2016 - 21.10.2016.

Baumgartner, Rupert J.: International Sustainable Development Research Society (United Kingdom), Executive secretary

Baumgartner, Rupert J.: Journal of Cleaner Production, Subject Editor

Baumgartner, Rupert J.: Jury Saubermacher Umweltpreis, Member

Baumgartner, Rupert J.: PhD-Opponent Tampere University of Technology, Finland

Baumgartner, Rupert J.: PhD-Opponent University of Wageningen, The Netherlands

Baumgartner, Rupert J.: PhD-Referee University of Natural Resources and Life Sciences, Vienna

Baumgartner, Rupert J.: Sustainable Development, Member editorial board

Gelbmann, Ulrike: Session Chair Depo&RecyTech 2016, 09.11.2016.

Rauter, Romana: Journal of Cleaner Production, guest editor

Stern, Tobias: Habilitation Referee, Universität Hamburg

Stern, Tobias: Journal of the Austrian Society of Agricultural Economics, Editor

Stern, Tobias: PhD-Opponent University of Eastern Finland

Stern, Tobias: PhD-Referee, University of Natural Resources and Life Sciences, Vienna

Stern, Tobias: Scientific committee Central European Biomass Conference (CEBC) in Graz

Reviews were undertaken for following journals:

- Biomass and Bioenergy
- Business Strategy and the Environment
- California Management Review
- Computational and Mathematical Organization Theory
- 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:

- Institute of Systems Sciences, Innovation, and Sustainability Research Report #1: Florian Hold, Informelle Abfallwirtschaft in Österreich – Chancen, Risiken und Praxis. Graz, October 2012 (in German).
- Institute of Systems Sciences, Innovation, and Sustainability Research 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).
- Institute of Systems Sciences, Innovation, and Sustainability Research Report #3: Manfred Füllsack (Ed.): Networking Networks. Graz, May 2013 (in English).
- Institute of Systems Sciences, Innovation, and Sustainability Research 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).
- Institute of Systems Sciences, Innovation, and Sustainability Research Report #5: Gastinger, B.: Biologische Abfallbehandlung in der Steiermark und ihr Beitrag zum Klimaschutz. Graz, December 2013 (in German).
- Institute of Systems Sciences, Innovation, and Sustainability Research 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).
- Institute of Systems Sciences, Innovation, and Sustainability Research 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).

3.7 DuPont Young Professor 2016

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 "2016 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 "2016 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.

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 16: 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.umweltsystemwissenschaften.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 17: Joint Master Programme

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 Mag. Ulrike Krawagna 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).

In the first study year, the EU universities offer basic modules on industrial ecology and its key tools. In the second study year, all consortium universities offer a specialization module in industrial ecology (third semester), cf. the figure below, before the master's thesis has to be conducted in the fourth semester.

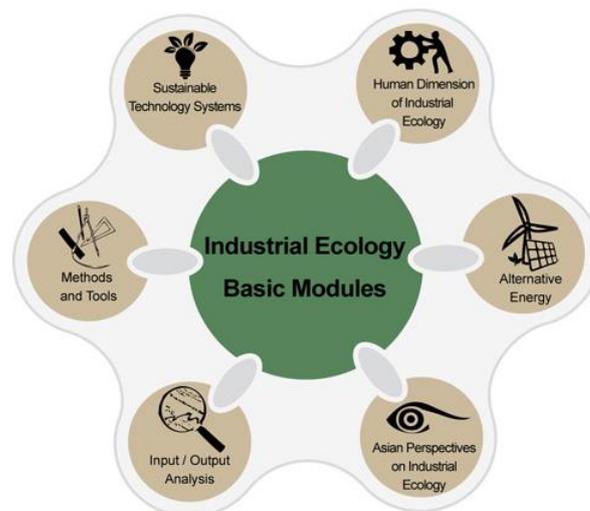


Figure 18 : Structure of the MIND programme

According to the Erasmus Mundus regulations, MIND students have to study at least one semester at two different European countries of the consortium. Moreover, some students have the opportunity to spend one semester at one of the non-European MIND universities. It is intended to run MIND at least for five consecutive editions, i.e. study years 2011/12 to 2016/17. For the same period, the EACEA is supporting MIND by granting scholarships for students and scholars and by contributing to the running administrative costs.

In August 2016, the fourth generation of MIND students has been awarded with their Diplomas during the jointly organized MIND summer school and graduation ceremony, organized at Seggau Castle in Styria.

The MIND consortium plans to submit a new proposal for MIND+ in 2017 in order to get an extension of the funding through the European Commission until study year 2021/22.

More information on MIND can be found at www.emmind.eu.

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 Completed theses (master and doctoral)

In 2016 28 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.

1. CHEN, Hui-Ling: Circular Design: Developing a Framework for Product Service Design in a Circular Economy (Baumgartner, Rupert; Aschemann, Ralf)
2. FRANKE, Fabian: Revisiting Local Agenda 21: Analyzing the implementation of the sustainability program in Treptow-Köpenick, Berlin (Posch, Alfred)
3. GABRIELLA, Natasha: A Delphi Study of Factors Affecting the Forest Biorefinery Development in the Pulp and Paper Industry: The Case of Bio-based Products (Posch, Alfred)
4. GERSTL, Michael: Studienverlaufsanalyse. Eine systematische Auswertung der Inskriptionen und Prüfungen der USW BWL Graz Studierenden (Füllsack, Manfred)
5. GRETSCHNIG, Verena Katrin: Potenziale von internetbasierten Medien zur Awareness raising im Umweltbereich am Beispiel von Food Waste (Gelbmann, Ulrike)
6. GUTSCHI, Dieter: Social Entrepreneurship and its Values: A Complexity Perspective (Rauter, Romana)
7. HUBER, Matthias: The emerging field of sustainability consulting agencies - A case study (Baumgartner, Rupert; Rauter, Romana)
8. LANDERL, Patrick: Status and Future Perspectives of Electric Buses in Urban Public Transport - An assessment of existing projects, state of technology and economic aspects (Posch, Alfred)
9. LASSNIG, Melanie: Beteiligungsprozess(e) der Europäischen Kommission bei der Entwicklung und Überarbeitung von Umweltkriterien für die öffentliche Beschaffung - Problemanalyse und Lösungsvorschläge (Posch, Alfred)
10. LASSNIG, Nina: Schrumpfende Nahversorgungsstrukturen vor dem Hintergrund einer alternden Gesellschaft. Handlungsempfehlungen für eine Verbesserung der Nahversorgung in der obersteirischen Marktgemeinde Vordernberg (Aschemann, Ralf)
11. LIN, Xingyu: Backcasting Life Cycle Sustainability Analysis - A case study of future scenarios of private electric vehicles driving in European Union (Posch, Alfred)
12. MAIR, Claudia: Optimierung eines Abfallmanagementsystems in der Fahrzeugindustrie: Eine Fallstudie in einem österreichischen Montagebetrieb (Baumgartner, Rupert)
13. MENZL, Petra: Corporate Social Responsibility (CSR) in KMU - Unternehmensverantwortung am Beispiel österreichischer Hotelbetriebe (Gelbmann, Ulrike)
14. MILCHRAHM, Helena Maria: Consumers' Perception on Palm Oil in Austria (Posch, Alfred; Aschemann, Ralf)
15. NEUHERZ, Lisa: Das österreichische Bundes-Energieeffizienzgesetz als Dilemma für Energielieferanten: langfristige Auswirkungen und mögliche Lösungsvorschläge. Eine Delphi-Studie über die Zukunft von Energieversorgungsunternehmen (Stern, Tobias)
16. PRIMAS, Matthias Eduard: Phantomstaus: Ursache, Wirkungen und Möglichkeiten ihrer Vermeidung. Eine Untersuchung mit agenten-basierten Modellen (Füllsack, Manfred)
17. SARIC, Filip: Zukunft der Abfallverbrennungsanlagen in Österreich aus Sicht der Anlagenbetreiber (Gelbmann, Ulrike)

18. SCHIFFER, Florian: Die Integration von Nachhaltigkeitsmanagement in Österreichs Banken. Identifikation und Analyse unternehmensinterner Indikatoren und Potenziale eines steirischen Unternehmens (Baumgartner, Rupert)
19. SCHÖNBERG, Martin: Die Anwendung Sen's Capability Ansatzes auf Corporate Social Responsibility (Baumgartner, Rupert)
20. SWOBODA, Philipp: Rock Dust as agricultural soil amendment: a review, (Posch, Alfred)
21. UNGER, Sandra: Integrated Reporting - An empirical comparison of the International Integrated Reporting Framework and current state of the art reporting of selected oil and gas companies (Baumgartner, Rupert)
22. VESELINOV, Milan: Backcasting on development and diffusion of Circular Economy in transition economy countries: The example of the Republic of Serbia (Aschemann, Ralf)
23. WASSERBAUR, Raphael Reinhold: Resilience analysis of a complex network. Resilience pattern and early warning signals of a pollinator-plant web (Füllsack, Manfred)
24. WRANN, Christina: Benchmarking Study of Sustainability Aspects in the Electronics Industry (Baumgartner, Rupert; Rauter, Romana)
25. ZACHARIAS, Gudrun: Adoption von Elektromobilität in Gemeinden. Steirische Gemeinden als Vorreiter bei der Implementierung von Elektromobilität (Posch, Alfred)
26. ZEHENTNER, Theresa: Transformation reifer Geschäftsmodelle durch innovative Startup- und Akquisitionssysteme (Baumgartner, Rupert)
27. ZILIAN, Laura Samantha: Diffusion of information on sustainable mobility concepts - A case study at the University of Graz (Füllsack, Manfred)
28. ZSIFKOVITS, Isabella: Aktuelle Epidemienmodelle. Eine qualitative Evaluierung von Modellen zur Vorhersage und Berechnung des Übertragungsrisikos des Ebola-Virus (Füllsack, Manfred)

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

1. ENGERT, Sabrina: Corporate Sustainability Strategies: An Analysis of the European Automotive Industry (Baumgartner, Rupert)
2. HECHER, Maria: Energy Transitions in Energy Regions: An Analysis of Heating System Adoption Decisions and its Impact on the Environment (Posch, Alfred)
3. HERMANN, Robert: Landfill mining in Austria - economic and ecological assessment of landfill mining projects (Baumgartner, Rupert)
4. SCHÖNMAYR, David: Plastics recycling in the automotive sector - rethinking the industry by integrative research and holistic solutions for sustainable management in the automotive plastics production and recycling system (doctoral school for Geography; Baumgartner, Rupert)
5. WINKLER, Thomas: Emission trends of greenhouse gases for Austria - general scenarios and focus on livestock production systems (Winiwarter Wilfried; Posch, Alfred)

4.3 Course list

Summer Term 2016			
Type	Course	Contact hours	Lecturer
PS	Applied Systems Sciences	2	Granigg W, Hofer C, Lechner G, Maraun D, Rieder H, Schober A
VU	Calculus for Systems and Environment Sciences	4	Peichl G, Prager W
KS	Eco-Controlling	2	Baumgartner R, Paul A, Zimek M
KS	Environmental Decision Making	2	Brudermann T
VO	Human Beings and Environment: Biosphere and Eco-Systems	2	Raspotnig G, Tschernatsch M
AG	Interdisciplinary Practical Training	4	Friedrich A, Lauer P, Omann I
AG	Interdisciplinary Practical Training	4	Dullnig K, Reiter K, Seebacher U
AG	Interdisciplinary Practical Training	4	Klade M, Seebacher U, Von der Hellen C
AG	Interdisciplinary Practical Training - Environmental impacts of renewable energy systems	4	Aschemann R, Bachhiesl U, Knoll P, Narodoslowsky M
AG	Interdisciplinary Practical Training - Simulation Game: Carbon Capture and Storage (CCS)	6	Aschemann R, Friedrich A, Schweitzer S
AG	Interdisciplinary Practical Training - Sustainability in global supply chains	6	Baumgartner R, Damert M, Fritz M, Schöggel J
AG	Interdisciplinary Practical Training - Transition Town Graz	4	Fischer W, Gelbmann U, Peskoller A
PS	Introductory Seminar - Elementary Statistical Concepts and Methods, Examples and Practice	1	Feit T, Seebauer S
PS	Environmental and sustainability management systems	2	Baumgartner R
SE	Master Seminar	2	Baumgartner R, Füllsack M, Posch A, Stern T
AG	MIND Summer School	2	Aschemann R
VO	Modelling of Systems	2	Desch G, Füllsack M
PS	Corporate Social Responsibility	2	Knechtl-Grabner E
OL	Orientation Course Environmental Systems Sciences	1	Baumgartner R, Füllsack M, Huber A, Kramer K, Steininger K, Sulzer W
DQ	PhD Doctoral Colloquium I	2	Baumgartner R, Füllsack M, Posch A, Stern T

UE	Practical Approaches to Systems Sciences	2	Hofer C, Kleinberger-Pierer M, Kupsa S, Schober A, Schröck A
KS	Product and Service Development	2	Globocnik D
PS	Project Management	2	Posch A
SE	Realising Scientific Contribution in Sustainable Business Studies: A Process Approach	2	Dentchev N
AG	Research Project Innovation Management	4	Brudermann T, Crockett S, Posch A
PS	Selected Topics of Sustainability and Innovation Management	2	Stern T
KS	Selected Topics of Sustainability and Innovation Management	2	Kiesnere A, Stern T
SE	Seminar for Postgraduates	2	Baumgartner R, Füllsack M, Posch A, Stern T
SE	Seminar for Research Methods	2	Hecher M, Seebauer S
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	Strategic Sustainability Management	2	Gelbmann U
SE	Sustainability and Environmental Management	2	Posch A
KS	Sustainability Entrepreneurship	2	Stern T
KS	Sustainable Innovation	2	Rauter R
VO	Systems Sciences 2	2	Füllsack M, Propst G
VU	Systems Sciences 3	2	Granigg W
KS	Value Chain Management	2	Aschemann R
VU	Vector Analysis for USW	3	Batzel J, Fripertinger H, Hötzl E, Prager W, Schwaiger J
KS	Waste and Recycling	2	Gelbmann U, Heigl M

Winter Term 2016/2017

Type	Course	Contact hours	Lecturer
PS	Applied Systems Sciences	2	Jäger G, Rieder H
VU	Calculus for Systems and Environment Sciences	4	Batzel J, Hötzl E, Keeling S, Prager W, Rosenberger S
SE	Complexity Research	2	Strunk G
KS	Eco-Controlling	2	Baumgartner R, Mair C, Zimek M
KS	Environmental and Technology Assessment	2	Aschemann R
KS	Environmental Decision Making	2	Brudermann T
VO	Environmentally Oriented Innovation and Technology Management	2	Rauter R, Stern T
VO	Human Beings and Environment: Anthroposphere	2	Posch A, Steininger K
VO	Human Beings and Environment: Geosphere	2	Lazar R, Lieb G, Sulzer W
KS	Integrated Management Systems	2	Dully S, Ulz A
VO	Integration and Evaluation of Systems	2	Füllsack M
AG	Inter- and Transdisciplinary Case Study on Sustainable Development	6	Brudermann T, Crockett S, Posch A, Winkler T
AG	Interdisciplinary Practical Training	4	Bednar-Friedl B, Dullnig K, Kozina C
AG	Interdisciplinary Practical Training	4	Gelbmann U, Hammerl B, Höflechner T, Peskoller A
AG	Interdisciplinary Practical Training	4	Klell M, Schröck A, Trattner A
AG	Interdisciplinary Practical Training	4	Hasler A, Janitschek G, Poppmeier C
VO	Interdisciplinary Working Methods	2	Aschemann R
SE	Introduction to Industrial Ecology	2	Aschemann R
PS	Introductory Seminar - Elementary Statistical Concepts and Methods, Examples and Practice	1	Ambros R, Feit T
AG	IP - Circular Economy - System change towards a sustainable future	6	Aschemann R, Baumgartner R, Klampfl-Pernold H
AG	IP - Sustainability in global supply chains - a stakeholder perspective	6	Baumgartner R, Damert M, Fritz M, Schöggel J
SE	Master Seminar	2	Baumgartner R, Füllsack M, Posch A, Stern T
KS	Methods for inter- and transdisciplinary problem-solving	2	Aschemann R

PS	Reportage of Sustainability	2	Resel K
PS	Corporate Social Responsibility	2	Knechtl-Grabner E
OL	Orientation Course Environmental Systems Sciences	1	Baumgartner R, Bednar-Friedl B, Fischer W, Füllsack M, Huber A, Kramer K
UE	Practical Approaches to Systems Sciences	2	Hintermüller S, Hofer C, Kleinberger-Pierer M, Kupsa S, Schober A, Schröck A
KS	Product and Service Development	2	Globocnik D
AG	Research Project Innovation Management	4	Rauter R, Stern T
KS	Selected Topics of Sustainability and Innovation Management	2	Stern T
SE	Seminar for Integration and Evaluation of Systems	2	Füllsack M
SE	Seminar for Modelling of Systems	2	Füllsack M, Schmickl T
SE	Seminar for Research Methods	2	Füllsack M, Hecher M
SE	Social competences for managing sustainable development	2	Seebacher U
SE	Social Competences for Working in Inter- and Transdisciplinary Teams	2	Seebacher U
VO	Statistics	2	Feit T
KS	Strategic Sustainability Management	2	Gelbmann U
VO	Sustainability and Environmental Management	2	Baumgartner R
KS	Sustainability Entrepreneurship	2	Kiesnere A, Stern T
AG	Sustainable Development - Integrating Perspectives	6	Brudermann T, Posch A, Steiner A, Winkler T
KS	Sustainable Innovation	2	Rauter R
VO	Systems Sciences 1	2	Desch G, Füllsack M
VU	Systems Sciences 3	2	Granigg W
SE	The Sustainability Challenge	2	Posch A
PV	Tutorial for Postgraduates	2	Baumgartner R, Füllsack M, Posch A, Stern T
VU	Vector Analysis for USW	3	Prager W
KS	Waste and Recycling	2	Gelbmann U, Schmidt G



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