

Creating a Real World Laboratory for Transformative Sustainability Research at Universities – a Case from Austria

Topic „Transformative science and societal impact“

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ABSTRACT

Our societies face multiple grand challenges such as climate change, global population growth, social polarisation, anticipated shortages of natural resources, biodiversity loss, economic instabilities, etc. These persistent problems of unsustainability are complex, riddled with uncertainties and deeply rooted in our societal structures and culture (Weaver and Rotmans, 2006) including our economic principles. The currently predominant research system of mainly disciplinary approaches falls short in adequately addressing these problems (Lang et al., 2012).

However, universities increasingly recognize the need to address these grand challenges (Gerzabek et al., 2012, Oldenburg, 2013, Katholische Universität Eichstätt-Ingolstadt, 2015). With regard to research practices, some authors suggest that a 3rd academic revolution is under way that *“transforms universities into institutions committed to both academic excellence and addressing the urgent sustainability issues of our contemporary age”* (Yarime, Trencher et al. 2012). A particular type of research that supports a transition towards sustainability and leads to structural change is named transformative research (Schneidewind and Singer-Brodowski, 2014). But current structures at most universities do not provide adequate incentives to follow such a pathway of transformative research (Yarime et al., 2012). Thus, the question remains how research institutions and universities have to change in order to provide framework conditions that allow and even encourage researchers to contribute to societal and sustainability oriented transitions, and how this change can be accomplished in a system whose self-reproducing features are a basic part of its self-picture.

The paper describes the efforts of the University of Natural Resources and Life Sciences (BOKU) in Vienna to respond to this challenge. Furthermore, since such challenges cannot be met solely on the level of an individual university, the issues are also dealt by the Alliance of Sustainable Universities in Austria. At BOKU the process is embedded in the sustainability strategy of the university, which started in 2013 in close cooperation with Vienna University of Economics and Business. Whereas many of the measures to become more sustainable are quite straightforward, the necessary transformation of research structures for more sustainability is more difficult.

Keeping attempts small-scale and in experimental settings seems to be an appropriate approach at present. The experiments pursued show characteristics of real world laboratories, such as co-design and co-production, transdisciplinarity, long-term orientation of the process, continuous methodological reflection, and accompanying research (Wagner and Grunwald, 2015). Thus, the results achieved so far can be seen as small-scale versions of real-world laboratories that aim to strengthen transformative research at universities and thus increase the societal and sustainability impact of research. Main settings within this experimental approach are a) a continued discussion and vision development in the framework of the BOKU sustainability strategy, b) a guest seminar that involved university members and stakeholders; c) the BOKU energy cluster for informal cooperation in this field and d) the Alliance of Sustainable Universities in Austria with its expert-group, its interactions with the rectorates of the member universities, as well as its stakeholder interactions.

So far, the process has succeeded in including sustainability in the main strategic papers of the BOKU and developing awareness of the issue through a lighthouse event including the Austrian Minister of Research, several members of rectorates and further relevant stakeholders. Moreover, at BOKU a first version of a vision for university research and education for a sustainable future has been developed. This, in combination with trustful and active interuniversity cooperation within the Alliance of Sustainable Universities, strengthens the sustainability process at BOKU will form the basis for further initiatives and discussions. Nevertheless, it is necessary to establish a broader sense of urgency and importance of the topic throughout the University and to make it a well-founded basis of BOKU's day-to-day decisions.

1. Introduction

1.1. Societal Responsibility of Universities

Our societies face multiple grand challenges such as climate change, global population growth, social polarisation, anticipated shortages of natural resources, biodiversity loss, economic instabilities, etc. These challenges are known for long, but there are no simple solutions to them. They are intertwined with each other and affect different dimensions, such as the social or biophysical dimension. Thus, they can be interpreted as “persistent problems of unsustainability”, which are complex, riddled with uncertainties and deeply rooted in our societal structures and culture (Weaver and Rotmans, 2006) including our economic principles. In order to approach them, systemic transitions are needed that take these characteristics into account.

There is a general agreement that science will play an important role in approaching these challenges and that universities will have to be one of the key players in a transition to sustainability. In the Austrian University Law the assignment to contribute to a sustainable development is stated in the first paragraph: „§ 1. *Die Universitäten sind berufen, der wissenschaftlichen Forschung und Lehre, der Entwicklung und der Erschließung der Künste sowie der Lehre der Kunst zu dienen und hiedurch auch verantwortlich zur Lösung der Probleme des Menschen sowie zur gedeihlichen Entwicklung der Gesellschaft und der natürlichen Umwelt beizutragen*“ [„Universities are called to serve the scientific research and teaching, the development and appreciation of the arts and the teaching of art, and thereby to contribute responsibly to solving the problems of the people and for the thriving development of society and the natural environment“].

Also the "Declaration on Science and the Use of Scientific Knowledge", which was adopted by the World Conference on Science, on 1 July 1999, states that *“The sciences should be at the service of humanity as a whole, and should contribute to providing everyone with a deeper understanding of nature and society, a better quality of life and a sustainable and healthy environment for present and future generations.”*

Universities increasingly recognize the need to address these grand challenges and show their efforts in Sustainability Reports (e.g. Gerzabek et al., 2012, Oldenburg, 2013, Katholische Universität Eichstätt-Ingolstadt, 2015, Michelsen et al., 2008). Their attempts cover issues of operation (e.g. green procurement, waste management), but – in accordance with a whole-institution-approach – should also cover the main tasks of universities, i.e. teaching and research. Whereas operational issues are often straight forward – but still difficult to implement due to financial reasons – teaching and research practices touch the inner structures, the self-conception, and long traditions within universities.

This paper focuses on the role of research and science, if universities want to comply with their societal responsibility.

1.2. Research and Science for a Sustainable Development

Research and teaching traditionally are organised in disciplinary structures that cannot reflect the systemic nature of the above persistent problems. Conventional approaches fall short in addressing the challenges of our time (Gallopín et al., 2001, Kates et al., 2001). New ways of knowledge production and decision making are needed (Lang et al., 2012, Wiek et al., 2012a). With regard to research practices, some authors suggest that a 3rd academic revolution is under way that *“transforms universities into institutions committed to both academic excellence and addressing the urgent sustainability issues of our contemporary age”* (Yarime, Trencher et al. 2012).

When it comes to the question, what kind of science is needed that would be able to address the problems of our time, two main aspects are always mentioned:

- an approach that takes into account the linkages between and within systems, and
- some kind of collaboration and knowledge exchange between those affected by the problem and researchers.

These two concepts are main parts of Sustainability Science as discussed by Kates et al. (2001), which seeks to understand the fundamental character of interactions between nature and society, as well as by Gallopín et al. (2001), who call for a “Science for the twenty-first century”.

Gallopín et al. (2001) call for a fundamental systemic approach, meaning that it is the researchers’ responsibility to consider potential impacts of their research and to justify which system parts they do or do not include. Following a systemic approach also means to include data, that might not be exact in traditional scientific terms – but that still provide more information than excluding the data for reasons of missing preciseness. With regard to sustainability it is especially important to include the interaction of social and natural systems. In order to meet this condition, an interdisciplinary approach is a prerequisite.

Addressing the second requirement means applying participatory methods or following a transdisciplinary approach. According to Lang et al. (2012 ,page 27) “*transdisciplinarity is a reflexive, integrative, method-driven scientific principle aiming at the solution or transition of societal problems and concurrently of related scientific problems by differentiating and integrating knowledge from various scientific and societal bodies of knowledge.*” Thus, within transdisciplinary research the scientific process is interwoven with the societal process.

Sustainability science can be both analytical as well as transformative. Whereas the former tries to understand patterns of unsustainability as well as transformations towards sustainability, the latter acts as a transformative factor itself and contributes to a structural change towards sustainability. It thus actively aims to support a societal transformation towards sustainability – or, as the WBGU puts it, it acts as a catalyst of transformation.

Wiek et al. (2012b) observe that sustainability science since its inauguration in 2001 developed in these two directions. The WBGU (Wissenschaftlicher Beirat der Bundesregierung für Globale Umweltveränderungen (WBGU), 2011) differentiates transformation research as the analytical form from transformative research as the transformational mode. The concept of transformative science was further elaborated by Schneidewind and Singer-Brodowski (2014 , page 123). They stress that transformative science includes not only system knowledge, but target and transformation knowledge gains importance. Knowledge derives from real-world labs and transformation processes.

Tàbara et al. (in preparation) elaborate on the specific case of transformative climate science and state that it

- Focuses on solutions, not only problems and trends.
- Integrates motives, values, human nature and agency.
- Focuses on deep causes and social-ecological interactions (mainly global systems unsustainability), not only symptoms.
- Links local/situated integrated solutions of multiple problems to global processes.
- Supports the coordination of ‘global systems of solutions’ to support SD.
- Moves from a sectoral, incremental approach about solutions to an integrated, multiplicative, non-linear approach.
- Aims to understand and support the empowerment of agents’ transformative capacities.
- Helps to redistribute rights and responsibilities and addresses institutional and behavioural change.

Sustainability science and related concepts of research cannot replace disciplinary or interdisciplinary research. Their role is an additional one – but one that is necessary to meet the challenges of sustainability. As disciplinary research is still the predominant mode, university structures are adapted to this kind of research. When following a research mode as described above, various barriers and difficulties come up – simply because it does not fit to current structures or because there is active resistance towards this developing research approach.

Barriers & Difficulties to Change Research Practices

In 2001 Kates et al. (2001) described the need for a “Sustainability Science” and Gallopín et al. (2001) ask for a new way of performing research. Eleven years later, Van der Leeuw et al. (2012) state that there is still more rhetoric than an actual shift in scientific practices. Although the need for a new science is thus well known for quite some time, there is still little change to be found at universities.

In a world of finite resources, new, additional movements are often seen as competitors. This holds also true for research. As a relatively new concept of research and by expanding the concept of research into fields, which have not been considered as science so far, transdisciplinary or even transformative research is quite contested within the science community, and still has a minor role in science institutions. In GAIA, a major journal for transdisciplinary research in the German speaking countries, a debate has been going on about transformative research in 2014 and 2015 – in reaction to an article by Peter Strohschneider (2014) who confronts this type of research with a number of shortcomings like solutionism, dedifferentiation or the dissolution of (justified) borders by transdisciplinarity. This debate shows some of the epistemological and methodological based difficulties in changing the research setting at universities.

Moreover, research structures hinder a stronger development of transdisciplinary research. Current career models and tenure schemes do not provide adequate incentives to follow such a pathway of sustainability research (Yarime et al., 2012). Funding structures make it difficult to work inter- or even transdisciplinarily, as collaboration with stakeholders work requires long-term relationships, which contrasts with short-term funding for research projects (Van der Leeuw et al., 2012). Moreover, the societal value of research is often not an evaluation criteria in the funding process. Alternative funding schemes that especially consider these aspects would help to strengthen implementation-oriented research (Jäger and van Raggamby, 2013).

Another often-stated barrier to this kind of research is the fact that journals which accept inter- or transdisciplinary papers often have lower-impact factors (Van der Leeuw et al., 2012, Lee, 2006). Career models that are to a large extent based on this numerical factor preclude research approaches that are transdisciplinary. Furthermore, current higher education lacks training for skills that are needed in such research approaches (Whitmer et al., 2010, Van der Leeuw et al., 2012). Additional skills like moderation, facilitation, communication, etc. are not part of formal education, but they are also not given credit in the evaluation of research proposals (Jäger and von Raggamby 2013).

Finally, the characteristics of the main research institutions – universities – add another degree of complexity and make it especially difficult to change their way of functioning. One important feature of university are very specific power structures (Svanström et al., 2012, Sharp, 2002), that lack a single control point and include numerous subcultures. Simple top-down approaches do not work. Instead, specific, action-research oriented and iterative processes of change are needed (Svanström et al., 2012).

Sharp (2002) also adds that dominating mental models at universities lack the perception of universities as part of a finite world and that the critical mass for changing universities is still missing. The “myth of a rational university” makes them believe that “*they have reached the highest possible levels of functionality and whatever is lacking must be accepted as an inevitable limitation of the system.*” Also van der Leeuw (2012) diagnoses that “*academia suffers from anachronistic pedagogy, inertia, and disciplinary insularity and isolation*”, but hopes that this diagnosis is the beginning of a long process of change.

1.3. Research Question

Given the above-mentioned barriers and difficulties, the question remains how research institutions and universities have to change in order to provide framework conditions that allow and even encourage researchers to contribute to societal and sustainability-oriented transitions,

and how this change can be accomplished in a system whose self-reproducing features are a basic part of its self-picture.

This paper deals with the following research question: What can be learned from the cases of the BOKU sustainability strategy and the Alliance of Sustainable Universities in order to support universities to contribute better to a societal transition? Which factors can help to change universities in order to better contribute to a societal transition?

It focuses on the aspect of the change process, i.e. the question: How can a change process in universities best be organized and implemented that supports researchers to contribute to societal and sustainability oriented transitions?

1.4. Real-World Laboratories

As already mentioned above, specific, action-research oriented and iterative processes of change are needed (Svanström et al., 2012) in order to initiate a change at universities. This conference paper contributes by describing and analysing specific processes that take place at the BOKU University for Natural Resources and Life Sciences in Vienna and the Alliance for Sustainable Universities in Austria. The processes are long-term oriented, open and continuously reflected and analysed by the process coordinators. They live from a broad dialogue and interaction between the participants. The two institutions in their endeavour to become sustainable universities can thus be seen as the real-world setting of real-world laboratories.

Real-world laboratories are a paradigmatic approach of transformative research. They are defined as real-world settings or problems, where a science-led transformation takes place. The settings can be regions, cities, etc., but also institutions such as universities. As there is always an exchange between science and the real-world setting, a transdisciplinary approach is a prerequisite of a real-world laboratory (Ministerium für Wissenschaft, 2013).

Effective and successful real-world laboratories have to fulfil the following criteria (Wagner and Grunwald, 2015, Ministerium für Wissenschaft, 2013):

- co-design and co-production of the research process with the civil society
- transdisciplinary understanding of the process by actors
- long-term support and orientation of the process
- continuous methodological reflection
- coordination of the supporting research by institutions that are experienced in transdisciplinary research processes

Real-world laboratories are thus learning processes towards sustainability that combine a real-world setting with a research setting.

2. Research Context

2.1. BOKU University of Natural Resources and Life Sciences

The BOKU University of Natural Resources and Life Sciences in Vienna (BOKU) has traditionally focused on topics of agriculture and forestry. Thus, sustainability issues have always played an important role. Meanwhile the university broadened its topics toward spatial and infrastructure sciences, food science and biotechnology, environmental engineering, etc. Its outside and self-perception is still that of a sustainable university (Universität für Bodenkultur, 2014). It was the first Austrian university to be EMAS certified, one of the two first universities in Austria that published a sustainability report, it is highly ranked within the international Green metric ranking for universities and has received numerous awards for its endeavours. In 2010 the BOKU Centre of Global Change and Sustainability (gWN) was founded to promote internal and external cooperation and research at BOKU in the areas of global change and sustainability and to promote sustainability at BOKU – in academic areas (teaching and research) and in everyday

campus operations (green campus). It thus has the role of a change agent towards sustainability within the university.

2.2. Alliance of Sustainable Universities in Austria

The Alliance of Sustainable Universities in Austria (in the following: Alliance) was founded in 2012 as an informal network of universities that aims to promote sustainability issues in Austrian universities and thus contribute to a more sustainable society. Currently nine Austrian universities are members of the network. BOKU took a leading role in the formation of the Alliance, and still does in coordinating the activities.

Through its joint activities under one umbrella, the Alliance strengthens sustainability issues generally and also provides added motivation to its members to integrate sustainability at their institutions and provides support to their efforts. Each participating university commits itself to develop a sustainability strategy.

The main objectives of the Alliance are to exchange good and best practice-experiences and to start joint activities. It follows a whole-in-institution approach and covers the fields of research, education, operations, society/knowledge transfer, as well as identity. On a superordinate level, it aims more generally at anchoring sustainability issues at universities and thus to contribute to a sustainable society.

3. Results: Real-World Laboratories BOKU and Alliance

If universities themselves become real-world laboratories and cases of transdisciplinary research, the criteria and design of a real-world laboratory have to be adapted accordingly. Especially the relation between societal practice vs. scientific practice and definition of researchers vs. real-world stakeholders need to be defined.

The conceptual model of an ideal-typical transdisciplinary research project (Lang et al., 2012) shows a societal practice and a scientific practice that run in parallel and which are interwoven within the research project. Thus, actors from academia and actors from practice interact within the project, but they have different roles: i.e. they are responsible for the societal or the scientific process, respectively.

If universities themselves form the case, actors from academia are also actors from practice. Thus, it is more difficult to distinguish between the roles. For the work presented here, we distinguish on the one side between those who coordinate and lead the process. They take the research part, as they also focus on the scientific practice; on the other side are those who live and work in the real-case “university” – they take the part of the civil society stakeholders, although they might be researchers themselves. But they do not take a research part within the project discussed. They will be called “university stakeholders” in order to separate them from further parts of the civil society who are in the context of universities further important stakeholders: experts from ministries and administration, as well as the broader civil society with its expectations towards universities.

3.1. The BOKU Sustainability Strategy as a Real-World Laboratory

The BOKU sustainability strategy is an on-going process of implementing, learning, re-adapting, and trying out new approaches in order to contribute to a sustainable development of the university. As such it can be seen as a real-world laboratory within the BOKU.

The BOKU sustainability strategy was developed in 2013-14 in a broad participatory process that included about 140 researchers, students, and members of the university administration. A kick-off workshop collected first ideas on stakeholders to be involved, visions of a sustainable BOKU and the status-quo. In the following step, four thematic workshops revealed existing initiatives as well as fields of action in teaching, research, operations, identity and society (the latter two covering organisational culture, strategy and interactions with society). Each of the four

workshops was led by one member of the rectorate, a fact that also underlined the commitment of the university management. The discussion was led according to the AISHE tool (AISHE 2.0, 2012). This “Assessment Instrument for Sustainability in Higher Education” proposes six criteria for each topic, which built – in a slightly modified form – the basis for a status-quo analysis of sustainability at BOKU. Starting from this assessment, possible measures were collected in the AISHE-workshops that might help to move forward with regard to sustainability.

The workshops resulted in a catalogue of over 100 proposals for measures that could help BOKU to move forward with regard to sustainability. The total list of measures was ranked in a synthesis workshop. Finally the rectorate decided on about 20 measures. Some of them were realised right after the finalisation of the strategy development process. Some were started within 2014 and 2015. For a few it was decided to begin them in the performance period of 2016-18, and they are being discussed at the moment (summer 2016). The process was established for the first period of 2014-18, but the current performance agreement between the university and the Ministry of Science foresees a continuation of the process for the next performance period (2019-22).

The implementation process is coordinated by the same group as the development process. This group is experienced in transdisciplinary research and has a very strong understanding of stakeholder integration – both, with regard to stakeholders from within the university and with regard to stakeholders from outside university (experts, colleagues, ministries). A so-called reflection group meets regularly in order to discuss successes, shortcomings and failures of the process and to re-orient the methodological approach within the process.

Two years after the formal implementation of the strategy, a deeper reflection of the process revealed that some processes are going well, whereas there is no movement with regard to others. In particular it was possible to implement those measures that do not touch deeper structures of the university, e.g. energy analyses of university buildings, the possibility to hold “Green Meetings”¹. Measures mainly failed due to unclear and/or contradictory responsibilities or missing instructions – thus, the repeated attempt by the coordination group to initiate change did not show impact.

The Topic of Research within the Strategy

With regard to sustainability research, AISHE-workshop participants mentioned several times within the strategy process many of the difficulties and disadvantages for researchers doing inter- or transdisciplinary work, such as difficulties to publish in high-ranked journals, fewer funding possibilities, etc. Nevertheless, only two of the finally decided measures fall into the topic of research, which is due to the results of the weighting process:

- Establish cross-linkings between the departments of BOKU: this measure aims at strengthening the cooperation between researchers of different departments on specific topics. It was decided to start with the topic “sustainable energy”, which affects researchers from social research, technical sciences, planning, material sciences, etc. The BOKU Cluster on Sustainable Energy was established (see below).
- Enhance the interface of research and public relations with regard with topics of sustainability: this measure is planned to start in 2016/18 and comprises a regular screening of research projects with regard to sustainability related topics. This measure has not been further discussed so far.

Further measures touch research, such as the elaboration of a common understanding of sustainability including issues such as research, inter- and transdisciplinarity; or a yearly BOKU Sustainability Day to present i.a. sustainability research.

¹ „Green Meeting“ is the Austrian Ecolabel for Meetings and Events that meet strict criteria with regard to communication, transport, food, resource management, etc.
See <http://www.umweltzeichen.at/cms/en/green-meetings-and-events/content.html>

A farther reaching strategy with regard to a broader discussion of research for sustainability / transformative research at BOKU was considered as too controversial for the time being and former initiatives already proved to be difficult and inconclusive. The strategy process did not lead to enthusiasm to make changes in this respect.

Nevertheless, the gWN as coordinator of the sustainability strategy with agreement from the rectorate decided to keep the discussion going. The fact that research for sustainability was included as an important topic of the BOKU development plan 2015 (Universität für Bodenkultur, 2014) and finally, in the performance agreement with the ministry of research, shows that the university management is interested in the topic. The latter agreement states that BOKU's activities shall "ultimately contribute to the necessary transformation of the society and the economic system, in order to promote (combined technological, social and economic) innovations for a "Low-Carbon-Society" and a sustainable economic system. Within the topic of "cooperations", the performance agreement also mentions the development of a "feasible definition of the societal impact of research" as one field of action of BOKU together with the Alliance of Sustainable Universities in Austria. The coordination team builds on these references in order to take actions with regard to research for sustainability. One step that was taken in this regard is the invitation of Jill Jäger as a guest professor to BOKU.

Guest Professorship on Research and Sustainability

Jill Jäger's guest professorship from October 2015 to January 2016 included a series of lectures on "Implementation-oriented Research for Sustainability" and a seminar on "Criteria of sustainability in research and teaching". They were open to students, but special invitations were also sent to members of BOKU academia. Besides teaching, the guest professorship aimed at keeping the discussion going and further establishing the topic at BOKU.

The lecture series aimed to develop an understanding of why implementation-oriented research is needed for achieving sustainability, discuss methods for stakeholder engagement, identify necessary skills of researchers and discuss in detail the elements of implementation-oriented processes. Moreover, the particular role of visions and scenarios were illustrated and barriers for implementation-oriented research were examined. Also possible solutions, both in research funding and in education were considered.

In the seminar the participants were involved in a creative discussion about the kind of process needed for the introduction of sustainability research and respective criteria in a university environment. The participants developed a vision of "A world as we would like it..." and a vision about research and teaching at BOKU in 2030 that would contribute positively to the world-vision. Building on the "Vision and Principles for Harnessing Research and Development for Sustainable Development" that were developed by the Visions RD4SD-project (Jäger, 2013), the participants elaborated and ranked criteria that are important to promote and strengthen research for a sustainable development at the BOKU.

The visions and the criteria were presented to a larger circle of experts and university stakeholders (students, academia and ministry) in a final seminar. While during the semester only 2-3 members of academia visited the lecture/seminar – 15 persons came to the final workshop. The participants discussed points of action for implementing the vision and achieving the developed criteria.

As one of the main points the need for new structures at universities was mentioned. These structures should act as "laboratories for change" and allow for a far-reaching discourse that includes a system-oriented approach. Such laboratories could also allow for creative spaces within the "inflexible, oiltanker-like" university.

Second, the need for new decision mechanisms & incentives was discussed: Within universities decision structures are not clear. Universities are hierarchical institutions that include many heads. Moreover, research funds influence decisions strongly. Participants discussed partly contradicting (self-)perceptions of universities: universities as institutions with public funding

versus universities that compete for funding; universities as centres of education versus centres of research. Thus, universities need to develop clear positions and work on a change of values. If research for sustainability should be promoted the added value has to be communicated clearly.

A third main point of discussion was the dialogue with society and with other disciplines: Inter- and transdisciplinarity has to be fostered in research and teaching. But stakeholder participation has to be done carefully: Transparency, the influence of lobbies, heterogeneity of stakeholders were mentioned as critical issues. Also in the development of strategic papers and curricula, stakeholder integration has to be considered. Art was named as a special medium for this dialogue, as it addresses emotions and can thus help to raise awareness for the Grand Challenges and for the necessity of a transformation towards sustainability which also includes alternative behaviour at the personal level – both among scientists and among stakeholders. It therefore should be used to disseminate research results and to strengthen the bridges between science and societal stakeholders.

BOKU Cluster on Sustainable Energy

One of the challenges in research is the fact that collaboration (especially within one institution) between scientists is not very common. Missing incentives, funding regulations that ask for collaboration with other institutions/regions, but that do not acknowledge collaborations within one university, and the strong paradigm of disciplinary research hinder tight exchange and teamwork across institutes' boundaries. This dilemma was recognized during the development of the BOKU sustainability strategy and resulted in the initiation of a BOKU Cluster on Sustainable Energy.

Starting from a first analysis of energy research topics, all researchers concerned were invited to a first meeting that aimed at getting to know the research topics of each other. This first event resulted in a rough, but impressing picture of the wide expertise within BOKU, which touches technical, engineering, natural, social, and economic disciplines.

In order to get into action and provide stronger incentives for cooperation, a first research proposal was elaborated that integrated the wide expertise in order to contribute to the Austrian aim of a low carbon society. During the elaboration of the proposal difficulties of inter- and transdisciplinary cooperation became evident. The participating institutes have partly never collaborated before (especially disciplines that are very divergent in traditional disciplinary terms), thus they found it difficult to define their specific contribution to the common goal. Due to lack of time, no intensive discussion could be held that could have overcome this difficulty. The proposal was not approved by the funding institutions – one of the arguments that was brought forward by each evaluator in the one or other way was: *“The consortium's strength is also its weakness: a common project of different units within one university”*. The consortium thus could not prove that it is able to fulfil the tasks and provide the expertise within one organisation.

The next decisive step was a one day retreat of 25 energy researchers, which aimed at (a) taking a next step in getting to know each other and (b) elaborating guiding principles of collaboration. The deliberative methods included spatial positioning and follow-up group discussions along methods used in research and goals of research. In preparing the guiding principles the Group InVention Method (GIVE©) by SPES (Jungmeier and Stöglehner, n.y.) was applied, a democratic tool to collect ideas in a very efficient way also in big groups.

Based on the results of the retreat an editorial team wrote a “Guideline and Strategy for the establishment of a BOKU Energy Cluster”. The need for cooperation is argued by (1) the wish to contribute to the strategic development of energy policy and particularly of energy research policy at different levels, (2) the development of large collaborative projects, and (3) activities in the field of teaching and training. A main driver for collaboration is also the increasing demand to cluster – coming (informally) from the European (European University Association, EUA), and the Austrian level (Austrian Ministry for Transport, Innovation and Technology).

Table 1: Examples to promote transformative research according to the criteria of real-world labs

Criteria of real-world labs	Guest Professorship	Energy Cluster
Co-design and co-production of the research process with the civil society	Development of visions and related measures with students and guests from academia, ministry, administration.	Development of a cluster-strategy within energy researchers of BOKU
Transdisciplinary process understanding of actors	Given with regard to lecturer and hosts; transdisciplinarity given through guests, students and participants of the final discussion	Focus on interdisciplinary cooperation; transdisciplinarity aimed at through cooperation with funding institutions, industry, etc.
Long-term support and orientation of the process	4 month lecture series, but guest lecture as one part of the discussion / transformation	Starting process, no end-date
Continuous methodological reflection	By lecturer and hosts	Within the coordination group
Coordination of the supporting research by institutions that are experienced in transdisciplinary research processes	Lecturer and hosts experienced in transdisciplinary processes	Coordination group experienced in transdisciplinary processes

3.2. The Alliance of Sustainable Universities as a Real-World Laboratory

The Alliance functions as a real-world lab across universities. It is a continuous process of moving forward, overcoming hurdles and finding entry points for sustainability action. Depending on the constellation at each university, experts, members of rectorates, administration, and academia collaborate and further develop the process. “Experts” are those people at the universities who take responsibility for sustainability issues – most of them are experienced in transdisciplinary research as well.

A main step with regard to commitment and visibility was the signature of a Memorandum of Understanding by all rectorates in October 2015. It stresses the whole-in-institution approach and the collaboration with regard to the expert group, but also working groups and joint research and administrative projects. A common “Understanding of Sustainability”, elaborated by the Alliance experts, forms an important part of the Memorandum.

Table 2: The Alliance of Sustainable Universities according to the criteria of real-world labs

Criteria of real-world labs	Alliance of Sustainable Universities
Co-design and co-production of the research process with the civil society	Co-design between rectorates, experts, members of the ministry of research and science; co-production mainly within expert group in exchange with rectorates and academia/administration.
Transdisciplinary process understanding of actors	Given through coordination group.
Long-term support and orientation of the process	Informal process that has no defined end; long-term thinking with regard to processes/working groups that are planned and carried out.
Continuous methodological reflection	Continuous reflection of processes within expert group as part of their 3-4 meetings a year.
Coordination of the supporting research by institutions that are experienced in transdisciplinary research processes	Coordination group and most experts experienced in transdisciplinary processes

Symposium of Chances (original name: “Enquete der Chancen”)

Although research is one of the topics of the collaboration, it does not play a major role in the regular meetings, which might be due to the interests and the background of participants.

The topic got more attention when members of the Alliance were invited by the then Austrian president to discuss the issue of societal responsibility of universities in an informal meeting with the Austrian Minister of Science and Research. It resulted in the “Symposium of Chances”, jointly organised by the Alliance and the Ministry. It took place on October 6, 2015 under the topic of “Societal Responsibility of Universities”.

The nine member universities there presented a jointly elaborated working paper to the Minister which highlights two aspects of research that should be especially considered. The first one touched research and asks for a discussion of the societal and sustainability impact as an

additional criteria in the evaluation of research. The second one relates to teaching and asks for incentives for inter-university cooperation on the topics of sustainable development and Grand Challenges.

The symposium consisted of an input presentation by Dirk Messner who stressed the need for a new research paradigm and three public conversations between members of the rectorates, the Minister and a representative of the business sector. The conversations were facilitated by experts from the Alliance and addressed the topics “Societal responsibility of universities”, “What is responsible science?” and “Expectations of the economy towards universities”.

Dirk Messner, keynote speaker and Helga Kromp-Kolb, one of the organisers from the Alliance, summarized the main results at the end (Lindenthal et al., 2015):

- **transdisciplinarity and networks:** exchange and communication between researchers and between researchers and the society is necessary for excellent inter- and transdisciplinary research; also international and cultural networks are essential; only cooperation and combination of knowledge from different disciplines leads to system integration – which is needed to meet the challenges of our time.
- **time issue:** cooperation and building networks needs time and has to be taken into account in project and proposal evaluations; Global Change phenomena do not let much time: therefore competences have to be clustered, in order to gain tempo.
- **(inter)disciplinarity:** strong disciplinary research is necessary for good interdisciplinary work; moreover, researchers with skills to integrate knowledge and ability to understand processes are needed;
- disciplines need to **recognize limits and borders** of their work, then they can be overcome; conflicts (between disciplines, domains, within universities) need to be discussed at least, not necessarily solved; questions which are not addressed hinder humanity in its further development.

As a follow-up activity, a series of dialogue conferences between universities, economy/industry and civil society will take place in autumn 2016. These dialogue conferences aim at continuing the dialogue and starting closer cooperation between the above-mentioned stakeholder groups in order to discuss solution pathways in the respective fields. Four conferences will take place in autumn 2016 on specific topics like mobility, energy, sustainable entrepreneurship, or distributional issues. A continuation of the conference series in the following years is planned.

Table 3: The symposium of Chances according to criteria of real-world labs

Criteria of real-world labs	Symposium / Dialogue Conferences
Co-design and co-production of the research process with the civil society	Co-design between universities of alliance and the bmwfw; co-production of knowledge at the symposium and dialogue conferences
Transdisciplinary process understanding of actors	Given with regard to coordinating team; participants and discussants come from academia, industry/economy/civil society; transdisciplinary approach as main aspect of the process;
Long-term support and orientation of the process	Dialogue conferences only financed for 1 year, but continuation probable; continuation of the discussions as one aim of the conferences
Continuous methodological reflection	By hosts (experts of the Alliance)
Coordination of the supporting research by institutions that are experienced in transdisciplinary research processes	Given with regard to hosts

4. Discussion: Learnings from the Cases

What can be learned from the cases of the BOKU sustainability strategy and the Alliance of Sustainable University in order to support universities to better contribute to a societal transition? We identify key factors that can help to change universities in order to better contribute to a societal transition.

4.1. Broad Understanding and Integration of Culture of Cooperation

One factor that can be identified as a big success factor is trustful cooperation. Informal and trustful cooperation based on a common understanding of the urgent need of sustainability transition in society in general and in the areas of responsibility at universities is a key factor for the Alliance of Sustainable Universities. But also with regard to the BOKU sustainability strategy and the energy cluster the success of such a cooperation is shown in working groups and clusters. Working inter- and transdisciplinarily needs a culture of cooperation and dialogue, between people, departments and institutes of different disciplines, and in the case of transdisciplinarity also across the borders of university with stakeholders, decision makers or affected people.

In the case of the energy cluster, researchers named two reasons for cooperation: (a) the wish to contribute to a sustainability transition with regard to energy – thus recognising that cooperation is necessary to meet the challenges of a carbon-neutral energy system, and (b) the very practical reason that they hope cooperation would increase the success rate of project proposals. The need for cooperation was also stressed in the symposium of the Alliance and the final workshop of the guest professorship. In the Alliance and in the development of the BOKU sustainability strategy the deliberative approach strengthened cooperation for a common aim. Participants are willing to share their knowledge and experiences freely.

Although research and science is often characterised by competition (for funds, for positions, for findings), we found that most researchers we worked with are eager to cooperate and acknowledge the need to do so. Researchers are to some extent used to cooperate within research projects – which is often demanded by funding structures and concentrates on the issue of the research topic. A more open and trustful cooperation that aims at elaborating synergies, new research fields, co-design and co-production of knowledge is less frequently found.

In the case of project-related cooperation, missing incentives and funding regulations that ask for collaboration with other institutions/regions are probably one reason why it is sometimes difficult to encourage researchers to collaborate. Calls for projects and evaluation criteria of proposals do not acknowledge collaborations within one university, and the strong paradigm of disciplinary research hinder tight exchange and teamwork across institutes' boundaries (Whitmer et al., 2010).

The working culture at universities is another difficult setting for cooperation – especially if it is project independent: although the motivation of researchers at the BOKU and in the Alliance universities to cooperate and to take part in meetings, workshops, change processes is high in general, it is difficult to have processes going and to bring together a group of people regularly. Activities of the Alliance, the BOKU energy cluster, participation in the discussion process of the guest professorship are mainly voluntary. Although the university management has given the formal commitment and supports the processes, there is little or no possibility to have these contributions integrated in evaluations and merits from this work are sometimes not immediately apparent. Thus, the participation– though based on idealistic motivation – often has rather low priority, which leads to volatile participation in working groups and process events.

A further difficulty was recognised when a first joint proposal between different BOKU energy researchers was elaborated. While some of the researchers were used to inter- and also transdisciplinary research, others had so far mainly cooperated with research institutions and disciplines that are more closely related. For the latter it was difficult to find entry points in the joint research project and they argued that it was difficult for them to find out, how they can contribute best. This experience showed that getting to know each other is very important also within one institution. In order to cooperate successfully it is necessary to know who is working with which methods, researches which topics, and to build trust. This is very time consuming and needs continuous efforts. The fact that time was too short when the first proposal was developed was probably one reason for failing.

A culture of cooperation cannot stop at forming consortia for research projects, but means a project-independent atmosphere of mutual support, knowledge-exchange and the willingness for collaboration. It goes beyond cooperating within and between universities, but also includes science-society cooperation – which is also reflected in transdisciplinary co-design of projects and co-production of knowledge.

Especially project-independent cooperation is not yet anchored in the structures of a university. For the time being, it is mainly based on personal relationships, idealistic or intrinsic motivation (for a sustainability transition) and trust between the main players. In order to make them long lasting, it is necessary to integrate such cooperation within more formalised – yet not bureaucratic – structures. This need for new structures was also mentioned at the workshop of the guest-seminar. Such structures would need to support both the cooperation between researchers of one or more universities outside research projects and the cooperation with society. The energy cluster and the Alliance with their five working groups themselves are first attempts to develop such structures. In order to keep them running and extend the circle and intensity of participation, it would be necessary to develop further incentive structures. Developing criteria for cooperation in a wide sense and implementing them in funding and career evaluation schemes would be a further important step. Such criteria have a strong impact on the working culture and could thus change the habits and routines of work at university. As long as the working culture does not value open, project-independent (and transdisciplinary) cooperation, change processes will depend on individual actors who act on strong personal beliefs and conviction.

Cooperation with actors outside universities has also been shown to be an important success factor. Be it the informal and formal support of Ministry staff with regard to the foundation and major success stories of the Alliance, be it the interest and participation in the discussion process of the guest professorship by experts from Ministries and NGOs, or the participation and support of the discussion of the sustainability strategy at the BOKU – input and backing from outside the university helps to stress the importance of the topic within university.

In summary it was observed that in the field of sustainability transition open and project independent cooperation within universities and with external stakeholders is necessary, has positive effects and is wanted by university members. Nevertheless, it needs to be well prepared, well accompanied and it needs special structures that embed – especially project independent – cooperation. Universities must provide for such spaces to get to know each other (rooms, time, and incentives to come). They have to build up a new culture of cooperation and trust, replacing the currently dominating competition for funds, performance and recognition. The energy cluster and the Alliance are good examples for positive effects of openness and cooperation, but still they did not overcome other structural problems so far. A long-lasting success is yet to be proved in both cases.

4.2. Measurement of Societal Impact

Although research for a sustainable future must somehow have a societal impact, it is a challenge to measure it. Mentioning the necessity to develop measures for the societal impact in the BOKU developmental plan and as a central point in the joint working paper of the nine Alliance-rectorates corresponds with the international debate. Just recently, Krainer and Winiwarter (2016) made a proposal on how to measure social impact building on the concept of “productive interactions” (Krainer, 2014) and the four dimensions of observable impacts by Wiek et al. (2014) both in Krainer and Winiwarter (2016). The finding of evaluation criteria that measure the social/societal and the sustainability impact of science (in addition to the scientific impact) is a new field of research (Tàbara and Chabay, 2013, Wolf et al., 2013, Penfield et al., 2013, Wolf et al., 2015, Jörg et al., 2014, Holbrook and Frodeman, 2011).

Contributing to this debate will be an important factor in order to strengthen socially relevant research – on the one hand due to the fact that it helps keeping quality standards of research, on the other hand in order to contribute to evaluation systems for projects and career pathways of

researchers at universities that equate explicitly socially relevant research with disciplinary basic research that has no claim of being socially relevant. In the current university system, agreed quality measures would moreover give the possibility to implement an incentive system that motivates researchers to engage in transformative research.

4.3. Training and Skills

Competences that are needed for supporting sustainable universities in the fields of science, teaching, dissemination and knowledge exchange are currently not in the centre of academic training. These are mainly communication, facilitation and other interpersonal skills, as well as specific didactic skills in the field of Education for Sustainable Development (ESD). New forms of cooperation and collaboration demand new forms of communication and the knowledge of deliberative methods. The necessity for such skills was mentioned in several Alliance workshops and working groups, in the final workshop of the mentioned guest seminar, as well as in the symposium by several speakers and discussants. This is in line with findings from other inter- and transdisciplinary projects, like the InContext project (Jäger and van Raggamby, 2013).

A process like the development of the BOKU sustainability strategy, the implementation of an energy cluster, the success of the Alliance, or transdisciplinary processes in general cannot be achieved without integrating the knowledge, the experience, but also the concerns and doubts of all participants.

If universities want to contribute to a sustainable future and want to strengthen transformative research, they must invest in the development of such competences in their students, as well as in their researchers and the administration. Not all researchers must have such skills, but the process coordinators must and the share of people experiences in them must increase.

As one of the discussants at the symposium put it: Communication skills and the ability to enter into dialogue with actors of society gains increasing significance. The representative of the business sector argued that also with regard to teaching, additional skills are asked for: teachers do not only need to be competent in their research, but also live the values of sustainability, give orientation and be able to motivate their students.

4.4. Transdisciplinary Processes Orientation

Orienting the change process at universities along a transdisciplinary transformative research process helps to keep a high quality of the process and a high level of continuous reflection, but it also fits into the university culture and thus makes it more easily defensible.

Following the above-mentioned factors of cooperation, quality measurement and skills and building on the experiences from the processes of the BOKU sustainability strategy and the processes of the Alliance we argue that the following aspects were important in order to get the process going:

- Keeping personal (informal) and trustful contacts:
Keeping good and trustful relations with university stakeholders and building a good climate of cooperation and transparency is the basis for a good change process. Informal contacts are also important in order to explore possible ways or current limits of action.
- Opening doors, not breaking windows:
This saying is one of the leading mottos of our work which is based on the experience in the sustainability process at the Leuphana University of Lüneburg (Michelsen et al., 2008). Concentrating on issues, where strong opposition arises, takes much energy and can destroy good relations. Changing the subject, and finding other ways to deal with the controversial subject in another way or postponing it for some time, seemed more promising. Yet it is important to find a balance between giving up too soon and not provoking longer-lasting resistance. While trying to bring forward measures with less resistance, it is necessary to keep the discussion going in the more debated fields and to

work on “*establishing a sense of urgency*”, as named by Kotter (1995) as a first step to change.

- Seeking support from different groups in the university:
Inside support can come from academic staff, students, and administration. Their possibilities and ways to help might be different, but all of them are important. Students form a large group that can hold quite some power and open the field of opportunities, as they have other ways of getting active than employees. Students of many Alliance Universities are building a group with important impact in the field of Education for Sustainable Development and dissemination (events like Sustainability Days). But they are a fluctuating group that needs much time for staying in good contact (Lukman and Glavič, 2007). Academia usually has strong interests and needs returns on the time and energy invested. We observed that also those members of the academic staff, who have an interest in transdisciplinary sustainability-oriented work and should be strong partners, are busy with daily routines and for meeting disciplinary expectations, so that support is limited with regard to time needed. The same holds true for supporters from administration. Individually motivated and sustainability-committed members of the administration play a vital role in many success stories, especially in the field of environmental management at the Alliance universities. A key factor for success is the commitment by the rectorate for all these processes.
- Building alliances with supporters from outside:
In order to overcome the inertia of universities, diagnosed by Van der Leeuw et al. (2012), we found it helpful to get support from stakeholders outside the university. It need not be active support, but the fact that they articulate the necessity for change of research and university structures or that they stress the societal responsibility of universities helps to keep the momentum and find entry points for discussion.
- Formalise key factors:
Concentrating on having key factors integrated in strategic papers of the university needs good support from inside and outside the university (see above), but gives diverse advantages. The integration of
 - a sustainability strategy in the performance agreements of all nine Alliance universities,
 - the memorandum of understanding between the nine Alliance universities including many aspects of a sustainable university,
 - education for sustainable development (ESD) and needed social impact factors in the working paper of the Alliance rectors and in the BOKU development plan,support continuity even if central positions in the process change, and form an important entry point in discussions and argumentations.
- Building up a common basis for sustainability activities at universities with regard to language and a common understanding of sustainability: The participatory elaborated “Understanding of Sustainability” at BOKU serves as an important point of reference during the process. At the level of the Alliance, two documents build a common basis of important criteria of sustainability and the transformation at universities:
 - the understanding of sustainability of all nine Alliance universities
 - the handbook for preparation of sustainability concepts at universities
- Attempts from different sides:
The attempts described in the paper, i.e. theoretical discussion on the issue in the frame of the guest professorship, the installation of an energy cluster with more practical implications, activities on strategic level like the symposium or the BOKU sustainability strategy, follow different approaches with outcomes on different levels. Following a variety of approaches (a) gives the opportunity of mutual support, but also (b) increases resilience if one attempt has to be given up due to resistance, lacking resources, changing background conditions.
- Continuous reflection of the process:

On the one hand, it is important as a process coordinator to take a step back from time to time and to self-critically look at the process, its advances, but also its challenges and fall-backs. This internal reflection process support adaptations and necessary re-orientations of the process. On the other hand, it needs an external reflection which also reflects the work of the coordination group. Moreover, this external group enlarges the group of multipliers and can also support the coordination group to promote the process towards university management.

5. Conclusions

Supporting a transition towards a sustainable world needs new research approaches. They need to overcome disciplinary boundaries and follow a systemic approach in order to reflect the interconnectedness of real-world challenges. They need to integrate actors and stakeholders in order to include their preferences, knowledge, and intentions. Transdisciplinary research approaches for a sustainable development do so. Transformative approaches even go a step further and intend to act as a transformative force. Such research approaches differ strongly from conventional, disciplinary research. As university structures and cultures are adapted to conventional approaches, change processes are needed at universities that provide spaces for these upcoming research approaches.

This paper describes two real-world laboratories to start such change processes at the BOKU University and the Alliance of Sustainable Universities in Austria. Both processes aim at sustainable universities with regard to their operational performance, research, teaching and knowledge exchange with the society. The paper focuses on the research aspect.

It identifies three key factors that need to be addressed in order to support universities in taking their responsibility for humans' challenges: building a broad culture of cooperation at universities, valuing the societal impact of research by developing respective evaluation criteria and training researchers and students in those skills that are necessary to perform transdisciplinary and transformative research.

As universities are particular settings for change processes, it helps to apply conditions of transdisciplinary research to these processes. Learnings from the cases suggest that a careful, yet determined approach makes changes at universities possible.

6. Literature

- AISHE 2.0 2012. AISHE 2.0. Manual. Assessment Instrument for Sustainability in Higher Education. WU Version 1.
- GALLOPÍN, G. C., FUNTOWICZ, S., O'CONNOR, M. & RAVETZ, J. 2001. Science for the Twenty-First Century: From Social Contract to the Scientific Core. *International Social Science Journal*, 53, 219-229.
- GERZABEK, M., LINDENTHAL, T. & MAYR, H. (eds.) 2012. *Nachhaltigkeitsbericht 2011-2010*, Wien: Universität für Bodenkultur.
- HOLBROOK, J. B. & FRODEMAN, R. 2011. Peer review and the ex ante assessment of societal impacts. *Research Evaluation*, 20, 239-246.
- JÄGER, J. 2013. Eight Principles for Implementation-Oriented Research. *The First Global Conference on Research Integration and Implementation*. Canberra, September 8-11.
- JÄGER, J. & VAN RAGGAMBY, A. 2013. *How the EU can support local transition processes* [Online]. Policy Brief of the InContext-Project. Available: <http://www.incontext-fp7.eu/sites/default/files/InContext-PolicyBrief->

- [How the EU can support local transition processes.pdf](#) [Accessed August 5, 2016].
- JÖRG, B., WADDINGTON, S., JONES, R. & TROWELL, S. 2014. Harmonising Research Reporting in the UK–Experiences and Outputs from UKRISS. *Procedia Computer Science*, 33, 207-214.
- JUNGMEIER, P. & STÖGLEHNER, G. n.y. Group InVention Method (GIVE©) by SPES. *RURALpro BOOK OF INSPIRATION*. http://ruralpro.mtk.uniwest.hu/boi/index_boi.htm.
- KATES, R. W., CLARK, W. C., CORELL, R., HALL, J. M., JAEGER, C. C., LOWE, I., MCCARTHY, J. J., SCHELLNHUBER, H. J., BOLIN, B., DICKSON, N. M., FAUCHEUX, S., GALLOPÍN, G. C., GRUEBLER, A., HUNTLEY, B., JÄGER, J., JODHA, N. S., KASPERSON, R. E., MABOGUNJE, A., MATSON, P., MOONEY, H., III, B. M., O'RIORDAN, T. & SVEDIN, U. 2001. Sustainability Science. *Science*, 292, 641-642.
- KATHOLISCHE UNIVERSITÄT EICHSTÄTT-INGOLSTADT (ed.) 2015. *Nachhaltigkeitsbericht 2014_15*.
- KOTTER, J. P. 1995. Leading change: Why transformation efforts fail. *Harvard Business reviews*, March-April, 58-67.
- KRAINER, L. & WINIWARTER, V. 2016. Die Universität als Akteurin der transformativen Wissenschaft: Konsequenzen für die Messung der Qualität transdisziplinärer Forschung. *GAIA-Ecological Perspectives for Science and Society*, 25, 110-116.
- LANG, D. J., WIEK, A., BERGMANN, M., STAUFFACHER, M., MARTENS, P., MOLL, P., SWILLING, M. & THOMAS, C. J. 2012. Transdisciplinary research in sustainability science: practice, principles, and challenges. *Sustainability Science*, 7, 25-43.
- LEE, C. 2006. Boundary-crossing research meets border patrol, Perspective: Peer review of interdisciplinary scientific papers *Nature*, doi:10.1038/nature05034.
- LINDENTHAL, T., BOHUNOVSKY, L., ULMER, V. & LUKS, F. 2015. *Inhaltlicher Bericht zur "Enquete der Chancen: Gesellschaftliche Verantwortung von Universitäten"* [Online]. Wien. Available: <http://nachhaltigeuniversitaeten.at/wp-content/uploads/2015/09/inhaltlicher-Bericht-Enquete-final.pdf> [Accessed August 5, 2016].
- LUKMAN, R. & GLAVIČ, P. 2007. What are the key elements of a sustainable university? *Clean Technologies and Environmental Policy*, 9, 103-114.
- MICHELSEN, G., ADOMSENT, M. & GODEMANN, J. (eds.) 2008. *Sustainable University. Nachhaltige Entwicklung als Strategie und Ziel von Hochschulentwicklung*, Bad Homburg: VAS.
- MINISTERIUM FÜR WISSENSCHAFT, F. U. K. B.-W. (ed.) 2013. *Wissenschaft für Nachhaltigkeit. Herausforderung und Chance für das baden-württembergische Wissenschaftssystem.*, Stuttgart.
- OLDENBURG, C. V. O. U. (ed.) 2013. *Nachhaltigkeit an der Carl von Ossietzky Universität Oldenburg. Ein Bericht von Studierenden*.
- PENFIELD, T., BAKER, M. J., SCOBLE, R. & WYKES, M. C. 2013. Assessment, evaluations, and definitions of research impact: A review. *Research Evaluation*, 1-12.

- SCHNEIDEWIND, U. & SINGER-BRODOWSKI, M. 2014. *Transformative Wissenschaft. Klimawandel im deutschen Wissenschafts- und Hochschulsystem*, Marburg, Metropolis.
- SHARP, L. 2002. Green campuses: the road from little victories to systemic transformation. *International Journal of Sustainability in Higher Education*, 3, 128-145.
- STROHSCHNEIDER, P. 2014. Zur Politik der Transformativen Wissenschaft. *Die Verfassung des Politischen*. Springer.
- SVANSTRÖM, M., GRNDAHL, F., HOLMBERG, J., LUNDQVIST, U. & AREHAG, M. 2012. The university and transformation towards sustainability: The strategy used at Chalmers University of Technology. *International Journal of Sustainability in Higher Education*, 13, 219-231.
- TÀBARA, D., JÄGER, J., MANGALAGIU, D. & GRASSO, M. in preparation. Defining transformative climate science in the context of high-end scenarios. *to be submitted to Regional Environmental Change, Special Issue on the IMPRESSIONS Project*.
- TÀBARA, J. D. & CHABAY, I. 2013. Coupling human information and knowledge systems with social-ecological systems change: Reframing research, education, and policy for sustainability. *Environmental Science & Policy*, 28, 71-81.
- UNIVERSITÄT FÜR BODENKULTUR 2014. BOKU Entwicklungsplan 2015 genehmigt vom Universitätsrat am 3. Dezember 2014. Wien.
- VAN DER LEEUW, S., WIEK, A., HARLOW, J. & BUIZER, J. 2012. How much time do we have? Urgency and rhetoric in sustainability science. *Sustainability Science*, 7, 115-120.
- WAGNER, F. & GRUNWALD, A. 2015. Reallabore als Forschungs- und Transformationsinstrument Die Quadratur des hermeneutischen Zirkels. *GAIA-Ecological Perspectives for Science and Society*, 24, 26-31.
- WEAVER, P. M. & ROTMANS, J. 2006. Integrated Sustainability Assessment: what is it, why do it, and how? *International Journal of Innovation and Sustainable Development*, 1, 284-203.
- WHITMER, A., OGDEN, L., LAWTON, J., STURNER, P., GROFFMAN, P. M., SCHNEIDER, L., HART, D., HALPERN, B., SCHLESINGER, W. & RACITI, S. 2010. The engaged university: providing a platform for research that transforms society. *Frontiers in Ecology and the Environment*, 8, 314-321.
- WIEK, A., FARIOLI, F., FUKUSHI, K. & YARIME, M. 2012a. Sustainability science: bridging the gap between science and society. *Sustainability Science*, 7, 1-4.
- WIEK, A., NESS, B., SCHWEIZER-RIES, P., BRAND, F. S. & FARIOLI, F. 2012b. From complex systems analysis to transformational change: a comparative appraisal of sustainability science projects. *Sustainability Science*, 7, 5-24.
- WISSENSCHAFTLICHER BEIRAT DER BUNDESREGIERUNG FÜR GLOBALE UMWELTVERÄNDERUNGEN (WBGU) (ed.) 2011. *Welt im Wandel. Gesellschaftsvertrag für eine Große Transformation.*, Berlin.
- WOLF, B., LINDENTHAL, T., SZERENCSEITS, M., HOLBROOK, J. B. & HEß, J. 2013. Evaluating Research beyond Scientific Impact How to Include Criteria for

Productive Interactions and Impact on Practice and Society. *GAIA-Ecological Perspectives for Science and Society*, 22, 104-114.

WOLF, B. M., HÄRING, A.-M. & HEß, J. 2015. Strategies towards Evaluation beyond Scientific Impact. Pathways not only for Agricultural Research. *Organic Farming*, 1, 3-18.

YARIME, M., TRENCHER, G., MINO, T., SCHOLZ, R. W., OLSSON, L., NESS, B., FRANTZESKAKI, N. & ROTMANS, J. 2012. Establishing sustainability science in higher education institutions: towards an integration of academic development, institutionalization, and stakeholder collaborations. *Sustainability Science*, 7, 101-113.