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The RHESD Framework: Typology for Sustainability Research and Higher Education

Abstract

Research and higher education play a vital role in addressing today's sustainability challenges. However, different types of research and higher education contribute differently to societal sustainability transformations. This exploratory article proposes the RHESD Framework distinguishing four types of each Research and Higher Education for Sustainability according to key characteristics that lead to different degrees of sustainability-oriented societal impact. The authors aim to contribute to the development of precise notions of sustainability research and higher education to orient them more systematically towards societal sustainability challenges and support the development of targeted science policies.

Keywords

sustainability science, transformative science, sustainability impact, science policy

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Das RHESD Framework: Typologie für nachhaltige Forschung und Hochschulbildung

Zusammenfassung

Forschung und Hochschulbildung spielen eine zentrale Rolle bei der Bewältigung heutiger Nachhaltigkeits Herausforderungen. Unterschiedliche Typen tragen jedoch verschieden zu gesellschaftlichen Nachhaltigkeitstransformationen bei. Dieser Artikel schlägt das RHESD-Framework vor, das vier Typen von Forschung und Hochschulbildung für Nachhaltigkeit anhand zentraler Merkmale unterscheidet, die zu unterschiedlich starkem gesellschaftlichem Impact führen. Ziel ist es, präzisere Begrifflichkeiten zu entwickeln, um eine gezieltere Ausrichtung von Forschung und Hochschulbildung auf Nachhaltigkeits Herausforderungen zu ermöglichen und die Entwicklung von förderlichen Rahmenbedingungen zu unterstützen.

Schlüsselwörter

Nachhaltigkeitswissenschaften, transformative Wissenschaft,
Nachhaltigkeitsimpact, Wissenschaftspolitik

1 Introduction

The idea of sustainable development or sustainability⁵ describes development that aims for a good life for all people (inter- and intragenerational) within planetary boundaries and addresses social, environmental, economic and cultural aspects. Given current severely unsustainable developments (e.g., Richardson et al., 2023), sustainability transformations, i.e., profound changes in technical, economic, socio-cultural and institutional systems, are needed to restore and sustain livelihoods of present and future generations. Sustainability transformations are “(1) complex, multi-level processes, (2) [...] characterized by unpredictability, emergence and experimentation, (3) normative processes and (4) [...] directed, shaped, and co-created by governance approaches, future visions, social movements, relationships with nature and more” (Orr & Burch, 2025, p. 982).

Science, i.e. research and higher education, plays a crucial role in understanding sustainability challenges and in contributing to solutions which address them (Schneidewind et al., 2016). *Research* can generate new knowledge to understand sustainability problems and support the identification and development of appropriate sustainability-oriented solutions (Stephens et al., 2008). *Higher education* can provide students with necessary competencies and skills to understand and deal with sustainability problems (e.g., systems thinking or normative competencies) (Brundiers et al., 2021; Molitor et al., 2022) to become active agents of change (Stephens et al., 2008).

Discussions regarding the (re-)orientation of science towards sustainability have been taking place since the 1990s. Various concepts such as sustainability science (Kates et al., 2001), transformative science (Loorbach & Wittmayer, 2024; Schneidewind et al., 2016), mode 2 science (Nowotny et al., 2003), transdisciplinary science (Bergmann et al., 2005; Pohl & Hirsch Hadorn, 2006), higher education for sustainable development (Franco et al., 2019) or climate change education (Molthan-Hill et al., 2019) are being widely discussed and applied.

⁵ Both terms are used interchangeable in this article.

Calls for research and higher education to actively contribute to sustainability transformation processes (Büttner et al., 2023; Independent Group of Scientists appointed by the Secretary-General, 2019; Loorbach & Wittmayer, 2024; Messerli et al., 2019; Schneidewind & Singer-Brodowski, 2014; UNESCO, 2017; United Nations, 2023) are controversial (see e.g., Strohschneider, 2014). However, as Grunwald (2015) argues, it is not a matter of excluding traditional scientific approaches, but rather of (re-)orienting framework conditions, scientific structures and criteria of scientific excellence to take account of sustainability aspects and societal impacts (Hölscher et al., 2021; Loorbach & Wittmayer, 2024).

1.1 Problem framing and desideratum

In a project that aimed to identify criteria for assessing the impact of research and higher education of Austrian universities on societal sustainability transformations⁶, it became evident that a more precise distinction of types of *Research and Higher Education for Sustainable Development* (RHESD) was required. Currently, broad and diverse conceptions are used in scientific discussions and applied work at universities (e.g., concerning sustainability reporting) leading to ambiguity in terminology. Therefore, the proposed RHESD Framework distinguishes four types of sustainability research and higher education based on key characteristics to provide more precise notions in the field of RHESD.

⁶ For further project results please refer to: <https://boku.ac.at/nachhaltigkeit/nachhaltigkeit-in-der-forschung/wissensbilanzierung-und-nachhaltigkeit-projektergebnisse>

1.2 Development process and methodological limitations

The RHESD Framework was developed mainly in the context of Austrian universities with a focus on BOKU university and is thus considered exploratory. The development process, taking place from 2022-2023, included

- a. exploratory literature research (including scientific and grey literature) to identify existing RHESD definitions and typologies including key characteristics (see literature cited in Table 1);
- b. four exploratory expert interviews with experts in the field of RHESD from BOKU university to get deeper insights into important characteristics of RHESD and to guide further literature research;
- c. two workshops and follow-up discussions with 19 RHESD experts and relevant stakeholders⁷ to discuss the findings and initial versions of the RHESD Framework. The aim of these workshops was to assess the comprehensiveness of the RHESD Framework.

Methodological limitations include the exploratory character of the development approach and the Austrian context of most experts included. The authors acknowledge the exploratory character. Nevertheless, the inclusion of several feedback loops with experts in different settings (see b and c above) substantiates the consistency between literature findings and expert opinions. A potential geographical bias resulting from experts mainly based in Austria is balanced as the experts are part of the international scientific community and thus integrated broader perspectives in their feedback.

⁷ i) workshop at BOKU university with five participants associated with the working group on sustainability research; ii) workshop with 14 participants from the Austrian Alliance of Sustainable Universities; iii) online discussions with international working groups on ESD and international research groups working on university sustainability indicators.

2 Results

The RHESD Framework distinguishes four types of RHESD (Chapter 2.2) based on key characteristics (Chapter 2.1).

2.1 Key characteristics for distinguishing types of RHESD

Table 1 presents eight key characteristics used to distinguish the types of RHESD. It also indicates whether the key characteristic is applicable to research, higher education or both.

Table 1: Key characteristics distinguishing types of RHESD (own illustration)

Key Characteristic	Applying to		Distinction along
	Re-search	Higher Education	
Content	x	x	gradient from a a) <i>peripheral</i> to b) <i>strong focus</i> on <i>well-defined</i> sustainability concepts and aspects (Bellina et al., 2019; Frommherz, 2022; Independent Group of Scientists appointed by the Secretary-General, 2019; Schneidewind et al., 2016). Contents are e.g., SDGs, three pillars of sustainability, bulls-eye model, triangle of sustainability; resilience; system orientation; efficiency, sufficiency, consistency; justice; participation.

Modes	x	x	gradient from a) <i>monodisciplinary</i>, b) narrow <i>interdisciplinary</i> (van Dusseldorp & Wigboldus, 1994) and c) broad <i>interdisciplinary</i> (van Dusseldorp & Wigboldus, 1994) approaches (i.e., accounting for the interconnectedness of different systems (i.e., environmental, social, economic, cultural) (International Science Council, 2023; Spangenberg, 2011; Wiek et al., 2011), to d) <i>transdisciplinary</i> approaches (i.e., accounting for normative und societal-oriented concepts) (Büttner et al., 2023; Franco et al., 2019; Hugé et al., 2016; International Science Council, 2023; Loorbach & Wittmayer, 2025; Mochizuki & Yarime, 2015; Orr & Burch, 2025; Pflitsch & Menzel, 2026; Schneidewind & Singer-Brodowski, 2014).
Breadth of approach	x	x	degree of <i>systemic thinking</i>, consideration of <i>multiple perspectives</i> and <i>system-oriented trade-offs/synergies</i> to account for all relevant subsystems and the normative orientation of sustainability (Büttner et al., 2023; Franco et al., 2019; Frommherz, 2022; International Science Council, 2023; Loorbach & Wittmayer, 2025; Orr & Burch, 2025; Pflitsch & Menzel, 2026)

Efforts for societal impact	x	x	use of methods and practices that aim for societal sustainability impact (i.e., changes in perceptions, behaviors or practices in society) (Ladikas et al., 2022)
Types of knowledge	x	x	different sustainability-relevant <i>types of knowledge</i> (Pohl & Hirsch Hadorn, 2006) that are <i>generated</i> through research and <i>acquired</i> in education: a) <i>system</i> knowledge (i.e., understanding of systems and systems' interconnections), b) <i>target</i> knowledge (i.e., understanding desired future systems) and c) <i>transformation</i> knowledge (i.e., understanding corresponding change processes) (Büttner et al., 2023; Messerli et al., 2019)
Teaching approaches	NA	X	gradient from a) <i>transmissive</i> teaching (i.e., educational content is presented by teachers and reproduced by students) towards b) <i>participatory</i> and <i>transformative</i> teaching (i.e., actively engages students in knowledge creation (Bellina et al., 2020; Sterling, 2011) and supports 2 nd and 3 rd order learning (see below))

Levels of learning	NA	X	gradient from a) <i>1st order learning</i> (i.e., conformational, content-focused, no reflection on values and norms; “doing things better”), to b) <i>2nd order learning</i> (i.e., reformative, critically questioning assumptions and values, possibly leading to changes in perceptions, behaviors or values of learners; “doing better things”), towards c) <i>3rd order learning</i> (i.e., transformative, reflection of one’s own world views; “seeing things differently”) (Sterling, 2011)
Sustainability competencies	NA	X	gradient from teaching that focuses a) on <i>content</i> - towards teaching that supports b) <i>sustainability-relevant competencies</i> (i.e., participation, system thinking, co-operation or reflexive thinking) (Brun- diers et al., 2021)

NOTE: SDGs = Sustainable development goals; NA = not applicable

2.2 Types of RHESD

Based on these key characteristics, the RHESD Framework distinguishes four types of research and higher education. Figure 1 (research) and Figure 2 (higher education) visually represent the RHESD Framework. More intense colors indicate greater relevance of the key characteristic for the respective type. The waved lines indicate that the distinction between the four types is fluid. As frameworks always simplify reality, the RHESD Framework represents an idealized distinction.

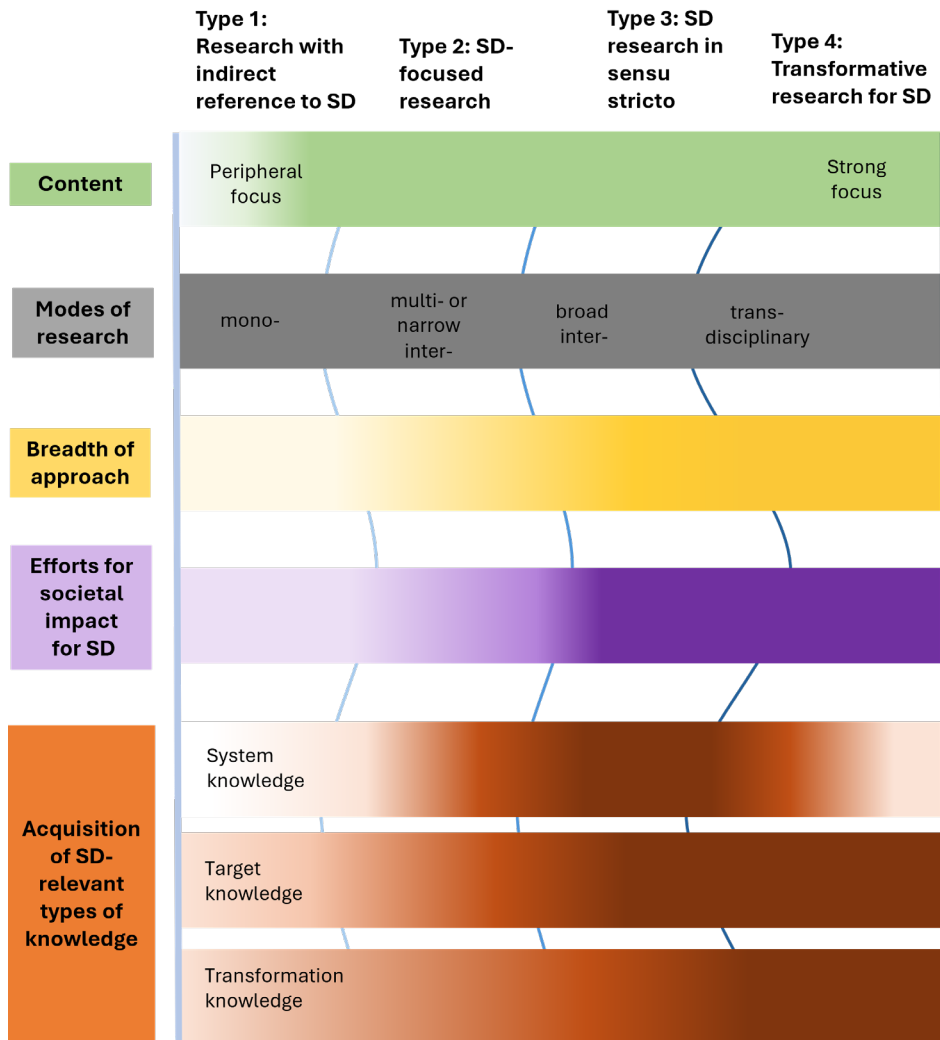


Figure 1: The RHESD Framework for research showing four types of sustainability research and their key characteristics (NOTE: SD = sustainability; own illustration)

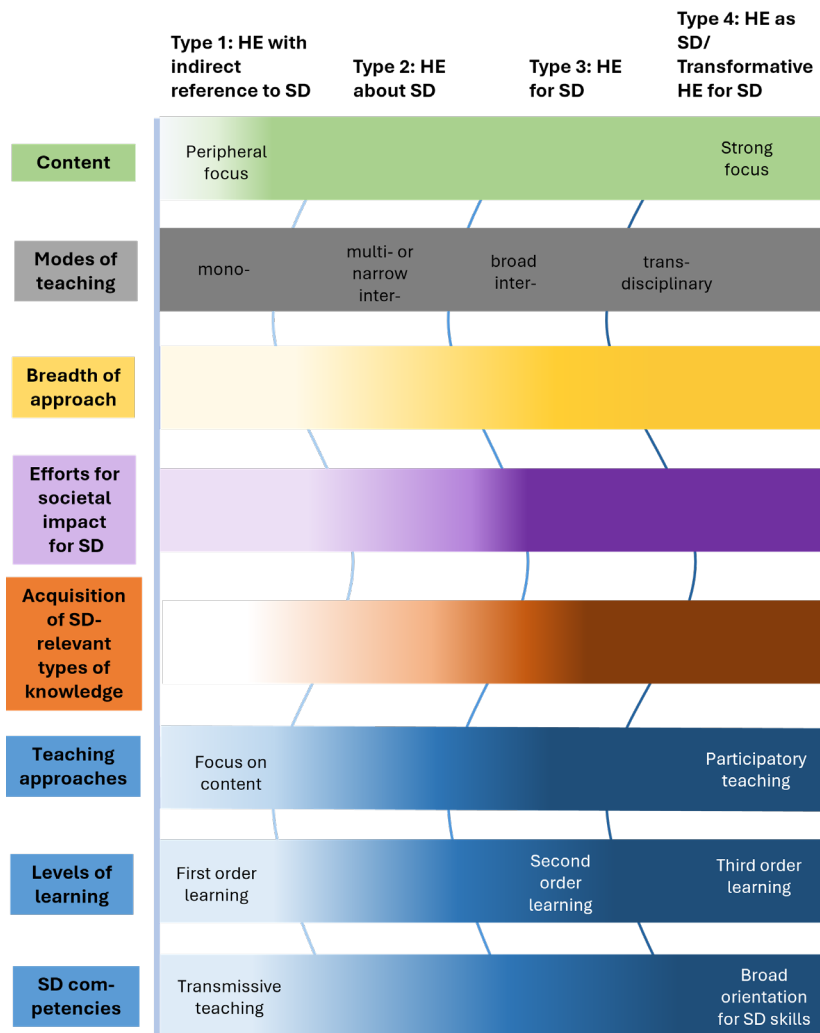


Figure 2: The RHESD Framework for higher education showing four types of sustainability higher education and their key characteristics (NOTE: HE = higher education, SD = sustainability; own illustration)

Type 1: RHESD with indirect reference to sustainability

This type refers to research that deals singularly with environmental, technical or social systems, where sustainability challenges are indirectly addressed. Therefore, this type of research only indirectly contributes to solving sustainability challenges. It uses monodisciplinary approaches and provides valuable disciplinary knowledge that can help to understand sustainability issues. Due to the lack of a systemic approach, it does not deal with trade-offs between different sustainability dimensions, thus generating little system knowledge. As stakeholders and their perceptions and demands are not integrated, this type does not produce target or transformation knowledge. Thus, its potential for direct sustainability-oriented societal impact is low.

Examples for this type of research are research on atmosphere dynamics, poverty research or research on how to make engines more efficient.

This type of higher education includes higher education on topics that may be relevant to sustainability, but they are not explicitly framed in a sustainability context. It often takes place in monodisciplinary courses (e.g., ecology, sociology) and provides knowledge about individual aspects of a particular system. It does not aim to train “change agents” who would have a societal impact or to promote sustainability-competencies. The focus is primarily on knowledge acquisition. Therefore, transmissive teaching approaches and first-order learning are adequate.

Lectures and programs on ecosystem services, environmental management, green chemistry or social justice are considered education with indirect reference to sustainability.

Type 2: Sustainability-focused research and higher education about sustainability

Sustainability-focused research (Hugé et al., 2016; Reimoser & Wedl, n.d.) addresses research questions related to sustainability topics (e.g., issues of SDGs). Different dimensions of sustainability are considered but not necessarily conflicts between them. This type is primarily produced in a science-to-science discourse,

merely considering the societal significance and impact of its results. This results in a relatively low aim for transformations, making transformation knowledge and the (broad) involvement of stakeholders less important.

Monodisciplinary research that contributes to the field of renewable energy, biodiversity, or climate change mitigation can be named as examples.

In higher education about sustainability (Mochizuki & Yarime, 2015), sustainability is thematically added to the current educational offerings to deepen the students' awareness, knowledge and understanding of sustainability. The basic curriculum and teaching approaches remain unchanged. Different perspectives and trade-offs between different sustainability issues and dimensions are only touched upon but not discussed or reflected in depth. Methodologically, the teaching of sustainability topics is based on lectures by experts (transmissive), as the goal is to increase the students' content knowledge. This results in first-order learning with little societal impacts.

First-order learning courses that address sustainable systems (e.g., sustainable food, mobility, energy, housing) are considered higher education about sustainability.

Type 3: Sustainability research in sensu stricto and higher education for sustainability (HESD)

Sustainability research in sensu stricto (Frommherz, 2022; Hugé et al., 2016; Reimoser & Wedl, n.d.; Vogt & Weber, 2020) is characterized by a direct and well-defined reference to sustainability challenges with contributions to their solution. This type of research acknowledges that sustainability problems are highly complex and systemic, necessitating a systemic and broad interdisciplinary approach that considers different sustainability dimensions and associated trade-offs and synergies. The focus is to generate system, target and to a lower extent transformation knowledge. This necessitates the integration of stakeholders, e.g., through participatory methods, thereby enhancing the potential for societal impact.

Research on and for sustainability transformation paths, including process dynamics, conditions and interdependencies, in the field of sustainable mobility, housing, energy or food systems are examples of type 3.

Higher education for sustainable development (Bellina et al., 2020; Mochizuki & Yarime, 2015) focuses on enabling students to become active change agents in sustainability transformations. Therefore, it focuses on learning and applying systemic sustainability-oriented knowledge from very different disciplines and on critically questioning non-sustainable societal processes. This is achieved by stimulating second order learning through critical discussion of assumptions about sustainability and solutions to sustainability problems from different perspectives. Relevant in this context is the application of the acquired knowledge and skills beyond the educational context to initiate societal changes towards sustainability.

Examples of HESD are courses on sustainability governance or classes which work on inter- and transdisciplinary case studies with a sustainability focus.

Type 4: Transformative research and higher education for sustainability

Transformative research (German Advisory Council on Global Change, 2011; Loorbach & Wittmayer, 2024; Schneidewind et al., 2016) differs from sustainability research in *sensu stricto* in its aim to actively initiate and catalyze societal sustainability transformation processes, i.e. its explicit intention to intervene. The explicit focus on sustainability-oriented societal impact and its interventionist character necessitates close cooperation between scientific and societal actors and thus transdisciplinary approaches. Transformative research for sustainability focuses on the production of target and transformation knowledge.

Transformative research⁸ can thus be understood as transdisciplinary research that co-designs and co-creates sustainable systems (e.g., energy, food, mobility) or transdisciplinary research on sustainable regional development including concrete change processes.

Transformative higher education (German Advisory Council on Global Change, 2011; Schneidewind et al., 2016) differs from HESD in its aim to stimulate third order learning, i.e., a critical reflection of learners' worldviews (Sterling, 2011), and thus providing fertile ground for the development of students' competencies to create and implement new and innovative solutions for sustainability challenges. This requires (disruptive) learning experiences that challenge current worldviews and thus is difficult to facilitate (Sterling, 2011). Transformative higher education offers opportunities, i.e. student-centered and participatory learning environments, where students play an active role in their learning process (German Advisory Council on Global Change 2011).

Courses that confront learners with new and challenging situations can trigger transformative learning and are considered transformative higher education⁹. For example, art interventions or applying acquired knowledge in unusual surroundings (e.g., in elderly homes or different cultural settings) can challenge current worldviews.

⁸ Although proclaimed for several years, transformative research is still in an experimental phase with few concrete examples.

⁹ Transformative learning in the context of sustainability is also in its infancy and little research on actual results are available.

3 Potential practical application

By articulating four types of RHESD, the RHESD Framework contributes to the development of more precise notions in the field of RHESD. Even though the distinction remains fluid, it sharpens the discussion on sustainability-oriented research and higher education. It increases the transparency of different RHESD types and supports the practical work of universities (of applied sciences) and non-university research institutions.

Distinguishing types of RHESD is particularly relevant for supporting further development of sustainability research and higher education, e.g., through targeted science policies. Bernhard et al. (2024), e.g., build on the RHESD Framework to screen, analyze and transform research and higher education in their Toolbox for the Transformation of Higher Education.

The RHESD Framework can be further applied to:

- serve as a transparent, efficient and consistent guideline for reporting on RHESD, e.g. as part of sustainability reporting to clarify which characteristics or types of RHESD are prevalent at a higher education institution;
- address RHESD more clearly in strategic papers or curriculum development, e.g. by making explicit which of the four types is/are a strategic goal;
- develop transparent and consistent criteria for funding schemes for RHESD based on the key characteristics, e.g., if funding organizations aim at transformative research, aspects such as transdisciplinarity or impact-orientation are main criteria for positive evaluation;
- help to develop evaluation and review criteria for RHESD at institutional, project or individual level, e.g., if universities want to enhance their sustainability profile or increase sustainability expertise, they can include above-mentioned criteria for individual evaluations in the context of career promotion or curriculum development;

- enable policy makers to support science with a high chance of sustainability-oriented societal impact, e.g., by providing research and higher education funding programs tailored to types 3 or 4.

4 Novelty of the RHESD Framework

Despite the already existing basic lines of this discourse and the focus of this paper on Austrian universities, the authors consider the newly developed RHESD Framework valuable for broader discussion in the RHESD landscape as it extends existing frameworks in important aspects:

- UNESCO (2017) highlights the equal importance of education and research in sustainability science and promotes the connection between the two. This consistent perspective is currently lacking in literature (e.g., Orr & Burch, 2025) and is addressed in the RHESD Framework.
- The RHESD Framework can be flexibly employed in the respective context (see Chapter 3).
- The RHESD Framework distinguishes a type not yet included in other frameworks: Type 1 research and higher education with indirect reference to sustainability. This allows for the inclusion and acknowledgement of research and higher education that provide important building blocks for understanding and strengthening sustainability without directly addressing sustainability challenges. Without this type, contribution assessments of research and higher education to sustainability transformations may be inaccurate or incomplete.
- The participatory approach consistently integrated expert perspectives in the development of the RHESD Framework.

With this exploratory article, the authors (1) call for awareness of differences and wish to stimulate a broader reflection on the types of RHESD and their charac-

teristics and (2) propose how to practically apply the RHESD Framework in the sustainability agenda and policies of universities (of applied science) and non-university research institutions.

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¹⁰ Austrian Federal Ministry of Education, Science and Research

¹¹ The project website as well as the German interim and final report and a detailed description of the distinctive characteristics can be accessed online: <https://boku.ac.at/nachhaltigkeit/nachhaltigkeit-in-der-forschung/wissensbilanzierung-und-nachhaltigkeit-projektergebnisse>

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