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ORIGINAL PAPER

Combining knowledge bases for small wins in peripheral regions. An analysis of the role of innovation intermediaries in sustainability transitions

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Abstract A growing number of economic geography scholars have discussed the spatial dimensions of sustainability transitions (STs), which entail radical changes in socio-technical systems to overcome societal, economic, and ecological problems. This involves innovation processes with a broad range of distinctive actors. Innovation intermediaries, such as universities and research institutes, are needed to support and accelerate the transfer of knowledge. Nevertheless, little is known about the influence of such actors on the configuration of the knowledge bases required for STs. This article presents insights from 14 semi-structured interviews with experts conducted in a regional innovation system (RIS) in East Germany. In cooperation with the Eberswalde University for Sustainable Development, we investigate four innovation intermediaries in the region of Eberswalde. The analytical framework links the concept of differentiated knowledge bases to small wins. Our results show that, first, in the Eberswalde region, the relevant actors involved in regional knowledge transfer focus predominantly on synthetic knowledge bases, such as experience-based knowledge of local area settings. Second, symbolic knowledge bases are crucial and often prerequisites for intermediary organizations to recombine knowledge bases and support the capability to innovate in regional knowledge transfer. Symbolic knowledge entails the ability to translate scientific findings to a language that can be understood by the various actors in knowledge transfer. Third, changes in organizational structures complement changes in cultural–cognitive and normative institutions to support innovation on a systemic level and foster change processes.

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1 Introduction

In recent years, innovation-focused research on economic geography has analyzed the effects of various combinations of knowledge sources and actors on the capability to innovate in regions (Asheim et al. 2011b; Fernandes et al. 2021). This has been accompanied by a growing recognition of the significance of sustainability-related challenges in pioneering innovation policy, particularly those that align with the objectives set forth in the Sustainable Development Goals (United Nations 2015). Consequently, innovation scholars have called for innovation policy to be redefined as a transformative framework to overcome "wicked" problems (Schot and Steinmueller 2018). Contextual and supporting conditions for sustainability-oriented innovation are central to accounting for the effects of such innovation on the economic, ecological, and social dimensions (Klewitz and Hansen 2014; Paech 2006).[1] Research on sustainability transitions (STs) outlines the importance of multi-level interaction for long-term changes in socio-technical systems (Loorbach and Rotmans 2010; Raven et al. 2012).

Until recently, the spatial dimension of ST and its effects on innovation processes have played a subordinate role in studies (Raven et al. 2012; Strambach 2017). In an emerging research strand, economic geography scholars examine the geographical characteristics of transition processes. They contribute to the literature by exploring the way in which geographical relatedness affects the development of emerging technologies (Hansen and Coenen 2015). Furthermore, geography scholars can help explain the dynamics of STs, addressing the need for greater sensitivity to place-specific factors that shape innovation processes and the effects of scale and regions' related interdependencies (Binz et al. 2020). Overall, the geography of STs requires further research. According to Binz et al. (2020), further research on geographical transitions should introduce "regional" and "urban" as categories related to the numerous factors of socio-technical systems. This directs the focus to not only singular socio-technical systems but also the effects of transitions through multiple socio-technical systems. Transition studies need to elaborate on theoretical frameworks exploring the trajectories and settings, such as norms or institutional frameworks, through which local regimes shape transition processes on certain geographical scales (Binz et al. 2020).

This study contributes to the discussion on knowledge bases, higher education institutions (HEIs), and their roles in STs. In their seminal paper, Asheim and Coenen (2005) present insights on the ways in which knowledge bases shape innovation processes. On this basis, Strambach's (2017) pioneering study links the concept

[1] Therefore, in this article, we consider innovations not only as technological novelties but also as innovations in economic and social systems and in lifestyles (OECD Statistics 2013).

of differentiated knowledge bases to STs. This analysis provides insights into the knowledge bases of heterogeneous actors in transnational cooperation. HEIs play a crucial role as knowledge generators in the development of knowledge bases. They have also been recognized as change agents that support and accelerate the diffusion of sustainability-oriented innovation (Radinger-Peer and Stoeglehner 2013; Stephens et al. 2008). The role of universities as drivers of regional transition processes depends on their boundary-spanning capacities. Such capacities are evident in a university's interactions with a wide range of actors, from business to civil society, and in the integration of knowledge from different disciplines, perspectives, and knowledge within the university (Pflitsch and Radinger-Peer 2018).

Overall, the literature is still in an premature state, particularly regarding the interplay between HEIs and their effect on knowledge bases in contributing to sustainability-oriented innovation. Accordingly, we apply an exploratory case study to assess the regional innovation system (RIS) of Eberswalde in Eastern Germany. The region was selected because of the structure of a peripheral innovation system with a central HEI—the Eberswalde University for Sustainable Development (EUSD)—that has an explicit focus on sustainability-oriented innovation. Central to our case study is the cooperation between the EUSD and three regional intermediaries. Our 14 semi-structured interviews with experts focus on knowledge bases in transition processes. We aim to answer the following research questions: In the Eberswalde region, what regional knowledge bases are recombined in the knowledge transfer of the EUSD and the three other intermediaries in service of sustainability-oriented innovation, and in what manner?

This study aims to connect the literature strand on the geography of STs with knowledge bases in regions. We focus on collaborative innovation process, particularly on the requirements for the transfer of knowledge between businesses, researchers, and administrative and societal actors. Our contributions are threefold. First, we investigate the recombination of knowledge bases in regional knowledge transfer. This extends Strambach's (2017) transnational approach to the regional level. Second, we apply the empirical insights to universities, providing regionally relevant knowledge for sustainability-oriented innovations that enable transformation processes (Pflitsch and Radinger-Peer 2018). Third, our case study presents exploratory insights with a dynamic perspective to examine the knowledge transfer of the EUSD and three affiliated regional intermediary organizations in the period between 1992, the year the university was founded, and 2020.

2 Literature review

2.1 Addressing differentiated knowledge bases and regional innovation systems

The concept of differentiated knowledge bases enhances the understanding of the conditions and emergence of innovations and knowledge flows (Asheim et al. 2007; 2011b; Asheim 2007; Asheim and Gertler 2005; Bennat and Sternberg 2020) and helps develop a broader understanding of knowledge-driven dynamics (Bennat and Sternberg 2020; Grillitsch et al. 2019). The early contributions of Nonaka and

Takeuchi (1995) and Lundvall and Borrás (1997) ocused on the interaction and transformation of implicit and codified knowledge to explain the creation and utilization of knowledge. Based on calls for the concept to be broadened (Johnson et al. 2002), three different knowledge bases have been defined (Asheim 2007; Asheim and Gertler 2005), forming the foundation of innovation (Asheim et al. 2017).

First, the analytical knowledge base—also called "know-why"—is built on scientific knowledge derived by deductive, abstract models, theory formation, and testing (Asheim et al. 2011a). It is largely codified and universal, due to its high degree of abstraction, and thus is transferable over distance (Manniche 2012). Second, the synthetic knowledge base—also called "know-how"—is linked to the application or new combination of existing knowledge (Asheim et al. 2011a). This knowledge can be acquired as a result of tests, experiments, simulations, or practical work within a company or in exchange with customers or suppliers (Jensen et al. 2007). Parts of this knowledge are inherently implicit and therefore spatially specific, but there may also be codified and easily transferable parts (Manniche 2012). In the case of applied research, research and development (R&D) and codified knowledge are often based on synthetic knowledge bases. Thus, this codified synthetic knowledge tends to be generated in an inductive process of experimentation, testing, or computer-based simulation (Asheim et al. 2011b). Third, symbolic knowledge—also called "know-who"—is associated with the innovative creation and economical use of the esthetic values and attributes of products, such as product design (Asheim et al. 2011a). Therefore, this knowledge base is strongly related to the generation of immaterial values of meaning and desire and not to material technical products, differentiating it from synthetic and analytical knowledge (Asheim et al. 2011b). It emerges from interactions with clients or actors in professional networks and involves "open-ended, creative and artistic thinking, performance and interaction" (Manniche 2012).

The existing combinations of knowledge bases in regions reflect an important structural factor of regional innovation systems and, consequently, of specific regional innovation policies (Asheim et al. 2017; Bennat and Sternberg 2020). The RIS approach highlights the role of geographic proximity in knowledge transfer and localized learning processes among regional actors (Asheim et al. 2016; Sternberg 2007). Within the institutional framework of RISs, the central actors are companies—the users of knowledge—and universities, private and public research institutes, and intermediary organizations—the generators of knowledge (Asheim et al. 2016; Asheim and Coenen 2005). RISs incorporate regions with varying institutions and degrees of structures. Important studies in the RIS literature argue that diverse types of regions face different sorts of systemic challenges (Isaksen 2001; Isaksen and Trippl 2017; Tödtling and Trippl 2005). Consequently, peripheral regions, such as the Eberswalde region, that have weak organizational support and infrastructure can be classified as organizationally thin RISs (Isaksen and Trippl 2016; Tödtling and Trippl 2005).

Universities play an essential role in RISs as generators of knowledge and as intermediaries between public and private actors (Cooke 2004). Specifically, universities respond to the regional demand for knowledge, especially among actors that have difficulty integrating new knowledge sources (Muscio 2007). Given that universities are challenged to make social, cultural, and economic contributions to

regional development, in addition to the traditional goals of conducting research and providing education (Carayannis and Campbell 2012; Etzkowitz and Leydesdorff 1995; Trippl et al. 2015), universities function as innovation intermediaries (European Commission 2009; OECD 2007). Innovation intermediaries broker between other actors in innovation systems (Howells 2006; Janssen et al. 2020; van Lente et al. 2003). For universities to play a role in RISs, effective knowledge transfer needs to meet the regional requirements for specific knowledge bases. Knowledge transfer ideally occurs through mutual knowledge exchange, with feedback loops between different actors from business, research, administration, and civil society (Grundel and Dahlström 2016) to provide cultural, educational, and social benefits to society (Formica et al. 2008).

The literature on RISs has discussed not only knowledge flows inside an RIS but also extra-regional knowledge sources (Chaminade et al. 2019; Martin et al. 2018; Trippl et al. 2017). In this regard, universities with access to global knowledge networks play a crucial role as intermediaries for regional actors. They also attract actors who have access to global academic knowledge pertinent to the region and support entrepreneurial activities through the creation of spin-offs (Chaminade et al. 2019). National and regional innovation politics often play a crucial role by supporting new knowledge links in regions, where they fund regional initiatives and projects of regional actors such as universities (Chaminade et al. 2019).

2.2 Differentiated knowledge bases and knowledge transfer

Previous studies have argued that the knowledge transfer of analytical, synthetic, and symbolic knowledge bases requires intra- and inter-organizational social learning practices, depending on socio-spatial contexts (Asheim 2012; Asheim and Gertler 2005; Asheim et al. 2007; Manniche and Testa 2018; Mattes 2012). Accordingly, specific knowledge transfer channels are necessary for the transfer of analytical, synthetic, and symbolic knowledge bases (Yruela and Fernández-Esquinas 2015). Therefore, universities need to adapt their knowledge transfer to the existing knowledge bases of their regions and their demand for innovation support in order to play an effective role in RISs.

Historically, it has been argued that analytical knowledge can be effectively transferred in technology transfer without geographical proximity through extra-regional knowledge linkages (Chen and Hassink 2020). This knowledge base is largely built on explicit knowledge that can be codified easily and is less dependent on social and geographical proximity (Mattes 2012). Sectors with dominant analytical knowledge bases predominantly use codified R&D results, such as patents and publications (Asheim 2007). However, only a small fraction of companies use analytical knowledge bases to improve their competitiveness (Grillitsch et al. 2019; Yruela and Fernández-Esquinas 2015), as the majority of companies (i.e., small- and medium-sized enterprises—SMEs) have limited or no capacity to conduct R&D (Grillitsch et al. 2019; Tödtling and Trippl 2005). Even companies with strong analytical knowledge bases, such as those focusing on patenting, rely on informal channels of knowledge transfer (Gulbrandsen et al. 2011).

Synthetic knowledge bases require greater involvement of actors in the process of knowledge exchange. Such knowledge bases rely on tacit knowledge (Asheim et al. 2011a), which is connected to geographical, cultural, and social contexts (Tödtling and Trippl 2016). Without interaction between the knowledge provider and user, tacit knowledge is difficult to convey and detach from the social context (Bozeman 2000). Furthermore, transfer activities for synthetic knowledge bases consist of the synthesis and recombination of different forms of knowledge (Yruela and Fernández-Esquinas 2015). In particular, learning in this context is considered collaborative, with the application of bottom–up approaches (Mattes 2012). Effective knowledge transfer for synthetic knowledge entails offering advice, practical support through applied research, and tailored analyses (Yruela and Fernández-Esquinas 2015).

The transfer of symbolic knowledge requires localized learning and bi- or multidirectional interaction. Symbolic knowledge is characterized by tacit knowledge and its context-specificity (Asheim et al. 2011a; Martin and Moodysson 2011b), depending to a large extent on location, class, gender, and other contextual factors (Asheim and Hansen 2009; Gertler 2008). Symbolic knowledge is also characterized by the norms, habits, and everyday cultures of various social groups (Asheim et al. 2011a; Gertler 2008). Knowledge transfer in RISs has been discussed in terms of the integration of civil society actors, participatory activities, and participatory communication to enable shared and mutually localized learning (Grundel and Dahlström 2016).

Research has concentrated mostly on the perspective of differentiated knowledge bases. According to various studies, innovative companies combine numerous kinds of knowledge bases (Grillitsch et al. 2017, 2019; Jensen et al. 2007; Tödtling and Grillitsch 2015). Knowledge bases are required in companies as compound mixes, depending on the different phases of the innovation process (Asheim et al. 2011a; Moodysson et al. 2008), even in cases where one knowledge base is dominant in an industry (Martin and Moodysson 2011a). In a Spanish case study, Pinto and Fernández-Esquinas (2018) show that industries with dominant analytical knowledge bases depend on synthetic or symbolic knowledge for implicit co-transfer. This affects the role of knowledge transfer and the perception of its effectiveness (Pinto and Fernández-Esquinas 2018).

In this context, actors' analytical and synthetic knowledge absorptive capacity accelerates through the use of symbolic knowledge in knowledge transfer. According to Akgün et al. (2019), such absorptive capacity allows not only firms but also other actors to connect knowledge with external knowledge and to enhance its usability (Akgün et al. 2019; Cohen and Levinthal 1990). Thus, a common shared language within organizations contributes to knowledge-sharing and diffusion. In particular, language is relevant as a set of symbols that a group has agreed on to bring a shared understanding or meaning to events, objects, or experiences (Samovar et al. 2010). This enables members of an organization to share their knowledge with other members and to learn collectively (Akgün et al. 2019). It serves as a framework for shared understanding and community building (Kleinsmann et al. 2010) and can therefore be understood as a part of informal institutions. The symbolic knowledge of intermediaries functions as a link between the absorptive capacity of an organization and external analytical knowledge. By successfully addressing the common language

of an organization, an intermediary supports the translation of analytical knowledge to the common language and provides access to otherwise inaccessible external knowledge.

Although many studies have elaborated on knowledge transfer and knowledge bases, differentiated knowledge bases have not yet been investigated in the context of regional knowledge transfer, to the best of our knowledge. Our study expands the perspective on knowledge bases by exploring knowledge bases in civil society and their combination with other knowledge bases.

2.3 Recombination of differentiated knowledge bases for small wins

Stemming from the public administration and environmental governance literature, the concept of small wins helps in addressing multidimensional societal problems. Small wins constitute in-depth changes which develop transformative change through bottom–up and top–down mechanisms (Termeer et al. 2017). Thus, small wins entail small-scale innovations which can be found in different contexts and are incremental in nature (Bours et al. 2021). Through the accumulation of many small wins, these incremental innovations can drive transition processes to solve complex and multidimensional societal problems (Termeer et al. 2017; Urpelainen 2013). Just like radical transformations or "big wins," the accumulation of small gains enables deep transformative change away from the status quo of society, when it is guided by a larger vision of change (Termeer et al. 2015). Four fundamental characteristics of small wins have been discussed in the literature (Termeer and Dewulf 2019). First, small wins lead to results which are visible for the involved actors. Second, they foster in-depth changes of practices and institutions such as routines, beliefs, or values (Bours et al. 2021). Third, small wins are of moderate importance, as they are implemented at the regional level and limited in their effects. Fourth, small wins are actions that are beneficial to a group of actors but not directly harmful to opponents, even though a positive response by one party can be perceived as harmful by another (Termeer and Dewulf 2019).

Small wins conceptualize local or regional transition processes among a broad variety of actor types and interactions. Small wins may constitute a strategy to deviate from existing normative and social–cognitive institutions of the involved actor groups (Bours et al. 2021). Therefore, the small gains approach also has aspects of social innovation and can facilitate the analysis of regional STs. Addressing the place-specific institutional and social environment and understanding potential institutional barriers in certain niches are crucial for sustainability-oriented innovation and, consequently, for systemic changes (Rodríguez-Pose 2013; Smink et al. 2015; Strambach 2017).

The differentiated knowledge base approach is theoretically valuable for the small-wins approach, because it conceptualizes the interaction of technological and science-based knowledge with different mixes of tacit and codified knowledge (Asheim 2007; Manniche 2012; Strambach 2017). Effectively addressing the institutional environment of the involved actor groups requires place-specific symbolic knowledge (Strambach 2017). This is crucial for a small-wins strategy, because small wins aim to alter the informal institutions and therefore the institutional environment

of the involved actor groups. Furthermore, addressing the institutional environment facilitates the detecting and overcoming of potential institutional barriers in certain niches, which is as crucial for a small-wins strategy as it is for other transition strategies (Bours et al. 2021; Rodríguez-Pose 2013; Smink et al. 2015; Strambach 2017).

In summary, ST theory provides an understanding of how transition processes move socio-technical systems toward sustainability. The small-wins approach also shows that accumulated incremental innovations can drive transformative change. However, the social aspects of these change processes are not yet fully understood. The concept of a differentiated knowledge base can complement transition theory through the symbolic knowledge base category. Little is currently known about how the combined utilization of differentiated knowledge bases of heterogeneous actors affect and facilitate STs. Our case study addresses this research gap. As a first approach, Strambach (2017) highlights the importance of symbolic knowledge in the transnational cooperation of actors with different cultural backgrounds. Our study aims to build on those findings and extend the understanding of the context of regional knowledge transfer among heterogeneous actors.

3 Methodology and research design

This section discusses the methodological basis that links the methods to synthesis and theory building. We use a case study approach (Eisenhardt 1989; Ridder 2017) to expand theoretical concepts and models, going beyond the status quo in terms of the role of knowledge bases in STs. In the exploratory phases of research, case studies effectively describe and investigate new or surprising empirical phenomena. Multiple case studies help reveal the multidimensionality of empirical phenomena by analyzing the differences within and between cases (Yin 2018). The empirical material facilitates insights into the ways in which the different knowledge bases of heterogeneous actors are recombined into sustainability-oriented innovation through knowledge transfer. The material should also help in understanding the structure of the RIS of the Eberswalde region and the actors involved.

For our empirical study, we conducted semi-structured interviews based on a guideline with representatives of the EUSD and regional organizations actively involved in regional knowledge transfer as intermediaries between different actors. Regarding the selection of interviewees, employees of the transfer office of the EUSD were interviewed (contact had already been made with these employees before the start of this study). Afterwards, snowball sampling following the example of Radinger-Peer and Pflitsch (2017) was applied to identify relevant actors involved in regional knowledge transfer. First, the interviewed members of the transfer office gave recommendations regarding the most active members of EUSD faculties engaged in knowledge transfer. Second, the interviewed faculty members recommended active EUSD members and important intermediary organizations that partner with the respective EUSD faculties in regional knowledge transfer.

During the interviews, the interviewer repeatedly referred to the previously introduced problem (Assarroudi et al. 2018; Mayring 2012). The interview guideline

Table 1 Key questions in the four interview sections

Section 1: Knowledge transfer	Please describe the organizational structures of regional knowledge transfer
	Please exemplify how knowledge transfer projects take place in the region
	How does knowledge transfer trigger learning processes?
Section 2: Innovations and the innovation process	Please describe the innovations created or currently being developed
	Please describe your role in innovation processes
	What role do universities, experience-based knowledge, and communication-based knowledge play in the innovation process?
Section 3: Regional innovation system	What kind of cooperation exists among regional actors?
	How durable is the cooperation? What actors have joined or disappeared over time?
Section 4: Sustainable development	What role does sustainable development play in your organization/work?
	Please describe the role of innovation in sustainable development

distinguished between the main questions, which were always asked, and detailed questions, which varied significantly in wording and were added or omitted as needed (Azul 2016). The interviewer had already dealt with theoretical and empirical findings relevant to the problem (Mayring 2016). The questions themselves were formulated as open-ended questions so that the interviewees could answer freely and provide a rich data set (Kuckartz 2019; Mayring 2015). The interviewees were former employees or were currently working for one of the faculties or intermediary organizations, covering a period from the establishment of the EUSD in 1992 to 2020. At the EUSD, former and current professors and research assistants from three of the four faculties of the university were recruited as respondents.

The semi-structured questionnaire was divided into four sections (see Table 1). First, we began with the general structure and activities of knowledge transfer and the initiated learning processes. Second, we discussed targeted and implemented innovations during knowledge transfer projects and knowledge bases. Third, we asked about long-term cooperation and networks between actors in regional knowledge transfer. Finally, the respondents were asked about the role of sustainable development and sustainability-oriented innovation in regional knowledge transfer.

Interviews were conducted with 14 experts between March and May 2020. The interviews lasted between 52 and 150 min. They were recorded, transcribed, and discussed among the authors. The interviewees' statements were checked and, if necessary, supplemented by consulting other publicly available sources. To evaluate the interview data, we used content-structured qualitative content analysis, which consists of dividing interview materials into categories and subcategories derived from the literature that is relevant to the research questions (Kuckartz 2018). All main categories and subcategories are listed in the coding guideline (Table 3 in the Appendix). Under the main category, "knowledge bases," we analyze the role of knowledge bases in regional knowledge transfer, using proxy terms in the questions to make them easier to understand. These proxy terms are "academic knowledge" for analytical knowledge bases, "experience knowledge" for synthetic knowledge bases, and "communication knowledge" for symbolic knowledge bases.

4 Empirical setting

In this section, we provide a brief description of the faculties of the EUSD and the three intermediary organizations, as well as the regional knowledge transfer structures to which they are linked. In order to address the heterogeneity of the university's support of the innovation process, three faculties were selected to expose the differences in the promotion of small wins and in the support for the building of regional knowledge bases.

The research capacities of the East German economy subsystem and the infrastructure of knowledge-intensive business services are more weakly developed than in West Germany (Kujath 2015). This is especially the case in the Eberswalde region, where nearly all enterprises are small and there are almost no private innovation agencies or larger enterprises with research divisions. This organizational thinness is a result of the economic transformation process in East Germany, which was, especially in the Eberswalde region, followed by de-industrialization and the closure of most large manufacturing enterprises (Blum 2011). Therefore, in contrast to West Germany's universities and public research institutes, those of East Germany play a more crucial role in RISs in terms of providing human and financial resources for research projects (Kujath 2015). East German universities must not only generate knowledge but must also recognize extra-regional knowledge sources that can be useful for regional actors and then transfer that knowledge to these actors via the "antenna function" (Fritsch et al. 2007). This helps small enterprises overcome their low knowledge absorption capacities and implement radical innovations.

Indeed, the EUSD plays an active role as the intermediary of innovation in the Eberswalde region. Among other intermediaries in the region, the EUSD has a reputation as a promoting incubator for the practical implementation of theoretical projects. The initiated knowledge transfer projects of the EUSD serve as niches which promote sustainability-oriented innovation for incubation (Geels 2020). In general, the EUSD is known as a reliable partner because of its presence in regional media and projects.

Inside the EUSD, the Faculty of Forest and Environment (faculty 1), the Faculty of Landscape Management and Nature Conservation (faculty 2), and the Faculty of Sustainable Business (faculty 4) were selected for in-depth analyses of their effects on knowledge bases and their contributions to small wins.[2] A transfer center supported the faculties in their knowledge transfer, from which two staff members were interviewed to obtain a general overview of the overall transfer activities of the EUSD. We also interviewed members of three regional intermediary organizations, each of which had a close partnership with the three faculties (see Table 2). For each of the external stakeholders, a regional organization that had a close relationship with a specific EUSD faculty was selected. These intermediary organizations are the State Competence Center Forest Eberswalde (SFE) for faculty 1, the Biosphere Reserve Schorfheide-Chorin (BRSC) for faculty 2, and the Chamber of Commerce and In-

[2] In light of the close links between the transfer activities of faculty 3 and those of the transfer center and faculty 4, we decided not to include it in our sample.

Table 2 Interviewee details

Number	Organization	Status	Position	Professional network
1	Faculty 1	Active	Professor	Forestry
2	Faculty 1	Retired	Professor	Forestry
3	SFE	Active	Transfer-specific	Forestry
4	SFE	Retired	Management	Forestry
5	Faculty 2	Active	Professor	Ecological land use
6	Faculty 2	Active	Professor	Ecological land use
7	BRSC	Active	Management	Ecological land use
8	BRSC	Retired	Management	Ecological land use
9	Faculty 4	Active	Professor	Commerce and industry
10	Faculty 4	Active	Professor	Commerce and industry
11	CIEB	Active	Management	Commerce and industry
12	CIEB	Retired	Management	Commerce and industry
13	Transfer Center	Active	Transfer-specific	Superordinate
14	Transfer Center	Active	Transfer-specific	Superordinate

dustry of Eastern Brandenburg (CIEB) for faculty 4. Employees in management or knowledge transfer positions were interviewed.

Structurally, the RIS of the Eberswalde region consists of relatively autonomous networks of actors. However, there are also interfaces between these networks through individual organizations or individuals. The collaborative relationships are integral parts of the three networks of knowledge transfer. First, the network of faculty 1 and the SFE is primarily focused on forest owners and foresters of private and state forests as stakeholders. It also includes other stakeholders in the forest ecosystem, such as conservationists. Second, the network of faculty 2 and the BRSC includes actors in the fields of organic agriculture, ecotourism, and nature conservation. These actors are farmers, beekeepers, nature conservation associations, administrations such as the county, and food processing companies or schools in the field of environmental education. Other important partners of the BRSC in projects are supra-regional universities aside from the EUSD, such as the University of Greifswald. Third, the network of faculty 4 and the CIEB covers SMEs in the areas of manufacturing, tourism, and services. Other important intermediaries in this network are the economic development agencies of the local counties and the state of Brandenburg, as well as private law business associations. EUSD students constitute an important actor group in the knowledge transfer of all three networks, as they make independent contributions to EUSD transfer projects and participate independently in the civil society sector (e.g., in initiatives).

Aside from these intraregional connections within the Eberswalde region, interregional linkages with outside actors are essential for all three networks of knowledge transfer. For example, faculty 1 and the SFE cooperate with the Leibniz Centre for Agricultural Landscape Research, a research institute near the Eberswalde region. Activities of the BRSC are closely linked to the University of Greifswald in Mecklenburg-Western Pomerania, north of Eberswalde; however, its spatial proximity allows the EUSD to also transfer knowledge to and from the BRSC. Unfortunately,

the region has a shortage of large enterprises that operate internationally and bring knowledge into the region.

In addition to these networks, a wide range of civil society actors, such as initiatives, foundations, associations, schools, and even EUSD students, have established themselves as important actors in the RIS of Eberswalde. The EUSD, SFE, CIEB, and especially the BRSC have developed knowledge transfer activities for these groups in the form of workshops and public contests, such as school competitions. According to the interviewees from the transfer office of the EUSD, civil society actors are often characterized by high intrinsic motivation and enthusiasm for social processes. The WaldWelten Foundation, founded by the city of Eberswalde and the EUSD and sponsored by the SFE, is involved in environmental education and cultural events. The BRSC is active in the field of sustainable development education, providing guided tours and courses, especially for school classes. The CIEB organizes robotics competitions for children and teenagers to engage their technical skills and interests. All three knowledge transfer networks build on transfers to civil society, representing regional niches in which sustainability-oriented innovation can be nurtured.

In summary, the RIS of the Eberswalde region is impacted by three autonomous knowledge transfer networks, with limited interference between the networks of faculty 1 and SFB, faculty 2 and BRSC, and faculty 4 and CIEB. These networks are surrounded by a lively network of civil society actors.

5 Results

The first subsection below presents insights on knowledge transfer's contributions to small wins for STs. In the second subsection, we present characteristics and functions of knowledge bases relevant to regional actors during sustainability-oriented knowledge transfer. In the third subsection, we describe knowledge flows between heterogeneous groups in the Eberswalde region.

5.1 The development of innovation in the Eberswalde region

In this section, we examine collaborative innovation processes of the Eberswalde RIS. Specifically, we analyze the extent to which these innovations can be combined effectively in a small-wins strategy. Therefore, we apply the four characteristic criteria of small wins to those innovations which are developed in the multidirectional knowledge transfer of the EUSD and its partners. These innovations are regionally limited to Eberswalde and meet the criterion of moderate importance.

The knowledge transfer projects discussed in the interviews provided few examples of technical innovation. These innovations were explicitly designed to conserve resources, often relating to wood materials. Faculty 3 is a driver of sustainable technical innovation, with newly developed products aiming to reduce the overconsumption of wood and initiate circular product cycles. This improves the existing product cycles. Examples of these products are bicycles made largely of wood and guitars made of domestic wood instead of tropical wood. These products are created

through technology transfer projects in which knowledge is predominantly imparted unilaterally by faculty 3 without other actors (e.g., from civil society). The potential to alter social practices of actors regarding sustainability (e.g., by encouraging consumers to buy more products made from domestic wood) has not been fully exploited. The public sector mainly promotes technology transfer and has only recently begun to promote civil society knowledge transfer.

The three knowledge transfer networks collaborate mostly for incremental organizational innovations, while radical technical innovations play a subordinate role. For example, faculty 2 and the BRSC have collaboratively developed organizational innovations, such as new marketing channels in organic farming and concepts of ecological land use. Faculty 4 and the CIEB experiment with modelling business processes and testing digital applications and processes. As for faculty 1 and the SFE, their knowledge transfer focuses on reorganizing forest conversion.

Organizational innovation in combination with social innovation was discussed as essential in regional knowledge transfer between the EUSD and intermediaries. The contributions to innovation at the systemic level can be linked to three dimensions. First, in the Eberswalde region, the combination of social and organizational innovation helps to advance sustainable development. An example of such a combination was a participatory discussion among professors, researchers, administrators, and students within the EUSD before the university was renamed "Eberswalde University for Sustainable Development" in 2010. This led to a stronger organizational orientation in everyday working practices and knowledge transfer activities that contribute to sustainability. This name change does not represent a small win in the narrow sense, because there are no direct visible outcomes in terms of sustainability. However, it indirectly led to a stronger alignment of the university to sustainability in knowledge transfer projects which had visible outputs.

Another example of combined social and organizational innovation is the attempt of the BRSC to increase the acceptance of its land use practices. The BRSC teaches and communicates to stakeholders, such as regional farmers and other land users, the processes of sustainable land use as an organizational innovation. In the long term, this leads to visible results in the form of more natural landscapes and the emergence of organic farming businesses. In the short term, the BRSC's ecological land use practices pose challenges to farmers who can no longer apply conventional farming methods. Nevertheless, the land use projects have promoted organic farming businesses around the BRSC. The organic village of Brodowin, which lies in the center of the biosphere reserve, is the largest Demeter farm in Germany, covering 1250 hectares. Therefore, the fourth criterion for small wins is only partly fulfilled in the short run but fully fulfilled in the long run. Furthermore, the BRSC develops these processes of sustainable land use together with stakeholders in a participatory learning process that facilitates new social practices and represents social innovation.

Second, there is potential for linking organizational and social innovations to system changes by assembling heterogeneous actor groups, as social innovation requires diffusion in diverse parts of societies (Table 3 in the Appendix). The knowledge transfer networks have developed specific activities for societal actors, including civic associations such as the Civic Foundation Uckermark-Barnim, which is engaged in the promotion of ST education for children. However, in the Eberswalde

region, there are separate platforms and events for societal actors and businesses, such as SMEs or organic farms. These two groups of actors do not usually engage in common transfer activities. Therefore, organizational innovations emerge from the knowledge transfer of these intermediaries without societal participation. As a result, these innovations do not possess the capacity to effectively transform social practices and consequently do not constitute small wins.

Third, there is much greater potential for small wins in the Eberswalde region through a combination of technical, social, and organizational innovation that leads to deep changes. The "Region 4.0" project, for example, promotes sustainability-oriented small-scale innovations in the Eberswalde region by encouraging multi-stakeholder cooperation between societal, public, and business actors (Müller et al. 2015). The hope is to foster cyclical innovation processes and knowledge transfer among heterogeneous actors. "Region 4.0" serves as a platform consisting of several distinctive projects. In this context, direct exchanges between actors from civil society, business, and administration are promoted through small projects.

An example is the project "Social Logistics," where a regional public transportation company uses feedback from citizens as input to adapt its mobility services to regional needs. The aim is to improve the public transportation infrastructure for the stakeholder groups involved. Thus, the first criterion for small wins is fulfilled. The project creates a win-win situation for the transportation company, as the demand for public transportation will eventually increase if the mobility service is better adapted to the needs of potential customers. Therefore, the fourth criterion for small wins is also fully fulfilled. This example of sustainable mobility represents a combined organizational and social innovation.

In summary, "Region 4.0" is a platform for small-scale changes aimed at developing bottom–up sustainability-oriented practices. This approach represents novel insight into the Eberswalde region, which thus far has facilitated the implementation of small wins. However, technology development hardly plays a role in "Region 4.0." Incremental technological innovations are developed in the region but are not systematically combined with organizational and social innovations. Consequently, incremental organizational innovations are the predominant kind of innovation created through regional knowledge transfer. These innovations are particularly relevant in combination with social innovation, which has enabled the formation of new sustainability-oriented practices in the EUSD and BRSC through sustainability-oriented small-scale innovations. However, organizational and technical innovations in the region still have weak links to social innovation. Approaches to implementing small wins in the Eberswalde region involve combining social and organizational innovation.

5.2 The role of knowledge bases in sustainability-oriented knowledge transfer

Codified analytical and synthetic knowledge plays a major role in knowledge transfer between the EUSD and regional intermediaries. However, knowledge transfer activities are not restricted to business–university interactions. One interviewee from faculty 2 emphasized the relevance of analytical knowledge to make sense of discussions between regional actors and find evidence-based solutions in the innovation

process. Codified knowledge based on analytical and synthetic knowledge bases is used:

- The codified knowledge used by faculty 2 and the BRSC relies primarily on the foundation provided by analytical knowledge bases. The respondents specifically described in-depth codified expertise or further thinking processes based on scientific knowledge. This knowledge is crucial; it serves as basic knowledge in the research of the BRSC and the EUSD.
- Similarly, the codified knowledge used in the knowledge transfer between faculty 1 and the SFB is mainly analytical knowledge. In the interviews, the role of basic knowledge, mainly from the natural sciences (e.g., botany), was emphasized.
- The codified knowledge used by faculty 4 is based on the synthetic knowledge base. According to one interviewee, it usually originates from experiential knowledge in written form, such as case studies and technical literature on knowledge transfer. In this case, the codified knowledge of faculty 4 originates from applied research which mainly uses synthetic knowledge rather than analytical knowledge. The knowledge transfer of faculty 4 does not have a high proportion of R&D activities. As discussed in the interviews, it mostly aims at solving problems, such as the modelling of business processes.

Moreover, tacit synthetic knowledge is crucial in the Eberswalde region, as it is often the only source used by the EUSD, SFE, BRSC, and CIEB, including organic farmers, SMEs, and forest owners. In fact, most interviewees emphasized experiential knowledge because of its site-specific and person-specific characteristics. In the case of forestry, tacit synthetic knowledge is based on specific knowledge of the local forest areas on site, which are mainly accessible to district foresters and forest owners. Eberswalde, as a forest science location, is characterized by its traditional emphasis on this site-specific knowledge.

Symbolic knowledge is necessary to change place-specific cultural–cognitive and normative institutions and address specific stakeholders in knowledge transfer. Symbolic knowledge is used by the EUSD, SFE, BRSC, and CIEB. In terms of knowledge transfer, these intermediaries have specialists who handle communication with other organizations. These communication experts handle the communication of intermediary organizations with other regional actors. Therefore, communication knowledge is not broadly dispersed inside organizations.

The main function of symbolic knowledge in knowledge transfer is to overcome communication barriers between heterogeneous actors that have different communication styles and perspectives on problems. It is often the case that a cooperation partner with can use codified analytical and synthetic knowledge for problem solving only if this knowledge is transformed into the common language of the respective stakeholders. Codified synthetic and analytic knowledge from researchers needs to be translated to the common language of the regional stakeholders to be accessible and usable for them. Symbolic knowledge is needed to build communication channels that capture diverse perspectives and consist of comprehensive language. Therefore, symbolic knowledge and the associated symbolic knowledge bases serve as a connector linking experiential and academic knowledge in knowledge transfer processes. Thus, communication specialists of BRSC, EUSD, and SFB precisely ex-

tend regional stakeholders' absorptive capacity for codified synthetic and analytical knowledge. Moreover, the intermediaries need synthetic and analytical knowledge of their own. Codified synthetic and analytical knowledge represent the content for knowledge transfer, while symbolic knowledge serves as the transmission medium.

The codified synthetic and analytical knowledge of BRSC, SFB, and EUSD is linked to national and international scientific research supporting practice-oriented solutions for Eberswalde stakeholders. These solutions often represent novel approaches limited to the regional level. BRSC, SFB, and EUSB play the role of diffusers of extra-regional knowledge.

The stakeholders of BRSC, SFB, and EUSB mainly play the role of knowledge exploiters who use the transferred knowledge to solve their problems, but they also give feedback based on their own experience. This feedback allows BRSC, EUSD, and SFC to adapt and develop their scientific knowledge to regional contexts. Therefore, the partner actors in knowledge transfer function as a knowledge source in the innovation process of sustainability-oriented knowledge transfer.

In summary, analytical, synthetic, and symbolic knowledge bases are relevant in sustainability-oriented knowledge transfer in the Eberswalde region. All actors depend on synthetic knowledge bases in all transfer activities, while only the EUSD, SFE, and BRSC use codified knowledge based on synthetic and analytical knowledge bases. Symbolic knowledge bases are essential to corroborate synthetic and analytical knowledge bases that are useable for regional stakeholders by translating and enhancing trust in an RIS.

5.3 Knowledge flows in the Eberswalde regional innovation system

In this section, we explain the direction of knowledge flow in regional knowledge transfer between heterogeneous actors. A mutual knowledge exchange exists between the EUSD, the intermediaries, and their partner actors. The interviewed experts emphasized the collaborative process as a prerequisite for systemic change activities.

Analytical, symbolic, and synthetic knowledge flow bi-directionally between regional knowledge transfer networks. For example, faculty member 4 referred to the utilization of knowledge produced by one actor by others as "Ping-Pong." The intermediary organizations operate as mediators, generators, and recipients of knowledge. In these networks, a variety of actors, such as forest owners, organic farmers, or SMEs, exclusively contribute to tacit synthetic knowledge in knowledge transfer projects. The EUSD, BRSC, and SFE use this knowledge as an input for prospective transfer or research projects, recombining analytical and synthetic knowledge to answer novel research questions. This enables them to align their research to practical applications, described by faculty members 2 and 4 as "practice-relevant." Stakeholders in these projects facilitate innovation and knowledge exchange processes using practice-oriented knowledge as innovation output.

EUSD students play a central role in the Eberswalde RIS, driving reciprocal regional knowledge transfer. Students benefit from the knowledge outputs of regional projects concerning innovation processes and challenges, such as time constraints in production, interacting in innovation networks, and the effects of scientific findings

on the ability to innovate. According to a member of faculty 2, the students feel "needed" because they work not for "the desk or a good grade" but to provide creative proposals for projects or specific problems. In these projects, the students also gain experience regarding the various roles played by those involved in knowledge transfer, such as teachers, researchers, or university representatives of the EUSD. Students enrich their codified analytical and synthetic knowledge with new ideas and perspectives as knowledge input in knowledge transfer projects. For a member of faculty 4, it is essential for students of the EUSD to learn to participate in the innovation process of sustainability-oriented knowledge transfer. Faculties 4 and 2 have knowledge transfer activities specifically designed for students as part of the study curriculum. These activities enable students to tackle and solve society-relevant problems.

Extra-regional linkages play a crucial role in stimulating knowledge flows in the Eberswalde region. Participatory formats of knowledge transfer in the Eberswalde RIS were introduced by the EUSD in the form of a pilot project. A transfer audit resulted in the first strategic examination of knowledge transfer at the state level, in cooperation with external experts from academia, business, and civil society (Donors' Association for the Promotion of Humanities and Sciences in Germany 2020). According to an interviewee from faculty 2, this examination initiated an internal and external reflection process concerning the EUSD's understanding of knowledge transfer: "And then we thought, okay, in which direction should we go? What is our understanding of transfer? Is it just classic technology transfer, as I have already described ... And then we discussed this with various actors inside and outside the university." The audit results prompted the development of a transfer strategy for both the state of Brandenburg and the EUSD. Moreover, as early as the 1990s, the BRSC implemented participatory transfer activities, building on UNESCO's Seville Strategy for Biosphere Reserves from 1995. The Seville Strategy urged biosphere reserves to foster collaboration among diverse stakeholders and facilitate the exchange of knowledge among them. According to a retired member of the BRSC, the management of the biosphere reserve tried "to think ahead about our concepts. And to make a strategy out of that and to communicate that with the people, with the residents, primarily in the departments, with the people on the ground." The BRSC often realized participatory research projects with extra-regional universities and research institutes, such as the German universities of Marburg, Greifswald, or Dresden. The research teams learned to adapt their research goals to the actual conditions in the biosphere reserves.

Furthermore, societal actors exchange knowledge with the EUSD to solve pressing societal and sustainable problems as innovation output. According to a member of faculty 2 and a transfer office employee, the EUSD accelerates participation by giving various civil society groups platforms such as eco film festivals where "individual groups can meet and talk to each other." While there is direct knowledge exchange between university and societal actors, there is a lack of direct knowledge exchange between societal and business actors.

According to most interviewees, a combination of synthetic, analytical, and symbolic knowledge is necessary for successful knowledge transfer in the Eberswalde region. The codified analytical and synthetic knowledge of the EUSD, SFE, BRSC,

and CIEB is combined with the tacit synthetic knowledge of regional stakeholders. This requires network structures that favor the embedding of regional stakeholders. Therefore, symbolic knowledge, which gives communication experts insights into different roles in knowledge transfer, is key to addressing stakeholders' cultural–cognitive and normative institutions, including trust in regional actors such as the EUSD or positive attitudes to regional sustainable development in workshops. According to a member of faculty 4, in-depth knowledge transfer with regional actors is only possible through "communication at eye level and constant responsiveness." Moreover, intermediaries' support is needed to develop institutions' changing beliefs and shared understandings. As a result, building consensus about sustainability is a precondition of sustainability-oriented collaborations, since the level and nature of understanding differ greatly among the various stakeholders. Therefore, the EUSD, BRSC, SFE, and CIEB work on contextualizing analytical and synthetic knowledge through symbolic knowledge. In the Eberswalde region, symbolic knowledge plays the role of an accelerator and establishes links between synthetic and analytic knowledge.

Based on the interviews, an effective regional knowledge transfer requires the combination of analytical and synthetic with symbolic knowledge bases. In summary, the synthetic knowledge bases of regional partners are combined with the analytical and synthetic knowledge bases of the EUSD, SFB, BRSC, and CIEB in knowledge transfer to facilitate a collaborative innovation process. For this combination, symbolic knowledge bases of transfer specialists from the EUSD, SFB, BRSC, and CIEB are crucial.

6 Discussion and policy implications

Our findings highlight the necessity of combining various types of knowledge, especially between different industrial sectors, which has implications for policymakers. Research on combinatorial knowledge bases has emphasized the importance of tailored policy measures that match the specific context of an RIS (Asheim and Coenen 2006; Asheim et al. 2011a; Manniche 2012). With regard to knowledge transfer, it is not only the dominant knowledge bases in an RIS that must be considered but also the knowledge bases that have high potential synergies in an RIS.

Meso-level systems such as RISs depend on combinatorial knowledge bases. Therefore, innovation policy should promote the efficient knowledge transfer of heterogeneous knowledge bases across cognitive and institutional boundaries (Grillitsch et al. 2017; Manniche 2012). This requires participative and collaborative initiatives that integrate science, engineering, and cultural knowledge (Manniche 2012). In this context, combinatorial knowledge bases represent an integrative tool for understanding how heterogeneous groups of actors with their diverse knowledge bases can be connected or separated. Our study illustrates this by examining the combination of actor groups' knowledge bases in regional sustainable development. Symbolic knowledge bases provide support for overcoming cognitive barriers. This highlights the need for approaches that integrate science-, engineering-, and culture-

based knowledge by bringing together diverse stakeholders who usually operate in separate networks.

However, our study has empirical limitations, as the sample consists of actors from academia and related intermediary organizations only. Nevertheless, our study explores—as a first step—knowledge combinations in regional knowledge transfer for incremental sustainability-oriented innovation. Further research should analyze innovation interdependencies other than knowledge for sustainability-oriented small wins.

Unlike traditional research on knowledge bases, the concept of transformative innovation policies advocates for a shift in innovation policy towards addressing societal challenges (Lawhon and Murphy 2012). This requires an analysis of radical change in socio-technical systems (Coenen et al. 2015; Geels 2004). However, because the ST policy literature has often neglected geographical factors, there is a lack of policy implications at the regional level, and the geography of ST concepts is still in a conceptual state regarding the regional level (Binz et al. 2020; Coenen et al. 2015; Tödtling et al. 2021).

In contrast, the RIS concept enables decision-makers to identify specific structures and knowledge to promote regional innovation (Asheim and Gertler 2005; Tödtling and Grillitsch 2015; Tödtling and Trippl 2011). In this context, the notion of challenge-oriented RISs describes RISs with the ability to coordinate the innovation activities of multiple actors, from enterprises to civil society organizations, to tackle societal challenges (Isaksen et al. 2022; Tödtling et al. 2021). In the face of environmental problems, the adoption of RIS transformation strategies is urgent (Isaksen et al. 2022). Mission-oriented RIS transition strategies benefit from the participation of new actor groups, such as societal actors, in co-generating knowledge and specializing in place-specific needs (Larrea and Karlsen 2021; Tödtling et al. 2021). This promotes effective project implementation, which in turn facilitates reconfigurations of RIS that are more attuned to the needs of regional stakeholders.

7 Conclusion

In order to capture processes for sustainability-oriented innovation at a regional level, we focus on the knowledge flows and networks between intermediaries and their partners in inter-organizational knowledge transfer. This case study aims to identify the regional knowledge bases that are recombined in the knowledge transfer of the EUSD and three other intermediaries in the Eberswalde region into sustainability-oriented innovation and the ways in which they contribute to small wins.

The key findings of our analysis are trifold. First, in the Eberswalde region, most actors involved in the regional knowledge transfer of the EUSD, BRSC, SFE, and CIEB have predominantly synthetic knowledge bases (Asheim 2007). This dominance of synthetic knowledge characterizes geographically and structurally peripheral regions (Tödtling and Trippl 2005). Therefore, the Eberswalde region can reasonably be regarded as typically peripheral (i.e., an organizationally thin region). At least three autonomous networks of knowledge transfer have formed around these regional actors, and a growing number of societal actors surround these networks. In

most cases, however, civil society is not in direct exchange with partner actors. These networks are also complemented by connections to extra-regional intermediary organizations, such as universities and research institutes. The influx of extra-regional knowledge is crucial to the development of participative regional knowledge transfer. These findings support the claim that the collaboration of heterogeneous actors is important for developing sustainability-oriented innovation (Strambach 2017).

Second, symbolic knowledge plays an important role in participative forms of knowledge transfer. In the participatory research approach, heterogeneous actors collectively gather knowledge about a specific problem (Lindberg et al. 2012). Symbolic knowledge in communication is important not only within professional communities (Asheim and Hansen 2009) but also in participatory communication among heterogeneous actors. The reason for this is that symbolic knowledge requires a deep understanding of norms, habits, and everyday cultures within different social groups (Asheim et al. 2011a). This understanding allows for effective engagement with the normative and cultural–cognitive institutions of regional stakeholder groups, including their attitudes to sustainability-oriented innovations and their shared perspectives. Innovation processes for sustainability-oriented innovations need to address the social and institutional environments of heterogeneous actors in knowledge transfer. Therefore, synthetic and analytical knowledge bases must be integrated with symbolic knowledge bases to promote the circulation of knowledge.

We found that the integration of synthetic, analytical, and symbolic knowledge can also be observed in the knowledge transfer in the Eberswalde region. Communication specialists of symbolic knowledge allow regional intermediaries to combine their own codified analytical and synthetic knowledge with the experience-based synthetic knowledge of their partners. Furthermore, symbolic knowledge enables the intermediaries to extend their regional stakeholders' absorptive capacity for codified synthetic and analytical knowledge. Hence, intermediaries engage in knowledge exchange and contribute to innovations through reciprocal knowledge transfer with their partners, including societal actors. This collaborative, multifaceted approach aims to foster sustainability-oriented innovation within the region.

Third, the organizational innovations that emerge from these innovation processes are predominantly incremental. Regional actors increasingly combine organizational and social innovations to benefit from small wins. Incremental innovations emerge in industries with dominant synthetic knowledge bases. Social innovations within the academic context emerge through the participatory interaction of distinct groups of actors (Howaldt and Schwarz 2010). Furthermore, these innovations develop in close connection with symbolic knowledge bases.

In addition, technical innovations focusing on ecological sustainability—also mostly of an incremental nature—are created in the Eberswalde region. However, these innovations are hardly associated with organizational and social innovations. This hinders increases in the social acceptance of these technical innovations and thus their successful economic implementation on the market. Linking the technical innovations with the existing social and organizational innovations could bring about a change in the regional demand and could promote sustainable technical innovations. Solving many multidimensional societal challenges requires combining technological and non-technological solutions (Hekkert et al. 2020; Wanzenböck

et al. 2020), which would also increase the potential impact of existing transformative projects.

8 Appendix

Table 3 Coding guidelines

Category		Definition and differentiation
1.	*Knowledge base*	See Asheim et al. (2011a)
	1.1. Codified knowledge	Codified knowledge brought in by EUSD and other universities in the transfer process. Analytical knowledge bases are highly codified. Synthetic knowledge bases also include codified knowledge (Asheim et al. 2007)
	1.2. Experience knowledge, practical skills, and specific know-how	Represents tacit synthetic knowledge related to solving specific problems. It is mostly based on personal experience gained through practical learning and work experience (Asheim 2007)
	1.3. Communication knowledge and knowledge about prospective cooperation partners	Represents symbolic knowledge embodied in esthetic symbols, images, (de)signs, artefacts, sounds, and narratives with strong cultural content. It is related to an in-depth understanding of the habits, norms, and everyday cultures of social groups
2.	*Innovation*	Novel products, processes, and practices or the enhancement of existing ones (Asheim et al. 2011a)
	2.1. Technical innovation	Novel or upgraded products
	2.2. Process innovation	The adaptation of new ideas and behaviors in organizations
	2.3. Social innovation	Purposeful reconfigurations and improvements of social practices found in broad sections of society (Howaldt and Schwarz 2010)
3.	*Initiators of innovation*	Actors that initiate innovation processes
4.	*Contribution to sustainable development*	The effects that regional innovation has on sustainable development by changing socio-technical regimes (Lawhon and Murphy 2012)
5.	*Learning process*	Learning as a process that leads to new knowledge or transfers old knowledge to new people (Lundvall and Johnson 1994)
6.	*Actors in knowledge transfer*	Participants in knowledge transfer
	6.1. Active actors	Actors that actively shape knowledge transfer
	6.2. Stakeholder groups	Passive actors addressed by knowledge transfer

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