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Social innovation for regional energy transition? An agency perspective on transformative change in non-core regions

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ABSTRACT

Regional energy transitions are largely understood as technology-driven processes. We argue that social innovation (SI) is as important and that scrutinizing it calls for an agency perspective. Analysing two examples of SI in energy in Austrian non-core regions, we show how resources, relations and reflexivity enabled agency to promote SI and consequently sustain energy transition. We find that SI produces new regional resources and capacities, provides directionality for transformative change, and herewith aids the consolidation of transition pathways. Hence, we conclude that agency and SI are key variables of sustainability transitions and transformative change that deserve more scholarly attention.

KEYWORDS
social innovation; energy transition; agency; non-core regions

JEL O35, P25, Q42, R11
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INTRODUCTION: GOING BEYOND TECHNOLOGY-DRIVEN CONCEPTIONS OF ENERGY TRANSITION

Energy transitions have become a focal point of interest in transition studies. They are crucial for sustainable societal transformations, and provide an insightful area of study for understanding the relation between socio-technical regime change, multilevel policy interactions and innovation systems (Geels, 2002; Kern & Smith, 2008). Since significant differences can be perceived in how energy transitions unfold in different regions, regional energy transitions have also become a key interest in economic geography (Coenen et al., 2021).

One reason for a determined regional perspective on energy transitions is the ongoing technology-driven decentralization of energy systems (Adil & Ko, 2016). It holds the potential for new industrial path development based on the overhaul of an entire infrastructure system, including the modes of production and consumption (Simmie et al., 2014). Another reason is to give (new) purpose to locally available renewable resources. In many non-core regions in particular, these resources constitute an economic pillar, making energy transition an attractive policy objective (Bridge et al., 2013; Murphy & Smith, 2013).

While typically studied in the frame of science- and technology-based innovation, recent endeavours have shifted the focus to the role of social practices and human agency in energy transition to better understand how social change comes about (Hewitt et al., 2019; Wittmayer et al., 2020). This includes a stronger emphasis on the role of social innovation (SI) in energy transition. Herewith, a more nuanced understanding of societal change is introduced that tackles some blind spots of science- and technology-based understandings of socio-technical regime change (Hewitt et al., 2019). This paper contributes to this line of research by showing how SI sustained energy transitions in two Austrian non-core regions and what role agency played in these processes.

We focus on non-core regions because they have emerged as energy transition frontrunners despite obvious disadvantages regarding their scientific and technological knowledge base (Mattes et al., 2015; Wirth, 2014). Accordingly, we assume that regional energy transition

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processes in non-core regions are not purely technology driven, but depend to a great degree on social relations, interactions and practices, and their dynamics throughout the transition process. This contributes to elucidating the research gaps on the role of agency in transitions (Köhler et al., 2019) and of SI in the technology-driven formation of socio-technical regimes (Wittmayer et al., 2020).

The remainder of the paper is structured as follows. It begins with the concept of global innovation systems (GIS) to clarify our understanding of how innovation as such develops in a multiscalar context. Going beyond science- and technology-centred innovation approaches, we add a distinct SI perspective that addresses the practical and territorial aspects of transformative change. Based on that, we conceptualize how agency shapes SI. We look into the energy transition processes of the two Austrian non-core regions, Murau and Güssing, to retrace the role of SI in energy empirically, finding that it is indeed vital to the respective socio-technical transitions. To conclude, we discuss the implications of these findings for future research on SI in socio-technical transitions and regional transition policies.

LITERATURE REVIEW: A SOCIAL INNOVATION PERSPECTIVE ON NON-CORE REGIONS IN TRANSITION

Innovation systems and transformative change

In the understanding of innovation systems, technology development and diffusion are both an individual and collective act. Hence, the concept emphasizes the importance of networks and relations between different actors within an innovation system as well as the interplay with regulative, normative or cultural–cognitive institutional dynamics that shape these interactions (Bathelt & Glückler, 2011; Scott, 2008). The most frequent system delimitations are national, regional, sectoral or technological systems of innovation (Edquist, 2005). Binz and Truffer (2017) reinterpreted the overlaps between various innovation systems approaches with the GIS approach. They provide a framework for comprehending the creation and integration of system resources at the global level, differentiating innovation systems by the industry's dominant innovation mode and the economic system of valuation.

Spatiality is important in both global and regional perspectives on innovation systems. Acknowledging the notion of path development, the regional innovation systems literature draws attention to regional specialization, specific policy competences and institutions as drivers (or barriers) of innovation (Tödtling & Trippl, 2011, 2018). The GIS literature stresses how in customized valuation processes, place-specific knowledge is key for aligning complex technologies with institutions, and embedding these technologies in the respective organizational structures and governance configurations (Binz & Truffer, 2017; Rohe, 2020). In both perspectives, tacit knowledge, interactions and institutional contexts are thus significant for the innovation process, respectively the varying geographies of innovation (Rohe, 2020; Tödtling & Trippl, 2011). Importantly, both call for an understanding of innovation that goes beyond science- and technology-driven or firm-led approaches and takes note of the significance of non-technological innovations as system- and path-shaping entities (Moulaert et al., 2005; Tödtling & Trippl, 2018).

In a similar vein, generic technology-neutral innovation policies have recently been criticized for lacking breadth and directionality when it comes to addressing complex, unstructured problems and 'Grand Challenges' (Wanzenböck et al., 2020; Weber & Rohracher, 2012). Hence, during the last decade, innovation policy has been reframed as 'transformative change' (Kattel & Mazzucato, 2018; Schot & Steinmueller, 2018). By taking directionality as a starting point, transformation is understood as the process of change from a current status quo to a new and desired state (Hölscher et al., 2018). In this novel frame, transformative innovation policy refers to socio-technical system change that requires the purposeful adaptation of embedded directions and solution-oriented interactions (Schot & Steinmueller, 2018). The purposefulness implies that agents set deliberate actions in order to shape their environment in accordance with their interest. Transformative solutions go beyond science- and technology-based innovations that are purely market oriented and inherently depoliticized both in terms of their creation and diffusion (Wanzenböck et al., 2020; Wittmayer et al., 2020). Therefore, an analytical approach is suggested that acknowledges SI, complementing and broadening the understanding of innovation systems, socio-technical regimes and (energy) transition processes (Wittmayer et al., 2020).

We develop such an approach to look at the specific manifestation of socio-technical regimes in non-core regions, herewith adding to the debate on their role in societal transformations and energy transition more specifically. Non-core regions are typically characterized by organizationally thin, fragmented or even locked-in innovation systems (Trippl et al., 2016) and 'long-lasting and strongly intertwined phenomena of economic, social and demographic decline' (Leick & Lang, 2018, p. 214). Yet, some non-core regions were obviously successful in creating viable transition pathways (Mattes et al., 2015). Authors have thus pointed to the necessity of capturing the specific qualities of non-core regions in terms of breaking with path dependencies and creating development perspectives that go beyond conventional growth paradigms (Leick & Lang, 2018). Recent studies have indeed shown how SI can unlock the transformative potential of non-core regions (Castro-Arce & Vanclay, 2020). Such studies are important, since they can serve as exemplary cases and seeds of change for transition (Geels, 2011). However, they call for a thorough definition of SI first.

SI and transformative change

SI has been used in different societal domains including policy, business, civil society and academia, referring to different scales and scopes of societal change (Marques et al., 2018; Moulaert et al., 2017). This fuzziness has

prompted critique regarding its usefulness as an analytical concept and normative framework (Marques et al., 2018). In order to better understand energy transitions, however, we need to unravel how social practices and relations change and are reconfigured and co-produced between actors, since they build the basis for the transformation of the socio-technical system (Bock, 2016; Hochgerner, 2009; Moulaert et al., 2013). Despite its fuzziness, the concept of SI hence provides us with a useful lens through which to study the relationship between socio-technical regime change and the reconfiguration of social practices. Based on different strands of SI literature (Castro-Arce & Vanclay, 2020; Hochgerner, 2013; Moulaert et al., 2013; Wittmayer et al., 2020), we define SI as a multilevel, iterative innovation process that responds to concrete social needs by changing social configurations and practices, for example, by creating new (social) business models, actor networks, governance modes, policy interventions or organizational entities. This includes a distinct focus on societal practices and acknowledges their (political, economic, cultural or judicial) embeddedness, their inclusive character, and their grounding in societal needs, hereby distinguishing it from traditional (technological) innovation perspectives (Howaldt & Kopp, 2012; Marques et al., 2018).

Hochgerner (2013) conceptualizes such a practice-oriented perspective, describing SI as an iterative process of idea, intervention and implementation that creates lasting impact on a societal practice and its context. The initial idea stage is defined by the recognition of a societal challenge vis-à-vis existing societal functions. The challenge sparks the development of alternative options that take into account local contexts and their relevance for change. If an idea has been developed, an intervention must follow that connects the alternative options to a set of success factors that validate the chosen approach (e.g., via prototyping). Once an intervention has proven to be initially viable, the implementation phase enacts the realization of the reconfigurations and transformations envisioned by the alternative idea. In practice, these schematic phases are highly iterative, overlapping and integrated, depicting an often 'chaotic' innovation process. However, if it accomplishes creating changed practices and interactions, that is, impact, the SI process can be considered 'complete' (Hochgerner, 2013).

This conceptualization offers a structured perspective on the formation and development of the SI process itself, but lacks the consideration of socio-technical change and related governance arrangements. Recent contributions aim to connect innovation systems and socio-technical regimes with concrete actors, practices and their contexts, bridging practical–organizational (Hochgerner, 2009, 2013; Mumford, 2002) and territorially oriented SI concepts (Moulaert, 2013; Moulaert et al., 2017). The growing transformative social innovation discourse stands out in this regard (Pel et al., 2020).

Transformative social innovation builds on a strand of theory that considers SI and territorial development as inextricably linked (cf. Avelino et al., 2019; Castro-Arce & Vanclay, 2020; Moulaert, 2013; Oosterlynck et al., 2019). It takes into account newly evolving relationships, their relation to social and organizational change, and their embeddedness in specific spatial contexts and innovation systems in order to make sense of non-technological innovations and the reconfiguration of regional social practices (Bock, 2016; Moulaert, 2013; Murray et al., 2010; Zapf, 1989). Accordingly, SI can – at least in parts – compensate for the lack of investment capital or technology and still get transformative processes going (Bock, 2016). The concept also stresses the potential of SI to change actor roles, visions and goals, and add new actors and instruments to the governance of regional development and innovation (Oosterlynck et al., 2019). While this constitutes an important premise for socio-technical change, it also points to the significance of agency in assembling the necessary resources for SI and putting transformed roles, visions and instruments into practice.

We define agency as purposive human action, that is, doing something intentionally to achieve a wished-for social effect. In the context of SI in energy, our focus is on change agency that aims to alter system states as opposed to reproductive agency that looks to maintain a status quo (Jolly et al., 2020). Grillitsch and Sotarauta (2020) have proposed a valuable framework for the study of change agency that emphasizes the deliberate construction and realization of development opportunities to explain path development. Conceptually, the authors embed agency in an 'opportunity space' to make sense of the possibilities for action. Accordingly, an opportunity space involves regionally specific preconditions, temporally specific configurations of knowledge, institutions and resources, and the respective agential perceptions and capabilities (Grillitsch & Sotarauta, 2020). The deliberate arrangement and exploitation of such opportunity spaces is particularly relevant in regions whose development perspectives are closely linked to sustainability transitions, where adopted pathways face a critical juncture and problem and solution definitions can be contested (Wanzenböck et al., 2020). The same holds true for non-core regions. Here, change agency is pivotal in making a virtue of necessity and creating opportunities for potential pathways despite the scarce regional assets at hand.

We take this conception of deliberate change agency as our starting point. Analytically, this calls for a micro-level perspective on agents' purposive actions in transformative change processes. At the same time, taking 'the emergent nature of structure and … agents' varying capabilities, resources and powers' (Grillitsch & Sotarauta, 2020, p. 706) seriously calls for a relational approach that links evident human action with enabling regional, structural, institutional, resource- and knowledge-oriented variables (Grillitsch et al., 2021). This way, the double dialectic of structure and agency in regional change processes can be properly addressed (Jessop, 2001). We introduce our conceptualization of agency in SI for regional energy transition in the following section.

RESEARCH CONCEPT: CAPTURING AGENCY IN SOCIAL INNOVATION

Placing agency in the SI process

Empirically analysing the role of SI in regional transitions calls for an agency perspective. Such a micro-level perspective is necessary since SI can be considered a deliberate attempt of addressing social challenges through mindful human action (Hochgerner, 2013; Pel et al., 2020). However, since 'anything actors do happens within conditions that pre-exist them' (Leca & Naccache, 2006, p. 633), we embed our analysis of agency in SI in a multidimensional framework. It takes into account the multi-scalar spatio-temporal resource- and knowledge-oriented variables that allow for transformative action in the first place (Grillitsch & Sotarauta, 2020).

At the core of our study lies the fourfold SI process as introduced above, complemented by a notion of transformative change and the embedding of SI (Hochgerner, 2013; Murray et al., 2010). It combines a practice-oriented perspective (Hochgerner, 2013) with a focus on territorial (governance) structures that shape the socio-technical regime (Castro-Arce & Vanclay, 2020; Pel et al., 2020) and stresses the distinct social dimension as compared with traditional understandings of innovation, that is, the introduction of new services, products or organizational models (Organisation for Economic Co-operation and Development (OECD), 2005). This implies an emphasis on the reconfiguration of social practices that tackle societal needs and establish new, inclusive actor relations. The development of a challenge-driven idea for social change typically marks the onset of that process, followed by the idea's trial implementation and its consequent institutionalization, respectively its embedding into a governance path towards regional transformation (i.e., impact).

Agency is key at each stage of that process. With regard to regional energy transition in non-core regions, it resembles many of the characteristics of the DUI-based innovation mode ('doing, using, interacting') in spatially sticky innovation systems, where valuation is customized to local contexts (Binz & Truffer, 2017). DUI-based innovation is experience based (Jensen et al., 2007). Actors reflect current challenges and opportunities with past experiences and learning from prior action. '[T]he DUI-mode of learning most obviously refers to know-how and know-who which is tacit and often highly localized' (Jensen et al., 2007, p. 685) Agency thus implies utilizing this (tacit and place-based) knowledge plus a variety of accessible means and coupling them with other actors, networks and contextual developments (Jensen et al., 2007).

Hence, we conceptualize agency in SI as purposive human action that builds on the reflexive utilization of various knowledge stocks, accessible artefacts and resources in conjunction with regional conditions (Grillitsch et al., 2021), relevant actors and networks (Binz & Truffer, 2017), beneficial institutional contexts (Lawrence et al., 2011), and critical events at multiple scales (Grillitsch et al., 2021; Jessop, 2001). Intentionality is important inasmuch as agency is driven by individual or collective interests and the quest for pragmatically combining these with an existing regional path, the limited resources at hand and uncertain critical events (Grillitsch et al., 2021; Suitner & Ecker, 2020). Consequently, we argue that agency is conditioned in three respects, namely, by resources, reflexivity and relations, that facilitate purposive action at each stage of the SI process (Figure 1).

The three conditionalities of agency in SI

- *Resources* involve access to artefacts and capital (e.g., workforce, funds, technology), institutions (i.e., norms and values, rules and regulations), and the discursive process (e.g., communication, visioning, policy development). Access to artefacts and capital is a salient resource of human agency towards transformative change (Burch et al., 2014). Access to institutions implies the capacity to employ institutional configurations or do institutional work (Lawrence et al., 2011). In terms of discourse, it involves discursive power to influence the communicative process, the formation of visions, narratives and imaginaries (Moss et al., 2015). By all means, knowledge regarding how to tap into these resource dimensions is key in the SI process (Castro-Arce & Vanclay, 2020; Fuenfschilling & Truffer, 2016; Grillitsch et al., 2021).
- *Reflexivity* involves learning from one's own or others' past experiences (Steen, 2016), appropriately assessing the clarity or fragility of future paths (Chlebna & Mattes, 2020; Tödtling & Trippl, 2018), and keeping a watch on opportunities for change (Grillitsch et al., 2021; Jessop, 2001). Past experiences can entail prior involvement in similar processes of change, professional expertise, past job positions, tacit knowledge or personal ties to the region (Grillitsch & Sotarauta, 2020; Suitner & Ecker, 2020). Critical contemplation of future development scenarios implies pronounced awareness of the discursive and policy landscape, that is, existing concepts and plans regarding regional (energy) futures, and the conflicts and issues between jarring socio-technical imaginaries, regional narratives and visions of a sustainable future (Sotarauta, 2018; Späth & Rohracher, 2010, 2012). Critically observing technological and policy developments on multiple scales and reflecting how these might impact one's own transformative project and its chances to succeed, hence is an important aspect of reflexivity (Benner, 2020; Grillitsch & Sotarauta, 2020).
- *Relations* imply the reconciliation of the reflexive use of resources with regional conditions, multi-scalar networks and institutional configurations and critical junctures of events (Jessop, 2001). Coordinating one's actions with determinant structural circumstances such as a path-dependent regional economy, the limited local availability of natural resources or rural settlement

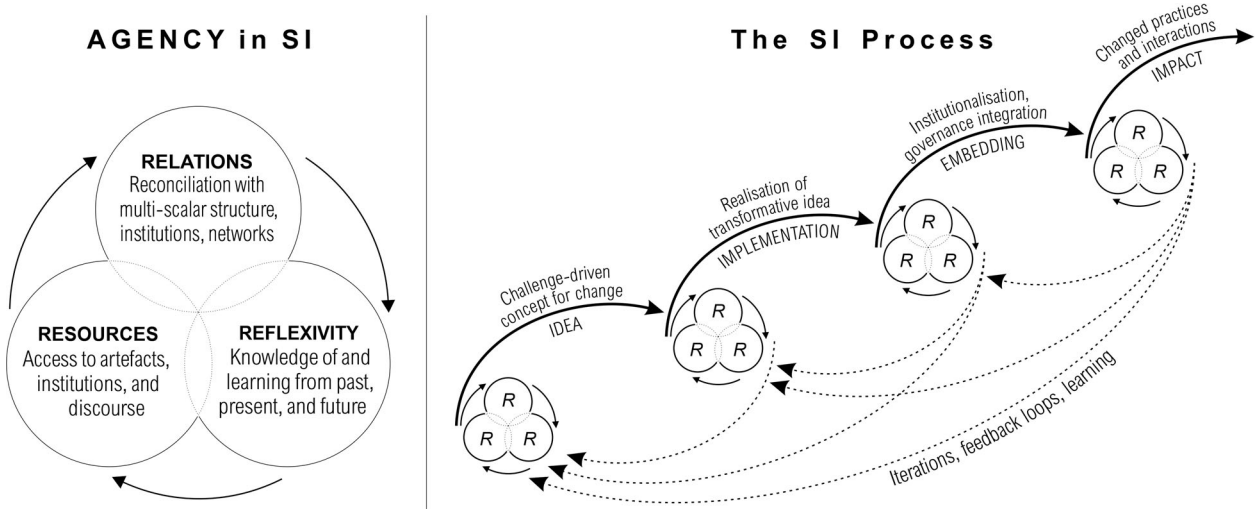

Figure 1. Conceptualizing agency in the fourfold social innovation process.
Source: Authors' elaboration.

structures is key, since they hugely influence what is possible and what is not regarding transformative change in the short to medium term (Grillitsch et al., 2021; Svensson & Nikoleris, 2018). Connecting with actor, firm and policy networks on various scales is also vital to see if ideas resonate, generate a critical mass or access to new resources (Binz & Truffer, 2017; Hecher et al., 2016; Ruppert-Winkel, 2018). Exploiting beneficial institutional configurations on multiple scales (e.g., funding opportunities, changing market regulations, established regional values and identities) is as important in this regard (Wirth et al., 2013). It coincides with being 'literate', informed and reflected about the socio-technical constituents of energy systems as such, relevant technological developments in the field, transition processes happening elsewhere, and critical events unfolding on various scales (Grillitsch et al., 2021; Jessop, 2001).

This concept equips us with the necessary analytical understanding to contribute to elucidating the research gaps regarding the role of agency and SI in regional transitions. In the next section we describe how we operationalized the concept empirically.

SOCIAL INNOVATION IN ENERGY: TWO AUSTRIAN EXAMPLES

Methodology

We have developed our methodology along the lines of the innovation biography approach (Butzin & Widmaier, 2016). Innovation biographies are a process tracing method that uses historical event analysis and in-depth semi-structured interviews to reconstruct the micro-, meso- and macro-perspective of knowledge creation in innovation processes (Manniche & Testa, 2018; Yeung, 2003). The method served as orientation for devising our own approach to tracing specific SI processes. We aimed to study events signifying and surrounding the SI on multiple scales to reconcile the micro-perspective on agency with the meso-perspective on socio-technical regimes and their embeddedness in place-based institutional contexts. Interviewing actors on their perceived role and activities in promoting the respective SI process is a central methodological step in this regard. In order to make sense of the so-acquired information though, it must be traced back to the multitude of conditionalities of agency we mentioned above. A thorough historic event analysis covering these aspects therefore must be conducted first (Butzin & Widmaier, 2016; Keaney et al., 2018).

We developed a mixed methods design that began with desk research on the conditions for energy transition in the respective regions. It involved (1) an analysis of regional structural data, key development indicators and the structure of the local energy system to depict significant path dependencies (Murray, 2010; Refsgaard et al., 2011); (2) policy analysis regarding the energy field and regional development, including an overview of the spectrum of instruments and the associated multi-scalar legal framework (cf. Weimer & Vining, 2017); and (3) content analysis of materials related to strategy development and visioning within and beyond the region (Krippendorff, 2018). The so-created overview allowed sketching major events in the evolution of the respective energy transition process and gave initial insights into the institutional context, discursive framing and actor landscape, enabling the identification of projects with transformative potential and the key individuals involved (Keaney et al., 2018) (cf. Table A1 in Appendix A in the supplemental data online for an overview of the materials).

In a second step we conducted in-depth semi-structured interviews with key individuals on the emergence, development and impact of the respective projects in order to draft the evolution of the SIs (Dunn, 2016). Therefore, we combined purposive and snowball sampling to select interviewees (Creswell & Creswell, 2017). First, key actors of SI in energy that appeared from desk research

were chosen. The sample was then complemented with individuals who, according to the initial group of interviewees, played a significant role in the respective SI process, too (Flick, 2018). The sample was expanded until no further actors of relevance could be detected, respectively until data saturation regarding the SI process set in (Creswell & Creswell, 2017; Saunders et al., 2018). However, since agency in regional energy transition is hardly ever confined to regional interventions (Coenen et al., 2021), interviews also involved at least one representative from the supra-regional level. Overall, this led to five consecutive interviews in each case study region.

Interview guidelines were determined by the fourfold structure of the SI process and the three conditionalities of agency as conceptualized above (cf. Table A2 in Appendix A in the supplemental data online for the interview guideline and an anonymized list of interviewees). All interviews were conducted in person in the respective regions in June–July 2018. Each interview took about 60–90 minutes and was audio-recorded for later verbatim transcription. Transcripts were coded and categorized with MaxQDA software. Using a deductive thematic coding approach informed by our theoretically derived categories (Saldaña, 2013), we aimed to unveil to what extent and at what stage of the SI process interviewees' depictions reflected our conception of agency in SI. Triangulation was key (Yeung, 2003), as after each interview we revisited the regional transition pathway and linked the located conditions, resources and critical events with purposive action. Interview statements thus helped prioritizing materials of relevance to trace back the energy transition process and get more nuanced insights into agency in SI (Ricks & Liu, 2018).

We applied this methodology to a study of the Austrian regions Güssing and Murau. Both regions correspond to our definition of non-core regions (cf. Statistics Austria, 2021), while constituting energy transition frontrunners (Späth & Rohracher, 2012; Hecher et al., 2016) where SI played a key role. We develop vignettes to anecdotally narrate how agency spurred SI for energy transition in the two regions. That way, we create 'concrete examples of people and their behaviors [and] stories about individuals, situations and structures' (Barter & Renold, 1999, p. 1) that point to the very particular change-in-social-practice dimension we aim for, while still allowing to draw generalizable conclusions on agency in transitions (cf., e.g., Rutherford & Coutard, 2014). The results are presented below.

For matters of readability, references to the empirical material were coded. For detailed information on these materials, see Tables A1 and A2 in Appendix A in the supplemental data online. Comments in brackets refer to our 'Conceptualizing agency' framework, as presented in Figure 1.

The Murau region: turning local wood energy solutions into knowledge-intensive services

The Murau region is located in a narrow Alpine valley in the Austrian province of Styria. It long struggled with the structural consequences of 1980s deindustrialization and decline, while priding itself with turning its local woodworking tradition into an innovative wood industry of networked firms and a comparably high share of workers (RC6–RC8). In terms of energy transition, the region has made a virtue of necessity. Based on an expansion of small hydropower in the past decades, the local energy provider, Murauer Stadtwerke, pursued the goal of implementing a regional energy transition process (TD8).

The region has never been connected to the wider gas grid and therefore has largely been dependent on oil for heating (RC11). In 2008, fuelled by high oil prices and the demand of the regional hospital, Murauer Stadtwerke developed the idea of introducing a renewable solution for heat production (IM2; IM4). A regional consortium developed the concept for building a district heating plant that would secure the business of an established regional wood industry and combine it with growing environmental objectives. Specific regional conditions (i.e., limited availability of land due to flood risks, the remote location of the hospital) demanded a unique and technologically advanced solution that, in consequence, allowed building up highly specialized knowledge (IM2; IM3). Once the project came to fruition, it spurred the vision of energy self-sufficiency and the capitalization of established knowledge and networks, as one interviewee stated:

> We learned a lot from that process in terms of how to tackle complex technical challenges and who to approach to get it done. We also knew, of course, that our region had achieved something special here that we can build on.
>
> (IM1)

The successful realization of the district heating plant was the trigger for a specific SI – the Murauer Energiezentrum (MEZ). The heating plant project enabled Murauer Stadtwerke to acquire highly specialized knowledge, and a dense intra-regional network of small and medium-sized enterprises (SMEs) and actors with extra-regional ties. This led to the sentiment that these knowledge stocks and networks should be capitalized in order to generate revenue in an economically fragile region and open up business opportunities for a diverse range of regional actors associated with energy, economy and regional development (TD7; TD8; IM1) *[→ idea/resources]*. The specific regional preconditions (RC7; RC8; TD8; TD9) led to the belief that new modes of organizing regional information, production and consumption of energy were needed in order to consolidate the new path (IM5) *[→ idea/relations]*. The reflection on the importance of access to high-end technologies and collaboration between diverse actors hence materialized in the idea of establishing an intermediary knowledge broker in the region: the MEZ (IM1; IM2) *[→ idea/reflexivity]*.

Murauer Stadtwerke took the lead in implementing the MEZ. Being a 100% subsidiary of the municipality, the energy provider was able to combine resources such as deep knowledge of regional institutions and Austrian regional development policy with technological and

economic know-how of the energy sector (TD11) *[→ implementation/resources]*. Additionally, the organization has close ties to decision-makers with access to relevant policy and business networks and institutions. This again helped gain access to ongoing policy discourse and allowed relating the idea for the MEZ with an existing institutional context (IM2; IM3) *[→ implementation/relations]*. Based on the strong foundation of Murauer Stadtwerke and its commitment to the MEZ idea, other key regional development actors such as the regional economic association and the LEADER Local Action Group supported the project, for example, by financing its corporate identity through LEADER funds (IM1). This meant connecting it to other small-scale initiatives in the region as well as to attract further national funding in the course of the Austrian Climate and Energy Model Regions Programme (TD7; IM1) *[→ implementation/relations]*.

Subsequently, the MEZ was institutionalized as a subsidiary of the local energy provider. It functions as a service and sales office that provides the network of regional SMEs with market access and links local firms with potential customers (TD11). Different processes of regional communication, mediation and intervention in the energy system that so far had been mostly informal and based on personal networks were institutionalized and embedded in the regional energy system *[→ embedding/resources, relations]*. Practices concerning the development and implementation of energy solutions in the region were reconfigured as a one-stop-shop for a broad set of energy production and energy efficiency solutions for extra-regional firms, municipalities and institutional investors (IM2; IM4). The MEZ led to significant asset reconfiguration as it concentrated distributed regional knowledge and assets to a coherent set of marketable energy transition solutions *[→ embedding/relations, reflexivity]*: 'We wanted to commercialize our prior efforts in regional energy transition and therefore pooled knowledge and marketable energy solutions in one platform' (IM2).

Beyond that, the MEZ also changed relations between actors by aiding regional SMEs and financial actors to participate in energy-related economic activities and connecting them with extra-regional actors, for example, insurance companies in search of green power plants as part of their investment portfolio (IM2) *[→ impact/relations]*. Herewith, the MEZ generated additional projects for regional businesses, reinforcing a trajectory that contributes to value creation and quality jobs (RC4; RC6–RC8). The MEZ meets the criteria of an SI in several respects, hereby going beyond a traditional business model innovation. The new organizational entity changed social practices in the region by facilitating the interaction of SMEs, consumers and municipalities. It made these interactions more inclusive by offering and brokering knowledge between actors that before had been excluded. And by enabling new, more sustainable forms of energy production and consumption, it addressed concrete societal needs. Today, the Murau region accounts for a network of over 100 hydropower and biomass plants, and over 600 photovoltaic (PV) facilities that cater for the self-sufficiency of the region in terms of heating and electricity (RC11; TD11). While this can only in small parts be attributed to the MEZ itself, the SI has facilitated turning the regional energy transition into both a marketable industry and regional identity, and consolidating the energy transition process institutionally *[→ impact/resources, relations]*.

The Güssing region: from pioneering renewable energy pilots to inclusive regional transition

The Güssing region is located in the province of Burgenland in south-east Austria. Its economic development has long suffered from its close vicinity to the Iron Curtain and the European Union's (EU) external border to Hungary, making it one of the poorest regions in Austria, dominated by agriculture and forestry and characterized by overall bad accessibility (RC4; RC7; TD12; TD14). With Austria's accession to the EU in 1995, Objective 1 Cohesion Funds were made available to Burgenland. Hence, actors in the region were given the financial opportunity to experiment with renewable energy as a driver for endogenous development and regional energy self-sufficiency (IG1; IG4). The process involved investments in renewable energy infrastructure and resulted in a network of intermediary knowledge and implementation actors that would go on to shape the new path (TD13; IG2; IG4). Today, the region's energy sector accounts for a comparably high share of employment and multi-scalar networks in related research and development (R&D) activities (RC7; RC8; RC11; TD13; TD14). However, a decade ago, a critical juncture of events began to put the energy transition in jeopardy. The phasing-out of EU Cohesion Funds was to leave a financial void for the advancement of the laboriously built renewable energy infrastructure after 2013 (IG4). The sustained post-crisis price drop for fossil fuels and the rigid federal regulations for renewables posed a severe threat to the competitiveness of regional green energy (TD15; TD16). And the increasing professionalization and internationalization of regional energy experts left the local community behind, as one interviewee remembers:

> It was key for our success as an energy region that we more and more became experts in renewable energy technology and were increasingly connected to an international scientific and entrepreneurial network. But at the same time this led to the sentiment that our local population was losing touch with energy transition.
>
> (IG2)

Energy stakeholders in the region recognized these threats. A key actor was the European Centre for Renewable Energy (EEE), which was founded in 1996 in order to manage the renewable energy transition process in the region (TD15; TD16). In 2013, it developed the idea of a participatory project that would ensure citizens' inclusion in regional energy transition again: a participatory citizen power plant. The EEE found allies within the state

administration that had the will and resources for the joint intervention (IG4; IG5) *[→ idea/resources]*. EEE's specialized sectoral know-how and knowledge of institutional configurations enabled it to function as facilitator and coordinator of numerous regional pilots for renewable energy solutions that provided knowledge for setting up the concept of a participatory power plant. These included technological innovations aimed at technological path creation (e.g., the construction of Austria's biggest biomass power plant at that time), as well as participatory and cooperative models that were considered important for the simultaneous energy self-sufficiency objective (e.g., local farms as wood suppliers to the novel power plant) (IG1; IG2; IG5) *[→ idea/reflexivity]*. Due to its intermediary role, the EEE had access to a dense network of policymakers, practitioners, researchers and entrepreneurs in the energy field, at both regional and national levels:

> We consider ourselves 'caretakers' concerning regional energy issues. To this end, we have to be aware of the policy process on different levels, and be part of networks to react to new developments early and connect ideas and stakeholders properly.
>
> (IG1)

This embeddedness allowed the EEE to recognize critical junctures and act on them accordingly, reconciling gained experiences, future-oriented policy, path development and consultation *[→ idea/relations, reflexivity]*.

The EEE hence developed a concept for citizen power plants based on a participatory financial model for PV facilities as a means to increase ownership of the energy transition by the regional public (IG1; IG5). Having learned from past experiences with participatory approaches, the EEE was aware that they were useful to promote ownership, inclusion and identity (TD16) *[→ implementation/reflexivity]*. The EEE secured state funding for preparatory works and recruited 12 municipalities that brought in suitable municipal roof areas, and organized information events for interested citizen investors (IG1; IG3) *[→ implementation/relations]*. Citizens invested in the systems at 2.5% interest per year for 13 years. The plants were built and owned by the municipalities, which guaranteed investors capital security (TD16). The EEE, at the same time, secured the fixed feed-in tariff, which represented a major hurdle as the business plan built on the availability of very limited national funding (IG1; IG5) *[→ implementation/resources]*. Thus, the initiative was a collective act of the EEE providing the idea, organizational capacity and knowledge, 12 municipalities supplying the project sites, a local plumbing firm installing the PV systems, hundreds of citizens willing to invest, and financial support from state administration and federal funding schemes.

The concept was further developed into an 'all-inclusive package for PV citizen power plants for the municipalities' (IG1) by the EEE to make it viable *[→ embedding/reflexivity]*. The entire planning, financing and installation of the systems was carried out by the EEE with state funding, thus keeping the costs for municipalities low (TD17; IG3) *[→ embedding/resources]*. This shifted the configuration of energy production practices in the region, as it involved municipalities and citizens in a process that is usually enacted by national or regional energy providers. The intervention became so successful that some of the plants were expanded soon after construction and the number of citizen investors increased (TD17). Since the citizen power plants became paid-off municipal property (IG3), they ultimately ensured an upgrade of the energy system, a relief for tight municipal budgets, and a reconfiguration of assets in the energy production system *[→ embedding/relations]*.

Overall, the SI expanded and further consolidated the invested, networked community of individual and institutional actors aiming for transformative change, and consolidated the energy transition pathway by establishing a new practice of municipal–citizen–civil society energy production (TD15; TD16) *[→ impact/relations]*. It further enhanced the capacities of key actors regarding instrumental and processual knowledge on energy production, and amplified the region's prevalent imaginary of an innovative energy pioneer (IG1; IG2) *[→ impact/reflexivity]*. In terms of structural effects, the EEE's intervention remained a one-off action. However, further replications and expansions of the participatory green finance and civic power plants idea took shape inside and outside the Güssing region, hence serving both as marketable know-how and image factor. The project's success even caused the state administration to develop its own funding scheme for the promotion of PV systems on municipal buildings based on the Güssing experience (IG1; IG5) *[→ impact/resources]*.

DISCUSSION

The two examples show how fundamental the reconfiguration of practices and interaction modes is for regional energy transition. Murau and Güssing both lacked directionality regarding how to further develop their energy transition pathways. The respective SIs in energy were thus purposefully developed to address this uncertainty, creating ownership of the transition process and a new, social needs-oriented and inclusive business model, respectively.

In Murau, SI helped reshaping the regional wood energy path into a knowledge-intensive service economy. The MEZ generated economic value through extra-regional linkages and by providing knowledge and resources regarding the technological and institutional complexity of energy transition in a multi-scalar governance setting. It changed existing practices in terms of approaching the development of energy solutions by introducing a new actor into the ecosystem. By creating the MEZ as an inclusive knowledge broker, the manifold interconnections between regional SMEs, public authorities and households were reconfigured in a way that consolidated the path towards a renewable energy system. Regional SMEs approached energy provision solutions in

a new way, profiting from international knowledge stocks and their embedding in multilevel governance structures. They gained access to new resources and contacts through the MEZ, enabling them to provide more holistic energy solutions to customers.

In Güssing, what seems like a minor green finance project helped to sustain the efforts of a region that has been deeply invested in technological path creation upon regional renewables for over 20 years. It added a practice-oriented perspective to the technology-driven path that was crucial to sustain the transformation of the regional energy system. Initiated by a well-connected intermediary actor, the EEE, the pilot intervention promoted civic ownership, making energy transition meaningful to a critical mass. It also empowered municipalities to engage more actively in bottom-linked governance, enabling their and the citizens' agency in energy transition. Based on its specialized sectoral know-how, deep institutional knowledge, and its access to policy, practice and research networks, the EEE served as intermediary facilitator of the SI in Güssing. This allowed it to anticipate and critically reflect changes in the multi-layered configuration of the regional energy transition endeavour. The example is particularly interesting, since the state's Smart Specialisation efforts recently failed due to a lack of mobilization, implementation and ownership (Benner, 2020), whereas the SI in Güssing provided just these qualities to ensure a successful transition process.

The two examples also illustrate how social practices shape processes of energy transition in a territory and how new configurations and actor constellations are crucial to ground technological innovations. The reconfiguration of social practices is not just a by-product of technological innovation, but the expression of purposeful human action aimed at resolving regional issues through new forms of social interaction between individuals and private and public organizations. The purposefulness can be traced by looking at how key actors in the two cases took action upon reflections of past, present and future developments, how they gained, combined and used resources to advance the SI, and how they related it to multi-scalar territorial contexts.

Reflecting on the empirical observations, a couple of things stand out. As concerns reflexivity, key actors profited from their personal connections with the region, for example, they grew up there or associated professional achievements with it. Hence, they had conspicuous knowledge and understanding of the region's past development path, recurring development challenges, regional narratives and how they interact. At the same time, they stood out regarding their tacit knowledge of regional development policy in Austria, and regarding knowledge of and learning from prior projects in the energy transition realm. This combination allowed them to anticipate critical junctures and create a tailored challenge-driven concept for change.

As concerns resources, first, actors of SI in energy were in key positions that allowed them to access institutional resources and regional discourse (e.g., visioning processes), which gave them freedom to act in the first place and made it possible to (re-)organize actors, networks and resources in favour of their idea. This also illustrates that agency is deeply connected to persistent power relations. Second, the LEADER Programme and the Austrian Climate and Energy Model Region Programme that both regions had acquired funding from, enabled key actors to draw on an institutional and financial background that spurred their agency. In retrospect, these funding mechanisms were crucial for the realization of the respective SIs in energy, highlighting the importance of extra-regional linkages and resources for non-core regions.

Relatedly, these programmes also influenced agency in terms of relations by granting regional actors access to adjacent expert, policy and practice networks where advice and practical examples of innovation in energy were shared that inspired the idea phase and aided key actors in getting these ideas for social change on the ground. This shows that SI does not develop in an institutional vacuum but is often nudged or even directly enabled by specific expressions of public policies in a multilevel context (Castro-Arce & Vanclay, 2020).

The key organizations in the two SI processes, the EEE and Murauer Stadtwerke, used their exclusive resources, relations and reflexivity to set the course for the outlook of regional energy transition. Access to discourse enabled them to shape the transition process according to their knowledge and experience, producing specific sociotechnical imaginaries for each region. While in Güssing this imaginary included public participation and ownership, in Murau it focused on creating a new regional business model. Hence, while both SI processes emanated from an interwoven actor constellation of intermediaries linked to civil society, public authorities and the private sector, they entail different nuances of (dis)empowerment regarding regional ownership, acceptance and impact of energy transition (Avelino et al., 2019), implying that SI is per se neither good or bad (Wittmayer et al., 2020).

CONCLUSIONS

In this paper we engaged with the role of SI in energy transition in non-core regions. We argued that regional energy transitions are not purely technology-driven processes, but that they depend to a great degree on SI. SI is a purposive multi-stage innovation process aimed at reconfiguring social practices and interactions for transformative change. To understand how SI in energy comes to fruition, a micro-level perspective on agency is necessary. We conceptualized agency comprehensively as conditioned by diverse resources, relations and reflexivity that facilitate purposive action at each stage of the SI process. Our empirical examples illustrated how analyses of agency and SI can help create a more nuanced understanding of societal change in studies of socio-technical regime change (Hewitt et al., 2019). The cases also showed that socially innovative solutions provide directionality for transformative change processes. Hence, SI is key for managing

regional low-carbon energy transitions, particularly in those cases where transitions are highly contested or regional paths face a critical juncture.

Our SI approach combined organizational and territorial dimensions of societal change to take into account both the changing practices and relations as well as their embeddedness in specific spatial contexts and innovation systems. Such a comprehensive view has proven to be necessary to reconcile the micro-perspective on agency with the meso-perspective on socio-technical regimes and their embeddedness in place-based institutional contexts and herewith properly address the structure–agency dialectic in regional development. Relatedly, our take on agency sheds light on those configurations that endowed actors with the capabilities, resources and powers to address problems (e.g., unsustainable systems) and provide direction herein. In both cases, this agency perspective unveils how and why the key SI actors were able to take intermediary roles as caretakers of the overall energy transition process and hence become place-based leaders in and beyond energy.

These results have implications for regional transition policies and the decentralization of socio-technical systems of energy production and consumption, particularly as concerns the related societal rearrangement of an entire infrastructure system. Such rearrangements produce winners and losers, raising resistance in agents and regions that fear to be left behind (Rodríguez-Pose, 2018). This dynamic has the potential of derailing transitions. Thus, a couple of lessons for energy transition policies can be drawn from our results, especially in the context of an envisioned just transition in non-core regions. As we showed, SI can help in embedding new practices in regional contexts, increase inclusion, ownership, and the socio-economic benefits for regional actors by aligning the transition process to regional capacities. However, the ability of actors to successfully navigate this problem-solution space (Wanzenböck et al., 2020) depends on highly specialized and distinct territorial criteria. Thus, in our cases, intermediary actors either played a crucial role *for* the SI (e.g., LEADER, the EEE), or a new intermediary was the outcome *of* the SI (e.g., the MEZ). Consequently, we suggest that energy transition policies should attempt to build on existing intermediary networks, facilitating the interaction between social and technical regime aspects, or, in case such actors do not exist, aim to establish them.

Further, the examples illustrate how SI produced new regional resources and capacities through generating new knowledge stocks (spatially sticky learning) and adapting them to the regional context (valuation). SI contributed to overcoming resource scarcity in non-core regions by introducing new business models, governance modes, and policy interventions. From a policy perspective, this implies that a holistic approach to energy transition that goes beyond technological innovation support is well justified and indeed crucial to overcome the existing barriers for energy transitions. Specifically, this could be achieved through making SI a part of dedicated funding programmes for energy solutions, giving room for reflexive approaches towards energy challenges that tackle them in the necessary holistic way.

Our analysis also has consequences regarding our understanding of the transformative potential of SI. Functionalist renderings of SI often focus on its organizational dimension of 'doing good' (Murray et al., 2010). However, the reconfiguration process associated with SI builds on intentional agency aimed at enforcing certain pathways instead of others. This aspect deserves more critical attention, particularly in the context of sustainability transitions, where potential growth paths coincide with perspectives for transformative change. It demands digging deeper into questions of power in transitions and transformative change (Avelino et al., 2019) and uncovering the instrumentalization of SI, for instance to rebrand exclusive or elitist initiatives as 'social' (Marques et al., 2018). In a similar manner, SI processes are not immune to produce unintended effects, as the Güssing case showed. The participatory ownership model was in the end substituted by a state funding scheme that pushed citizen investors out of the process, herewith diminishing the inclusive character of the initiative. Furthermore, our examples strengthen the perspective of SI as a bottom-linked intervention that goes beyond pure grassroots approaches, hereby contributing to the analytical clarity of the concept and opening up new research avenues (Castro-Arce & Vanclay, 2020).

The purpose of this paper was to contribute to the role of SI in energy transition and zoom in on the role of agency in enacting SI in non-core regions. While the discussion above highlights some major insights in this field, there are also certain limitations to the paper that indicate further research need. First, due to our selection of cases, findings are associated with the specific Austrian multilevel governance framework (e.g., the existence of climate and energy model regions) and therefore need to be contrasted with conceptually similar cases in different policy contexts. Second, our process-oriented understanding of SI was instrumental to trace the innovation in our examples and to elucidate the conditionalities of agency related to the four phases. However, in order to better understand how SI works in different dimensions of socio-material relations, a complementary approach that puts more emphasis on concrete and traceable expressions of SI in collective practices is necessary. Specifically, a focus on how SI changed aspects of doing, organizing, framing and knowing energy transition as suggested by Pel et al. (2020) could yield useful results.

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