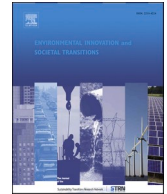




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Power to, over and with: Exploring power dynamics in social innovations in energy transitions across Europe

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ABSTRACT

This paper explores how power relations are manifested, altered and/or reproduced in processes of social innovations in energy transitions (SIE). We explore this research question by developing an interdisciplinary and transdisciplinary power heuristic building on different dimensions of power: power to, power over and power with. This conceptual framework helps us analyse the power dynamics in multiple types of SIEs that aim to contribute to sustainable energy transitions across three different national contexts: Germany, Poland, and the United Kingdom (UK). Our findings show how social innovation involves different dimensions of power to/over/with, and how power relations are both altered and reproduced. The cases under study also lead us to argue that understanding how power dynamics develop requires the analysis of the interplay between different power dimensions across the multiplicity of actors within different SIE-fields and their initiatives.

1. Introduction

While there is a growing agreement that current energy systems need to be decarbonised, debates are still ongoing on what exactly such a low-carbon and sustainable energy future should look like. Besides the many ecological and economic harms and challenges, transitions to sustainable energy systems also need to tackle numerous social issues linked to existing power relations (Brisbois, 2019; Sovacool and Brisbois, 2019). In line with the latter, we argue that energy systems suffer from inherently problematic power relations of inequality, exclusion, exploitation and extractivism. This implies that while technological innovation may be a necessary ingredient to tackle energy challenges, it is not sufficient for successfully tackling the ecological, economic, and social challenges in energy. These

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challenges are intertwined and systemic, and addressing them calls for *transformative social innovation* (Wittmayer et al., 2022a).

Transformative social innovation is defined as changing social relations involving new ways of doing, thinking and organising (Avelino et al., 2019; Wittmayer et al., 2020), which challenge, alter and/or replace dominant institutional arrangements (Haxeltine et al., 2017; Pel et al., 2020). Although there is an increasing recognition that transformations require socio-technical changes, the social dimensions of energy transitions are often neglected (Hirsh and Jones, 2014; Miller et al., 2014). Even in the field of sustainability transitions (Markard et al., 2012; Köhler et al., 2019; Loorbach et al., 2017), where there is an explicit socio-technical perspective and where many social dimensions of transition processes are addressed, social phenomena are often considered as dimensions of technological innovation. The added value of a social innovation perspective is to acknowledge the social as an object of innovation in and of itself (Avelino et al., 2019; Hölsgens and Schultze, 2020).

The issue of power relations is inextricably linked to the question about the transformative potential of social innovations in energy (SIE), and of innovation more generally. Understanding this potential thus requires studying how power relations are manifested, altered and/or reproduced in ongoing SIE-processes (Pel et al. 2020; Wittmayer et al., 2021). Both the fields of social innovation and sustainability transitions have been elaborately critiqued for ignoring or downplaying the role of power in processes of innovation and transition (e.g. Brandsen et al., 2016; Hendriks, 2009; Meadowcroft, 2009; Moulaert et al., 2007; Moulaert et al., 2017; Scoones et al., 2015; Smith and Stirling, 2010; Swyngedouw, 2005; Teasdale et al., 2020). Some of these critiques are accompanied by attempts to conceptualise power in relation to innovation and transitions, often in the energy context (e.g. Ahlborg, 2017; Avelino and Wittmayer, 2016; Avelino, 2017; Brisbois, 2019; Geels, 2014; Grin, 2010; Hess, 2013; Hoffman, 2013; Hoffman and Loeber, 2016; Sovacool and Brisbois, 2019; Teasdale et al., 2020). Notwithstanding this increasing attention to notions of power, research that links SIE and energy transitions in explicit power terms seems to be lacking. This is problematic because much research about innovation and transformative change in the energy sector tends to revolve around issues of power, i.e. individuals, organisations, and systems' (in)capacity to mobilise various types of resources to achieve a certain goal. A more systematic use of power concepts could provide insights into the socio-political dynamics of systemic change, where many actors in the energy system are changing their roles and activities whilst new actors come in.

This paper presents a systematic effort to integrate the concept of power into the analysis of SIE. Given that research on SIE is inherently interdisciplinary, and often transdisciplinary (Wittmayer et al., 2017), this requires an understanding of power that can be applied in an inter- and transdisciplinary context and that enables meaningful exchanges about power between researchers as well as practitioners working in the field of SIE. As such, this paper aims to answer the following research question: *how can we conceptualise and analyse power in the context of inter- and transdisciplinary research on SIE?* Answering this research question, we develop an inter- and transdisciplinary power heuristic that helps to increase our understanding of the socio-political dynamics of SIE. In doing so, we answer the above mentioned call for conceptualising and operationalising power perspectives into research in social innovation and sustainability transitions.

This paper is organised as follows. In Section 2, we introduce our methodology in three elements: a conceptual heuristic, empirical case studies and inter- and transdisciplinary workshops. We specify how the three empirical cases used in this paper have been clustered, selected and analysed. In Section 3, we present the conceptual heuristic of power for analysing SIEs. Out of the multiplicity of possible approaches, we focus on mapping three generic dimensions of power: power to, power over and power with. In Section 4, we analyse how power to/over/with has manifested across our three different cases: (1) cooperative organisation models for renewable energy in Germany, (2) pilot energy clusters in Poland and (3) actions against fracking in the United Kingdom (UK). In the discussion (Section 5) we discuss insights on power to/over/with that we gained across the different SIE-cases. We conclude (Section 6) by offering a reflection on the main insights on how power to/over/with manifest in SIE, and suggestions for future research.

2. Methodology

This research took place in the context of the EU-funded three-year research project "SONNET" (Social iNNovation in Energy Transitions), which focused on the emergence and development of SIE and involved researchers from various disciplines, as well as various societal stakeholders, in particular policy makers and energy entrepreneurs across Europe. In this context, we developed and applied a conceptual heuristic of power through an iterative inter- and transdisciplinary research process, which included empirical case-studies on SIE across various European countries. In this section, we shortly introduce the three main elements of the methodology underlying this paper: (1) developing a conceptual heuristic of power, (2) three empirical cases and (3) inter- and transdisciplinary workshops. Whereas this section elaborates on how the conceptual heuristic was developed, as a precondition to understand its origins, the content of the heuristic is further discussed in Section 3.

2.1. Developing a conceptual heuristic of power

In an inter- and transdisciplinary context like the SONNET-project, in which power is just one out of many topics, it is necessary to select power dimensions and perspectives that seem fitting for that research context. Here the challenge is to simplify - to a certain extent - the power concepts, but without losing the multi-dimensional complexity of power. Based on a literature review, and building on our earlier work on power (Avelino, 2021), we selected the distinction between power to, over and with as a focus. We then further operationalised these dimensions by (1) sharpening and 'translating' these power dimensions into short definitions and characterizations, including a collaboration with a graphic artist to visualise the concepts and (2) formulating empirical questions to be asked about SIE for each of these power dimensions. In Section 3, we present the conceptual heuristic of power, including the visualisation with short definitions (Fig. 1) and the formulation of empirical questions (Table 2).

2.2. Embedded case-studies of SIE

We carried out multiple, embedded case studies of SIEs (Wittmayer et al., 2022), by investigating three diverse SIE-fields within three national country contexts. Next to using multiple case studies for building theory and thereby enhancing generalisability of results (Eisenhardt and Graebner, 2007), we made use of an embedded case study approach, which allowed us to describe diverse subunits of analysis (Yin 2003). The main unit of analysis is the SIE-field. Drawing on the work of Fligstein and McAdam (2011), we have defined the SIE-field as an arena/space that includes a specific SIE as well as SIE-initiatives (actors who work on SIEs) and other field-actors (actors who enable and impede SIEs) - making those our other units of analysis.

In this paper, we focus on three different SIE-fields across three countries that showed promise to provide conceptual insights on power dynamics (Table 1). The three countries are diverse in terms of location (western and eastern Europe), energy market structure (e.g. relative strength of fossil fuels and renewables), and are in different stages of energy market liberalisation (which creates specific conditions for SIEs development).

Between July 2020 and March 2021, we gathered data through analysing documents, conducting in-depth interviews, and carrying out participant observation following a standardised research design (Hielscher et al., 2020). This resulted in comprehensive, country-specific case study reports, outlining the emergence and development of each SIE-field over the past 5–10 years (Dańkowska and Stasik, 2021; Heidary et al., 2020; Hielscher et al., 2021), which have been comparatively analysed (Hielscher et al., 2021). For the purpose of this paper, we focus on the power dynamics within these three specific case-studies.

For the SIE-fields under study in this paper, we carried out a total of 36 in-depth interviews with policy makers, actors involved in local, regional, and national SIE-activities, and fellow academics (see overview of interviewees cited in this paper in appendix). The interviewees were very diverse, ranging from leading figures who initiated the SIE-initiatives, to members of such initiatives, to partners, and policy-makers. More information about the interviews can be found in the underlying reports (Dańkowska and Stasik, 2021; Heidary et al., 2020; Hielscher et al., 2021). These in-depth interviews were supplemented with document reviews and observational data for data enrichment and triangulation. For the document analysis, we examined primary and secondary sources. Primary sources consisted of books, reports, leaflets and websites written by SIE-initiatives and secondary sources consisted of academic journal articles, newspaper features, intermediary reports and policy documents. We particularly focused on documents that helped us deepen our understanding of key events and activities mentioned by the interviewees. In addition, we attended 10 relevant events to conduct participant observation organised by SIE-initiatives and intermediary organisations to better understand contextual conditions (Yin, 2003; Hielscher et al., 2020, 2021). Once the data was collected, it was coded and analysed using the qualitative software tool NVivo before writing up a historical narrative in the comprehensive case study reports. This was not a linear process, but involved going back and forth between collecting data, writing up parts of the report, and gathering more data (Hielscher et al., 2021).

For gaining insights regarding the research question guiding this paper, i.e. on how to conceptualise and analyse power, we used the power concepts discussed in Section 3 to formulate questions about power dynamics in analysing the empirical cases and to inform interview questions. These power concepts also guided the qualitative analysis, which resulted in analytical summaries. These summaries were reviewed by interviewees to validate assumptions, findings, and direct quotes used. Next to the reliance on three different sources of data, this validation increased the trustworthiness of our results (Schwartz-Shea 2006).

2.3. Inter- and transdisciplinary workshops and labs

The results from the empirical analysis were discussed, refined and validated in an inter- and transdisciplinary context through three workshops/events organised at different stages of the analysis process: (a) interdisciplinary workshop with all co-authors to

Table 1
Overview of SIE-fields under study.

SIE-field under study	Definition of SIE-fields	Reasons for selection	Country
Cooperative organisation models for renewable energy (REC)	Cooperative organisation models in the renewable energy sector have changed the role of citizens in the energy system. They enable citizens to actively engage in the energy transition thus not only passively consume energy but to participate actively in the generation of energy.	The long history allows for reflections on changing power relations, seeing that REC has in some European countries become a more common energy actor.	Germany
Pilot energy clusters (PEC)	Pilot energy clusters are predominantly based on novel cooperations between public, private and scientific actors to test local energy projects. They therefore move towards more cooperative ways to work together through creating local agreements surrounding the production, consumption, storage and sale of local energy such as renewables.	This grouping of local actors with a common interest to address local energy issues helps to focus on collaborative efforts for change and therefore allowing to observe power.	Poland
Actions against fracking (AAF)	Actions against fracking make use of actions and framings to stop particular energy pathways such as fracking. People organise, network and mobilise and carry out, for example, protests, information events and lobby work to be able to frame the debates and stop projects surrounding fracking.	Its stark orientation towards moving away from fossil fuels and in the process changing the mix of the energy systems promises interesting insights into power relations.	United Kingdom

discuss and compare power insights within and across SIE-field and countries in March 2021; and (b) two transdisciplinary events ('Power Labs') with around 60 researchers, policy makers and social innovators in the field of energy to discuss and test our interpretations and analysis in February and in June 2021. The concepts and exercises used in this process were codified into a Transformative Power Guide (see Geus et al., 2021). The details of this inter- and transdisciplinary process and Power Lab have been described and discussed by Geus et al. (2023).

As part of this process, and based on the initial empirical analysis outlined under 2.2., researchers came together during an interdisciplinary workshop to discuss their analysis results concerning issues of power. This analysis was written up in so-called 'power vignettes', short stories on how 'power to', 'power over', and 'power with' are manifested in the SIE-fields under study. These power vignettes were used as preparatory material and a starting point for discussion in the transdisciplinary events with other researchers and societal stakeholders and acted as boundary objects for inter- and transdisciplinary collaboration and knowledge integration (Pohl and Hadorn, 2008). In doing so, they increased the validity of our conclusions, supported the 'fitness' of theoretical concepts and delivered an opportunity to gather more empirical data.

3. A conceptual heuristic: power to, power over and power with

Amongst debates about the meaning of power and the best ways to study it, most scholars tend to agree that power is relationally constituted and that it "resides in the social context" (Barnes, 2002, p. 127). As Clegg puts it, people "possess power only insofar as they are relationally constituted as doing so" (1989, p. 257). This means that when the social context changes, power relations are bound to change as well, and that as such, changing power relations form an inevitable dimension of social change and innovation. While most power scholars agree that power is inherently relational, they fiercely disagree on how such power relations should be understood and studied. Power being one of the most contested concepts in social and political theory, it has been argued that power can be viewed as an 'essentially contested' 'family resemblance concept' (Haugaard, 2002; Lukes, 1974), i.e. one of those words that can never be captured in one single definition and will always remain contested. In this section, we propose how to make sense of the notion of power through a dialectic and multi-dimensional approach, explain our focus on distinction between power to, over and with, and translate this into a conceptual heuristic.

3.1. A dialectic and multi-dimensional approach to power

In earlier work, we identified the following seven prevailing and recurring contestations about power: (1) Power 'over' versus power 'to', (2) Centred versus diffused, (3) Consensual versus conflictual, (4) Constraining versus enabling (i.e. structure versus agency), (5) Quantity versus quality, (6) Empowerment versus disempowerment and (7) Power = knowledge versus power ≠ knowledge (see Avelino, 2021). Rather than 'choosing sides' within these power debates or attempting to 'solve' them, we propose to acknowledge these power contestations as different dimensions of power. In very general terms, power can be defined as *the (in) capacity of actors to mobilise means to achieve ends* (ibid.). Here the use of the double meaning '(in)capacity' serves to recognize that capacity by one actor at one level can imply incapacity elsewhere, and that power is both enabling and constraining (cf. Hayward and Lukes, 2008). More relevant than such generic definition, however, is to then further enrich this broad notion of power with a more context sensitive, complex set of dimensions and to operationalise different dimensions of power into a research design. In this paper, we follow this line of argument and aim to dialectically explore how different dimensions of power manifest in SIE.

There are a broad range of multi-dimensional power frameworks in the literature, which aim to synthesise different perspectives on power. Two notable examples include the three circuits of power by Clegg (1989), distinguishing between relational, dispositional and structural power, and the four dimensions of power by Haugaard (2012, 2020), which distinguishes between (1) power as violence, coercion and authority, (2) power conflicts over structures and dominant ideology, (3) the social construction of norms, knowledge and consciousness, and (4) the "making of the social subject" i.e. processes of subjectification. In the field of sustainability transitions, several authors have built on these and other power frameworks to explore different dimensions of power in transition processes. For instance, Grin (2010) builds on Arts & Tatenhove (2004) to relate Clegg's concepts of power to the Multi-level Perspective on transitions, arguing that 'niches' exercise relational power, while dispositional power is exercised at the level of 'regimes' and structural power at the level of the so-called 'landscape'. In turn, Geels (2014) builds on Grin (2010) and several others, to distinguish instrumental, discursive, material and institutional forms of power exercised specifically by regime actors to resist transformative change.

Insightful as these frameworks may be, they have several challenges when it comes to employing them for analysing SIE-processes. First, many existing concepts and framework of power tend to focus on (the interaction with) regime structures and power elites. While this is very important, it is less appropriate to analyse power dynamics *within* innovation initiatives themselves. Second, many concepts and frameworks of power tend to be couched in layers of sophisticated social and political theories, as the example above demonstrate. Intriguing as these may be for political power specialists, they are less suitable to be used in the context of inter- and transdisciplinary research. As explained in chapter 2, the challenge is to simplify without losing the multi-dimensional complexity of power. Therefore, we propose to focus on the distinction between power to, over and with, following the work by authors such as Partzsch (2017) and Pansardi and Bindi (2021). While *power over* refers to an asymmetrical relation between two or more actors or groups of actors, *power to* consists of the ability of the actor herself to carry out certain specific outcomes, and *power with* refers to the ability of a group to act together in view of collective outcomes or goals (Pansardi and Bindi, 2021). In the next subsection, we introduce each of the concepts, and after we synthesise them into a conceptual heuristic to study and discuss how power relations manifest in SIE.

3.2. Power to, over and with

Power is derived from the Latin word *potere* - 'to be able'. Some argue that power "is always a concept referring to an ability, capacity or dispositional property" (Morriss, 2002, p. 283). Such understandings of power as capacity are referred to as *power to* perspectives. *Power to* refers to the capacity to intentionally mobilise resources and/or to achieve specific goals, i.e. 'getting things done', which includes intentionally affecting outcomes. Theories that focus on *power to* as a capacity include definitions of power as the capacity of humans to act in concert (e.g. Arendt, 2002) or the capacity of systems to achieve collective goals (Parsons, 1967). These theories are criticised for ignoring the relational or oppressive aspects of power 'over' others (Lukes, 1974). Understandings of *power to* are also criticised for "fail[ing] to account for individuals or groups in the community who, though they do not exercise power, nonetheless have power, in the sense that many people try assiduously to anticipate their reactions" (Dahl and Stinebrickner, 2002 in Ref. to Bachrach and Baratz, 1962). Or in other words, even when actors are not intentionally exercising 'power to' achieve a goal, they can still be involved in the exercise of structural power, also referred to as 'power over'.

Such *power over* perspectives have a more structuralist focus on coercion, force and domination, which includes forcing others to do things they would not do otherwise, or the constraining of agency by impeding structures. *Power over* includes processes of coercion, domination, dependency, oppression, and exploitation, and it can manifest in different, more or less transparent ways, including visible, hidden, invisible as well as unconscious ways. Structural power can be both centred and authoritative as well as more subtle and diffused. While authoritative power "comprises definite commands and conscious obedience", diffused power "spreads in more spontaneous, unconscious, decentred ways throughout a population, resulting in similar social practices that embody power relations but are not explicitly commanded" (Mann in: Stewart, 2001, p. 25). An essential trait of diffused power is 'normalisation', i.e. the belief that certain practices are 'moral' or in the 'common interest', which relates to Luke's (1974) idea of power as preference-shaping, and to various discursive interpretations of power as found in Foucauldian analysis (Foucault, 1980, 1982). The ability of oppressing without blunt violence is regarded by some as the essential characteristic of *power over*. According to Foucault, "power is a form of pacification which works by codifying and taming war through the imposition of particular knowledge as truth" (Foucault, 2002, p. 185). Here it is relevant to acknowledge that *power over* is not necessarily a negative or undesirable phenomenon. As argued by Haugaard when discussing what he calls the second dimension of power: "Contrary to common sense perception, the exclusion of certain forms of decisions through structural constraint is not inherently normatively reprehensible, and two-dimensional power does not necessarily entail domination. In fact, as an empirical process, the second dimension of power constitutes one of the conditions of possibility for justice" (2012:40).

Power with is a third dimension (cf. Partzsch, 2015, Pansardi and Bindi, 2021). *Power with* is about the collective capacity to collaborate to achieve collective goals, and includes co-action and empowerment as a goal in itself. From a *power with* perspective, actors can enhance their joint power, as is the case in Parsons' definition of power as the capacity of a societal system to achieve collective goals (1967, p. 93). This notion of power with builds on Arendt's interpretation of power as "the human ability not just to act but to act in concert" (Arendt 2002, p. 137). With this definition, Arendt emphasises that: "Power is never the property of an individual; it belongs to a group and remains in existence only so long as the group keeps together. When we say of somebody that he is 'in power' we actually refer to his being empowered by a certain number of people to act in their name" (ibid). As such, an important difference between *power to* and *power with* is that in *power with*, the aspect of coaction and empowerment are both conditions and goals of power in and of themselves. As such, in *power with*, the sharing of power, as a goal, supersedes more individual goals aspired to in the exercise of *power to*. As emphasised by Partzsch, in reference to Arendt: "Finding agreement becomes an end in itself and does not (only) serve the assertion of particular interests", and "the actions of individuals (and their self-interests) are not irrelevant in processes of power with; however, individuals only unfold their power when acting together with others" (Partzsch 2015: 195).

Taken together, *power to*, *over* and *with* can be used to explain persistence of the status quo as well as change when studying innovation and transitions. While they are distinct, they are not exercised independently from one another. In analysing how these different types of power are intertwined (Partzsch and Fuchs, 2012), we gain deeper insights into the dynamic interplay between different kinds of actors and initiatives, representing diverse interests, values and agendas. As a result we propose to understand SIEs as dialectical processes in which partisan actors espouse conflicting views about desired systems of energy production, distribution and consumption, and execute different dimensions of power to achieve specific goals.

3.3. A power heuristic

In this paper we argue that a productive power perspective on SIE requires a pragmatic approach that combines theoretical perspectives and builds on insights from earlier applications, adopting contrasting or even incommensurable ontological and epistemological assumptions. Such an interplay strategy (Schultz and Hatch, 1996) simultaneously recognizes contrasts and connections between distinctive perceptions of power (distributed/centralized, bottom up/top down, etc.) and uses them to more fully capture the socio-political and socio-economic dynamics of the process.

In this sense we do not attempt to build a coherent theoretical framework. Rather, we see the interplay of power to/over/with as a heuristic tool that can be used across disciplines and beyond academia to increase inter- and transdisciplinary understanding of power dynamics in SIE. As such, we conclude with a power heuristic that uses the three dimensions of power, as operationalised graphically and textually for the Transformative Power Lab (see Fig. 1 below, and Section 2.1 and 2.3). The purpose of Fig. 1 is to synthesise debates about power, as discussed above in Sections 3.1 and 3.2., in three accessible and recognisable notions of power. The point of this heuristic framework is not to treat power to/over/with as separate or static characterisations of power exercises at one point in time. Rather, the aim is to also acknowledge how these different dimensions of power relate to each other and to gain understanding of

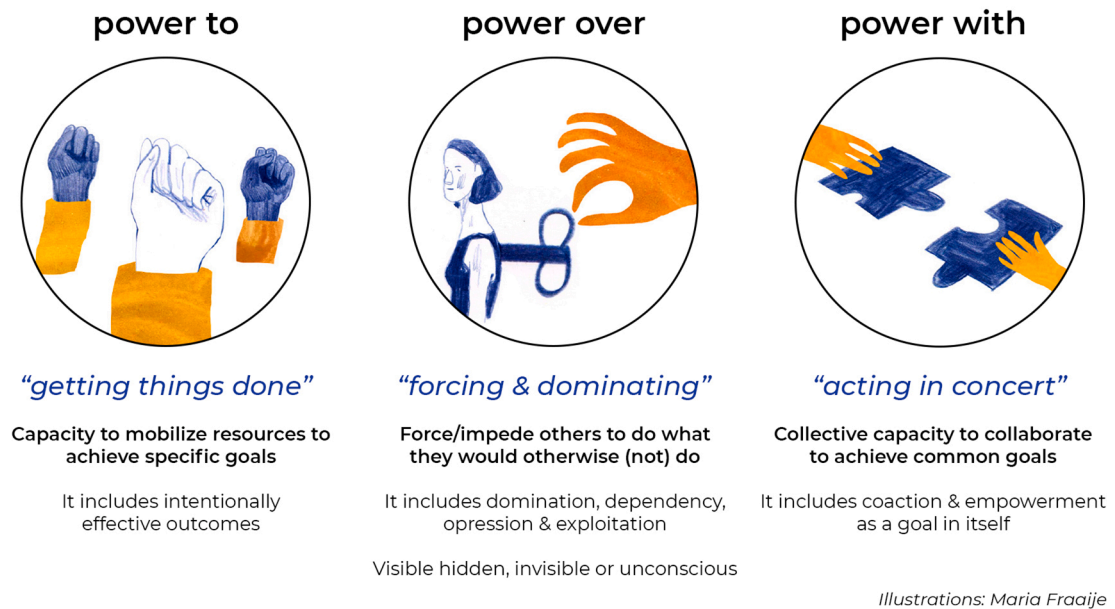


Fig. 1. Visual conceptualisation of power to, power over and power with (source: Geus et al. 2023).

Table 2

Conceptual heuristic and empirical questions to study power to/over/with in SIE.

Concepts of power	Foci of empirical enquiry > operationalised empirical questions to ask about SIE-cases
Power to: “getting things done”	How are which actors mobilising which resources to intentionally affect which outcomes?
Power over: “forcing & dominating”	How are actors impeded/coerced to do what thing that they would otherwise (not) have done?
Power with: “acting in concert”	How and which actors are collaborating to achieve common goals (and to what extent is empowerment a goal in itself)?
Power relations	How were power relations between which actors challenged and/or reproduced?

how power relations (can) change over time, including power to/over/with relations.

In addition, these three notions of power were applied to formulate empirical questions to study SIE as conducted in the power vignettes and in this paper (see Table 2 below, and Section 2.2). The next section will illustrate how these questions were answered for three different SIE-cases.

4. Case-studies on power in SIE-fields

4.1. Cooperative organisation models for renewable energy in Germany (REC)

The SIE ‘Cooperative organisation models for renewable energy generation’ refers to decentralised initiatives of citizens and local communities commonly owning the means of and participating in renewable energy production. In our research, we examined the development of renewable energy cooperatives in Germany over the past two decades.

Germany’s Energiewende, a climate and energy strategy for a transition towards a low-carbon, nuclear-free energy system, has major implications for the field. The Renewable Energy Sources Act (EEG), introduced in 2000 by a government coalition between Social Democrats and the Green Party, guaranteed a technology-specific payment for 20 years for renewable electricity fed into the grid (feed-in-tariff), providing renewable energy producers (including cooperatives) with long-term investment security. In addition, in 2006, an amendment to the German cooperative law simplified the process of establishing a cooperative. Against the background of these two policies, the number of renewable energy cooperatives was able to increase rapidly, from 8 in 2006 to 896 in 2020 (DGRV, 2021).

4.1.1. Power to: how are which actors mobilising which resources to intentionally affect which outcomes?

Most obviously, energy cooperatives encourage citizens to mobilise and own a variety of resources to produce decentralised and renewable energy. According to a DGRV (2021) survey, cooperatives were thus able to produce 8.8 tWh of renewable electricity in 2021 in this way. For cooperatives, the mobilisation of theoretical and practical knowledge is an important source of power to drive the energy transition forward. A key source of knowledge for cooperatives comes from gathering the knowledge of their 220.000 members. Many of these members acquire relevant knowledge through their professions, their involvement in local politics or their participation in conferences, workshops, associations or other similar activities. In addition, intermediaries are an important tool for the collection and dissemination of knowledge.

Intermediaries are also involved in the production of new knowledge, for example by commissioning or conducting research reports. An example of this is a discussion paper on local electricity trading, which was jointly written by the nationwide intermediary Bündnis Energiewende e.V., the energy supplier Greenpeace Energie, the 100% Renewable Foundation and the electricity company Schönau (Bündnis Bürgerenergie e.V., 2020). The authors of the study saw the benefits of local electricity markets in the improvement of self-consumption rates, an increased degree of self-sufficiency and reduction of electricity bills. The production of such research reports can provide renewable energy cooperatives and their intermediaries with arguments in the political debate on renewable energy policy and thus lend more weight to their political demands.

4.1.2. Power over: how are actors impeded/ coerced to do what thing they would otherwise (not) have done?

National energy policy is essential in setting the pathway for future energy systems, influencing how and with which resources energy is produced, and which actors remain relevant players in the future. Unsurprisingly, we observed that both incumbent energy companies and energy cooperative intermediaries tried to use their available means to exert *power over* energy policy making. Shaken to its foundations by the ongoing energy transition, the market coverage of the largest German energy suppliers fell from around 90% in the mid-2000s to 65% in 2020. However, these incumbents remain influential players with extensive financial resources and tight contacts to politics. They used their *power over* the energy sector to lobby for policies that suited their interests (Kungl, 2015).

After the first policy phase with favourable framework conditions for renewable energy cooperatives, the coalition government of Christian Democrats and Free Democrats introduced a number of changes with the EEG amendments of 2012 and 2014 that worsened these cooperative-friendly conditions (e.g. reduction of feed-in tariffs and introduction of an auction model for renewable energy). This contributed to a steep decrease in the number of newly founded cooperatives and a search for new business models (Kahla et al., 2017). According to one interviewee, renewable energy cooperatives needed "to always find new business models and to develop them before politicians sense that as a threat for the bigger companies and try to stop those developments" (Interview DE_EC_06).

4.1.3. Power with: how and which actors are collaborating to achieve common goals (and to what extent is empowerment a goal in itself)?

Renewable energy cooperatives are characterised by a high degree of cooperation (between cooperative members, between different cooperatives and with external stakeholders) and can therefore be considered a prime example of power with (Engerer, 2014). Solidarity and community is one of the basic principles of the cooperative legal form.

Democratic and non-hierarchical governance are another core principle of cooperatives. Decision-making processes within cooperatives are characterised by a one-member-one-vote principle, which stands in direct contrast to conventional forms of business, where control rights are distributed according to equity. "Every member of the cooperative has a vote, regardless of how much they are financially involved" (Interview DE_EC_07). The democratic structure empowers citizens to take an active role in shaping their own energy future. The previously passive consumer of energy takes on a new, active role: the 'prosumer'. Through the financing, construction and management of production sites for renewable energy, citizens actively participate in the transition to a sustainable energy system. Since in many cases, membership in cooperatives is possible with an investment of a few hundred euros, cooperatives also contribute to making citizen participation in the energy system possible on a large scale. An interviewee described renewable energy cooperatives as

"a deeply democratic construct. It really gives everyone access to knowledge, to technologies, to action. (...) It really creates the possibility for people to put things into practice. Lay people are allowed to join in. A very good opportunity to build up competencies and to democratise these competencies." (Interview DE_EC_07)

In addition, intermediary organisations on regional, national and EU-level facilitate cooperation not only between renewable energy cooperatives themselves (e.g. through experience and knowledge exchange or common policy work), but also with other relevant actors active in the field of renewable energy production and climate change mitigation. amongst others, we observed collaboration with foundations (e.g. 100% Renewable Foundation), research institutes (e.g. German Institute for Economic Research) or environmental NGOs (e.g. the Federation for Environment and Nature Conservation). On a more local level, it is also central for the success of cooperatives to work together with farmers, banks or municipalities. Meister et al. (2020) particularly emphasise the important role of cooperation with municipalities in providing roof space, land and receiving help with planning and approval procedures.

The formation of a broad network of regional, national and European intermediary organisations facilitated the representation of renewable energy cooperatives' interests: "[...] we asserted that a single cooperative does not really have a voice concerning politics. That was the starting point where we said, we want an umbrella organisation which represents the voices of energy cooperatives in our federal-state." (Interview DE_EC_07). In Germany, intermediaries such as the nationally operating German Cooperative and Raiffeisen Foundation (DGRV) or Bündnis Bürgerenergie e.V. provide political advocacy and help increase the capacity of energy cooperatives to contest powerful industries through e.g. press releases, joint statements on legislative proposals, publication of reports or other political lobbying activities. An example of their influence on decision-making processes is the EEG amendment 2020, which originally envisaged a reduction of the tendering obligation from 750 kW to 100 kW, which would have had a negative impact on the business models of energy cooperatives. After lobbying activities by Bündnis Bürgerenergie e.V. and DGRV, a reduction to 500 kW was made in the final amendment, representing a partial success.

4.1.4. Power relations: how were power relations between which actors challenged and/or reproduced?

Despite somewhat limited capacities to reinforce and uphold policy frameworks necessary for their thriving, renewable energy cooperatives are able to demonstrate how decentralised, citizen-led energy production can work in practice. They encourage new

actors and combinations of actors (i.e. citizens and local communities) to take on new roles (i.e. the production of renewable energy) - roles which were traditionally attributed to large and centrally organised utilities. By challenging the incumbent system of energy production and distribution, the rise of cooperatives can contribute to changes in existing power relations. At the same time, the field also *reproduces* existing power relations considering that the majority of members and representatives of cooperatives are white, male, and university-educated, which raises questions about barriers to membership and participation.

4.2. Pilot energy clusters in Poland (PEC)

The SIE-field “Participatory incubation and experimentation” describes novel collaborations between different types of actors aiming to test, experiment with and learn about diverse socio-technical solutions to energy-related issues. Governments often foster corresponding multi-actor collaborative platforms to facilitate exploring and acquiring knowledge. These platforms are designed to experiment with and evaluate novel solutions within specific local contexts. Solutions can be driven e.g. by advancements in technology, such as cutting-edge devices for microgrid management, or by social developments, such as innovative business models for energy prosumers.

A legal framework for “energy clusters” and accompanying competition for ‘Pilot Energy Cluster Certificates’, organised by the Polish Ministry of Energy in 2017–18 serves us as an example of a platform. Energy clusters,¹ introduced in 2016, are legally defined as a civil law agreement, which may include natural persons, legal persons, scientific units, research institutes or local government units, and which pertains to the generation and balancing of demand, distribution, or turnover of energy from renewable sources, or other sources or fuels, within a distribution network with a rated voltage of less than 110 kV (Gronkowska, 2017). Within the existing, highly centralised and coal-based power system, actors involved in clusters had to experiment with various operational possibilities (Micek et al., 2021). Below, we discuss a specific example of an energy cluster: Zgorzelec Cluster of RES Development and Energy Efficiency (ZKlaster), serving as a showcase for pilot energy clusters in Poland.

4.2.1. Power to: how are which actors mobilising which resources to intentionally affect which outcomes?

The competition for ‘Pilot Energy Cluster Certificates’ enabled local actors’ power to test new solutions in the energy sector: “It has opened the door to the world of energy for local actors” (PL-Interviewee#1). That required mobilisation of financial capital, the necessary technical knowledge and know-how, to fund and build new local infrastructure for energy production and distribution. ZKlaster invested in a smart grid demonstration project aimed at assessing the capabilities of energy clusters in providing an energy balancing service for the Distribution System Operator. As the former cluster CEO stated,

“It seems that the experiment has been successful ... We can see that with local generation and consumption based on the smart grid we are able to relieve the burden on the national power system ... This could be an ideal example of how local energy can affect the national power system” (quoted in Gramwzielone.pl, 2021).

Also, from its beginnings, through extensive education and information campaigns, ZKlaster has deliberately sought to raise awareness in local communities about the harmful effects of coal and the benefits of RES. Importantly, it operated in a coal-dependant region “where three generations were brought up on a coal culture” (PL-Interviewee#1). Gradually, ZKlaster mobilised public support and built alliances with key local stakeholders to prepare a strategy for transforming the region “from dependence on conventional energy, based mainly on lignite, towards renewable energy sources and energy efficiency” (PL-Interviewee#1).

4.2.2. Power over: how are actors impeded/coerced to do what thing they would otherwise (not) have done?

The current legal conditions largely hinder the pilot energy clusters’ development in Poland (e.g. due to the lack of their legal personality or dedicated energy tariffs) (Micek et al., 2021). Hence, energy clusters are dependant on establishing and maintaining good relationships with coal-based energy system’s incumbent actors such as policy makers or grid operators. For this reason, clusters’ development is often hampered by grid operators’ reluctance to cooperate. Similarly, policy makers resist creating new laws to level out existing power inequalities between energy clusters and grid operators. Hence, while ZKlaster has been successful in obtaining funding, e.g., to build connections of new PV farms on its own, for many other pilot energy clusters this was too challenging. As a result, most of them has “stagnated in hibernation” (PL-Interviewee#2).

Actors responsible for shaping the legal conditions have power over actors engaged in experiments: power over has been exercised by deciding on legal and infrastructural conditions that set the boundaries to the local experiments. For example, for ZKlaster, boundaries set by the existing energy law allowed only to experiment with the technological layer of the smart grid demonstration project (grid, storage, AI system), while commercial exchange of energy between cluster partners has not yet been possible. Thus, an important aspect of ZKlaster’s work has involved forging alliances and advocating for the implementation of more favourable regulations for energy clusters, to exert power over various stakeholders, including legislators and incumbents.

At the same time, incumbent actors rooted in the conventional energy system have been subjected to external power-over pressures, mainly from the European Union, to phase out coal and introduce energy communities to the Polish legislation (Hielscher et al., 2022). Pilot energy clusters have contributed to these pressures by presenting their potential as a solution to the growing grid congestion problems (due to their prospected ability to locally balance energy generation and consumption) and as key driving forces

¹ This case description uses data from a research project on energy clusters conducted in 2018–2022 supported by National Science Centre, Poland (grant agreement UMO-2018/31/D/HS6/02972).

for the decentralised energy development. Consequently, as a ZKlaster's representative observed: "We are no longer treated as a direct enemy by grid operators. Well, they don't have [an option], they just have to cooperate with us" (quoted in Dańkowska, 2022: 144).

4.2.3. Power with: how and which actors are collaborating to achieve common goals (and to what extent is empowerment a goal in itself)?

Pilot energy clusters exercise *power with* in the field of energy production and exchange by increasing collective capacity to achieve common goals and engage in collaboration which benefits participants from different sectors. In the case of ZKlaster, *power with* manifested in „the ability to network efficiently" (PL-Interviewee#1) at local, regional and national levels. Local cooperation included entrepreneurs and innovators, scientists (who offered their expertise), local officials (who could streamline the administrative process), and residents (who provided land for leasing). On the regional level, ZKlaster initiated and coordinated the development of a regional decarbonisation strategy. Importantly, the cluster leaders recognised from the outset that the success of these efforts depended on involving various stakeholder groups and "conducting effective communication between residents, mining industry, energy industry, business, investors, and NGOs" (ZKlaster.pl). Finally, ZKlaster engaged in networking at the national level through the cooperation with two key intermediaries, i.e. the National Chamber of Energy Clusters (which "allows clusters to unite and be more visible" - PL-Interviewee#1) chaired by ZKlaster's ex-coordinator, and the project "Development of distributed energy in energy clusters" (where „the strategy of energy clusters' development is the primary goal" - PL-Interviewee#2) led by the Ministry of Development and Technology. Both initiatives have been focused on exchanging knowledge, making recommendations, supporting new clusters, learning and lobbying based on collaboration with local actors, experts, and incumbents (e.g. grid operators or policy makers).

4.2.4. Power relations: how were power relations between which actors challenged and/or reproduced?

The development of pilot energy clusters illustrates the dynamics of power relations between incumbents and challengers in the Polish energy system. Experiments with energy clusters contributed to the gradual power shifts between actors in the energy sector: as the position of incumbents is still very strong, they started to acknowledge new entrants as valuable partners in exploring possible future energy pathways. Although the first spark of change came from the government (when introducing the energy cluster concept into Polish law and launching the competition for 'Pilot Energy Cluster Certificates'), power relations have changed mostly as a result of both grassroots efforts (such as, in the case of ZKlaster, the implementation of a smart grid demonstration project and building the support of local communities) and external pressures (such as European Union policy supporting decarbonisation and the development of energy communities). Nevertheless, the vast majority of energy clusters are not able to operate in the current unfavourable conditions. At this stage, only pioneering initiatives like ZKlaster are able to work against established rules and existing power relations, challenging the path dependencies built into the Polish energy system.

4.3. Actions against fracking in the UK (AAF)

The SIE 'actions against fracking' is made up of activities such as protesting, information gathering and lobbying work derived from different groups and organisations that aim to stop shale gas explorations and extractions. We investigated the emergence and developments of actions against fracking in the UK starting from the 2010s until 2019. Over the last decade, the extraction of onshore gas — particularly through hydraulic fracturing — has been contentious and controversial, not least in the UK. UK proponents emphasise the potential economic, security and environmental benefits of onshore gas, while opponents stress the incumbent environmental, health and climate risks associated with these extractions and operations. Despite promising geological estimates and strong support from the highest levels of the UK government, public support for shale gas explorations and extractions has declined. Growing opposition and protests have marked explorations and extraction attempts since 2013. In November 2019, the UK government halted fracking in England with immediate effect. The UK government said it would not agree to any future fracking until compelling new evidence is provided that proves fracking could be safe. The future of fracking is therefore open in the UK.

4.3.1. Power to: how are which actors mobilising which resources to intentionally affect which outcomes?

Actions against fracking primarily mobilise people and ideas of an alternative energy future to resist and challenge fracking and acidification of shale gas. People involved in 'actions against fracking' have had to be inventive, resilient, and persistent over the past years facing resistance by powerful state institutions and energy companies (Brock, 2020). People and groups have had to mobilise their emotional stamina (e.g., spending months at protest sites in any weather, requiring time whilst making financial sacrifices such as giving up jobs and creating strong social ties) and go through steep learning curves (requiring time and personal commitment to research information about the industry and its technology) to stop industry developments.

"I was always particularly impressed by Preston New Road because... people were there for five years day and night... Because it's quite easy to do an action somewhere and maybe people are arrested and have a trial and that's over. But to really stay with it for so many years. Every morning, getting police abuse, trauma to make yourself come to that gate, sing and knit. I think that is really quite impressive" (UK-Interviewee#2).

Most interviewees talked about the steep learning curve that they and the group had to go through to build the capacity to take diverse sets of actions against the industry. Some of the interviewees talked about how they used to consider themselves to be shy because they never had spoken even at a dinner party, but now found themselves talking to large groups of people, giving media interviews, and providing evidence at government select committees.

4.3.2. Power over: How are actors impeded/coerced to do what thing they would otherwise (not) have done?

Researching the shale gas industry and fracking activities, Brock (2020, p. 2 drawing on the work of Mobbs, 2013) has argued that “fracking is embedded in a complex web of personal and institutional relationships and vested interests that transcend state institutions, fracking firms, and investors”, demonstrating that the notion of power over is an integral part of the political economy of fossil fuels in the UK. In her work on fracking, Brock (2020, p. 1) has identified several strategies by drilling companies and state actors to exercise power over in order to manage actions against onshore shale and gas. Such strategies have included for instance “criminalisation and stigmatisation of land defenders, targeting campaigners as ‘domestic extremist’, physical abuse” in addition to “contracting of PR firms, lobbying, sponsorships of sports clubs and school competitions, ‘astroturfing’, and influencing local so-called democratic procedures”. Such strategies have often been extremely successful in achieving their goals.

Actions against fracking have particularly been able to exercise *power over* through the creation of strong alliances (such as between NGOs and local activists/ groups) that have filed legal actions, trying to influence fossil fuel policies based on the UK’s ambitious climate targets. For example, in 2018, an environmental campaign group brought a judicial review challenge of the UK’s National Planning Policy Framework (NPPF) (in which councils were asked to recognise the benefits of onshore hydrocarbons), arguing that changing the NPPF would go against the government’s policy to reduce greenhouse gas emissions under the Climate Change Act 2008. They won the case in the high court where key elements of the government’s national fracking policy were ruled unlawful.

“Ms Stephenson [member of Talk Fracking] said new scientific developments cast doubts on the government’s position that onshore shale gas had a lower carbon footprint than imported liquid natural gas... Talk Fracking said the government should have considered new evidence submitted to a public consultation, which challenged the policy” (Hayhurst, 2019).

This decision meant that future planning applications for fracking have been able to be objected to on current scientific evidence, especially about climate change, as opposed to government policy insisting on the great need for gas extractions. Still, it is important to keep in mind that legal actions require lots of resources and some of them have not been won by groups and organisations against fracking.

4.3.3. Power with: how and which actors are collaborating to achieve common goals (and to what extent is empowerment a goal in itself)?

There are several ways in which anti-fossil fuel groups seem to collaborate and support each other: creating groups, networks and intermediary organisations (local, regional and national), encouraging people to get engaged in several activities, creating a core base of people to work on the campaign, developing clear messages for the campaign, having diverse strategies and tactics for campaigns and direct actions, helping to spread each other’s messages and activities, just to mention a few. For example, the ‘Let Communities Decide’ campaign that was created to oppose the plans to fast-track fracking planning decisions in England and in the process brought together grassroots groups, NGOs such as Friends of the Earth, network organisations such as Frack Free United, and movements such as 350.org in 2018. The common goal between these groups and organisations was therefore not only to stop particular fracking projects but rather critique the governance of fracking to be undemocratic and highlight the need to make decision-making processes more transparent and inclusive. It was the slogan and alliance of actors that created lots of visibility for the campaign.

Two additional aspects that have been mentioned by several interviewees linked to collaboration and empowerment: a) the role of social media & networks and b) the increasing public discourse around climate change. Social media has allowed groups to document protests and their policing to tell their own stories of what has been happening. In addition, groups have been able to share stories with a wider audience – not only nationally but also internationally.

Experiences, knowledge and support can be shared more widely and quickly, making it easier to support each other. Generally, there seems to have been a shift from local groups trying to fight their own battle to supporting other groups (regionally, nationally and internationally), making anti-fossil fuel not only a local but national and international issue. Generally, there seems to have been a shift from local groups trying to fight their own battle to supporting other groups (regionally, nationally and internationally), making anti-fracking a larger issue.

“They’ve [campaigns] become more climate aware, as opposed to being anti-fracking at a local level. So, the focus has changed because as people become more aware of what fracking entails, then you see how it fits into the bigger picture” (Interviewee#7).

Greater connectivity and support for each other, whilst creating strong social ties have therefore contributed to being able to fight anti-fossil activities based on climate change grounds. Moreover, Being involved in anti-fracking deeply changed some people’s lives, often moving beyond fracking as an issue and becoming engaged in broader social and political climate issues.

4.3.4. Power relations: how were power relations between which actors challenged and/ or reproduced?

The 2019 moratorium on fracking might be a relevant moment to think about power relations. Several arguments have been made when trying to explain the reasons for the moratorium on fracking, for example, gaining traction through diverse activities such as increased national media attention, stopping exploration sites, starting legal cases, and influencing the public support for shale gas and fracking over the past years. Whilst discussing some of the arguments, it is important to keep in mind that a moratorium is a ‘hold’ on fracking (and not a decision to stop). Moreover, the narrowing of the definition of fracking by the UK government as part of the Infrastructure Act in 2015 meant that most onshore oil and gas extractions do not fall under the moratorium (Zalucka et al., 2021). It might therefore be possible to argue that changing the definition of fracking and putting in a moratorium (rather than a stop) have also been ways to ‘manage’ the public discourse and ease processes for the fossil fuel industry. Moreover, personal and institutional ties persist between shale gas companies and state actors in the UK (Brock, 2020). It is therefore questionable how far power relations have been shifted. Nevertheless, there definitely is more pressure on shale gas companies, considering the decline in public support for fracking and increased social media attention.

5. Discussion

While we do not aim to conduct a comparative analysis of the cases in terms of generalising causal mechanisms, we do aim to explore what we can learn from the different cases in terms of how power to, over and with manifest in SIE.

Power to has manifested in different ways in the SIE-field cases. In the case of PEC, policy changes have enabled SIE-initiatives to develop and establish the SIE. For example, the set-up of the EEG and changes to the cooperative law in Germany allowed SIE-initiatives working on REC to develop more reliable financial models and more easily set up a legal entity. It therefore became less demanding to sustain the SIE and establish it within the energy system. In contrast, for PEC, policy changes (e.g. competition to gain certificates) allowed the SIE to emerge. In the case of AAF *power to* manifested through pooling resources between SIE-initiatives in attempts to achieve their goals. For AFF, it has been mostly about mobilising large groups of people (rather than gaining policy support). In addition to pooling resources and mobilising people, SIE-initiatives often exercise *power to* based on realising energy projects and showing that such alternative existing energy systems are possible. AAF can meanwhile create narratives for energy pathways without fossil fuels.

In developing such alternative discourses and infrastructures, SIE-initiatives can be impeded by existing institutions (e.g. the development of PEC has stagnated due to legal constraints of setting up an energy cluster). Indeed, *power over* is actively exercised based on vested interest between established industry actors and policy makers who want to maintain business as usual. SIE-initiatives involved in AAF, for example, want to actively disrupt the existing fossil fuel based energy system where those with a vested interest in fossil fuels attempt to actively lobby for changing laws and regulations (such as changing rules around protest activities) to stop the activities by SIE-initiatives. More implicitly it can manifest by not considering the impacts of newly developed and changing policies on SIE i.e. changing subsidies for renewables, which had a large impact on REC. In addition, existing institutions (such as social norms) impede SIE developments, and maintaining these can be seen as a form of exercising *power over*. For instance, activities developed within PEC often require institutional changes for the SIE to develop over time. Although policy makers might support the SIE, they are reluctant and/or slow to make necessary changes to existing laws and regulations. In the case of Poland, the EU energy and climate policies have played a key role in putting pressure on the national government to move towards a more sustainable energy system, illustrating that *power over* can be overcome through alliances with actors who are able to increase the pressure for change (in this case the EU and their directives).

Here we also see how SIE-initiatives try to find ways to overcome structural impediments by finding legal loopholes and lobbying for policy changes. Aimed at setting up alternative energy infrastructures, some SIE-initiatives in PEC see the need to keep working relationships with more established energy actors to allow for regulations to be created that sustain their projects. The case of REC has been able to show how the SIE can be a potential solution to existing energy system problems (i.e. grid congestion) and set up several intermediary organisations to strengthen its cause. In doing so, SIE-initiatives end up exercising *power over* in the sense of enforcing new structural conditions. Aiming at setting up alternative energy infrastructures, SIE-initiatives in PEC see the need to keep working relationships with more established energy actors to allow for regulations that sustain their projects and the SIE. As such, we observe that SIE-initiative are not merely undergoing *power over*, but also actively exercising it, in terms of aiming to impede and/or force others to do what they would otherwise not have done, and in terms of developing new forms of structural power. Such insights contribute to existing research on power in innovation and transitions, where the focus is often on how structural power is exercised by regimes to resist change (e.g. Geels 2014, Avelino 2017): by analysing how *power over* is also exercised by and within SIE-initiatives, we gain a more comprehensive understanding of power dynamics beyond a simplistic niche-regime dichotomy.

Furthermore, looking at *power with* across the SIE-field cases, networking and learning are important for the emergence and development of all SIE-fields under study. Such networking and learning can be based on the need to create intermediary organisations and networking groups to collaboratively lobby for policy alterations and introductions and set in motion changes to regulatory frameworks. At the same time, these intermediary organisations and networking groups allow for the sharing of knowledge and experiences in order for the SIE to spread and institutionalise over time. As is also emphasised in the literature on innovation and transitions, incumbents are powerful and well-connected (e.g. Geels 2014, Sovacool et al., 2020), so newcomers and innovation initiatives need to build alliances, networks and advocacy coalitions to increase their power, which explains the importance of translocal networks in the diffusion of innovation (e.g. Loorbach et al., 2020, Avelino et al., 2020). Differences across the SIE-cases in this paper are about who is involved in setting up and running these organisations and groups and which actors do (or not) support them, drawing attention to differing actor groups, relations, and collaborations. For example, AAF and REC are often set up by community actors or NGOs who work on and support the SIE, whereas PEC is made up of public, market, and community collaborations. Another interesting feature about *power with*, as discussed in Section 3, is that the sharing of power can be a goal in itself, and that this goal of empowerment can replace or at least shift other initial goals. In the case of REC, for instance, the democratic aspect of cooperatives is often considered as important - if not more - as the production of renewable energy. In the case of AAF, the focus on anti shale gas exploration and extraction shifted towards climate awareness more broadly.

The strong presence of *power with* still does not mean that SIE-fields peacefully co-exist. Visions and narratives of future energy systems and their pathways vary between SIE-fields and across SIE-initiatives within the same SIE-fields (Wittmayer et al., 2022b). Often SIE-developments are signified through plural voices, aims and activities. Still, it seems that over the past years, through the rise of climate change movements (such as Fridays for Future and Extinction Rebellion) and popularisation of the 'climate crisis' discourse across Europe (e.g. local authorities declaring a climate emergency), large numbers of people could be mobilised, and collaborations (even between unlikely actors) have emerged that could challenge business as usual even in changing energy systems. As argued by Hewitt et al. (2019), these movements have come together in response to the global recession, rising energy prices and increasing

poverty issues surrounding energy. Better understanding *power with* dynamics help us better understand how such movements and initiatives operate and develop.

6. Conclusion

To unpack power dynamics in social innovation in energy, we proposed a conceptual power framework to empirically reconstruct how different relations and dimensions of power manifest in multiple types of social innovations in energy (SIE) across three different geographic, national contexts (Germany, Poland and the UK) and three different SIE-fields: (1) Cooperative organisation models for renewable energy (REC), (2) Pilot energy clusters (PEC) and (3) Actions against anti-fracking (AAF).

There is often a tendency to associate social innovation with *power to* (capacity to achieve outcomes) and *power with* (coaction and empowerment). Our findings show how social innovation goes beyond *power to* and *power with* and also involve considerable *power over* dynamics. Here it is not only about how structures and institutions are impeding SIE-initiatives, but also about (1) how SIE-initiatives develop new structures and institutions and (2) make others do things they would otherwise not do. For instance, existing international, European, and national climate goals have been mobilised by SIE-initiatives to exercise *power over* others through legal cases when climate goals are in danger of not being met.

Based on our analysis, we furthermore argue that the way and extent to which *power to/over/with* is exercised depends on complementary power exercised across SIE-fields and their initiatives. When it comes to assess power dynamics, it is not only key to consider how one specific SIE-initiative exercises *power to/over/with*, or even how power is exercised within a SIE-field, but rather about the interactions between different SIE-fields and the dynamic interplay between those initiatives and fields. Looking across the SIE-fields provides insights into the multitude of actors in energy transitions, who gets involved (or not), how and why, and what types of power relations they create. Such a multi-actor perspective on power dynamics in social innovation moves the transition literature beyond the bifurcation between niches and regimes and the so-called “David vs. Goliath narrative”. Here we are explicitly contributing to some of the few discussions about power in transitions and social innovation in the literature, where there is often a focus on the power of incumbents and vested interests in resisting regime change (Geels 2014) or in ‘power groups’ resisting social innovation (Ghys 2020). With our multi-dimensional understanding on *power to/over/with* we demonstrate that (1) *power to* and *power with* are other dimensions of power that SIE-initiatives (and other innovations) can use to challenge *power over*, and (2) how SIE-initiatives themselves also exercise *power over* to achieve their goals. Or in other words, social innovation is not just a matter of niche-actors exercising *power to/with* while incumbent regime-actors impede them by exercising *power over*. Instead, SIE-fields develop as niche-actors, intermediary actors as well as regime-actors that interact with different kinds of *power to/over/with* that both strengthen and impede the SIE-field and the aspired energy transitions.

Through the theoretical and empirical analysis of power as a phenomenon in the context of sustainability transitions, this paper developed an inter- and transdisciplinary heuristic which enables researchers to explore power dynamics underpinning transition and innovation processes. Our analysis illustrates how every dimension of power should be approached dialectically in the context of empirical research. When investigating how *power over* is constraining social innovation, there is a certain ‘dialectic duty’ to also consider how *power to* is enabling social change, as well as how *power over* may also enable change. Likewise, there is a dialectic responsibility to systematically question the future power implications of social innovations, which compels us to focus part of our power analysis on unravelling and deconstructing political contradictions, paradoxes and ironies that often lie beneath discourses on social innovation for more ‘sustainable’ and ‘just’ energy (Pel et al., 2023). This is partly about highlighting unintended consequences, such as how empowering some actors often leads to disempowering others, or how policies to achieve ecological sustainability goals on the short term can lead to unsustainable social relations and unbalanced power relations on the long term. Staying truly with a dialectic approach invites us to also acknowledge the potentially intended empowering effects of that same intervention.

For future research we suggest further developing the conceptual framework through additional empirical research and theoretical reflections. This includes, amongst others, the concept of *power within* from feminist work (e.g. Batliwala, 2011; Longwe, 2000; Rowlands, 2016), which centres on processes of socialisation where certain groups like e.g. women accept and normalise unequal power relations. Besides reflecting on the power dynamics within SIE-fields, it would be useful to also apply the framework to critically consider the role that researchers like us play in the power dynamics of knowledge co-production around SIE and energy transitions (Strumińska-Kutra and Scholl, 2022). Furthermore, although this paper advances beyond specific outcomes of a single SIE-initiative by taking a field approach as part of an embedded case study, future research could more systematically explore the ‘inter-field power dynamics’ co-shaping energy transitions.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that has been used is confidential.

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Appendix: Interviews cited in this paper

Interview number	Case-study report reference
<i>Actions against anti-fracking (AAF)</i>	
UK-Interviewee#1	Hielscher 2020
UK-Interviewee#2	
<i>Renewable energy cooperatives (REC)</i>	
DE-Interviewee#6	Heidary et al., 2020
DE-Interviewee#7	
<i>Pilot Energy Clusters (PEC)</i>	
PL-Interviewee#1	Dańkowska and Stasik, 2021
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