



Making sense of power through transdisciplinary sustainability research: insights from a Transformative Power Lab

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Received: 25 April 2022 / Accepted: 17 January 2023
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Abstract

If transdisciplinary sustainability research is to contribute to sustainability transitions, issues of power dynamics need to be understood and accounted for. However, examples of concrete methods that put this into practice are sparse. This paper presents a conceptual and methodological framework that develops a better understanding of the power phenomenon, while providing actionable knowledge. By focussing on the context of social innovation in energy transitions, we demonstrate how different theoretical conceptualisations of power can be translated into a collaborative, transdisciplinary research design. In a facilitated process, researchers, policy workers and practitioners from diverse social innovation fields developed and tested the Transformative Power Lab approach and co-wrote a ‘Power Guide’ as a strategic exploration of power dynamics in *sustainability transitions*, specifically regarding *social innovation in energy transitions*. Based on the insights that emerged during this process, we discuss how transdisciplinary and action-oriented approaches in sustainability transition studies might benefit from this approach and, potentially, develop it further.

Keywords Transdisciplinary research · Methods · Power · Sustainability · Social innovation · Energy transitions

Introduction: from conceptualisation to operationalisation of power concepts

The need to develop innovative, transdisciplinary research approaches that can contribute to sustainability transitions through facilitation has generated substantial discussion and research over the past decade (Lang et al 2012; Miller

et al. 2014; Fazey et al. 2020). Such approaches, in which researchers collaborate with practitioners to forge change through the co-creation of knowledge, is contrasted with ‘knowledge-first’ approaches in which scientists primarily act as knowledge providers (Wiek et al. 2012; Lang et al. 2012; Miller et al. 2014). Transdisciplinary research builds on similar assumptions as the field of action research, which aims to democratise knowledge processes and transform power relationships through critical reflection and action (Greenwood and Levin 2007; Reason and Bradbury 2008). However, whereas transforming power relationships is at the heart of action research, transdisciplinary research has traditionally tended towards a more instrumental use, primarily focussing on the practice of involving scientific and non-scientific actors for knowledge development.

Recently, however, tensions around accounting for normative stances and coping with power dynamics have been identified as priority areas of method development for transdisciplinary research (Bulten et al. 2021; Soininen et al. 2022; Strumińska-Kutra and Scholl 2022). Indeed, power has been the focus of a number of studies on the internal dynamics of transdisciplinary research processes (e.g. Fritz

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and Meinherz 2020; Fritz and Binder 2020; Kareem et al 2022; Osinski 2021), through which the (self-) reflexive perspective on the role of diverse actors has been enhanced by a) developing projects and research problems, b) co-creating knowledge (e.g. considering who is in, who is out, and whether disadvantaged groups are integrated) and c) bringing results of projects into reality/implementation (e.g. considering to what extent the results question existing discourses and institutions) (Fritz and Meinherz 2020). However, we argue that the development of power concepts as an outward lens for the *object* of study of transdisciplinary research still falls short.

The argumentation in this paper proposes a slightly different yet supplementary perspective, in two ways. First, it locates power as an object of a transdisciplinary exploration in a particular field (in this case social innovation and energy transitions). Rather than asking how power penetrates *transdisciplinary* processes, we ask how power penetrates *transition* processes, and we investigate this question through a transdisciplinary process. Second, we integrate the approach into transdisciplinary research to build strategic competences among transition actors. By co-creating knowledge on how power works, we aim to support actors to empower themselves and to strategically develop interventions for societal change. Instead of an *ex post* reflection on systemic barriers, we propose making (power related) barriers visible and (to a certain extent) manageable.

In this paper, we introduce the Transformative Power Lab (TPL) as an approach that responds to this gap in transdisciplinary research. The Transformative Power Lab was developed by transdisciplinary researchers in the context of social innovation in energy transitions (SIE). Although social innovation and action research have been described together before (e.g. Moulaert et al. 2013; Novy et al. 2013; Aiken 2017; Biekart 2017; Moulaert and MacCallum 2019; Moulaert and Mehmood 2019), concrete methods on how to transform power relationships in this discipline appear to be largely absent. Indeed, in our work as action researchers operating in this transdisciplinary context, we observe that there is a certain difficulty, or possibly even taboo, to talk openly about issues of power, while simultaneously there is an acknowledgement that there is a need to do so. This leads us to the question ‘*How can knowledge on power be developed and enacted in transdisciplinary research on sustainability transitions, specifically research on social innovation in energy transitions?*’

Both the concepts of ‘transitions’ and ‘social innovation’ have been defined—either implicitly or explicitly—in terms of shifting societal relations (e.g. Rotmans and Loorbach 2010; Franz et al. 2012; Moulaert et al. 2013; Avelino and Wittmayer 2016). We understand sustainability transitions to be long-term, structural transformations relating to persistent problems in societal subsystems (Grin et al. 2010; Markard et al. 2012; Loorbach et al. 2017; Köhler et al. 2019; EEA

2019). Social innovation then refers to innovations in the ‘social’, for instance new (combinations of) social practices or changing social relations (Howaldt et al. 2016; Moulaert 2013). This makes the understanding of power relations, and how they change, a necessary condition for understanding processes of (transformative) social innovation. Particularly since dominant discourses on social innovation and sustainability transitions share underlying notions on drivers for societal improvement, such as challenging broader societal power imbalances, and a belief in human knowledge and agency to change the world for the better (Avelino et al. 2019; Pel et al. 2020a, b; Wittmayer et al. 2020). However, many questions remain regarding the role of power relations in these processes, and how researchers can conceptualise these to study the alteration and/or reproduction of dominant regimes (e.g. Westley et al. 2017; Moulaert and MacCallum 2019). While studies on power and transitions have been developed, including on energy, studies on understanding power processes in social innovation appear to be few and far in between. Considering that energy transitions are inherently centred around issues of power, and related questions around social equity outcomes and democratisation of energy systems are gaining in pertinence, addressing this knowledge gap in *understanding* the inherent role of power in SIE seems timely (e.g. Hoffman et al. 2021; Pickering et al. 2022).

Besides *understanding* the role of power, we also emphasise the importance of *facilitating* social innovation in energy transitions with regards to power issues. For social innovations to contribute to just and sustainable energy transitions, theoretical insights on power need to be integrated into research on, and practice of, SIE. More specifically, we argue that developing power literacy can help actors gain a sense of agency in the context of SIE, while at the same time, allowing them to better cope with existing power structures. A glance into existing transdisciplinary formats that facilitate social innovation, such as *Urban Transition labs*, *Energy labs*, or *Urban Living labs* (Nevens et al. 2013; Dvarioniene et al. 2015; Voytenko et al. 2016), shows that explicitly unpacking issues of power is often still overlooked in these approaches. While in some cases, a reference is made to scoping the degree of power actors in a system have when selecting stakeholders, or setting the aim of “*decentralising power at local level and to stakeholders*” (Dvarioniene et al. 2015, p. 515), details about how the concept of power is unpacked and how this is acted upon remain unclear. Possibly, this could be related to strategic ‘apolitical’ positioning of such interventions. Nevertheless, specific heuristics on energy transitions, social innovation and power appear to be absent.¹

¹ Some power-related tools have been developed for specific target groups such as designers, facilitators and/or development agencies to deal with power or in partnership relations (E.g. A social field guide to power literacy; Oxfam quick guide on power analysis; Power: A

Building on insights from transdisciplinary research, the Transformative Power Lab is a tool comprising activities that aim to establish a ‘space for societal learning’ for democratisation, while conducting joint knowledge production and data collection on power concepts (Wittmayer and Schöpke 2014). The TPL aims to foster knowledge development and facilitate an interdisciplinary and transdisciplinary exchange on power dynamics in SIE to accelerate societal change by equipping participants (practitioners, policy workers and researchers) with a better understanding of power by making it visible and tangible, as well as to create a motivation to apply these insights to their work and strategies.

In this paper, we present and reflect on the research design of and empirical data from the TPL. This paper is structured as follows: "[Development of the Transformative Power Lab in the context of social innovation in energy transitions](#)" features a description of why and how we developed the TPL, including how the data analysis for this paper was conducted. In "[The Transformative Power Lab format](#)", we present the seven premises on power in SIE that form the basis for the TPL, how these premises are operationalised into ingredients (research design elements) and exercises, and what discussions emerged as a result. Finally, "[Reflections and conclusion](#)" highlights reflections and conclusions on the outcomes of the TPL, as well as recommendations on further implementation.

Development of the Transformative Power Lab in the context of social innovation in energy transitions

Below, we outline the general logic of the TPL and explain how empirical data collection (e.g. interviews, discussions, written feedback) and analysis were conducted. The focus of the empirical data was on the phenomenon of power and the process of research. We position the TPL as an approach, as it is constituted by a set of methods.

A team of transdisciplinary researchers, referred to throughout this paper as ‘we’ or the authors of this piece, developed and tested the TPL as part of the Horizon2020 SONNET project, which explored SIE across six European cities (Antwerp, Bristol, Mannheim, Warsaw, Grenoble and Basel) and six social innovation fields: (1) Cooperative energy production, (2) Campaigns against specific energy pathways, (3) Local peer-to-peer energy exchange, (4)

Footnote 1 (continued)

practical guide for facilitating social change, Spindle power shift). Notably, the Power Cube approach has been influential in offering ways to understand power for social change, offering exercises to differ between levels, spaces and forms of power (see Power Cube).

Operationalisation process

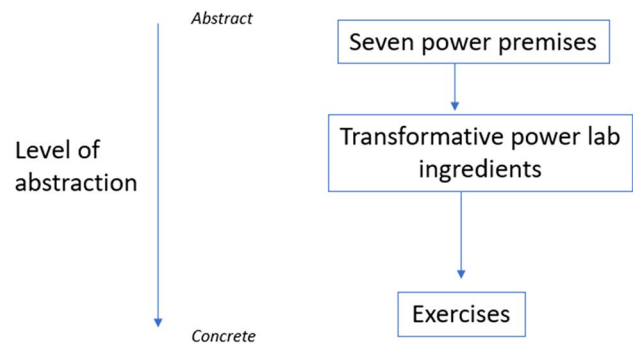


Fig. 1 The relation between premises, ingredients, and exercises in the operationalisation process

Energy gamification and incubation, (5) Participatory experimentation and incubation, and (6) Investment and finance mechanisms. Drawing on Fligstein and McAdam (2011), we define an SIE-field as “an arena/space that includes a specific SIE as well as SIE-field-actors working on it and other field-actors enabling and/or impeding it” (Hielscher et al. 2021), meaning there is a specific focus on system-niche power dynamics in the development of these fields.

The TPL was conceptualised and operationalised through a transdisciplinary research process. This process encompassed the following stages that took place partly in parallel and iteratively:

1. Developing premises, ingredients and exercises based on literature review and empirical material review
2. First iteration of the TPL
3. Redesign and adaptations for second TPL
4. Further analysis and codification in Power Guide and scientific article

Developing premises, ingredients and exercises based on literature review and empirical material review

The TPL consists of three key elements: premises, ingredients, and exercises, which are each elaborated on in "[The Transformative Power Lab format](#)" (also see Fig. 1). Throughout the process, the core team of interdisciplinary researchers discussed whether and how different conceptualisations of power resonated with the experience of researchers and practitioners of social innovation in order to develop premises. These premises were operationalised into seven ‘ingredients’ (i.e. research design elements) by using translation, which refers to finding both the language and the practical instances that would enable exploration

of SIE-related power dynamics. The ingredients form our suggestion for the research and facilitation tools to use when working with power in a transdisciplinary, action-oriented context. Finally, the exercises represent the concrete ways in which the ingredients were used during the two online iterations of the TPL in winter and spring of 2021.

The process for developing the premises, ingredients and exercises included a grey and academic literature review on power dynamics around SIE, starting from earlier conceptual work on power contestations by Avelino (2011, 2021), as well as scoping the key concepts of transdisciplinary research and action research, the intersection of social innovation, energy, power, and transdisciplinary methods such as labs.

In addition, a retrospective secondary analysis of existing empirical research within SONNET case studies² tested the power premises resulting from the literature review against empirical material. The core team developed guidelines for data collection and data analysis for fellow SONNET researchers, which included interview guidelines, survey questions and a reporting template to use (Appendix 1). The template included a short summary on power dynamics, reflections on powerful incumbent energy actors, energy-related power relations in the city, potential shifts, and the countervailing power of networks. In addition, two semi-structured interviews with actors from the energy sector in Antwerp were conducted by the authors, which allowed more in-depth questioning about power dynamics, practical displays of power, language used to describe them and initial ideas on the TPL ingredients. Taken together, these reviews and inputs informed a first design of the premises, ingredients and exercises of the TPL.

First iteration of the TPL

For the first TPL, SONNET project members, consisting of 49 researchers and policy workers, joined a 1-day online event. This event consisted of three parts, respectively, focussing on ‘*Seeing power in your city*’, ‘*Deepening Power: Power over/to/with in SIE-fields and decentralisation paradoxes of SIE*’, and finally ‘*Acting on transformative power*’. Each part started with an initial presentation followed by three to six break-out groups divided according to cities or SIE-fields. The plenary discussions were recorded and transcribed, the break-out group discussions were summarised by note-takers, and online chat messages were saved. For one exercise, called ‘*Strategising with critical power*

moments’, an online *Miro*-board was used by participants to fill out their own experiences, which was later transcribed and summarised by one of the authors. Afterwards, a survey was sent out to all participants, resulting in 17 responses. Based on this, as well as their own experience, a smaller group of 15 researchers participated in a workshop to evaluate the process and outcomes of the first TPL. Six main points of feedback resulted and led to a redesign of the TPL (see next section).

Redesign and adaptations for second TPL

For the second TPL, exercises were adjusted, removed and added based on the six points of time management (covering less topics to prevent overwhelming participants); preparation (providing more preparatory material); group division (adapting exercises to a diversity of backgrounds); facilitation (allowing for active moderation of discussions); keeping the visual and interactive elements; and finally, creating more concrete takeaway messages for participants. Power vignettes (see Appendix 2) were developed based on SONNET case studies providing examples of ‘power to’, ‘power over’, and ‘power with’—these short stories served as preparatory material and starting point for discussions.

The second TPL took place in June 2021 and consisted of ‘*Part I: Recognising power in the energy system*’; ‘*Part II: Diving into power dynamics in SIEs and unpacking unintended consequences*’; and ‘*Part III: Co-creating a guide to transformative power*’. The 56 participants came from public authorities (e.g. city municipalities, government agencies), civil society (e.g. energy cooperatives, activists, non-profits), research (e.g. universities, knowledge hubs) and private companies (e.g. energy companies). These participants were chosen based on their background and a short motivation, which they shared during registration. The programme consisted of two major presentations, plenary discussions and four break-out sessions. The second TPL was recorded, chat discussions were saved, and all plenary discussions were transcribed by a note-taker, while in the break-outs, note-takers used a live *Miro*-board to take notes. In addition, a visual note-taker supported the programme by providing intermittent visual impressions of the discussions thus far, and an overall ‘graphic harvest’ afterwards (see Appendix 3). This element was appreciated by participants, as it helped summarise discussions in a ‘light touch’ way. In addition, we collected feedback of 22 respondents through an online survey to understand how the approach and exercises might be improved for the Power Guide.

² These case studies were based on the review of secondary documents, as well as interviews and (online) participant observation during the SONNET project (Vernay et al. 2021; Stadler et al. 2021; Wittmayer et al. 2021; Dańkowska et al. 2021; Müller and Musiolik 2021; Hielscher and Iskandarova 2021).

Further analysis and codification in Power Guide and scientific article

The outcomes of the TPL process were included in a Transformative Power Guide (see Appendix 4), in which practitioners can find hands-on instructions for implementing the exercises from the TPL (de Geus et al. 2021a). The authors of this paper led the process of writing the Transformative Power Guide, while interested participants of the lab provided feedback and examples. During an online launch event of the Guide, two TPL participants presented how the premises and exercises had supported them to make sense of power in their respective contexts.

This article is based on the analysis of the different data sources specified above. That is, the transcriptions, chat discussions, and facilitator observations of the two transdisciplinary TPLs in which participants provided input from their own experience and practice. It also includes the evaluative activities related to these TPLs, namely a summary of the evaluation workshop of TPL1 and the survey results of TPL2. Finally, a seven-page transcript of the Power Guide launch was also included. These rich data sources were deductively analysed for the analysis in "[Reflections and conclusion](#)", by coding them using the Power lab 'ingredients' as explained in "[Ingredients and exercises of the Transformative Power Lab](#)". This coding was performed by one researcher, with checks by a second researcher to improve interpretative coherence.

The Transformative Power Lab format

In this section, we present the seven premises, ingredients and related exercises that resulted from developing the TPL format, as well as illustrations of the discussions that emerged during the process.

Seven premises on power in social innovation in energy transitions

Addressing all dimensions and contestations about power is both overwhelming and unrealistic, especially in an interdisciplinary and transdisciplinary context: it cannot be presumed that all actors involved either have the time or resources to dive into the vast body of research on this topic. Therefore, based on the methods described in "[Developing premises, ingredients and exercises based on literature review and empirical material review](#)", we formulated seven premises about core aspects of power:

1. **Futures:** Power needs to be questioned when considering different energy futures.
2. **Unintended consequences:** Knowledge co-creation on power is needed to unveil diversity of perspectives, and thereby surface unintended consequences.
3. **Language:** A language to discuss power needs to be developed.
4. **Sense of power:** People in SIE need to gain a sense of power.
5. **Multi-dimensionality:** Power needs to be considered from a multi-dimensional perspective.
6. **Transformative power:** Elements of transformative power need to be unpacked.
7. **Translocal power:** Global connections are needed to foster translocal power.

The seven premises have been primarily influenced by Avelino (2021), who categorised the most prominent debates about the nature of power, and the importance of specific dimensions into seven main 'contestations': (1) power 'over' vs. power 'to', (2) centred vs. diffused, (3) consensual vs. conflictual, (4) constraining vs. enabling, (5) empowerment vs. disempowerment, (6) power = knowledge vs. power ≠ knowledge, and (7) power as means vs. power as an end in itself. For each of these contestations, different scholars provide multiple concepts and perspectives to analyse power (e.g. Foucault 1980; Giddens 1984; Flyvbjerg 1998; Arendt 2002; Clegg 2002; Haugaard 2002; Lukes 2002; Parsons 2002). Rather than 'choosing sides' within these debates or attempting to 'solve' them, we argue that the different dimensions of these power contestations need to be acknowledged (Avelino 2021).

First, it needs to be recognised that those involved in imagining energy transition pathways have unequal positions and diverse (sometimes contradictory) interests and values, and hence different frames and preferences (Pel et al. under review). When describing future energy systems, re-imagining what power relations will look like needs to be inherently included. However, this is often overlooked: there is a tendency to imagine that energy futures are somehow free of power relations. This also means acknowledging the differences between e.g. traditional centralised energy providers that switch to renewable energy sources on one hand, and the rise of decentral energy cooperatives on the other hand. In one case, an oligopoly remains, meaning that a few powerful companies control the market, whereas in the other shared ownership is put front and centre. Both cases have their own power struggles, but there is a clear difference in the extent to which the sharing of power is an explicit aim (Brisbois 2020; de Geus et al. 2021b).

Second, unexpected power dynamics must be anticipated: while often SIE intend to change power relations in the energy system, implicitly or explicitly, there are also many unintended consequences that may reproduce or even exacerbate problematic power relations. Ongoing evaluation

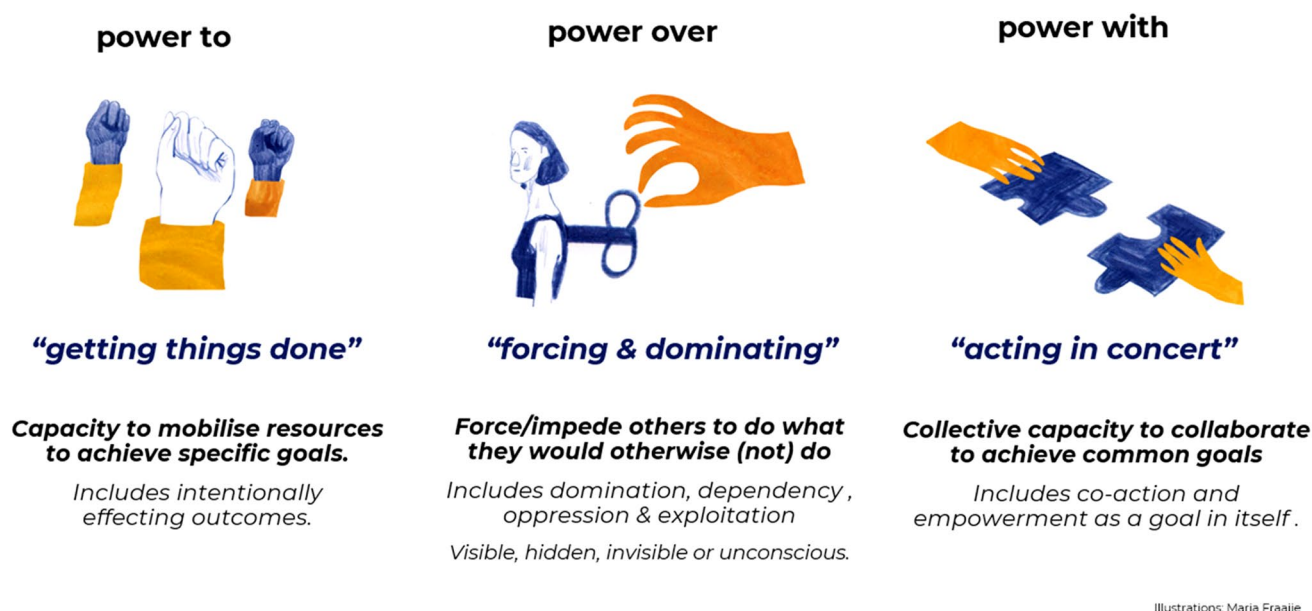


Fig. 2 Power to, power over and power with (based on Allen (1998), Partzsch (2017))

of the process from a power perspective is necessary because of these complex dynamics and unintended consequences. For instance, decentralisation in one place often comes with ‘centralisation’ of new power concentrations in other places: platforms and networks that (initially) aim to decentralise power to users/members can become a new concentration of power and/or profit (Brown et al 2020). Similarly, inclusive and participatory decision-making processes, as strived for in cooperatives, tend to be inclusive for some, and exclusive for others (Bauwens and Defourny 2017). Anticipating these unintended consequences will not prevent power challenges but can help address and compensate for them.

Third, there is a need to develop a language to discuss power. Talking about power can provoke negative or uncomfortable associations, causing people to avoid the subject (Gawerc 2006; Strumińska-Kutra 2016). If transformative change is understood as changing problematic power relations, it needs to be recognised that any taboo around power hampers the problematisation of power relations, and thus impedes the transformative potential of social innovation. Besides, the different associations and meanings that people tie to the concept tells us that there are many different ‘faces’ of power and ways in which it is experienced (Lukes 2002). Therefore, there is a need to become more confident when talking about power and to develop a language and capacities to do so (Temper et al. 2019; Goodwill et al. 2021; Hölscher et al. 2021; Strumińska-Kutra and Scholl 2022).

Fourth, social innovation actors need to gain a better sense of power. While vested interests are often blamed for reproducing the status quo, a sense of powerlessness, i.e. the inability to exercise power, is just as much an impediment

to change as the power of vested interests (Avelino 2011, 2017). For social innovation to be transformative, it needs to challenge existing structures and power relations (Avelino et al. 2019b; Pel et al. 2020a). Therefore, gaining a sense of power to do this and positioning oneself in relation to established actors is a prerequisite. Learning how other initiatives started off and managed to organise themselves can be one way for individuals to envision their own strategy and gain a sense of power.

Fifth, understanding power requires a dialectic, multi-dimensional perspective. To make conversations about power productive for understanding and facilitating SIE, we need to acknowledge the different dimensions of power, e.g. that power can be both constructive and destructive, oppressive and emancipatory, and so on (Avelino 2021). One of the most accessible ways to acknowledge different dimensions and complexity of power in an interdisciplinary and trans-disciplinary context is to distinguish between ‘power to’, ‘power over’ and ‘power with’ (see Fig. 2, based on Allen (1998), Partzsch (2017)). These terms have been selected, because (1) while not being exhaustive, they cover many different dimensions, and (2) they do so in accessible language. ‘Power to’ concerns intentional actions to reach a certain goal. This includes the power to be the owner of energy production systems, or for communities to be energy independent. ‘Power over’ involves force and domination, and impediments for actors to become involved or reach their goals. This can for instance not only concern money, rules, regulations, but also inequalities in terms of class, income, ethnicity, gender, or education. Power over can result from either intentional or unintentional historical developments.

Transformative power

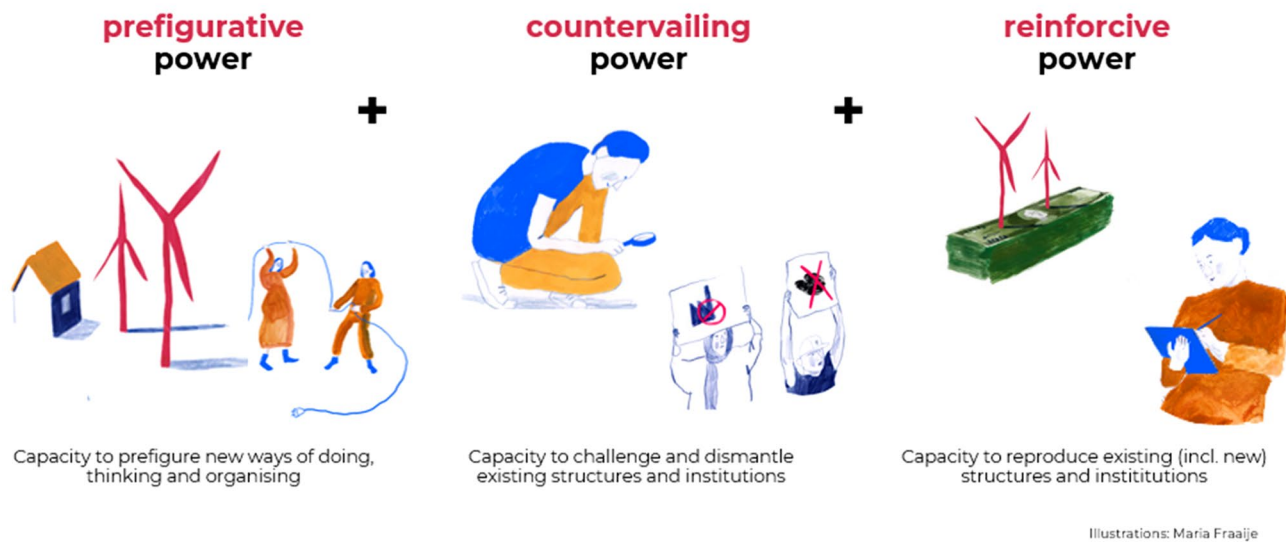


Fig. 3 Dimensions of transformative power (Based on Avelino et al. under review)

‘Power with’ describes how collaboration and empowerment can be a goal in itself. Even if collective goals are not reached, ‘power with’ describes the power in organising meetings, creating a community, democratic structures, involvement and inclusion, or the ability to generate income through a local energy market and spend this on local needs in the community.

Sixth, transformative power is about the relation between power and transformation. While concepts of power to/over/with enable critical analysis and mapping of the power in SIE, the concept of transformative power, consisting of prefigurative, reinforcing and countervailing power, makes it possible to explore what kind of power dynamics push transitions forward (see Fig. 3) (Avelino et al. under review). Innovative or ‘prefigurative power’ manifests, for instance, as people mobilise renewable energy sources and cooperative ownership as an alternative way to produce energy. Community energy initiatives are not just opposing the existing energy system or proposing a different one, but demonstrate, i.e. ‘prefigure’, an alternative energy future in the here and now. ‘Reinforcing power’, in turn, is about developing and implementing necessary institutional, regulatory, and financial frameworks that enable alternative energy systems, like for instance a feed-in tariff, which makes it financially feasible for citizens to invest in renewable energy technologies.³ Enforcing such regulatory frameworks is crucial to have transformative impact. In addition to innovative and

reinforcing power, ‘countervailing power’ is required to challenge and dismantle existing structures and institutions that reproduce problematic power relations. Transforming energy systems is not just about ‘adding’ new elements to it but also about the ability to criticise, replace and phase-out ways of doing, thinking, and organising that are problematic.

Seventh, and finally, translocal power refers to where, how and at what level power is exercised, and how that may enable transformative potential. Distinguishing translocal power is based on empirical research that indicates the significance of strategic collaboration between different types of SIE, different localities (translocality), and types of innovation and social change beyond energy systems (intersectionality) (TRANSIT 2017; Loorbach et al. 2020; Pel et al. 2020a; Avelino 2021). Combining local and issue-specific embeddedness with wider international connectedness can be particularly empowering in that it enables people to witness the results of their efforts in their direct local environment, while also having a wider sense of societal and global impact. Organising in translocal networks can be an alternative way to diffuse, grow and ‘scale-up’. An example of this is the European federation of citizen energy cooperatives (REScoop.eu), which represents the interests of over 1900 cooperatives in the European debate on the future of energy.

Ingredients and exercises of the Transformative Power Lab

Based on the premises, we developed ingredients for the TPL (see Table 1), which were translated into concrete exercises to facilitate strategic, practice-oriented discussions.

³ Feed-in tariffs are schemes through which individuals or collectives receive payment for feeding back excess renewable energy which they generated to the grid.

Table 1 The relation between the premises and the ingredients of the Transformative Power Lab

#	Ingredients of the power lab (what we do):	Related premises (why we do it):
1	Accessibility: Participants ease into association and exchange about the concept of power in an accessible way	3. Language; 4. Sense of power
2	Roles: Participants reflect on the multiple roles they (can) play across different institutional contexts	3. Language; 4. Sense of power; 5. Multi-dimensionality
3	Dimensions: Participants apply different dimensions of power to their own (energy) contexts and experiences	1. Futures; 3. Language; 4. Sense of power; 5. Multi-dimensionality; 7. Translocal power
4	Tensions: Participants articulate and discuss unintended power implications of social innovation in energy transitions	2. Unintended consequences; 3. Language; 5. Multi-dimensionality
5	Perspective: Participants identify how power has been exercised in the past (and can be in the future)	3. Language; 4. Sense of power; 5. Multi-dimensionality; 6. Transformative power
6	Transformative power: Participants consider what kinds of power are necessary for transformation and to what extent these are exercised in their own energy context	3. Language; 4. Sense of power; 5. Multi-dimensionality; 6. Transformative power; 7. Translocal power
7	Co-creation: Participants decide which issues and questions are relevant regarding power and energy and how these are discussed	3. Language; 4. Sense of power

Below, we use case examples brought in by participants, to illustrate what discussions emerged, i.e. what we learnt about power. The ingredients are presented in the order in which they were dealt with in the TPL: as such participants could build on the insights from previous ingredients as the programme progressed.

Ingredient 1—Accessibility

Discussing power can invoke uncomfortable feelings, or tendencies to disassociate with the term, for instance by relating it to high-level geopolitical processes rather than one's own direct context. The word *power* might even be an obstructive concept for some, preventing them from relating (shared) experiences due to divergent interpretations of the concept. However, rather than shying away from the term, the TPL sought to 'reclaim' it as a helping concept, by developing a context through which participants can share their experiences. The foundation of the TPL is to create accessible ways for participants to share their associations and experiences, e.g. through creative expressions such as theatre, music, drawings, art, informal conversations or (serious) games.

Ingredient 1 was developed into an exercise and experimented with during informal moments, such as through a playlist with songs related to power, and an energiser with so-called 'power posing' (pseudo-scientific postures to invoke confidence). For the exercise '*Developing a power language through images*' participants choose a visual ahead of the event, which represents power to them. During the TPL, participants use the image as their virtual background, and discuss in duos 'How does this image relate to power relations in your city/ SIE-field/ country?'.

Through these exercises, participants become aware of their associations with the concept power and gauge how

this differs from other perspectives. Images that participants brought included metaphors such as ice skates, electrons, a drop of water hollowing out a rock, and spinach seedlings, as well as more abstract depictions representing knowledge, art or collective action (see an impression of images in Appendix 3). Participants afterwards reported that the conversations had been inspiring, and that additional references to music and films had been shared during the exercise. One participant indicated that sharing personal experiences helped them to feel part of a collective movement, while others mentioned how the TPL demonstrated the range of different interpretations others have of the meaning of power, providing a low-threshold approach to initiate discussions on the concept.

Ingredient 2—Roles

This ingredient invites participants to reflect on the different roles in which they operate, how power plays out in these roles, and the agency they have to affect this. The associated exercise is called '*Seeing different roles: the multi-actor perspective*' and builds on the multi-actor perspective (MaP) (Avelino and Wittmayer 2016, 2018). The MaP is used to distinguish between actors and institutions: public and private; non-profit and for-profit; and formal and informal (see Appendix 5). Based on these divisions, state (government, public agencies), market (firms, businesses), community (households, families, etc.), and the non-profit sector (NGOs, associations, foundations) can be differentiated. In the middle, there is an overlapping hybrid sphere representing organisations such as social enterprises, which make profit but also prioritise social or ecological impact. Using the MaP, participants discussed 'What are the different roles you play in relation to the energy sector?'; 'How

powerful/powerless do you feel in those roles?'; and 'What roles do you want to play?'.

One participant explained how the MaP helped them understand their own context and agency as a person crossing boundaries: *"If you try to work in [the hybrid sphere] you dance around [state, market, and community]. (...) When we work on (...) retrofitting: the government can make some legislation, but businesses are more capable of doing it fast. So you have to link those two together and dance around the engagements that different actors can make".* Relatedly, the exercise challenged participants to reflect on the different scale levels at which power can be exercised: *"What struck me was that power has also to do with scale—the personal level, the scale of your community and (...) to see through these different scales all the time, and to see where the power dimension is right now: what am I looking at?"*.

Ingredient 3—Dimensions

After a lecture explaining the power dimensions 'power to', 'power over', and 'power with', which featured examples from the power vignettes, participants joined break-out groups of 4–5 participants who identified as working in the same SIE-field. Encouraged to start from their own experience, they discussed 'How does power manifest in your 'field' of social innovation in energy transitions?' by using the concepts power to/over/with.

The exercise opened up new perspectives and metaphors within the groups: in the Innovative financing group, participants reframed power as a ball that can be passed back and forth: *"It depends on where you are standing whether something is 'power to' or 'power over'. For example, governments have 'power over' because they shape the subsidies. But then projects have 'power to' take action and realise their goals after they've been given power."* In the Framings against fossil fuel energy group, participants asserted that to counter structures that exert power over, power with ought to inherently be part of strategies, e.g. through collaborations, (farmer) protests or talks with high-level political representatives. The groups on Participatory incubation and Experimentation and city level competition discussed that the power that funders exert over them to decide on the focus (i.e. what needs to be supported) and longevity of funding is limiting: *"The set-up of the participatory process exerts a lot of power over the participants; there is a need to set boundaries, which is a form of exercising power; [there is a] tension between acting in concert and getting things done"*.

Throughout the TPL, the participants continued to use power to/over/with to position themselves and their initiatives. In relation to power to and power over, they mentioned structural issues such as legislation and regulations, as well as how to liaise with established actors such as grid

operators. Participants reflected on how limited access to knowledge and resources weakens their ability to reach certain goals. The paradox of experimentation is that where there is power to innovate, there is not necessarily the power to change institutions and infrastructure that exert power over them. In addition, a participant mentioned internal power dynamics and (lack of) inclusivity: *"We see power structures coming back in our organisation"*. Another participant described how grid operators tend to favour large scale corporate projects and keep energy network capacities from energy communities. Talking about power with, participants mentioned translocal networking and their ability to learn from each other and collaborate. They also discussed the tension of differentiating between exercising power with in a 'positive' sense, rather than exercising power over, i.e. manipulating others in unbalanced power relations.

Ingredient 4—Tensions

Ingredient 4 enables an understanding of power tensions by uncovering potential unintended consequences. The exercise *'Unpacking power tensions'* was preceded by a short lecture on how structures are influenced by cultural discourses and norms, and how these can result in unintended consequences, e.g. how air conditioning default settings shape office dress codes (i.e. pant suits), or how decentralisation of energy systems can create new centralisations of power. The lecture also highlighted potential tensions within SIE, such as the risk of actors becoming stuck in their own circles and subsystems, rather than aspiring to permeate existing systems and 'becoming the new system' and norm. During the exercise, participants are divided into groups according to their respective SIE-fields to discuss 'What are the main power tensions of social innovations in energy transitions?'. The second question 'And how can you deal with those?' encourages developing actionable perspectives.

Participants reflected on how existing inequalities in society are mirrored and reproduced in their SIE—for example by having a rather homogeneous group of white middle-class members in an energy cooperative, instead of involving more people from marginalised groups. Among other barriers, jargon and pre-existing knowledge were identified as main causes for this. Participants discussed that, while being more socially inclusive is an aim, decision making might be easier in a homogeneous group. The question of how to organise democratic decision-making surfaced as a central dilemma. Another issue concerned how financing the decentralisation of energy systems (e.g. through crowdfunding) is not necessarily just and inclusive per se—while there is a tendency to assume that it is.

Unintended consequences were discussed with regards to how new actors and market arrangements influence local and national policy and market structures. The example

surfaced of how a local energy utility was disempowered by a new actor constellation consisting of an energy cooperative, corporate pharmaceutical company, and architecture firm initiating the implementation of a new district heating system. Another issue concerned the increased use of green technologies, such as wind turbine or PV panels, which leads to an increased use of certain resources of which the supply chains are characterised by inequalities and problematic power relations.

Ingredient 5—Perspective

Ingredient 5 challenges participants to dig deeper into the history of their own fields, to frame past events in terms of power exercised by certain actors. Becoming aware of past leverage points can support future strategising, for instance by initiating new collaborations, campaigns, or actions. This ingredient is based on the Critical Turning Points method (Pel et al. 2017).

The exercise for this ingredient is called ‘*Strategising with critical power moments*’. Critical power moments are significant shifts or challenges of dominant power relations and structures, which subjectively can have a ‘positive’ or ‘negative’ effect on SIE. Participants are asked to identify a critical power moment in SIE in their city, by describing in terms of “Who? What? Where? and When?”. They identified critical power moments in both the past and the future, and collected them on an online canvas (*Miro*-board). The identified critical power moments could be inductively sorted into four themes: citizen participation, campaigns and public information, funding and market design, and official agreements and legislation. Examples of past critical power moments included:

- Citizen participation: Warsaw Climate Panel in 2020; opening up to citizen ownership of wind farms; initiation of an eco-district.
- Campaigns and information: 2012 ‘Shale Gas free’ campaign.
- Funding and market design: introduction of a social tariff to reduce energy poverty; liberalisation of the energy market in Europe; subsidies for installing PV panels; a € 50.000 climate fund for SIE projects.
- Official arrangements and legislation: introduction of feed-in tariffs in 2000; shifting from feed-in tariffs to tendering in 2014.

Looking ahead at the future, potential critical power moments included:

- Citizen participation: wider acknowledgement of energy cooperatives, e.g. in production, efficiency, and demand

management; mandatory involvement of citizens in the governance of renewable energy projects.

- Public information and campaigns: more citizens pressuring governments for action; development of right-wing environmentalism; more farmers joining energy cooperatives.
- Funding and market design: SIE receives funding to ensure diversity and representation of marginalised groups; phase out of fossil fuel subsidies; improved financial conditions for collective prosumerism.
- Official legislation and agreements: improved legal support for prosumerism; collective ownership structures; local energy trading and/or new ways of sharing energy, e.g. in social housing.

Ingredient 6—Transformative power

Ingredient 6 encourages participants to understand how *prefigurative*, *countervailing*, and *reinforcive* power can complement each other in contributing towards transformation of systems, and that seeking potential (translocal) collaborations across fields, actors and sectors can strengthen the transformative power of a SIE. While it is likely that SIE exercises some (or all) of these three power dimensions to varying degrees, it is unlikely that it will exercise all of them equally. By becoming aware of which kinds of power they exercise, actors can understand their own strengths and weaknesses better and use these insights to form new alliances.

The exercise for this ingredient is called ‘*Strengthening your transformative power*’, and features the central questions ‘What is the prefigurative, countervailing and reinforcive power of your social innovation in energy transitions, and what obstacles do you identify in realising those?’; and ‘What are the synergies and tensions that arise between these three forms of power?’. During the TPL, the Open Space (see Ingredient 7) welcomed conversations about transformative power, after the topic of transformative power had been introduced in a lecture, which featured examples of how these forms of power can complement each other. During the launch of the Power Guide, transformative power was the main discussion topic.

Participants recognised prefigurative power in how energy communities showcase new ways of producing energy and creating communities. They flagged the importance of sharing positive examples and lessons learned from such prefiguration to scale its impact. With regards to countervailing power, participants identified the importance of campaigns such as anti-coal and anti-fracking campaigns in the UK. Through court cases, such as the case against Shell, and protests and lobbying (e.g. divestment campaigns), existing institutions are publicly questioned and, in some cases, even (partially) dismantled. Participants recognised

countervailing power in their own initiatives—as one participant from an energy cooperative stated: “*With [the energy cooperative] we have been exercising countervailing power [by] presenting our narrative, through which we delegitimise the current large scale fossil energy regime.*”

Participants highlighted examples of crowdfunding and translocal peer-to-peer financing support between cooperatives as reinforcing power, as it spearheads new structures of funding energy communities independently from banks: “*A very important point here is intercooperative solidarity. (...) By connecting to other cooperatives on the European level we are able to build relationships of mutual support and start building relative independence from banks.*”

Ingredient 7—Co-creation

Ingredient 7 opens up framings and conceptualisations on power to interpretations and questions from participants. The exercise for operationalising this ingredient is the Open Space methodology (Harrison 2008), adapted to an online environment, in which participants can initiate topics for discussion and coordinate their own conversations about this. In the registration form of the TPL, we asked participants what power dilemma, challenge, or question in the field of energy they would like to discuss. Participants were invited to register online for the group they preferred to join, to discuss how this issue is reflected in their context, and what strategies they know, or could be developed, to address it.

Seven discussion groups were formed, relating to (1) approaches to make more general statements about civil initiatives, (2) instruments to empower people on an individual and group level, (3) democratising energy and making it a common good, (4) linking bottom-up activities to more high-level political arenas, (5) empowering citizens to take an active role in energy transitions, (6) influencing large infrastructural and budget investments, and (7) collaborating with incumbent actors vs. focussing on grassroots action.

Other power-related issues that participants introduced themselves included *formal* power struggles between local and national governments vs. *informal* local leaders and political actors, how to improve energy cooperatives’ public image to become considered legitimate alternatives to established big players, and how power relations in SIE might be horizontal rather than hierarchical.

Reflections and conclusion

The starting point for this paper was the observation that transdisciplinary research has not developed sufficient ability to conceptualise and operationalise the phenomenon of power as an object of focus. This led us to the question ‘*How can knowledge on power be developed and enacted in*

research on sustainability transitions, specifically research on social innovation in energy transitions?’. We have argued that to improve our understanding and develop actionable knowledge on power, transdisciplinary research is needed. It can enable creating a shared language by uncovering perspectives of researchers, policy workers, and practitioners. Triggering experiences and stories about how power mechanisms work in social innovation in energy builds an in-depth understanding of transition processes, and power dynamics intertwined into it. At the same time, while developing and testing research tools, participants of the process can be provoked to reflect on their own positions in relation to power and on strategies for navigating the future.

After explaining how the TPL was developed, we outlined seven premises about power dynamics in sustainability transitions. These premises were developed in an iterative process of literature review and analysis of empirical data—case studies, interviews, and transdisciplinary discussions taking place throughout the research process. To further develop and explore the premises in the context of SIE, we operationalised them into seven ingredients, which are the foundational elements for designing workshops or other forms of collaborative formats to develop knowledge about power and enable strategic facilitation of sustainability transition processes. We demonstrated how these ingredients guided the development of exercises that translate an abstract, or even ‘threatening’ topic, to formats by which it can be explored through examples, stories, and collective exploration, within the boundaries of what the authors deemed feasible and relevant within the Transformative Power Labs as part of the SONNET project (the relation between all the elements is depicted in Table 2). The reflections on the research process became empirical data, and their interpretation pushed forward an understanding of complexity and dynamics of the power phenomenon and the collective and individual ability to act upon and in relation to it. Below, we reflect on the insights on power that resulted from the TPL, after which we conclude by discussing limitations and challenges for future research.

Reflections on the knowledge outcomes on power

With regards to Ingredient 1 *Accessibility*, it appeared to support a ‘demystification’ of the power concept, by inviting participants to share personal experiences, and engage in a process of collectively developing its meaning and use. Demonstrating the wide range of interpretations and ‘faces’ of power through metaphors rather than cognitive debates allowed participants to showcase the multi-faceted dialectics of power. Through Ingredient 2 *Roles*, participants reflected on the different scales at which power can play out—individually, on an organisational level, or collectively. For instance, by understanding oneself as a consumer as well

Table 2 Overview of relation between ingredients, premises, exercises, and main insights

#	Ingredients (i.e. what is done):	Related exercise(s) (i.e. how it was done in the TPL):	Related premises (why it is done):	Insights (i.e. what we have learned about the approach):
1	Accessibility: Participants ease into association and exchange about the concept of power in an accessible way	Developing a power language through images; Informal moments throughout the lab (e.g. power playlist; power posing)	3. A language to talk about power needs to be developed; 4. People in SIE need to gain a sense of power	- Open up conversations, interpretations and dialectics of power
2	Roles: Participants reflect on the multiple roles they (can) play across different institutional contexts	Seeing different roles: the multi-actor perspective; Cross-cutting conversations to gain awareness about how power can be exercised	3. A language to talk about power needs to be developed; 4. People in SIE need to gain a sense of power; 5. Power needs to be considered from a multi-dimensional perspective	- Reflections on scales of power (incl. personal level) and different kinds of power
3	Dimensions: Participants apply different dimensions of power to their own (energy) contexts and experiences	Understanding 'power to', 'power over', and 'power with' in your social innovation field	1. Power needs to be questioned when considering different energy futures; 3. A language to talk about power needs to be developed; 4. People in SIE need to gain a sense of power; 5. Power needs to be considered from a multi-dimensional perspective; 7. Global connections are needed to foster translocal power	- Provide language to unpack power in own SIE-context - Tendency to focus on 'negative' aspects of 'power over'
4	Tensions: Participants articulate and discuss unintended power implications and of social innovation in energy transitions	Unpacking power tensions	2. Unintended consequences; 3. A language to talk about power needs to be developed; 5. Power needs to be considered from a multi-dimensional perspective	- Tendency to repeat well-known tensions - Opportunity to facilitate more in-depth discussions
5	Perspective: Participants identify how power has been exercised in the past (and can be in the future)	Strategising with critical power moments	3. A language to talk about power needs to be developed; 4. People in SIE need to gain a sense of power; 5. Power needs to be considered from a multi-dimensional perspective; 6. The elements of transformative power need to be unpacked	- Need to link with other structuring concepts (e.g. Ingredients 2, 3 or 6)
6	Transformative power: Participants consider what kinds of power are necessary for transformation and to what extent these are exercised in their own energy context	Strengthening your transformative power; Open Space methodology	3. A language to talk about power needs to be developed; 4. People in SIE need to gain a sense of power; 5. Multi-dimensionality; 6. The elements of transformative power need to be unpacked; 7. Global connections are needed to foster translocal power	- Introduces strategic discussions, e.g. on translocal collaborations in order to exercise transformative power
7	Co-creation: Participants decide which issues and questions are relevant regarding power and energy and how these are discussed	Open Space methodology	3. A language to talk about power needs to be developed; 4. People in SIE need to gain a sense of power	- Weaving discussions on power into conversations on other topics - Demand for further understanding internal power dynamics

as a political actor and agent in a community. Reflecting on different roles later on supported distinguishing different kinds of power (e.g. relating to Ingredient 6 Transformative power).

By breaking down power into three categories in Ingredient 3 *Dimensions*, we offered participants a language and perspective to apply and recognise power in their own SIE-context. While the dialectic dimensions were emphasised throughout the TPL, most takes on ‘power over’ reflected negative rather than positive effects on developments in SIE. Unpacking ‘power over’ as a more structural form of power that can be both ‘positive’ and ‘negative’ could be a way to nuance this. Furthermore, well-known power tensions mentioned as examples were projected on participants’ own contexts, as opposed to exploring possible ‘new’ tensions.

Overall, the unintended consequences discussed under Ingredient 4 *Tensions*, while recognised as dilemmas, often appeared to be framed as inevitabilities. For instance, while some offered mitigation strategies for the homogeneity of participants in SIE (e.g. using accessible language), participants also defended it as a way to allow for easier decision making. However, this does not change the fact that participation is biased, as only certain profiles of people participate, limiting the inclusivity of SIE. While discussing unintended consequences invoked many inputs among the participants, again, these discussions repeated well-known dilemmas in the field around homogeneous participation and decentralisation. More time for discussions on how norms permeate material and social practices and cause unintended consequences could have potentially invited more in-depth exploratory discussions.

With regards to the exercise for Ingredient 5 *Perspective* on critical power moments, many scale levels were conflated, making it unclear how and why the examples given were particularly relevant to the discussion on power. Directly relating this exercise to another Ingredient (e.g. 2. Roles, 3. Dimensions or 6. Transformative power) could have potentially facilitated more structural, concrete, and in-depth discussions. Introducing the concept of transformative power through Ingredient 6 appeared to encourage strategic conversations about how to diversify activities and forge (translocal) collaborations with other SIE, to work towards common objectives and develop ‘power with’. Particularly through this ingredient, discussions on power could be further opened up by supporting actors to delve into more strategic ways of thinking, e.g. by exploring how transformative power dynamics relate to directionalities of future pathways as mentioned in premise 1 (Schon and Rein 1994; Reason and Bradbury 2008; Gaventa and Cornwall 2013; Chatterton et al. 2018; Pel et al. 2020b; de Geus et al. 2021b). Relatedly, deeper underlying power structures concerning certain issues of

patriarchy and coloniality (e.g. race and gender) were not comprehensively discussed, while issues around capitalism and modernity (e.g. poverty and class) were touched upon by participants. Understanding the underlying reasons for this and exploring how to relate to these deeper structures in discussions requires further study and experimentation.

Operationalising Ingredient 7 on *Co-creation* through the Open Space methodology highlighted how the scope of conversations tended to expand beyond issues related to power, which arguably complicated finding common ground in the discussions. Nevertheless, distinguishing between discussions related to issues of power and other topics could artificially create boundaries where there are none, allowing the concept to weave through discussions more naturally. Another issue that emerged during the Open Space concerns the importance of reflecting on internal power dynamics within the TPL, as it became clear that in this unfacilitated discussion format some individuals took up more space than others. Facilitating more in-depth discussions would require more time and trust-building to enable vulnerability among participants and spending more time on becoming aware of internal power dynamics of the process.

Limitations and future research

With regards to facilitation of the TPL, decisions were made to prioritise certain topics and questions in order not to overload participants, determine the right build-up of the programme for applying concepts in different exercises, and manage participants’ energy levels in an online format by switching between in-depth discussions and light touch exercises. We deliberately did not focus on the dynamics of ‘power within’ of the process, e.g. through managing who speaks during discussions and encouraging people to feel empowered to join conversation, as the research gap we identified rather concerned the construction of collective tools for discussing and understanding power in a particular field. Another issue is how many of the participants came from the network of the organisers of the Transformative Power lab, which arguably caused a bias, as well as a focus on participants who self-identify as working on SIE. Radical reflexivity on these issues could be developed further, particularly since there is a risk of *disempowering* actors in the TPL when not accounting for potential power asymmetries or oppression dynamics (Cunliffe 2016; Hölscher et al. 2019; Temper et al. 2019).

While the TPL offered the opportunity to reconstruct frames by including an Open Space and inviting associations through metaphors, we consciously decided to impose certain frames, to provoke conversations and build capacity on seeing and understanding power. Inevitably, the aim to build competencies in participants leads to the empowerment paradox, where actors are disempowered by

being dependent on those who ‘empower’ them. Alternatively, in future iterations these frames could be directly discussed with the participants, even more so than through an Open Space. Another dilemma concerned the extent to which incumbent actors ought to be pro-actively invited, and how this affects the dynamics in the group. It has been argued that when focussing too much on anti-hegemonic agendas, some actors may become alienated (Hölscher et al. 2021). As an example, a question that emerged in the team of authors concerned the issue of whether advocates of eco-modernistic ought to be pro-actively invited to the table.

The roles of researchers during the TPL and the decisions the researchers take through designing, facilitating and framing discussions are opportunities for further study (Wittmayer and Schäpke 2014; Strumińska-Kutra and Scholl 2022). As argued by Strumińska-Kutra and Scholl (2022) amongst others, promoting ‘political rigour’ through concrete tools, i.e. reflexive methods to deal with power dynamics in an extended peer community, is essential to address inevitable power asymmetries in transdisciplinary research, including how researchers exercise power (Kristiansen and Bloch-Poulsen 2013; Olesen and Nordentoft 2013; Temper et al. 2019). Building on recent work on power dynamics *within* transdisciplinary research, which provides guiding questions (e.g. Fritz and Meinherz 2020; Fritz and Binder 2020; Kareem et al. 2022), tools such as the ‘matrix of domination’ (Goodwill, et al. 2021), or insight in roles related to addressing issues of ownership, power, sustainability, and action in spaces of learning (Wittmayer and Schäpke 2014) can provide ways to further explore this.

While acknowledging the above-mentioned dilemmas, a core strength of the TPL approach is that it can contribute to democratisation by unearthing discussions, a plurality of perspectives and (shared) experiences on power. Through providing an interpretive frame, conversations about practices and dialectics of power opened up. In addition, offering perspectives and a vocabulary encouraged participants to engage in in-depth discussions on different kinds of power and even to strategise on how to increase or adjust the exertion of power in their SIE-context. For future research, we recommend testing the ingredients with incumbent players in energy transitions, and to investigate to what degree they also incite reflection with those who might not identify as social innovation actors. Another opportunity is to increase the internal reflexivity of the process. Finally, we invite other scholars and practitioners to experiment with new and alternative exercises and formats to operationalise the ingredients that were formulated in this paper. Considering the urgency of transforming energy systems, we signal many opportunities for researchers, policy workers and practitioners to employ the TPL in a diverse range of contexts; for

instance, to understand how to develop policy to support social innovation and alternative energy systems through a lens of power dynamics, particularly in the context of fast changing geopolitical relations and infrastructure demands.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s11625-023-01294-4>.

Acknowledgements This paper has been written as part of the SONNET project funded by the European Union's Horizon 2020 research and innovation programme under grant agreement number No 837498. We are thankful to all the participants of the power labs and others who have contributed to generating the insights in this paper, particularly those who contributed to the Transformative Power Guide, available at: <https://sonnet-energy.eu/power>.

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