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Social innovations in the German energy transition: an attempt to use the heuristics of the multi-level perspective of transitions to analyze the diffusion process of social innovations

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Abstract

Background: For a successful transition to a sustainable energy system, not only technical but also social innovations are required. A major challenge to social innovation research is how to translate the social innovation from a novelty with big potential into a mainstream practice. The multilevel perspective (MLP) of socio-technical transitions provides a heuristic to understand how niches can potentially break through to the regime level. In this paper, we examine in how far a multilevel perspective approach is suited to analyze and better understand diffusion trajectories of social rather than technological innovations, taking a social practice theory perspective. Five example projects, selected among the top social innovations for the *Energiewende* in North Rhine-Westphalia, are analyzed. We discuss to what extend the MLP provides a helpful tool to understand the transition processes.

Results: Social innovations can be very divers. We find that the MLP does not offer a one-size-fits-all framework for the analysis of the diffusion of social innovations. The MLP proves applicable only in those cases where the social innovation (1) can lead to a system change and (2) has a clear competing or symbiotic relationship with an existing regime.

Conclusions: Social innovations that aim to be transformative in the sense that they have the goal to be system changing (rather than incremental) can be analyzed along the heuristics of the MLP. For this type of social innovation, the MLP can be fruitful to learn to better understand the diffusion dynamics of social innovation and the barriers and drivers they might face. However, for social innovations that aim at incremental improvements without challenging the existing system, the MLP cannot be applied to study the diffusion process.

Keywords: Social innovation, Diffusion, Energy transitions, Energiewende, Innovation management, Multilevel perspective

Background

In recent years, two different but related concepts regarding innovations and their diffusion have found wide acceptance, albeit in different fields. On the one hand, the multilevel perspective (MLP) of transitions has become popular to analyze, explain, and govern transitions from one sociotechnical system to the next. On the other hand, the concept of social innovation has gained popularity as it has become clear (again) that innovations do not necessarily need to be technological.

Especially with an eye on a transition towards a more sustainable energy system, both approaches are promising: the multilevel perspective because it provides a heuristic to better understand how innovations can grow out of a petty niche and into the mainstream; social innovation because sustainable innovations often take the shape of, or at least involve, a change of social practice. A major challenge to social innovation research,

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however, is to understand the diffusion process of social innovations into a mainstream practice. It therefore seems natural to consider both concepts in parallel and to analyze to what extent the lessons from the multilevel perspective can be applied to social innovations and to learn to better understand the complexity of the diffusion of social innovations. In this paper, we examine in how far a multilevel perspective approach is suited to analyze, explain, and better understand the diffusion of social innovations (or lack thereof), taking a social practice theory perspective—such a link has been recognized as fruitful for transition research [1].

The multilevel perspective of transitions was developed by Geels as a heuristic to better understand and/or explain sociotechnical change. Geels defines transitions as 'shift[s] from one sociotechnical system to another, i.e., a system innovation.' System innovations are defined as 'co-evolution processes, which involve technological changes, as well as changes in other elements' ([2], p. 682). Geels, so far, focused mainly on technological changes. There is, however, at first sight, no reason to believe the MLP is not suited for social innovations, and various authors have tried to apply the MLP to a social innovation (e.g. [3]).

This paper starts with a background discussion of the multilevel perspective and of social innovation literature. Subsequently, it will introduce five exemplary cases of social innovations that aim to contribute to the German *Energiewende*. We analyze very briefly in how far these cases could be described in terms of the multilevel perspective. The 'Discussion' section then theoretically reflects on our research question: 'Can the MLP be useful as a heuristic to better understand the diffusion of social innovations?' The paper concludes by highlighting under which conditions the multilevel perspective on transitions can be a fruitful tool for social innovation research and by addressing worthwhile future research directions to strengthen our understanding of the diffusion of social innovations.

Theoretical background

The multilevel perspective

The multilevel perspective (MLP) for researching and understanding transitions was developed by Frank Geels and presented in numerous case studies (e.g. [2, 4–10]). Although the multilevel perspective of transitions has become extremely popular in the last decade, we believe it is necessary to start our paper with a very basic description. The MLP has too often been misused or misinterpreted in recent publications.

The MLP was originally developed as a tool to better understand (sociotechnical) transitions. Despite the concept's popularity and abundant use in the scholarly discourse, it is important to be aware from the start that 'socio-technical transitions (to sustainability) are a special research topic, because they are about *relatively rare*, long-term macro-changes' ([11], p. 38). Even though one can define regimes and transitions of varying size, it is thus important to ask from the start whether one is actually dealing with a real transition. In other words, is the process one is studying really a *system innovation*? Social innovation initiatives, for example, involve changing practices, and as we will argue below, these might lead to changes in existing systems, but are not necessarily *system* changes themselves.

The most import prerequisite for applying the MLP to a transition is the existence of the three analytical levels of niche, regime, and landscape. The MLP is based on the assumption that a stable regime exists. 'A technological regime is the rule-set or grammar embedded in a complex of engineering practices, production process technologies, product characteristics, skills and procedures, ways of handling relevant artefacts and persons, way of defining problems, all of them embedded in institutions and infrastructures' ([12], p. 340). Which artefacts and persons are relevant, and thus part of the regime, depends on the regime and/or transition under investigation. Geels and Schot ([13], p. 20) write: 'While technological regimes refer to communities of engineers, the functioning of socio-technical systems involves more social groups, e.g. scientists, users, policy makers, and special interest groups. These social groups interact and form networks with mutual dependencies. The intergroup coordination is represented by the concept of socio-technical regimes.' The focus remains on technological change, but many relevant social groups are involved (see also Fig. 1). Principally, one could therefore also imagine a regime in which not technologies and engineering practices are central, but other constructs.

The regime is predominantly stable. Geels and Schot [13] refer to various concepts from the social and economics sciences such as *momentum, lock-in, interpenetration* and *co-evolution* to clarify that the sociotechnical regime, is stable—though not totally immutable. "To ensure the functioning of socio-technical systems, (…) different groups (…) interact and form networks with mutual dependencies. (…) social groups 'interpenetrate': they overlap in some manner without losing their autonomy and identity (…). As a result, the different trajectories in socio-technical systems co-evolve (…). Fluctuations in one trajectory (…) are usually dampened by linkages with other trajectories (…). At times, however, changes in trajectories are so powerful that they result in mal-adjustments, tensions, and lack of synchronicities. These tensions create windows of opportunity for transitions" ([13], p. 21).

The *windows of opportunity* are important moments in transition processes as these are the moments when the

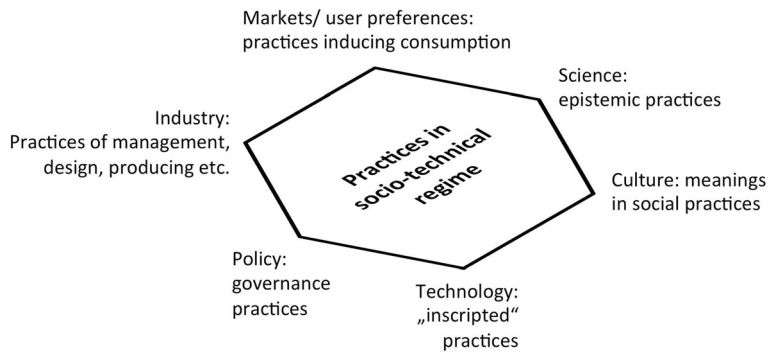

Fig. 1 Elements of socio-technical systems from a practice perspective ([39] based on [16, 37])

regime loses stability and niche innovations gain the possibility to interfere with the regime [13–15]. This is important because the transition theory assumes that 'regime changing' innovations usually take place outside the regime. The basic idea is that for the existing regime, a status quo situation is optimal. Regime actors have most power because they are part of the stable 'institutionalized' system and usually they have financial and/or political reasons to keep the system as it is.[1] The *windows of opportunity* represent a destabilization of the regime, and the possibility for a transition presents itself.

It is therefore remarkable how few transition scholars apply the idea of windows of opportunities (exceptions are [14, 15]). Many scholars, especially in the traditions of transition management or strategic niche management, start from the idea that innovations emerging on the niche level need to be nurtured and supported, often without paying proper attention to the regime or landscape. Geels reached a similar conclusion in a publication from 2014: "While the MLP has been used in many analyses of 'green' innovations and transitions, there are various problems in the way this has been done" ([16], p. 23). Geels asserts that because of the focus on 'green' niche-innovators, transition-scholars have paid less attention to existing regimes and incumbent actors, and often conceptualized the regimes merely as 'barriers to be overcome'. As commented by Geels, and underlined in the current article, 'this asymmetry runs counter to the initial MLP-formulations and the emphasis on multi-level alignments' ([16], p. 23). Missing is often an explanation of why/how regimes can become destabilized. For this, we need to consider the other two levels.

The regime is the middle level. Niches are usually portrayed as a kind of bottom-up movement. 'Evolutionary theories (and innovation studies) suggest that radical innovations often emerge outside or on the fringe of existing regimes, where niches act as incubation rooms that protect novelties against mainstream market selection' ([13], p. 22). Niches aiming to replace the existing regime can be said to have a competitive relationship to the regime, but they can also have a symbiotic relationship, when the innovation that emerges in the niche can be a competence enhancing add-on to the existing regime [17]. This relationship has a major impact on the ease of diffusion of the innovation. When innovations are protected (for example in niche markets or by dedicated actors who are willing to invest resources), they are provided with the opportunity to grow and become stronger. Eventually, they may then grow big enough to challenge or even replace the existing regime, or, if they have a symbiotic nature, align with the existing regime.

Since niches are the locales for innovation and radical change, these are usually at the center of attention in studies of transitions. As we aim to integrate the MLP in the analysis of social innovation diffusion, niches are also at the center of the current study, but we stress the need to integrate the other two levels in the analysis. Niches may grow out to become mainstream (especially if they are symbiotic) and may become able to challenge the existing regime without the regime to destabilize first. However, the logic of the MLP dictates that this will be much harder, and will take longer, compared to when windows of opportunities emerge in the regime.

The landscape, finally, hoovers as a more or less unreachable level above the regime. 'The socio-technical landscape forms a broad exogenous environment that as such is beyond the direct influence of regime and niche actors' ([13], p. 23). Although the landscape cannot be influenced by regime and niche actors, it is not a static unchangeable entity [15]. The landscape encompasses all exogenous processes that could be relevant to the regime and the possible transition process, for example the climate, urbanization, oil price, etc. In general, landscape changes will not be as quick or sudden as changes at the other levels. Nevertheless, it is very well possible that the landscape changes abruptly, for example through a natural disaster or because of radically different outcomes of an election. The landscape, although too often overlooked by transition scholars, is crucial in transition processes as changes in the landscape can

have a decisive impact on the regime. Changes in the landscape can cause the regime to loose stability and can therefore lead to windows of opportunity.

Social innovations

Whereas the origin of the MLP can be easily traced back to the work of Frank Geels, Johan Schot and a relatively small number of other scholars, the literature on social innovations is more diverse and dispersed. Rüede and Lurtz [18] in 2012, for example, identified seven different 'branches' of social innovation literature, all with their distinctive definitions and leading research questions. More recently, Van der Have and Rubalcaba [19] clustered the social innovation literature in 4 domains, but whereas some appear to be rather homogenous (e.g. those around the domains of 'community psychology' and 'creativity research'), the cluster of 'social and societal changes'—where we locate ourselves—is still rather heterogeneous in itself. A single definition of the meaning of the concept can therefore not be given.

The complexity is enhanced by the fact that—theoretically—social innovations are defined as changing social practices, while empirical studies often focus on small cases (initiatives) [20]. These initiatives and projects can cover a wide spectrum of forms and concepts and are dependent to a large degree on their local context [21]. Social innovations distinguish themselves from technical innovations in the fact that the locus of the change is not a new technology, but a changing (social) practice; as such, social innovation research has been called a new paradigm in innovation studies [22]. This does not imply that social innovations could not also make use of technology (and in fact they might do so more often than not). However, the technology is not the new aspect in it [23].

It is furthermore important to stress that we do not include any normative judgement in our understanding of social innovation; the consequences of social innovations can be viewed from different perspectives and can therefore be as ambivalent as technological innovations. The cases described in this paper are mainly initiatives aiming to change social practices, as such they are not social innovations yet, but they have the potential to have a broad impact changing social practices (within their respective target groups)—i.e. to become, or decisively contribute to, social innovations.

A critical aspect about social innovations and social innovation research concerns the question of how the social innovation can grow and diffuse. Social innovations, just like technological innovations, start as small inventions/initiatives. In order to understand why these initiatives may, or may not, develop into new social practices (i.e. become established social innovations), scholars have turned their attention to Tarde's theory of imitation [23], studied so-called social innovation ecosystems [24, 25] and addressed the importance of power and capacity building [26]. However, as these initiatives start small (i.e. as a niche) and aim to develop to the mainstream (i.e. replace, substitute, or align with, the existing regime), the transition paths laid out in the multilevel perspective have also generated interest (e.g. [3]). Acknowledging that for social innovations invention and diffusion tend to be very much intertwined [23] furthermore also the inner development of initiatives themselves need to be studied in order to understand diffusion more thoroughly.

Despite all difficulties in defining social innovation, and in finding unity in the discourses, it appears undisputed that the concept of social innovation represents a promising approach to the transformation of social practices in energy consumption. They 'can promote the expectation, generation, distribution, and stabilization of alternative everyday practices, that can satisfy needs, e.g. for nutrition, habitation or mobility in a less polluting way' ([27], p. 35). Already since the beginning of the 1990s, there has been an international debate on sustainability with a focus on necessary social innovations, aiming at an alternative and better satisfaction of needs [28, 29]. The call for a multidimensional concept of action that focusses stronger on the interfaces of economy, ecology and social issues has become clear [29, 30]. Many problems related to sustainability cannot or not sufficiently be solved by technologies, but require the ability of the society, to think in the long term and question existing practices. Thus, the transformation towards a sustainable development is the result not only of technological changes but also of comprehensive behavioural changes on different levels of action [29]. It takes place in association with social innovations as well as in interaction and connection with technological innovations [31, 32]. As social innovations aim at immaterial changes, they have been considered 'pacemakers for the realization of sustainable development' ([28], p. 13). According to Rückert-John, social innovations are of crucial importance in the context of social sustainability transformations due to the following three basic developments [32]:

1. *Actors in civil society (*e.g. *initiatives, civil society organizations) frequently associate the topic of social innovations with the sustainability discourse.* Its increasing significance can be recognized by increasing activities of civil society initiatives, networks, foundations and associations [33]. The need for a social transformation process to increase sustainability is increasingly expected.
2. In order to meet this need, there is a prevailing understanding that *technological innovations are no*

longer sufficient and a transformation to a sustainable development cannot be achieved without social innovations [29].

3. Problems in the transformation process of social environmental conditions are 'on one hand caused by uncertainties in the appropriateness of solutions of problems and in the equitable burden sharing, on the other hand the perception of environmental problems is hardly connected to everyday behaviour' ([34], p. 105).

Social innovations thus hold big promises for a transition towards a more sustainable future and small-scale initiatives abound. However, the question remains how these initiatives diffuse more broadly in society, and how they institutionalize as new social practices. The MLP provides an interesting heuristic to analyze and learn to understand transition processes; however, as argued above, the MLP was developed with an eye on socio*technical* transitions. In the next part, we therefore firstly scrutinize theoretically how social innovations can be linked to the MLP through social practice theories. Subsequently, we then address five examples of social innovation initiatives within the context of the German *Energiewende* to explore how the MLP could be suitable to analyze the diffusion process (and challenges) of these cases.

Linking social innovation to the MLP through social practice theories

From the discussion so far, we follow that the heuristic of MLP sharpens the perspective on the *social processes* that accompany the alignment of multiple levels during the diffusion or breakthrough of a (mostly studied technical) innovation in such a way that actual system change comes about (e.g. political or cultural changes). The concept of social innovation draws attention to novelties in social practices as such that may or may not have the potential to bring about systemic changes. In order to reason upon a link between the MLP and social innovations at a conceptual level, we argue for exploring social practice theories as a bridging idea. In the discussion on the concept of social innovation above, a link to social practices as the unit of analysis is obvious. The MLP heuristic also draws back on theoretical foundations that focus on social practices, i.e. Giddens' theory of structuration. To do so, we here first introduce some basics of theories of social practices. The MLP draws some insights from structuration theory but also the roots of practice theories lie in grand theories like Giddens' idea of structuration as they draw on the idea of duality of structure. Reckwitz [35] accordingly proposes social practices as the location of the social, where action and structure are mediated. He defines them as "a routinised type of behaviour which consists of several elements, interconnected to one another: forms of bodily activities, forms of mental activities, 'things' and their use, a background knowledge in the form of understanding, know-how, states of emotion and motivational knowledge" [35]. Shove et al. define social practices to consist of the elements of *meanings*, *materials* and *competences* and their relationship [36]. *Meanings* include mental activities, emotions, motivational knowledge; *competences* encompass understanding and practical knowledgeability, whereas *materials* refer to objects, infrastructures, tools, hardware and body. Recurring to social practices is also useful to link the MLP to social innovation. In spite of mutual criticisms between the two approaches, recently calls for developing links have been proposed [1, 3]. Transitions can, in terms of practice theories, be seen as a circumscribed process or as trajectories of change, within the time-space bound reproduction of social practices [37]. We here argue for conceptualizing the regime as a system of interrelated social practices by drawing on the suggestion by Watson [37], who states that socio-technical transitions can be analyzed as "transitions in 'systems of practices'". Note, therefore, that social innovations can very well have a *relevant impact on the system* without being a system innovation; they can influence the system, perhaps even up to the point where a regime change is unavoidable.

Linking structuration theory [38] and social practice theories [36] can help to understand social innovation and its relation to systemic change from an MLP perspective [39, 40]. Watson argues: '(...) practices (and therefore what people do) are partly constituted by the socio-technical systems of which they are a part; and those socio-technical systems are constituted and sustained by the continued performance of the practices which comprise them' [37]. Also in the MLP, regimes are understood as the 'locus of established practices and associated rules' [11]. These elements of socio-technical systems can be depicted as social practices, which are shown in Fig. 1.

The six elements of socio-technical systems as proposed by Geels [4] are the basis of this figure. For the example of mobility, Geels describes how these elements are built by certain actors, e.g. road infrastructures and car regulations were fostered by transportation ministries, and the elements mutually reinforce each other [4]. Markets and user preferences were shaped by the daily use of cars by user groups. The stability of sociotechnical systems/configurations is said to result from the (re)production of these elements by different groups of actors, just as practices as entity are stable by being reproduced by practitioners. Accordingly, taking a social practices perspective enables to link the notion of regime and systems because practices integrate the

intangible rule-sets (i.e. meanings) and the use of tangible artefacts (i.e. materials). The elements of a socio-technical system can then be understood as consisting of specific practices performed by respective actors or actor constellations. In industries specific management practices can be found, certain social practices routinized in government and administration shape the regime as well as how specific ways of usage are 'inscripted' in technological artefacts via their design (see also transformational design [41, 42]). The element of culture can encompass practices of cultural events but also represent the overarching element of meanings in practices. As already indicated above, markets/user preferences are shaped by the social practices around using the system of provision [43, 44] that a regime offers, e.g. individual mobility by car. 'Consequently, changes in socio-technical systems only happen if the practices which embed those systems in the routine and rhythms of life change; and if those practices change, then so will the socio-technical system' [37]. The MLP can then theoretically be extended not only to describe the social aspects that support or hinder the breakthrough of (sustainable) technologies but also of social innovations.

Methods

The methodology for this article draws back on results of a broader analysis of social innovations in the context of a research project on social innovations in relation to the energy transition in North Rhine-Westphalia (NRW), in which several initiatives with high potential were identified. Within this project, criteria were developed to narrow down the category of 'soziale Spitzeninovationen', loosely translated as 'leading edge social innovations'. Five of these social innovations were used for the research in this article. All five cases induced change on a local level.

Central in these criteria are the diffusion potential and extent to which the innovation can actually lead to change. Less crucial is therefore whether the innovation is radically new. Following Rogers, three criteria were developed: *broad potential*, *relevant impact on the system* and *relevant characteristics for adoption* [45]. These criteria will shortly be addressed before moving on to the description of the results of the five cases we analyzed.

The first criterion, *broad potential*, covers the theoretical applicability of an innovation. The applicability is determined foremost by the reach of the innovation. Indicators within this criterion are on the one hand the original reach of the innovation and possible side-products emerging from this innovation, such as joint venture undertakings or consortia. On the other hand, the kinds of actors involved in the innovation process are relevant for its reach potential (e.g. civil society, policy makers, NGOs, researchers or commercial enterprises). Furthermore, the transferability, both in terms of potential geographical and sectoral transfer, is considered. A social innovation is considered to have a broad potential if it can be adopted by many actors in different geographical and sectoral settings.

The second criterion, *relevant impact on the system*, addresses whether an innovation has the potential to cause a change in the system. Important within this criterion are changing behaviours, resulting in new skills, competencies and social practices caused by the initiative. Learning processes can be important for the impact on the system. The change can be institutionalized or fixed by law. Therefore, the possible impact of the innovation on policy-making should be considered to assess the impact on the system. Also, a link with existing innovation goals, such as the European targets laid out in the Horizon 2020 strategy, can increase the potential impact of the innovation, especially when the innovation succeeds in balancing the three dimensions of social, economic and environmental concerns.

The third criterion, *relevant characteristics for adoption*, encompasses those characteristics of an innovation that work out positively for a broad diffusion of the innovation. Important are above all those characteristics that were described by Rogers: high comparative advantage, low complexity, high compatibility, high provability and high visibility [45]. The possible existence of an already functioning comparable innovation and of success factors can enhance the compatibility and visibility of the innovation. A high compatibility can also be reached when the innovation fits well within everyday use, i.e. has a symbiotic relationship with existing practices. Transparency and the ability to transfer the innovation to other sectors are the other characteristics important for adaptation. Transparency is particularly important for the participation in, and transfer of, an innovation; the question from what phase onwards the innovation should be transparent is still open though.

On the basis of these criteria, we selected five leading edge social innovation initiatives in the German *Energiewende* and examined in how far these could be analyzed using the multilevel perspective heuristics.[2] To do so, the empirical examples were examined in a desk research along a heuristic of the following questions: What can be considered the 'regime' in the example? In how far can the example be considered a 'niche'? What kind of potential interactions between the 'regime' and the 'niche' can be expected in the example?

Results

BINSE

BINSE is a solar initiative in the town of Berchum. The purpose of BINSE is to create alternative constellations

to develop more sustainable energy production and consumption practices at the level of the town. It promotes the diffusion of renewable energies, such as solar power, solar water heating, biogas, geothermal energy and heaters with firewood and wooden pellets (in 2012, about 100 tons of pellets were purchased through the BINSE-'Einkaufsring'). The PV systems in the city of Berchum feed more than 500,000 kWh of electricity into the power grid each year. The 2-kW solar power system, which was put into operation at the local primary school in 2012, delivered 16,000 kWh of electricity during the first year of operation and generated 800 Euros through the feed-in remuneration. In addition, a filling station for electric mobility is available (one electric car and ten electric bikes). New joint projects develop from the citizens' initiative, which regularly gets together in the parish hall. The goal is to reduce the energy consumption and expand the renewable energies. The BINSE-project aims at changing the local energy system. Besides that, the project also provides information about climate impact, consultation for households about energy reduction measures and it sets up PV systems, charging stations for electric cars and heating installation powered by firewood and pellets. One goal of the project is to change behavioural routines and to initiate and strengthen networks for regular knowledge exchange. The strengthening of a feeling of solidarity among the villagers through joint goals and projects around energy provision from renewables represents a key feature of the project. The BINSE project can be considered as an example of a social innovation initiative as it aims at changing citizens' practices and as it targets behavioural routines. In this process, it makes use of, and is dependent on, technology and technological innovations, but as the crux of the BINSE initiative lays with the alternative constellations of actors (citizens, public administration) and practices, it is in essence a social innovation.

Now, how can this social innovation be analyzed in terms of the MLP? If many villages, towns or cities start to produce energy locally, this will have a significant effect on the regime; the local, sustainable, energy production thus has a competitive relationship with the regime. In this case, the regime is the conventional energy system based on central energy producers. They will be affected by the niche development as they could potentially lose customers. As the project is on the scale of communities, the impact is bigger than the actions of individuals. The potential independence of communities concerning their energy supply could definitely be a threat for the regime. The niche as well as the regime can be clearly identified and the niche development has the (theoretical) potential to change the regime (i.e. to be system changing), ergo the MLP can be applied to study the transition dynamics surrounding this social innovation. BINSE created a local niche. In this niche, the new constellations of actors and practices can prove their feasibility, and they can mature. The development of this niche is driven by landscape pressures regarding worries about the sustainability of energy production and consumption. The niche-regime interactions require deeper analysis, but if BINSE-like initiatives spread, the existing energy regime will face pressures from the maturing niche.

ZweitSinn

ZweitSinn is the label of the *eco-moebel GmbH* (eco-furniture) that was formed out of a research project at the TU Dortmund. Producers of ZweitSinn products exclusively use resources from second-hand furniture. The online portal 'ZweitSinn' offers a platform to independent producers and designers to sell their products. By re-using materials, the production of furniture reduces the need for new resources and energy and therefore limits the emissions of CO_2. Furthermore, the initiative offers work to migrants, long-term unemployed, disabled and uneducated people, and it provides first work experiences to young people.

Apart from the social benefits effectuated by employing workers with fewer chances on the labor market, the main innovation from a sustainability perspective is the saving of resources through production based on second-hand furniture. The initiative Zweitsinn concentrates on changes of social practices of different target groups within the society. Among the reasons for purchasing used goods, sustainability and partially fashion reasons are more important for many people than economic considerations. Within this fact lies a great opportunity to increase the market share for used goods, to reach more consumers and to change their behaviour. The initiative also focusses on changes in manufacturing furniture. To produce furniture, recycled materials from wood and other natural resources are used. In this case, the relevant regime is the existing socio-technical system of furniture making, which involves furniture makers that are well-integrated in the entire system from resource production till the sales of the furniture. ZweitSinn is a small initiative, currently still operating on the niche level, but theoretically, it could have the potential to challenge the existing regime. The old furniture making regime has operated under a landscape characterized by a culture of disposability in which broken products (or even functioning but old-fashioned products) were easily disposed and replaced. However, when social norms concerning sustainability and resource efficient consumption become more mainstream (landscape developments that have the potential to create windows of opportunity), these could de-stabilize the existing way of furniture consumption

and making and pave the way for the more sustainable products of ZweitSinn.

Zu gut für die Tonne

Zu gut für die Tonne, literally too good to be wasted, is an initiative that was started in 2013 by the *Akademische Förderwerk* in Bochum. Zu gut für die Tonne aims primarily at reducing food waste in canteens but its energy-saving portfolio has wider implications. Within the program, staff members from the canteens of universities were encouraged to identify possibilities to reduce waste in their canteens. Various (often small) measures added up to a savings of about 25% waste. Examples of these measures are the sales of products for half their usual price at the end of the day, reduction of freshly prepared meals and the sales of yesterday's meals for a lower price the next day. The project could also lead to visitors reconsidering their own handling of food products.

This initiative requires changing practices, both of the canteen's staff and its customers, as such it can be considered a social innovation. The visibility of the project as winner of the sustainability award of the city of Bochum, and the placement of the project as good example in the KlimaExpo.NRW in 2016, helps to spread the message and reach a larger target audience. This social innovation can therefore definitely be categorized as a leading edge innovation; nevertheless, the applicability of the multilevel perspective to analyze its diffusion should be questioned.

The innovation in this case lies in the way of dealing with food waste in a large canteen. By changing the practice of simply disposing the leftovers, to, for instance, selling them at reduced prices at the end of the day, less is wasted. However, the question arises whether this significantly impacts a relevant regime? Is Zu gut für die Tonne an innovation that either competes with an existing regime, or that has a symbiotic relationship with an existing regime? The innovation might change the practice of the cafeteria staff and, through its indirect impact, change the practices of others, and therefore have significant impact on the individuals and on the waste they produce; but this is hardly regime changing in the sense that the niche rivals the existing regime. The innovation also does not present an 'add-on' to the existing regime. The reduced waste might affect food suppliers and waste disposal companies because they might earn less, but these are not central in the existing practice the social innovation aims to alter. Therefore, the MLP appears less suited to analyze this social innovation. The innovation benefits and can gain momentum because of general landscape trends in the direction of sustainability and the prevention of food waste, but the heuristics of the MLP cannot be applied to better understand the diffusion (or lack thereof) of this innovation to other canteens.

Stromsparcheck

The project *Stromsparcheck* was initiated in 2005 in Frankfurt am Main, Germany. This project was developed because of the increasing number of power cuts. Its aim was to support households with low income to save energy, and therewith money. Main actor was the energy department of the City of Frankfurt. Key actors of this initiative were employees of the department who observed that the number of households, in which power cuts were executed, was increasing from month to month. The employees searched for a behaviour-oriented solution to this problem, which would reduce the number of power cuts in the city over the long term by changing everyday practices. Within the project, long-term unemployed people are offered a training to become energy savings advisers to these households. They visit households with low income and provide them with information on how to save energy. Furthermore, the program offers the households energy-saving products (such as LED-lights, etc.) for the value of 70 Euros. This case shows a change of social practices for two different target groups: Within the households, the residents change their practices and routines because by doing so, they are saving energy. But there is also a change in the work of the administration that can be perceived as a new social practice within this system. Employees of the responsible department find new ways to manage the problem of power cuts. They change their routines to find new and better ways to solve these problems and find new solutions for low-income households. This new way of how administration and affected households are working together to solve a problem can also be considered a socially innovative constellation.

In 2008, the project was nationwide appreciated and a diffusion with the name 'Aktion Stromspar-Check' took place in cooperation with new partners (Deutscher Caritasverband Frankfurt e.V., Zusammenschluss der Energie- und Klimaschutzagenturen Deutschlands). Beyond Germany, the project was presented at international meetings from 2010 on and soon received a very positive response. In order to transfer the 'Frankfurt model' to other countries of the EU, a joint application with a federation of French energy departments was submitted. Despite uncertainty about the long-term funding, Stromsparcheck can thus be considered a social innovation that has diffused fairly successfully already. The questions therefore are as follows: can we observe multi-level dynamics in this diffusion process? Was there interaction between an incumbent regime and the niche initiative? And what impact did the landscape have?

Like Zu gut für die Tonne, Stromsparcheck is a social innovation that enables people to save resources. The target group and the targeted reductions differ, but the overall picture is comparable. If electricity consumption is being reduced significantly, this will impact the existing regime of electricity producers and distributors. However, the innovation is not a niche that directly competes with the regime and it does not need to find its place within the existing regime, i.e. it has no symbiotic relationship with the regime. Niche-regime interaction is therefore lacking, and the existing electricity production regime does not need to destabilize under landscape pressures for Stromsparcheck to diffuse.

Stromsparcheck, provided it could become so big that a large number of households are being supported in their electricity consumption reduction, could be a serious landscape impact that forces the electricity producers and distributors to reconsider their businesses. However, to better understand the diffusion difficulties of this social innovation, the MLP is less suited as it is not the existing regime that tries to fight off competition; it is not about the interplay between the levels of niche, regime and landscape. The main challenge regarding the diffusion in this case lies with the lack of funding; Stromsparcheck is a charity initiative dependent on public funding. The Energiesparservice Frankfurt, for example, is integrated in the project 'Aktion Stromspar-Check' and receives partial funding from the Federal Environment Ministry's National Climate Initiative. Furthermore, a large share of personnel costs are borne by local authorities including the City's social and environment departments and the Job Centre. (Political) support for these tasks and positions is therefore not guaranteed in the long run.

Planspiel

The *Planspiel zu lastvariablen Tarifen*—loosely translated as 'business game on load dependent prices'—is a combined initiative of the 'Innovation City Ruhr', Emscher Lippe Energie (ELE) and RWE. The project aims to provide new information about how consumers deal with variable energy prices. The price of electricity varies depending on the availability of renewable energy. Participating households receive information about the expected price levels for the next day. Intelligent counters are used to measure the consumption. The idea is that households can adjust their consumption practices to the prices and can therewith save substantial amounts of money. At the same time, provided enough consumers adjust to the prices, network operators will be enabled to better spread the load. In this case, we see again (as in the example of BINSE) that technological innovation plays a central role (the smart meters and live updates on prices); however, the decisive element for the success of this initiative is whether or not the consumers indeed change their electricity consumption practices. Although building on technological innovation, it aims therefore above all at social innovation.

Planspiel is a prime example of a symbiotic initiative. Developed also in conjunction with regime actors such as RWE, Planspiel provides an ideal add-on for the existing regime. The existing regime of electricity producers finds itself confronted with various landscape pressures related to the production of electricity from polluting sources. At the same time, they are faced by technical challenges regarding the production and security of energy availability when producing electricity only from renewable sources. The sociotechnical system of electricity production is altered because the application of the Planspiel by consumers not only leads to a reduced consumption, but also to a different spread of the consumption. Consumers become part of the regime. The regime does not lose its dominant position as it sets the prices and thus steers the consumption pattern. The inclusion of smart meters in the control of the production process, and the changing consumption patterns, may mean that the sociotechnical system of electricity production and consumption can indeed be altered by this social innovation. As the effect on the production process may be more than incremental, the MLP might be of use to better understand the transition this innovation might possibly lead to.

We see how the multilevel alignment contributes to the transition process: the niche initiative can align with a destabilized regime that has to react to landscape impacts emerging from the growth of renewables (in turn affected by concerns about climate change and politically induced incentives for their development) and concerns about the polluting nature of their traditional resources. This prospective transition resembles the 'Reconfiguration pathway' [13, 17]. A thorough analysis of the transition process, and the possible barriers and opportunities, is beyond the scope of this paper, but the multilevel transition perspective will be helpful to better understand this diffusion of Planspiel.

These empirical examples have demonstrated how, in some cases, it is more easy to implement the MLP to the analysis of the diffusion of social innovations than in others. In the next section, we aim to further substantiate the theoretical link between social innovations and the MLP.

Discussion

Social innovation initiatives can be very diverse [21]. It may therefore not be altogether surprising that the MLP does not offer a one-size-fits-all heuristic for the analysis of the diffusion of the innovations. But then why do some social innovations provide a better fit with the

MLP than others? And under which conditions may the MLP prove helpful to understand the spread (or lack thereof) of social innovations?

Before turning our attention to the social innovations, we must return to the key elements of the MLP. Two crucial characteristics of a transition were identified. One, transitions were defined as 'shift[s] from one socio-technical system to another, i.e., a system innovation' ([2], p. 682). We should therefore start by asking whether the social innovation is actually a *system* innovation, or merely impacts the system. Two, the three analytical levels of niche, regime and landscape should be present. This means that when the social innovation is considered a niche, or has the potential to develop into a niche, there should be a matching regime to which the niche either competes or with which it can form a symbiotic relationship.

Is the social innovation a system innovation? As discussed above, social innovations aim at changing social practices. The changing social practices can be considered system or regime changes. The mere introduction of a social innovation, as for example the abovementioned Zu gut für die Tonne and Stromsparcheck, could be seen as steps towards the realization of social change, i.e. of changing social practices. However, they are not real niches that interact with an existing regime; often social innovation initiatives also do not have the ambition to be system changing [21]. Therefore, these individual initiatives, promising as they may be in the overall societal transition to a more sustainable economy, can hardly be analyzed individually along the line of an MLP-heuristic and the transition perspective.

The concept of Transformative Social Innovation (TSI) can provide some solace [46–48]. Transformative Social Innovation re-conceptualizes social innovation in relation to systemic change. It asks what is the systemic change the social innovation targets? Haxeltine et al. [47] classify social innovation in three categories: (1) grassroots social innovation, (2) broader-level initiatives and (3) systemic type innovations. The transformative social innovations are of the third type. These 'relate to fundamental changes in attitudes and values, strategies and policies, organizational structures and processes, delivery systems and services (…); i.e. social innovations that play a part in reshaping society as a more participative arena where people are empowered to look for ways to meet their own needs and those of others differently and hence to become less dependent on welfare systems and standardised product offerings from market economy and public sector organisations' ([47], p. 4). Although Haxeltine et al. actually take some distance from the MLP, the transformative social innovations do meet the requirements of system change and therefore meet the theoretical requirements outlined here.

The second question is whether the innovation can be seen as a niche, connected to an existing—competing or symbiotic—regime. A social innovation might—again provided it would succeed—cause a system change, but as the examples above have illustrated, this needs not necessarily mean that the social innovation replaces an existing regime, or merges with the regime as an important add-on. One of the aspects that make the MLP so appealing to study transitions is that it brings the incumbent regime and the niche innovation into the same picture and studies multilevel alignments. In doing so, it becomes more insightful to understand the relationship between niches and the regime. Strong incumbent actors tend to oppose radical innovations if the innovations do not have a symbiotic relationship with the regime and the MLP provides researchers with an insightful framework to better understand why, on the one hand, it is hard for niches to break through and why, on the other, windows of opportunity might emerge during which niches suddenly get a chance to spread.

Analyzing the examples of social innovations within the MLP framework shows that some of these innovations can certainly best be described at a stage prior to niche-formation. They can be characterized as (local) projects or initiatives, some of which have made steps towards inter-local phases. Replication of such initiatives is a central element in niche-formation [49]. However, given the tendency of social innovations to be modified more readily during their diffusion, a somewhat ambiguous quality should be considered: social innovations can both be imitated and thus replicated more readily in different contexts when they can easily be adapted; however, it is also possible that they are transformed into forms very different from the original ideas. Thus, potentials to challenge existing regimes need to be assessed with care [50]. Furthermore, modifications of novel practices during their diffusion might lead to alignment with regime elements and thus, social innovations might lose their transformative edge and become more symbiotic to the regime. This point exemplifies how the social innovation literature could benefit from more thoroughly taking into account insights from transition studies. Alignment to a symbiotic relation to the regime can ease the diffusion, but it can be questioned in how far the innovation can then still reach targets of, e.g. contributing to sustainable development. Vice versa transition research could benefit from taking social innovation as a concept of its own more seriously to understand the importance of changing practices for transitions. On the other hand, easy modifications to a social innovation based on experiences from local projects can also lead to formation of a more consolidated and concerted niche when information and created knowledge are shared among these initiatives in a proper

way. The above named potentials to challenge regimes can then be enhanced.

However, for some of the social innovations introduced above, there is not really an existing regime with which the niche innovation has a competing or symbiotic relationship. This does not mean that these innovations may not cause a system change, or lead to changing social practices. These changing practices might destabilize the existing regime. Electricity consumers, for instance, are part of the electricity system as production is highly dependent on consumption (i.e. demand). When social initiatives such as Stromsparcheck lead to changing consumer practices, the regime becomes destabilized due to the change within one of the regime actors; as a consequence, windows of opportunity might arise for alternative (more sustainable) modes of energy production. However, the social innovation does not directly compete with the essential service provided by the existing regime (i.e. around which the regime is formed), nor does it provide an 'add-on' to the existing regime. And in case it does grow to become a newly institutionalized practice, it does not replace or complement the existing regime, but merely opens it up for alternatives that might provide the same service. Ergo, the social innovation may have high potential to cause or facilitate a system change, without actually being a system change at the system-level required by the MLP.

Recapitulating, it can thus be said that the MLP can be a useful heuristic to examine the transition path—and possible barriers because of incumbent opposition—of social innovations if these meet the following conditions. One, the transition—provided the social innovation is successful—must lead to system change at a level higher than that of businesses or firms and populations (i.e. industries), but more specific than the level of societies or world systems. In other words, the social innovation must be transformative. And two, the social innovation must have a competing or symbiotic relationship with an existing regime that offers a similar product or service and that it can—at least theoretically—replace.

Conclusions

This paper examined whether the multilevel perspective of transitions can be a useful heuristic to analyze and better understand the diffusion of social innovations. Due to the diversity of social innovations, the MLP proved applicable only in those cases where the social innovation (1) can lead to a system change and (2) has a competing or symbiotic relationship with an existing regime. We therefore contribute to a relatively young branch of literature that has taken up the challenge of connecting the insights from the multilevel perspective with the spread of social innovations.

We have shown that while some social innovations meet these requirements, others do not. This does not mean that these social innovations have less potential to contribute to the transition towards a more sustainable energy system, nor that they cannot have a substantial impact on the existing regimes. However, as they do not form, or belong to, a niche that has a direct relationship with the existing regime, the MLP is less suited to analyze, and learn to understand, their diffusion mechanisms.

Drawing on the differentiation between initiatives and niches [14], furthermore social innovations can be classified to potentially form a niche competing with an existing regime when different initiatives can align together and those which may more indirectly influence the regime, e.g. through saving energy which in the long run might affect energy providers when an absolute decoupling of resource and energy demand from quality of life is achieved. The energy transition will need to rely both on a shift to renewables and a decrease in consumption, while so far the demand for electric power remains at high levels. Reduction through behavioural changes or more precisely, e.g. reduction of demand for conventional power from providers, will thus be needed [51, 52]. Above, we described such impacts driven by a sense of urgency within society to be rather landscape changes to providers. Finally, the actual impact at the regimes needs to be assessed from the bottom-up perspective of changes in social practice and potential regime reactions and alignment.

We have highlighted BINSE, ZweitSinn and Planspiel as social innovations that could benefit from a multilevel perspective analysis. The logical next step would therefore be to take these, and other examples of social innovations that meet the requirements laid out in this paper and analyze them in detail. This analysis should include a detailed study of the niche (who are the main actors, which regime does it challenge, how can it be nurtured, etc.), the regime (main actors, how are these actors interlinked, which methods are applied to shield of outsiders (i.e. niche innovations), where are potential weaknesses, etc.) and the relevant landscape (e.g. renewed rising oil prices and a general sense of urgency to act against climate change, etc.).

Endnotes

[1]This is not to say that transitions cannot be initiated or carried from within the regime; the emerging transition towards renewable energy sources in the UK, for instance, was largely initiated by the existing large-scale energy producers [53].

[2]We will not go into the question why these were selected as top social innovations here; this will be addressed more thoroughly in another paper that is still under development.

Abbreviations
MLP: Multilevel perspective; NRW: North Rhine-Westphalia

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Availability of data and materials
This research relied on a literature and desk research; information on the social innovations referred to is publicly available online.

Authors' contributions
The paper is based on collective work, and all authors contributed to all parts. RH reviewed the literature on the multilevel perspective and the analysis of the case examples. He wrote the main parts of the 'Background' and 'Conclusions' sections and contributed to the 'Methods' and 'Discussion' sections. SL reviewed the literature on social innovation and collected the background data for the cases. She wrote the main parts of the 'Methods' section and contributed to the other sections. MH wrote the main part of the 'Discussion' section and the part on linking the MLP and social innovations through practice theories; he contributed to the other sections, where he especially also wrote substantial parts for the 'Methods' and 'Conclusions' section. All authors read and approved the final manuscript.

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