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Towards a typology of intermediaries in sustainability transitions: A systematic review and a research agenda

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ABSTRACT

Intermediary actors have been proposed as key catalysts that speed up change towards more sustainable socio-technical systems. Research on this topic has gradually gained traction since 2009, but has been complicated by the inconsistency regarding what intermediaries are in the context of such transitions and which activities they focus on, or should focus on. We briefly elaborate on the conceptual foundations of the studies of intermediaries in transitions, and how intermediaries have been connected to different transition theories. This shows the divergence – and sometimes a lack – of conceptual foundations in this research. In terms of transitions theories, many studies connect to the multi-level perspective and strategic niche management, while intermediaries in technological innovation systems and transition management have been much less explored. We aim to bring more clarity to the topic of intermediaries in transitions by providing a definition of transition intermediaries and a typology of five intermediary types that is sensitive to the emergence, neutrality and goals of intermediary actors as well as their context and level of action. Some intermediaries are specifically set up to facilitate transitions, while others grow into the role during the process of socio-technical change. Based on the study, as an important consideration for future innovation governance, we argue that systemic and niche intermediaries are the most crucial forms of intermediary actors in transitions, but they need to be complemented by a full ecology of intermediaries, including regime-based transition intermediaries, process intermediaries and user intermediaries.

1. Introduction

Intermediary actors have been proposed as key catalysts that speed up change towards more sustainable socio-technical systems (e.g. Hodson et al., 2013) as part of sustainability transition policies (Wieczorek and Hekkert, 2012). The transformation of socio-technical systems is characterized by shifts in relations between actor groups, between infrastructures, and between technologies and contexts of application. The resulting changing contexts and, consequently, changes in positions of and interlinkages between actors increase the need for intermediary action (Van Lente et al., 2003; Moss, 2009).

With the exception of some early studies on intermediaries in transition processes (Van Lente et al., 2003; Geels and Deuten, 2006), the theme has only relatively recently gained traction in the sustainability transition field (Hodson and Marvin, 2009; Moss, 2009; Guy et al., 2011). It has also been related to actor roles and agency in sustainability transitions (Wittmayer et al., 2017; De Haan and Rotmans, 2018; Gliedt et al., 2018). Since 2009, much of this literature has focused on urban and energy contexts (e.g. Hodson and Marvin, 2009; Rohracher, 2009; Backhaus, 2010; Bush et al., 2017; Kivimaa and Martiskainen, 2018a). Studies using notions such as “middle actors” (Parag and Janda, 2014), “hybrid actors” (Elzen et al., 2012) and “boundary spanners” (Franks, 2010; Smink et al., 2015; Tisenkopfs et al., 2015) have addressed intermediary-like functions. Furthermore, terms related to mediating space, such as “user assemblages” (Nielsen, 2016) and “interaction arenas” (Hyysalo and Usenyuk, 2015; Hyysalo et al., 2017) refer to intermediation for technologies in transition without explicitly mentioning intermediaries.

There has been a recent increase in articles on intermediaries in the sustainability transition literature. These articles recognize that intermediaries can be influential in transition processes by linking actors – both new entrants and incumbents – and activities, skills and resources

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connected to these actors, to create momentum for change, create new collaborations around niche technologies, ideas and markets, and disrupt prevailing socio-technical configurations (e.g. Kivimaa, 2014; White and Stirling, 2015; Fischer and Newig, 2016). This literature presents a wide range of interpretations of intermediaries, with varying levels of capacity to influence change, i.e. change agency (Kivimaa, 2014; Parag and Janda, 2014), intent to drive sustainability transitions (e.g. Hodson and Marvin, 2009; Moss, 2009) and normativity ranging from neutral to strongly advocating a certain position (e.g. Elzen et al., 2012; Orstavik, 2014).

Despite the existence of an emerging body of research on intermediaries in transitions, inconsistencies regarding what might be called "transition intermediaries", and which activities they (should) focus on, has hindered communication of the concept and understanding of its usefulness to transition scholars and stakeholders. This is partly due to studies in this area having widely different starting points and conceptual foundations, similar to what Howells (2006) and Klerkx and Leeuwis (2009) have noted regarding innovation intermediaries. The analytical focus of existing research ranges from studying intermediary processes in innovation projects (e.g. Klerkx and Aarts, 2013; Martiskainen and Kivimaa, 2018) through analysing the aggregation of multiple experiments/projects (e.g. Geels and Deuten, 2006) to the classification and building typologies of specific kinds of organizations as intermediaries (e.g. Polzin et al., 2016; Barrie et al., 2017).

In this paper, we bring more clarity to the topic of intermediaries in transitions, by providing a definition and a tentative typology of transition intermediaries that is sensitive to issues such as emergence, neutrality and goals of intermediary actors in transition processes. We argue that both academic and policy communities can benefit from this. In our typology, we use the multi-level perspective (MLP) of transitions to structure the types of intermediaries, because this strand of transition literature has been the most explicit in its treatment of intermediaries. However, we also acknowledge other conceptual foundations owing to their important insights on the emergence, context and goals of intermediation.

Informed by Petticrew and Roberts (2006), we systematically reviewed literature on intermediaries in sustainability transitions and created a conceptual framework of intermediary types, highlighting key issues for future research and innovation policy. By engaging in such systematic review of literature, we attempt to ascertain:

1 What are the theoretical and conceptual connections made in studies focused on intermediaries in sustainability transitions?
2 What does the literature say about the origin of intermediaries in sustainability transitions?
3 In what contexts is intermediation occurring in sustainability transitions?

Through answering these questions, we create a typology, a definition and early conclusions of intermediation in sustainability transitions. Section 2 briefly summarizes intermediaries in innovation and sustainability transitions to guide and situate our systematic review. Section 3 explains the methodology. Our findings in Section 4 highlight the conceptual foundations of the literature on intermediaries in sustainability transitions, the emergence of transition intermediaries, different contexts for intermediating in transitions, the goals and normative positions of intermediaries, and changes in intermediation during transitions, ending with a proposed typology of intermediaries. In the discussion and conclusions (Section 5), we bring out some of the critique and gaps in this literature and highlight future directions.

2. Conceptual background

2.1. Intermediaries in innovation

Innovation studies and science and technology studies (STS) have for a long time paid specific attention to intermediaries (e.g. Baum et al., 2000; Howells, 2006; Meyer, 2010; Pollock and Williams, 2016). A common thread in this work is that intermediaries are found to bridge between actors involved in situations where direct interaction is difficult due to high transaction costs (e.g. locating a suitable partner to collaborate with, disincentives to collaborate) or communication problems resulting from differences in culture, interests, and capacity to absorb or exchange knowledge.

Some scholars perceive intermediaries as "facilitators of innovation", engaging in network and system-building activities (Klerkx and Leeuwis, 2009). This correlates with an understanding of intermediaries by actor-network theorists as actors (or non-human actants) that carry out their function without altering the shape of knowledge or goods being transferred (Latour, 2005). Others see intermediaries as actors who shape the entities being passed on (Stewart and Hyysalo, 2008; Meyer, 2010), for example, consultants translating scientific knowledge for their clients. Intermediaries are often described as neutral or honest brokers without clear normative interests beyond that innovation occurs (Pielke, 2007; Klerkx and Leeuwis, 2009). Yet some intermediaries have a clear normative orientation, acting as "champions" (Martiskainen and Kivimaa, 2018) and exercising steering through their translation functions (Meyer, 2010).

In a given emerging technology field, one may find a dynamic *ecology of differently positioned intermediaries*, with differing competences, remits and operational models. This leads each into intermediating only some aspects of innovation but not others (Stewart and Hyysalo, 2008). The ecology of intermediaries is subject to evolution in the course of an innovation process and in the maturation of a technology area (e.g. Klerkx and Aarts, 2013; Hyysalo and Usenyuk, 2015; Pollock and Williams, 2016).

Intermediary actors are often identified through the functions they perform, sometimes constituting a specific actor category with a separate identity, as either an individual or an organization. Based on these functions, typologies of intermediaries have been created for innovation systems and urban contexts. For example, Van Lente et al. (2003) distinguished three types: hard intermediaries, e.g. research and technology organizations, which engage in the transfer of technical knowledge and technology transfer; soft intermediaries, e.g. chambers of commerce or innovation centres, which are oriented to intermediating skills, human resources or learning from a business innovation perspective; and systemic intermediaries as more strategic actors, intermediating multiple actors, organizing discourse and creating conditions for learning. Klerkx and Leeuwis (2009) made a similar typology for the agricultural innovation system. Hodson et al. (2013), in turn, characterized four modes of intermediation in urban energy contexts by examining whether intermediaries initiate or implement externally produced or context-specific priorities, and whether their responses are systemic or episodic.

While some studies address specific types of intermediaries, the literature as a whole lacks clarity in how intermediation is defined, where it begins and ends, and where interaction in general becomes intermediation. As a result, intermediation covers a range from formal, self-recognized and defined forms, to informal and emergent (or even mostly hidden) forms of intermediation.

2.2. Sustainability transitions

The literature on sustainability transitions has introduced a broader outlook on innovation than mainstream innovation studies, moving beyond product or process innovation to focus on systemic change for sustainable futures.

The key premise of this literature is to study and promote *sustainable* transformative change, seen as a set of processes leading to fundamental shifts in socio-technical systems and involving far-reaching modifications to technological, material, organizational, institutional, political, economic, and socio-cultural dimensions (Markard et al.,

2012) with implications for policy. The literature has evolved rapidly, building on four key conceptual approaches: MLP, strategic niche management (SNM), transition management (TM) and technological innovation systems (TIS) (see Markard et al., 2012).

The boundaries of sustainability transitions research are fluid but informed by a shared normative orientation and a tradition of research drawing from the four core conceptualizations. Building on MLP and SNM, "niche" and "regime" have become prominent concepts in transition studies, although not used in all approaches. Niches are depicted as spaces in which radical innovations and experimentation are taking place, while regimes are described as relatively stable and shared configurations of technologies, practices and institutions (Rip and Kemp, 1998; Geels, 2002).

Research on sustainability transitions is multidisciplinary, with new openings made to better account for issues such as spatiality (Hansen and Coenen, 2015), politics (Avelino et al., 2016) and agency (Fischer and Newig, 2016). Temporality is an important aspect of transitions, even more so than in innovation intermediary studies, involving changes in the emergent and dominant socio-technical configurations. Thus, intermediary action may appear differently in different stages of transformative change. Normative directions of innovation are present in transition studies through considering consequences of change for environmental and social sustainability (Smith et al., 2010).

3. Method and data

To explore intermediaries in the context of sustainability transitions conceptually, we undertook a systematic review of academic literature, in a manner informed by Petticrew and Roberts (2006). We carried out a scientific literature repository search using keywords. We subsequently expanded from the resulting articles to their reference lists and citations to identify further articles. Our focus was on those articles that explicitly used the term "intermediary" in the context of sustainability transitions. The selection of articles was completed in three steps (I–III in Fig. 1).

First (step I), we searched Scopus combining search terms "transition*" OR "multi-level perspective" OR "strategic niche management" OR "technological innovation system*" AND "intermediar*" in the title-abstract-keywords fields. Following Markard et al.'s (2012) depiction of core theories of sustainability transitions, MLP, SNM and TIS were specifically searched. Articles referring to the fourth core theory TM were captured by the search word "transition*". We complemented the Scopus search with another one in Science Direct in the title-abstract-keywords fields because, while Scopus includes Science Direct journals, new articles are not updated to Scopus immediately after publication.

The resulting article abstracts were scrutinized using the following inclusion criteria (step II): the publication had to be (1) a peer-reviewed piece of academic work in the field of social science and business studies, (2) thematically oriented to transition studies, and (3) appearing in Scopus on 11 October 2017. In addition, we applied the following exclusion criteria: (4) articles that did not address innovation or change in the context of socio-technical systems were excluded (i.e. the term "transition" needed to be used in the sense of transformative change); and (5) articles in which the term "intermediary" was only used in passing (referring to 1–2 instances and not being part of the main focus) were excluded from our analysis. Abstract reading resulted in an initial selection of 45 articles of which 13 were omitted based on reading the full papers, resulting in 32 articles feeding into step III.

Step III involved searching the reference lists of the selected 32 articles for earlier relevant papers, taking into account terms with similar meaning. This "backward citation snowballing" resulted in nine additional articles. We also performed a "forward citation snowballing" by selecting for each of the 32 articles the "cited by" option in Scopus. The resulting list of citing articles was then scanned: title, keywords and abstracts were read to assess inclusion. This procedure resulted in 12 new articles. Backward and forward citation yielded 30 articles, of which nine were excluded after reading the full papers. Thus, 53 articles form the material for systematic review (Fig. 2).

The first author read and coded all the articles. To check for consistency, the second author read and coded randomly selected articles (see Appendix A for the list of codes and Appendix B for a complete list of articles). The two authors discussed coding in an iterative exercise. No significant inconsistencies emerged.

4. Findings of the systematic literature review

Section 4 presents and discusses the findings of the systematic literature review. The following is covered: the conceptual foundations of intermediaries and what transition perspectives they are connected to (Section 4.1); how intermediaries emerge in the context of transitions (Section 4.2); different contexts for intermediating in transitions (Section 4.3); the goals and normative positioning of intermediaries (Section 4.4); changes in intermediation during transitions (Section 4.5); and a typology of transition intermediary types (Section 4.6).

4.1. Conceptual foundations of intermediaries in relation to transitions perspectives

Transitions studies refer to intermediary actors through four conceptual lenses on which subsequent publications have mostly built. Research on intermediaries in transitions originated in 2003, when Van Lente et al. (2003) wrote a seminal piece on *systemic intermediaries* that is cited by 15 out of 53 articles in our review (221 citations in Google Scholar). They used concepts from research on systems of innovations (Lundvall, 1992; Nelson, 1993; Edquist, 1997), intermediation in knowledge-intensive business services, research and technology organizations, and public and industry organizations. They described systemic intermediaries as building blocks of innovation systems, being new types of intermediaries that operate "*in networks instead of 'one to one' mediation*" (Van Lente et al., 2003). Such intermediaries are seen to carry out systemic functions, including the articulation of options and demand, alignment of actors and possibilities, and support in learning processes. The article illustrates this in cases that relate to sustainability transitions.

Twelve articles in our review referred to another strand of the literature on intermediaries in transitions, i.e. urban transitions, building on the work of Hodson, Marvin and Medd (Medd and Marvin, 2008; Hodson and Marvin, 2009, 2010, 2012; Hodson et al., 2013). Conceptualization of intermediaries in this body of work has initially largely been formed from the empirical context of urban transitions. Some cross-referencing is made to Van Lente et al. (2003), and loose connections have been made to cultural intermediaries by Bourdieu (1984), technology translators by Iles and Yolles (2002), social intermediaries by Piore (2001), and the work of Callon (1986) and Latour (2005).

In 2006, Geels and Deuten (2006) described how intermediaries operate to connect local experimental projects and the building of a "global" niche for transitions (see also Geels and Raven, 2006). This conceptualization emerged from empirical and conceptual studies on niche development, rather than referring to previous academic conceptualizations of intermediaries. This work was only directly acknowledged in six other papers in our review (64 citations in Scopus; 138 citations in Google Scholar). However, Hargreaves et al. (e.g. Hargreaves et al., 2013; Seyfang et al., 2014; Smith et al., 2016) have built significantly on Geels and Deuten in further developing the conceptualization of intermediaries in niche development, and have, in turn, sparked a wide range of studies.

The latest scholarly lens on intermediaries in transitions (Klerkx and Leeuwis, 2009; Polzin et al., 2016; Barrie et al., 2017) increasingly connects to the large body of work on "innovation intermediaries". Klerkx and Leeuwis (2009) and Kivimaa (2014), being the first to make a connection between innovation intermediaries (Bessant and Rush,

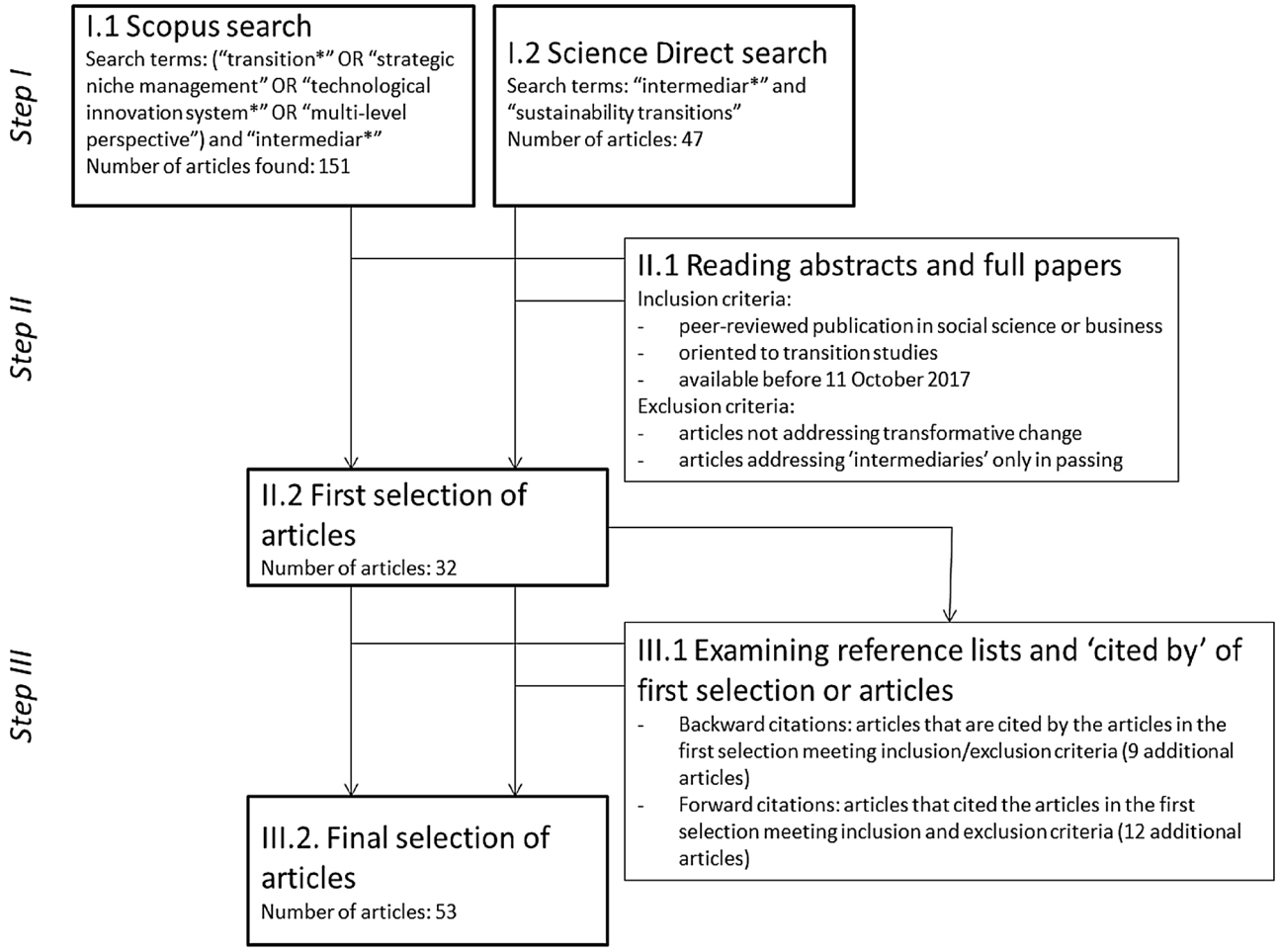

Fig. 1. Steps in selecting the publications.

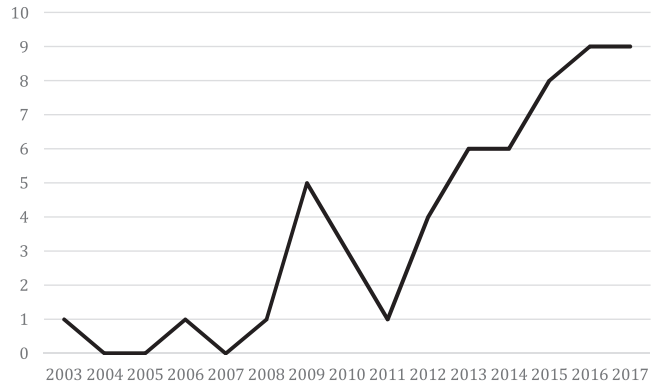

Fig. 2. Spread of articles included in the systematic review based on year of publication.

1995; Howells, 2006; Boon et al., 2011) and transitions, have informed recent research on intermediaries in transitions. Nine articles in our review referred to one or both of these sources (383/66 citations in Google Scholar and 168/30 citations in Scopus, respectively). This lens is differentiated from the first one. While systemic intermediaries link to the facilitation of interactions with the aim of strengthening the innovation system, innovation intermediaries derive, for example, from management studies' depiction of knowledge brokers (Hargadon, 2002) and science and technology studies (Guston, 1999), exploring a variety of innovation intermediary roles (also captured by the seminal review of Howells (2006)).

We, thus, identified four conceptual lenses through which intermediary work in sustainability transitions has been studied: (1) systemic intermediaries, (2) intermediaries in urban transitions, (3) intermediaries in niche development, and (4) innovation intermediaries in transitions (Fig. 3). Yet many articles in our review used the term "intermediary" without using any of these conceptual lenses as a foundation. Thirteen articles refer to only one literature source when briefly explaining the intermediary focus, and in four articles no grounding is given to the use of intermediary.

Over half of the studies reviewed treat intermediaries in the context of one or both of the two interlinked core approaches of transition studies (Fig. 4): MLP and SNM. Therefore, we specifically draw on the idea of intermediation in the interface of niches and regimes, two cornerstone concepts of MLP and SNM, in Sections 4.2–4.6. The literatures on technological innovation systems and transition management have been used much less to guide the work on intermediaries in transitions. However, the findings pertaining to intermediaries in the few articles written from the TIS perspective (e.g. Lukkarinen et al., 2018; Normann and Hanson, 2018) could be "translated" to the regime/niche orientation, because these articles also reference niche/regime studies. Slightly less than a third of the studies did not link to any of the four core perspectives, rather connecting to urban transitions, innovation systems, large technical systems and socio-technical arrangements. Urban transition studies, arguing the limited influence of MLP in place-based transitions, have focused on spatial or scalar intermediation between the city–region level and national governance (Hodson and Marvin, 2012) or between different localities within a region (Medd and Marvin, 2008).

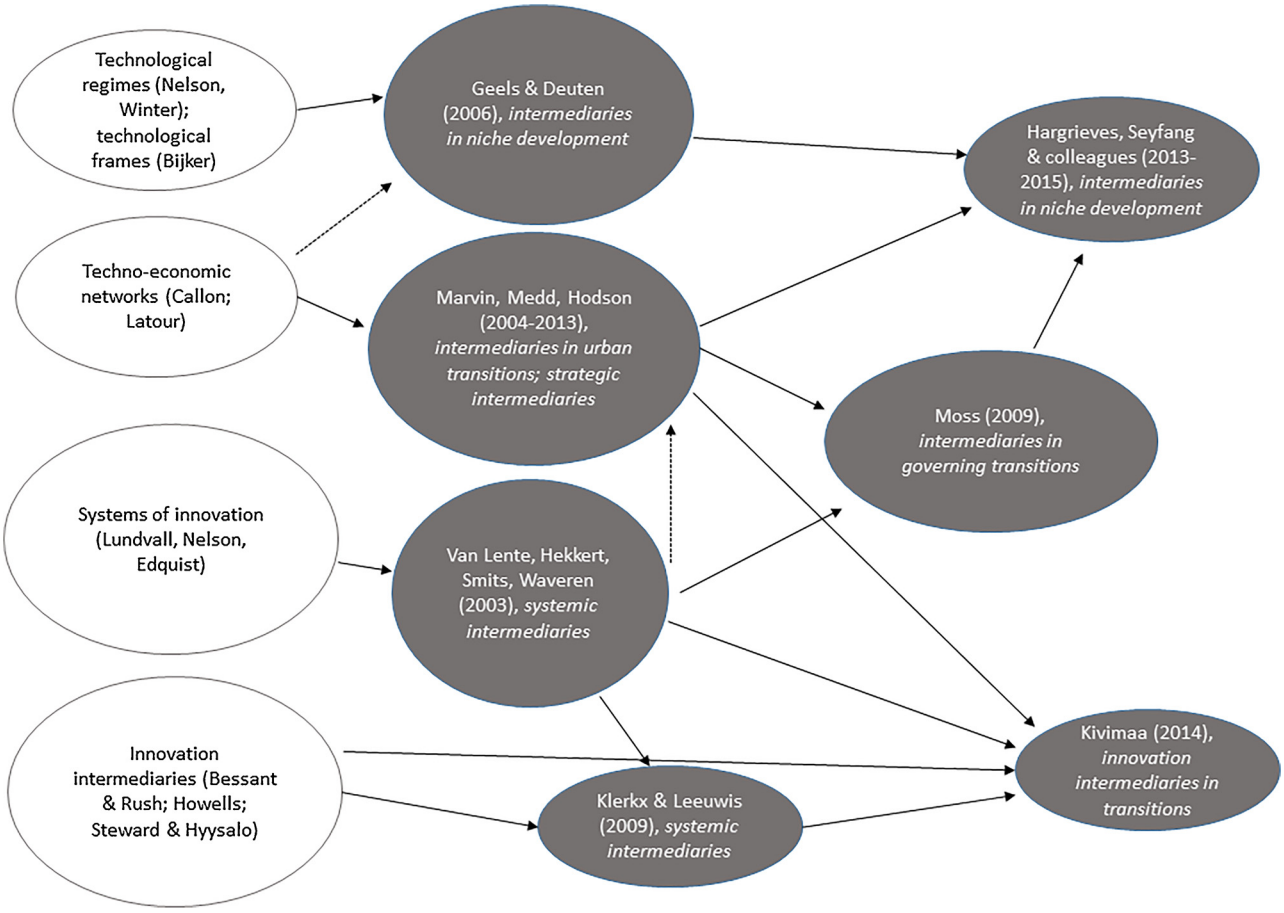

Fig. 3. Conceptual foundations and research strands of the emerging literature on intermediaries in transitions.

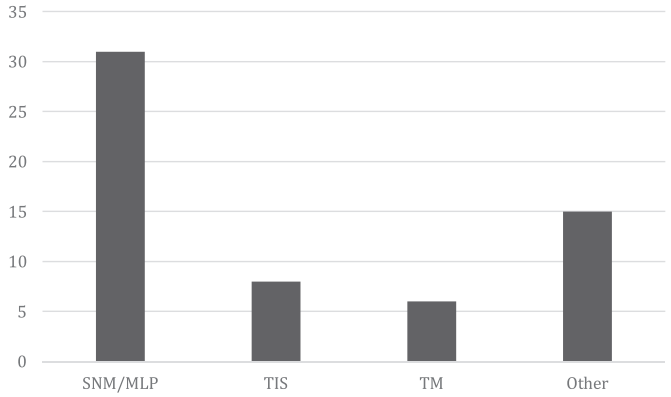

Fig. 4. Transition perspective adopted in the systematic review articles.

4.2. Emergence of dedicated "transition intermediaries"

While many of the articles reviewed did not explicitly address the origin of intermediaries, 27 articles articulated through empirical descriptions the varying ways in which intermediary actions *emerge* and, hence, pointed to the existence of what can be called a "transition intermediary". Our literature review presents four distinct ways through which the identity of "transition intermediary" emerges.

(1) Theoretically, perhaps the clearest one is a transition intermediary that is specifically established to intermediate a transition process (e.g. Hodson and Marvin, 2009, 2010; Hamann and April, 2013; Hamilton et al., 2015), for example, to coordinate local actions with the "sustainable" economic strategy of a city region (Hodson and Marvin, 2012), to facilitate the implementation of "neighbourhood contracts" for urban renovation (Kampelmann et al., 2016), or to promote low-carbon transition by engaging municipalities as "change laboratories" (Lukkarinen et al., 2018). Hodson and Marvin (2010) argue that intermediaries need to be created as new forms of governance to boost transitions. This may occur in places where, for instance, innovation policymakers or cities play an active role in transforming governance (Klerkx and Leeuwis, 2009; Hodson et al., 2013).

(2) Yet, more mentions as intermediaries were made in the systematic review of already established actors (organizations, individuals) who assumed intermediary roles and activities during their existence, even though they were not initially set up to intermediate (e.g. Rohracher, 2009; Schreuer et al., 2010; Horne and Dalton, 2014; Judson et al., 2015; Mattes et al., 2015). These may be part of the prevailing socio-technical system or of newly emerging niches or technological innovation systems, for example, advancing energy-efficient buildings (Fischer and Guy, 2009; Parag and Janda, 2014), renewable energy technology (Normann and Hanson, 2018), community energy (Martiskainen, 2017) or forest sector innovation (Berkvist and Söderholm, 2011). Judson et al. (2015) and Parag and Janda (2014) argue for the importance of established actors to adopt intermediary roles to advance transitions (also Fischer and Guy, 2009).

(3) Equally common are transition intermediaries that had not existed before, nor been mandated to intermediate by some higher-level actor, but had emerged in the process of transition. They may appear in response to large-scale institutional change (e.g. Moss, 2009; Rohracher, 2009; Backhaus, 2010; Moore et al., 2012) or to failures in markets and innovation systems to address sustainability

concerns or new technologies related to transitions (e.g. Van Lente et al., 2003; Klerkx and Leeuwis, 2009; Hamann and April; Hyysalo et al., 2013, 2017). For instance, Moss (2009) argues that intermediaries may especially originate in response to market restructuring and new modes of regulation, and to fill institutional gaps (a finding supported by a case of fiscal reform in Canada; see Moore et al., 2012). Hyysalo et al. (2013, 2018) found that peer-to-peer internet discussion forums grew to take a major intermediary role in the diffusion of renewable technologies. Kanger and Schot (2016) found user clubs becoming intermediaries during the emergence of the car, and being particularly important in accelerating transitions.

(4) Moss (2009) and Hodson et al. (2013) have made reference also to transition intermediaries unaware of their intermediation. They can often be found at the interface of radical innovation/experimental activities and the prevailing regime. Examples include social landlords (Judson et al., 2015), building professionals (Horne and Dalton, 2014) and architects translating low-carbon building regulations into practice (Fischer and Guy, 2009). Equally, user intermediaries, such as peers in internet discussion forums, only gradually understand that they have come to play an important role (Hyysalo et al., 2013, 2017, 2018). These kinds of actors may be crucial in forming a critical mass for accelerating transitions. For example, architects could play a significant, but so far non-actualized, role in intermediating low-carbon transitions (Fischer and Guy, 2009).

The above observations point also to the *evolution* of intermediaries. Changes in socio-technical system configurations are likely to lead to the formation of new intermediaries, changing intermediary roles and, perhaps, termination of others. Van Lente et al. (2003) and Klerkx and Leeuwis (2009) make an argument for the emergence of more systemic intermediaries in the context of changing innovation systems, intermediating in many-to-many relationships as opposed to intermediating in bilateral relationships. There are also sector-specific dynamics that influence intermediary emergence. The deregulation of electricity and water markets (Moss, 2009; Rohracher, 2009; Backhaus, 2010) led to the creation of new intermediaries connecting unbundled parts of the system.

During a transition new intermediaries may emerge and old ones cease to exist either intentionally, in the course of a "battle" between actors, or accidentally. Changing contexts may create conflicts between intermediaries (e.g. Moore et al., 2012), taking focus away from their task. Long-term intermediaries may choose to have a limited role to play in a given transition (Klerkx and Leeuwis, 2009; Kivimaa, 2014). When transition advances, tasks of intermediaries supporting niches may be taken over by regime players, making intermediaries less important (Kanger and Schot, 2016), or transition intermediaries may change their role and become intermediaries institutionalized as part of the new regime (e.g. Berkvist and Söderholm, 2011). As the proposals, solutions and uses that start as novel and different gradually tend to move towards normalcy and find their new institutional logics and stable actor configurations, a transition intermediary may transform to a more incremental player no longer able to act as an advocate or even a neutral party to alternative socio-technical configurations (e.g. Orstavik, 2014).

4.3. Different contexts for intermediation in transitions

Transition intermediaries operate in and between different contexts. One form of transition intermediation occurs between experimental and innovative local projects and the "global" niche (Geels and Deuten, 2006), global implying a more aggregate level instead of geographical scale. Empirical studies indicate that intermediary actors aggregate learning from individual projects and translate best practice, resources, standards and global visions to influence the formation of new projects and the selection environment (e.g. Raven et al., 2011; Seyfang et al., 2014; Holden et al., 2016). Hargreaves et al. (2013, p.77) found that, in addition to intermediating between different projects, community energy intermediaries increasingly broker and manage "partnerships between local community energy projects and other actors from outside the community energy sector – particularly major energy companies". Similarly, Raven et al. (2011) describe how mobilizing "allies", such as local politicians, was an important intermediary activity in increasing the public acceptance of new niche solutions in river management. Smith et al. (2016) go further in describing roles in policy advocacy, such as mobilizing political programmes to support a particular niche.

Intermediation between actors within experimental projects is an important micro-scale activity that has only recently been studied in the context of transitions (Kampelmann et al., 2016; Martiskainen and Kivimaa, 2018). On a project level, intermediation occurs between differing interests for the purposes of vision formation and project implementation (Martiskainen and Kivimaa, 2018) and between physical and people-oriented operations (Kampelmann et al., 2016).

Urban transition studies offer a spatial perspective to intermediation, where intermediation occurs between national, regional and city scales. In this context, intermediation may aim to improve integration between national (transition) priorities and city strategies (Hodson and Marvin, 2012), or to translate regional strategies into local practices covering multiple spatialities (Medd and Marvin, 2008). Thus, intermediaries cross both spatial and administrative scales (Hermans et al., 2016).

Another form of transition intermediation is that between consumers and producers (e.g. Van Lente et al., 2003; Medd and Marvin, 2008; Rohracher, 2009; Judson et al., 2015), where a process of intermediating interests and ideas and shifting power positions takes place. New technologies required for sustainability transition may diffuse among consumers "as is", but it is common that they require adjustment and re-innovation in particular locales where they are adopted, and may further require adaptions in consumer routines and practices. Installers, maintenance technicians and other users may act as intermediaries who facilitate and configure new technology to suit local particularities (Judson et al., 2015; Hyysalo et al., 2013, 2017; Schot et al., 2016). Research in this area has empirically focused on the energy use and heating of buildings (Horne and Dalton, 2014; Parag and Janda, 2014; Judson et al., 2015; Hyysalo et al., 2018), where different technological configurations can be made to derive system or architectural innovation (Martiskainen and Kivimaa, 2018). In some cases, such intermediation extends to the post-technology-adoption phase, in which the concrete benefits, e.g. for energy demand reduction, depend on how improved use of the technology is facilitated by intermediaries (Hyysalo et al., 2013; Grandclement et al., 2015; Martiskainen and Kivimaa, 2018).

A vital context for transition intermediaries is the overall system comprising both niche and regime actors, where intermediation is depicted as occurring between multiple network partners (Van Lente et al., 2003; Hodson and Marvin, 2009; Mattes et al., 2015; Lukkarinen et al., 2018) or system actors (Klerkx and Leeuwis, 2009; Polzin et al., 2016; Barrie et al., 2017). At the interface between new, radically different alternatives and the prevailing socio-technical regime, intermediaries link niche actors with dominant socio-technical structures, aid in negotiating change by assisting in the building of alliances, and bring in supporters from the dominant regime (Diaz et al., 2013; Elzen et al., 2012; Hargreaves et al., 2013; Ingram, 2015; Smink et al., 2015; Hess, 2016). In such contexts, intermediaries act as brokers between multiple priorities, interests and knowledge pools for creating a shared vision and activities to facilitate transitions. Mattes et al. (2015) describe how organizations from industry and administration have diverging organizational cultures and rationales for action and thus require intermediation in the context of creating innovation systems. Fischer and Guy (2009), in turn, exemplify how new regulation for energy transitions needs to be translated by intermediaries to be

understandable, so that building practitioners can implement it in practice. Such translation by intermediaries may also be needed across different regions and networks that have differing established interests (Medd and Marvin, 2008).

The multidimensionality, complexity and multi-actor-network orientation of transition processes makes the operation of one intermediary alone often insufficient. Indeed, our systematic review demonstrates that, in the transition context, an ecology of intermediaries plays an important role in creating new markets for innovative solutions through pooling knowledge, finance and people for niche development (Klerkx and Leeuwis, 2009; Rohracher, 2009), while simultaneously challenging existing market structures and voicing demands for regime change (Kivimaa, 2014). Thereby, transition intermediaries engage in both supporting radical innovation from the ground and disrupting the prevailing (unsustainable) socio-technical configurations from the system level. The ecology of transition intermediaries conditions the ways in which information is exchanged or translated and learning takes place (Geels and Deuten, 2006; Hodson and Marvin, 2009; Wihlborg and Söderholm, 2013; Seyfang et al., 2014). It is crucial to note that even within a specific ecology of intermediaries, the opinions and priorities of different intermediaries vary (Holden et al., 2016; Hyysalo et al., 2018), meaning that they do not concur necessarily on how the transition is best pursued.

4.4. Goals of intermediation and normative positions of transition intermediaries

Intermediaries are frequently labelled as "neutral" or "without specific agency" (Klerkx and Leeuwis, 2009; Backhaus, 2010; Kampelmann et al., 2016; Parag and Janda, 2014). There are, however, questions about the degree of neutrality intermediaries can possess in connection to change agency (cf. Kivimaa, 2014). Indeed, to denote their position, references have also been made to them supporting the "collective good" (Geels and Deuten, 2006), "societal benefit" (Hyysalo et al., 2013) or trustworthiness of knowledge (Wihlborg and Söderholm, 2013).

The systematic review reveals that many transition intermediaries are likely to possess a degree of bias and agency in relation to the *normative position* and *strategic goals* of espoused niches vis-à-vis the prevailing socio-technical configuration. Intermediaries may advocate particular socio-technical solutions or trajectories. Martiskainen and Kivimaa (2018) illustrate how some (but not all) intermediaries take on championing roles when working on zero-carbon building transitions. Holden et al. (2016), when describing intermediary organizations in advancing sustainable neighbourhood development, talk about visionaries having "a bias towards limiting human population growth to within local ecological capacity". Smith et al. (2016) illustrate political advocacy work supporting specific sustainable solutions. Other transition intermediaries may have biases through attachments to existing institutional regimes as parts of either formal governance structures (e.g. Orstavik, 2014; Polzin et al., 2016) or informal institutions (e.g. Parag and Janda, 2014; Hamilton et al., 2015).

Intermediaries may also be commercially or financially dependent on, for example, the government or industrial partners in their intermediation activities (Fischer and Guy, 2009; Hodson and Marvin, 2012; Moore et al., 2012; Horne and Dalton, 2014). This iterates Kivimaa's (2014) assertion that neutrality or bias may be dependent on politics, finance and technological orientation. In contrast, "strategic intermediaries" are specifically established to intermediate between sets of *different* social interests (and technologies) to produce an outcome that would not have been possible, or as effective, without their involvement (Hodson and Marvin, 2009; Kanger and Schot, 2016). What is of relevance is the legitimacy that transition intermediaries possess in facilitating and helping in configuring transitions.

4.5. Changes in intermediation over the course of transitions

Limited insight is available on how intermediation changes over the course of transitions, but this has recently received emerging interest (cf. Hyysalo et al., 2018; Kivimaa and Martiskainen, 2018b). Most articles on transition intermediaries focus on the early stage of transitions (sometimes labelled as "predevelopment"), when experimental projects are starting to form a niche and have some visibility. During this phase, making connections between local and global developments is seen as important to move beyond individual experiments towards a "successful" niche (Geels and Deuten, 2006; Hargreaves et al., 2013; Seyfang et al., 2014; Fontes et al., 2016).

Van Lente et al. (2011) describe how the functions of *systemic intermediary* organizations differ in different transition phases. In predevelopment, systemic intermediaries can articulate societal needs, make options visible and identify possible stakeholders to form an arena for transition. In take-off, systemic intermediaries aim to engage a critical mass of stakeholders for the new system and identify promising niches. In acceleration, systemic intermediaries can organize strategic workshops to align various perspectives and activities, and prevent strategic games. Kanger and Schot (2016) refer to how *user intermediaries* are important in aligning different elements of emerging socio-technical systems (products, infrastructure, regulation) to acceleration. Hyysalo et al. (2018, p.872) examine how user intermediaries accelerate transitions by "qualifying market information, articulating demand and helping citizen users to reconfigure the standard technology".

Disruption of the prevailing regime can be seen as a specific phase occurring simultaneously or subsequently to niche development. It is exemplified, for example, through transforming infrastructure systems, generating demand for new forms of intermediation previously not required or recognized (Backhaus, 2010; Moss, 2009; Rohracher, 2009). After disruption, intermediaries can help seize novel business opportunities in a newly stabilized socio-technical configuration, simultaneously shaping or transforming it (Rohracher, 2009) to the pursuit of their own and common objectives.

4.6. Building a typology of intermediaries

In Sections 4.2–4.5 we gained insights into how the articles describe intermediaries with respect to their emergence, context of intermediation, goals of intermediation, normative position and development over time. We combined these insights, and created, first, a longlist of intermediaries largely following the different labels given to these in the literature (systemic, strategic, niche, grassroots, collaborative, process, project, piecemeal and user[-side] intermediaries). Given a substantial number of articles referring to MLP or SNM (see Section 4.1), we took the approach of identifying the level at which an intermediary operates as one determinant in our typology. The motivations or the degree of neutrality and agency behind the intermediary additionally informed our typology. By identifying similar characteristics between different descriptions, we distilled five broader types of transition intermediaries, illustrated in Table 1. The categories in the typology are not mutually exclusive. Yet, in practice, many intermediaries are likely to be profiled more as one type than equally portraying the characteristics of several types:

(1) A *systemic intermediary* operating on all levels (niche, regime, landscape), promoting an explicit transition agenda and taking the lead in aiming for change on the whole system level.
(2) A *regime-based transition intermediary* that is tied through, for example, institutional arrangements or interests to the prevailing socio-technical regime but has a specific mandate or goal to promote transition and, thus, interacts (often) with a range of niches or the whole system.
(3) A *niche intermediary* typically working to experiment and advance

Table 1
Transition intermediary types arising from systematic review.

Category	Context/level of action	Emergence	Goal of inter-mediation	Normative position		Examples	Sources
				Position vis-à-vis niche	Neutrality/ interest		
Systemic intermediary	Intermediating on system level between multiple actors & interests	Typically established to intermediate	Pursues given (sustainability) goals on a system level; ambitiousness towards disruption to existing system	Outsider to specific niches, creating space for multiple, alternative niches	Typically regarded as a position of neutral, unbiased facilitator and broker, despite having an interest in stimulating transitions	Innovation Network Rural Areas and Agricultural Systems, Netherlands SITRA, Finnish Independence Fund Industrial Biotechnology Innovation Centre (IBioIC), Scotland	Van Lente et al. (2003), Medd and Marvin (2008), Hodson and Marvin (2009), Klerkx and Leeuwis, (2009), Backhaus (2010), Kivimaa (2014), Seyfang et al. (2014), Barrie et al. (2017), Bush et al. (2017), Lukkarinen et al. (2018), Rohracher (2009)
Regime-based transition intermediary	Intermediating on system level between multiple actors, within mandate given by dominant regime actors	Existing actor subsuming intermediary roles; or established by dominant regime actors to intermediate for transition	Pursues given (sustainability) goals through typically more incremental solutions or political aims	Outsider to specific niches, creating space for multiple, alternative niches	Regarded as a player in the dominant system but pursuing or empowered for change	Motiva, Finland Forest Industries' Water and Air Pollution Research Foundation, Sweden Greater Manchester Climate Change Agency Religious congregations (sometimes)	Kivimaa (2014), Hodson and Marvin (2012), Hodson et al. (2013), Berkvist and Söderholm (2011), Parag and Janda (2014) (middle actor), Polzin et al. (2016) (institutional intermediary), Mattes et al. (2015)
Niche (or grassroots or user) intermediary	Intermediating between local projects, and/or higher level of aggregation	Often emerging to intermediate when a niche (or TIS) develops	Pursues given (sustainability) goals and solutions from a perspective of a given niche (or TIS)	Insider to a specific niche (or TIS)	Regarded as player advancing a particular niche (or TIS)	Community energy initiatives, England Wave Energy Association WAVEC, Portugal Living Community Challenge, Canada/US Standardization committees for new technology	Geels and Deuten, (2006), Seyfang et al. (2014), Hargreaves et al. (2013), Hamann and April (2013), Fontes et al. (2016), Holden et al. (2016), Martiskainen, (2017), Smith et al. (2016), Hyysalo et al. (2013), Judson et al. (2015), Kanger and Schot (2016), Grandclement et al. (2015)
Process intermediary	Intermediating within experimental projects or specific processes contributing to transitions	Typically established/ employed to intermediate day-to-day action in transition projects or processes	Implementing context-specific priorities, informed by broader transition trajectories	Typically outsider to specific niche	Regarded as a neutral, unbiased "networker" that does not have specific "agenda" in the process	Sustainability consultant Project manager Architect	Elzen et al., (2012), Hodson and Marvin (2010), Hodson et al. (2013), Kampelmann et al. (2016), Martiskainen and Kivimaa (2018), Parag and Janda (2014), Audet and Gyonnaud, (2013)
User intermediary	Intermediating between technology (provided) and use, and/or niche technology and dominant configuration	Emerges from amidst users and consumers	Acts as facilitator, representative, or broker of end-use or end-users.	Insider or outsider to specific niche	Leans towards user interests (in some cases even as activists)	Internet discussion forum for heat pumps Car user clubs (in early phases) Advocacy groups Building manager (sometimes)	Hyysalo et al. (2013), Judson et al. (2015), Kanger and Schot (2016), Grandclement et al. (2015)

activities of a particular niche, and trying to influence the prevailing socio-technical system for that niche's benefit.
(4) A *process intermediary* that facilitates a change process or a niche project rather than broader niche (or TIS) level; often without explicit individual agency or agenda, but in support of context-specific (project-based or spatially located) and/or external (niche, regime) priorities set by other actors.
(5) A *user intermediary* translating new niche technologies to users and user preferences to developers and regime actors, qualifying the value of technology offers available.

The first three types have a relatively strong change agency (and mandate) to pursue sustainability transitions from either the whole system or niche perspective. The fourth type, process intermediary, has weak agency, functioning as a facilitator. The fifth type, user intermediary, can have strong or weak agency.

4.6.1. Systemic intermediaries

Some transition intermediaries operate on a system level (e.g. Van Lente et al., 2003: Klerkx and Leeuwis, 2009), and can be named as *systemic intermediaries*. Hargreaves et al. (2013, p.879) argue, "intermediation may be more about opening up space in different contexts […] for new and diverse kinds of activity, rather than about developing a single successful approach or a strategic vision for its growth and diffusion". For example, Van Lente et al. (2003) illustrate a systemic intermediary, Innovation Network Rural Areas and Agricultural Systems in the Netherlands, which created a forum assembling actors from the government, knowledge institutions, societal organizations and companies to identify and develop multiple innovations contributing to sustainable development. This network has been important in transitioning towards novel agricultural functions and more sustainable production systems (Klerkx and Leeuwis, 2009).

Klerkx and Leeuwis (2009) regard systemic intermediaries as catalysts of innovation, for example, in setting up experiments and articulating demands for producers on a variety of solutions (see also Rohracher, 2009; Hyysalo et al., 2013). Systemic intermediaries articulate, negotiate and align multiple interests across niches – and sometimes across regimes – to be more compatible with each other, advancing standardization and preventing strategic games (Van Lente et al., 2003; Rohracher, 2009). The Finnish Innovation Fund, Sitra, is an example of a financially and politically independent systemic intermediary that sets up a range of experiments in, for example, zero-carbon building, renewable energy, land use planning and individual capacity building, as well as aligning interests between companies, cities and the government to benefit transitions (Kivimaa, 2014).

Systemic intermediaries gain a certain level of trust from other actors, making them sometimes appear politically, technologically or financially neutral (Klerkx and Leeuwis, 2009; Kivimaa, 2014), more so than regime-based transition intermediaries or niche intermediaries. The perceptions of their capabilities to operate in favour of system-level change strategically may be due to their specific establishments to pursue certain change goals or processes (Hodson and Marvin, 2009, 2010). While systemic intermediaries may gain funding from governments or private funders, they share a large degree of independence in how they can use the funds to advance systemic change the way they see as best, thus, enabling politically more radical opinions and actions.

Systemic intermediaries are also important in disrupting the prevailing unsustainable socio-technical configurations, i.e. regimes (something that is harder for regime-based transition intermediaries to do). Kivimaa (2014, p.1372) argues that systemic "[i]ntermediaries may attempt to destabilize dominant regimes… by aiming to decrease public legitimacy for and endogenous commitment to an existing regime, or unintentionally disrupt existing structures". Their activities can target the disruption of existing institutional frameworks or markets (Kivimaa, 2014; see also Nielsen, 2016) or entail replacing existing networks with new ones, further disturbing existing structures (Klerkx and Leeuwis, 2009; Hodson and Marvin, 2009). In such actions, systemic transition intermediaries face other intermediaries acting as a counterforce that may "thwart rather than promote potentially useful but disruptive innovations" (Orstavik, 2014, p.857).

4.6.2. Regime-based transition intermediaries

There are also intermediary actors in transitions that are part of the established institutions in the prevailing socio-technical regime but yet inclined or mandated to work towards transformative change (Berkvist and Söderholm, 2011; Hodson et al., 2013; Parag and Janda, 2014; Polzin et al., 2016). We label them as *regime-based transition intermediaries*. They differ from those non-transition oriented regime intermediaries, such as trade bodies and labour unions, which try to preserve status quo. Existing actors, such as government agencies, business networks or building professionals, can take on roles of regime-based transition intermediaries and form networks with newly set up systemic or niche intermediaries (e.g. Parag and Janda, 2014; Mattes et al., 2015; Polzin et al., 2016), thereby building a new ecology of intermediaries. Sometimes, new intermediaries are established by regime actors at national or regional levels to facilitate sustainability transitions (e.g. Hodson and Marvin, 2012; Kivimaa, 2014).

While transition intermediaries in general may differ in whether they wish to engage in radical political activism or more reformist and incremental practical action (Hargreaves et al., 2013), regime-based transition intermediaries are more likely to take on the latter role (Kivimaa, 2014). Yet they can speed up radical innovation processes by "supporting the design of a policy environment that is conducive to the innovation process" (Polzin et al., 2016). When disruptive policy measures are created, regime-based transition intermediaries can translate such new forms of regulation into practice and make sense of a complex and changing policy environment to innovators (Fischer and Guy, 2009; Moss, 2009). For example, some architects have taken an intermediary role in translating energy efficiency requirements in building regulations to an understandable form to customers and other building sector actors (Fischer and Guy, 2009), thereby facilitating low-energy building transitions. Motiva, a government-owned energy and resource efficiency company in Finland, has facilitated cooperation between bioenergy advice and heat entrepreneurs, and between different renewable energy associations to benefit low-carbon energy transitions (Kivimaa, 2014). Regime-based transition intermediaries have also helped to find new sources of funding for basic and applied research and development, characterized by high technological and market uncertainty (Polzin et al., 2016).

The Greater Manchester Climate Change Agency, established with a mandate from the Association of Greater Manchester Authorities and the UK government to advance low-carbon transitions, was an intermediary between national and sub-national interests. Drawing from multiple streams of funding and, thus, differing strategic priorities, it developed capacity for behavioural change work, supported businesses in low-carbon issues, and developed critical infrastructure including combined heat and power (CHP) and renewable energy installations. While possessing some elements of a systemic intermediary, it can be regarded as a regime-based transition intermediary, effectively intermediating between the (dominant) interests of the national and the city-region regimes. Despite the change agenda, pre-existing economic interests dominated its actions. (Hodson and Marvin, 2012)

4.6.3. Niche intermediaries

Ample research has focused on intermediaries facilitating the development of specific niches (Geels and Deuten, 2006; Hamann and April, 2013; Hargreaves et al., 2013; Seyfang et al., 2014; Fontes et al., 2016; Smith et al., 2016; Martiskainen, 2017). Intermediation within a niche often centres between multiple projects and sometimes between those projects and the broader regime.

Niche intermediaries develop shared institutional infrastructure between similar projects. For example, UK community energy

intermediaries have facilitated the sharing of financial models and development of mentoring programmes between different initiatives (Seyfang et al., 2014). New institutional actors such as professional societies, industry associations and standardization organizations can also act as niche intermediaries (Geels and Deuten, 2006; Hargreaves et al., 2013). These actors perceive themselves as part of an emerging community with collective interests to both aggregate knowledge and guide local developments (Geels and Deuten, 2006). For example, WAVEC, a Portuguese wave energy association established in 2003 and the European Ocean Energy Association established in 2006 have created an important voice and facilitated vision creation for the wave energy niche, and helped to formalize the niche (Fontes et al., 2016).

Niche intermediaries make connections between particular and often isolated local innovation projects and with the wider world (cf. Howells, 2006). By doing "relational work" (Moss, 2009), intermediaries "are able to identify common issues and problems encountered across multiple local projects, and can therefore support niche development and diffusion by sharing this knowledge more widely, helping subsequent projects to benefit from accumulated experience" (Hargreaves et al., 2013, p.868). Campaigning and political advocacy activities play a role in this (Smith et al., 2016). For example, in the UK the Brighton and Hove Food Partnership lobbied for the recognition of and resource allocation for "land for communal growing" in the city strategy (White and Stirling, 2015).

Intermediaries aggregate not only new knowledge but also resources helping to nurture the niche (which may suffer from lack of resources and institutional support) through replication of projects and influence regimes to adopt niche ideas and practices (Seyfang et al., 2014). Organizations such as the Energy Saving Trust and Centre for Sustainable Energy have acted as such intermediaries in the UK.

Not all niche intermediaries have the ambition to scale up niches (Hargreaves et al., 2013). "Grassroots intermediaries" work bottom up to develop novel ideas and engage in a range of experiments. Grassroots intermediation can occur before an explicit niche has formed, or exists at most at local scale with options to form global links. In the UK's community energy, grassroots intermediaries have coordinated local projects existing in spaces where "the rules are different" from (and at times oppositional to) the mainstream (Hargreaves et al., 2013), voicing expectations and engaging in learning activities (Martiskainen, 2017).

4.6.4. Process intermediaries

Process intermediaries have facilitating and supporting functions in projects and processes contributing to transitions. They are usually established or employed to facilitate the realization of specific projects within a niche or in broader transition processes (such as arenas for networking or information exchange). They often work in tandem with project managers with a day-to-day management responsibility and connect to a "champion" with a more normative interest (Klerkx and Aarts, 2013). Their role is sometimes to implement context-specific priorities, informed by broader transition trajectories. They seldom "personally" engage in shaping the visions or expectations associated with the transition. In this vein, Parag and Janda (2014) interpret intermediaries as go-betweens without independent agency or capacity.

Process intermediaries are different from project managers present in transition trajectories by being outsiders to both niches and the regime (e.g. Elzen et al., 2012). Their key role, thus, revolves around developing connections between different groups of actors as supposedly neutral actors (Elzen et al., 2012) and advancing day-to-day activities or information exchange to benefit transitions. Martiskainen and Kivimaa (2018) highlight how, for example, an eco open homes event series, and an architect or a sustainability integrator in a building project, can be non-championing intermediaries and facilitate the progress of zero-carbon building. Kampelmann et al. (2016, p.83) describe management teams that were specifically employed to advance urban renovation processes in Brussels to overcome "barriers to cooperation on more sustainable approaches to environmental problems". They observed such actors to be more detached than other employees from the coordinating organization (in this case the municipal administration) and, thus, benefitting transitions.

Process intermediaries help to turn visions and expectations into material actions, facilitate vertical and horizontal cooperation and handle external relations of the projects (Kampelmann et al., 2016; Martiskainen and Kivimaa, 2018). In larger projects, intermediaries broker between different organizational or local–national priorities (Hodson and Marvin, 2010; Hodson et al., 2013). We argue that process intermediaries are important in the overall "ecology of intermediaries" because they can carry out day-to-day work to concretely advance transitions and gain trust from other actors by being regarded as neutral and unbiased due to the lack of personal or institutional agenda.

4.6.5. User intermediaries

Finally, *user intermediaries* are important in two ways. First, user intermediaries are peers, or user support organizations, who connect new niche technologies and practices to citizens and everyday life. They instruct users in novel technology by qualifying the characteristics and suitability of new technological options for different contexts, and by configuring technical and social elements of novelty (Hyysalo et al., 2013; Judson et al., 2015; Hyysalo et al., 2018). This role can be tied to a particular niche, such as heat pumps (Hyysalo et al., 2018) or automobility (Kanger and Schot, 2016), or cover multiple niches, for example, through companies finding an optimal mix of renewable energy and energy efficiency solutions for building renovations (Martiskainen and Kivimaa, 2018). This function is crucial in making sure that transitions accelerate through actual adoption and the use of new solutions.

Second, user intermediaries operate between the niches and the dominant socio-technical system, articulating (future) demands that their user community has regarding emerging (sustainable) technologies and representing users at the interface of niches and regimes (Hyysalo et al., 2013; Kanger and Schot, 2016). They act as a back channel to claims and actions by vendors, assemblers and maintenance technicians (Hyysalo et al., 2018). They have also been found to form initial knowledge-sharing networks, which, given virtual communities such as discussion forums, can grow into substantial information infrastructures (Hyysalo et al., 2013, 2018) potentially increasing the size and stability of the accelerating niche (Hyysalo et al., 2018; Kanger and Schot, 2016). Once niches become mainstream, user intermediaries may grow into regime-based intermediaries (Kanger and Schot, 2016).

5. Discussion and conclusion

5.1. Reflections on conceptualizations, origin and context of intermediaries in transitions

This paper aimed to bring more clarity to the topic of intermediaries in sustainability transitions, which resulted in constructing a typology that connects to the levels of niches and regimes and is sensitive to the processes intermediaries are engaged in, their normative orientation and goals for intermediation. We will now reflect on the three questions that guided our enquiry: (1) the theoretical and conceptual connections made in studies focused on intermediaries in sustainability transitions, (2) the origin of intermediaries in sustainability transitions, and (3) the context in which intermediation is occurring in sustainability transitions.

With regard to our first question, while an extensive background in intermediary research in innovation and STS studies exists, it is clear that much of the literature referring to intermediaries in transitions emerges more from empirical observations than solid conceptualization based on previous academic research. This is also our main critique of parts of this literature, as it has led to significant ambiguity regarding what "intermediaries" are in the context of sustainability transitions, and what they intermediate between. Several conceptualizations of

intermediaries can be found in the sustainability transitions literature. The articles are frequently unconnected both with other articles that address "intermediaries in transitions" and with the extensive intermediary research that has been carried out in other academic domains.

In presenting the results of the systematic review, we have attempted to bring clarity to this, while also demonstrating variety in the types of intermediaries in transitions and the diversity of aims and activities they pursue. This leads to our proposed definition of transition intermediaries as *actors and platforms that positively influence sustainability transition processes by linking actors and activities, and their related skills and resources, or by connecting transition visions and demands of networks of actors with existing regimes in order to create momentum for socio-technical system change, to create new collaborations within and across niche technologies, ideas and markets, and to disrupt dominant unsustainable socio-technical configurations.*

The systematic review shows that, although transition intermediaries are often also innovation intermediaries (see, e.g. Barrie et al., 2017), the normative orientation to sustainability, the socio-technical orientation and long-term temporal dynamics constitute a much broader variety that is part of the ecology of intermediaries. Transition intermediaries co-contribute to specific change processes that are more diverse than what is at play in processes for intermediating innovation (see Stewart and Hyysalo, 2008, for elaboration of the latter), transcending facilitation of bilateral relations and broadening the variety of actors and relations. Our typology, therefore, complements earlier typologies (Van Lente et al., 2003; Klerkx and Leeuwis, 2009; Hodson et al., 2013, Section 2.1), adding focus on whether the intermediary works on a system or sub-system level and whether it is tied to the interests of a specific innovation within a niche, the dominant regime, or can work as a neutral actor. We argue that this diversity in terms of *origin, levels* and connection to *transition dynamics* – and its importance to transitions in practice – should be made more explicit when addressing actors in transitions and the important roles they play (cf. Fischer and Newig, 2016).

For our second question, the systematic review shows that, in terms of *origin*, not many examples in empirical literature exist of establishing and giving a mandate for specific transition intermediaries to operate. Research that shows or assumes intermediary roles emerge gradually in response to socio-institutional pressures and socio-technological developments is more prevalent. These can be either new intermediary organizations or platforms, or already established actors taking up intermediary functions. In the latter case, actors are not always aware that they are performing intermediary functions.

For our third research question, by looking at common denominators and differences in terms of context of action, emergence, and normative position, we can distinguish five different types of transition intermediaries: (1) systemic, (2) regime-based, (3) niche, (4) process, and (5) user intermediaries. To existing literature we, thus, first, add the notions of a *regime-based transition intermediary* and a *process intermediary* and, second, clarify the different uses of the intermediary term in sustainability transition studies through our typology. Regime-based transition intermediaries have a mandate or mission to advance transitions but operate within their boundaries as players in the existing regime. Yet they are in a position (partly) to work against those intermediaries, such as many incumbent industry bodies, who wish to maintain status quo in the prevailing socio-technical system configuration (i.e. non-transition intermediaries). Process intermediaries focus mostly on making day-to-day work towards a transition more effective by gaining trust from other actors as neutral and unbiased as a result of lacking personal or institutional agenda. They do not press clear normative interests over the direction in which the transition process should be heading. Rather, as outsiders to niches and the regime, they support other actors to articulate this direction, helping them negotiate within localities of experimentation or with institutional actors. They have the position and capability to be mediators, and fulfil coordination roles in a way that *avoids* shaping the vision or expectation of the transition along the way.

Transition-oriented activities have an inherently *dynamic* dimension. Thus, the emergence of disruptive sustainability innovations is associated with creating and maintaining development pathways in which actors (intermediaries and others) have different roles that change over time. Yet, in the literature, too little attention has been given to how transition intermediation changes over time as the transition progresses. In particular, systemic and niche intermediaries appear to be key actors in transitions, while support from regime-based transition and process intermediaries is also relevant, as different intermediary roles and scales of activity are needed (a) in speeding up necessary transitions, and (b) as part of new transformative governance structures. Changes in the *ecology of intermediary actors* are also partially related to battles within or between different intermediaries. First, a specific intermediary initially emerges, is established or adopts intermediary roles and – later – may cease to exist and let go all or some of its intermediary functions. Second, the ecology of intermediaries that contributes to the sustainability transition over time on different scales and contexts also changes. The longevity of a specific intermediary can exceed or be much more limited than the duration of a transition.

5.2. Conclusions and lines for future research

Following on from the reflections in Section 5.1, the systematic review has given us more consolidated insights into the positioning and dynamics of intermediaries in sustainability transitions, which allows us to formulate a number of tentative conclusions regarding the nature of intermediaries in transitions:

1 Many important intermediary functions in transitions have been performed by emerging (rather than specifically established) intermediaries or actors unaware of their intermediation. This creates uncertainty regarding whether sufficient intermediary functions are actually in place when needed to support processes advancing sustainability transitions (or transformative change more broadly). Thus, (political) strategies are needed to guarantee that from a transitions perspective necessary intermediary functions will be carried out.
2 Systemic intermediaries are crucial to guide transitions from a whole system perspective, having the potential to disrupt existing socio-technical configurations and to assess a range of viable alternatives across multiple niches, regimes and spatial scales. Their importance lies in being unbiased towards selected socio-technical alternatives, while having a strong normative orientation for transformative change.
3 Niche intermediaries that connect different experimental projects and aggregate the build-up of new solutions for future socio-technical configurations are crucial in the early stages of transition. The key roles for such intermediaries include negotiating between different interests and priorities to create a consolidated vision and facilitating between the emerging and dominant socio-technical system configuration, normatively pursuing the realization of the consolidated vision, e.g. through advocacy activities. They can operate on different spatial scales (local, national, international).
4 Systemic intermediaries and niche intermediaries need the support of an ecology of different intermediaries as the challenge of sustainability transitions (and transformative change more broadly) is huge. Regime-based transition intermediaries gradually work to change the dominant (local, national or global) socio-technical configuration from within; process intermediaries are needed to facilitate day-to-day action benefitting transitions in different scales; and user intermediaries are necessary to connect all this to citizens and everyday life. The absence of one of these types in a given change process (e.g. in food systems, mobility systems or energy systems) can significantly hinder progress. Their importance seems to be all the more vital in the acceleration phase of transitions.

5 When a transition progresses it is likely that less intermediation will be required and many actors performing such roles become redundant. This expectation is likely to create battles within and between intermediaries, taking attention away from their intermediation activities, with potential consequences on the speed of the transition.

These tentative conclusions require further testing, and our systematic review shows areas where further empirical insight is needed. Too little attention has been paid to in what processes and between what elements in transitions intermediaries are crucial (cases where things did not happen without them). In addition, analyses have been insufficient to address the temporal dimension of transitions: what intermediaries do in different phases, how their roles and the ecology of intermediaries in which they operate change over the course of transition, and what happens when a new system is stabilizing and these intermediaries become redundant. These questions link to the need to know more about the politics at play, the normative positioning of intermediary actors, and the battle between different intermediaries – in terms of preferences regarding how the transition will unfold, but also for survival when resources are diminished or when transition progresses so that intermediaries in certain areas become less important. Many articles present a rather idealistic picture of intermediaries in transition, and this calls for a "reality check" on the complexity of intermediation in the real world and regarding what the most useful strategies are for supporting transformative change through intermediary actors.

With regard to the gaps identified, future research avenues could, thus, focus on (1) the processes of acquiring and losing intermediary positions; (2) what kind of intermediation takes place and is required in the acceleration and embedding phases of transitions; (3) what is the importance of heterogeneous mixes of intermediaries in transformative innovation policy and governance; and (4) how intermediaries, whether connected to niches or regimes, fulfil roles in crossing/connecting geographical and administrative scales. The above issues provide ample potential to connect future research on intermediaries to other emerging and important topics in sustainability transitions studies, including the politics (Avelino et al., 2016; Lockwood et al., 2016), geography (Hansen and Coenen, 2015; Truffer et al., 2015), and actor roles in transitions (Wittmayer et al., 2017; De Haan and Rotmans, 2018). Furthermore, as our review has been biased towards the MLP with its niche and regime levels as a structuring principle, future work should explore whether intermediaries fulfil similar functions in similar contexts when taking another transitions lens (e.g. technological innovation systems).

5.3. Policy implications and recommendations

From the policy perspective our concentrated look at intermediaries offers both an encouraging and a challenging message. The encouraging part is that many necessary intermediaries appear to emerge during the transition, when different actors respond to knowledge, coordination and service gaps regarding the alternative solutions in the market, or pressing societal concerns. An ecology of intermediaries may, therefore, come into being and evolve adequately, partly of its own accord. If it does so sufficiently, it can make an important contribution to the polycentric governance in transformative change. However, the emerging ecology of intermediaries may also lack sufficient direction, willingness or speed to grow to support the later phases of transitions, during which old structures become destabilized and disruptive innovations become embedded. Or even when successful, it may not cover all necessary intermediating functions or types.

The challenging part, thus, follows and calls for policy capacity to (1) monitor the continuously evolving transition processes and associated intermediary action. In many cases, policymakers may need to (2) establish new or support existing intermediaries, and (3) make sure that policies do not curtail excessively the operational space of already existing transition intermediaries. Examples show that policy changes can eradicate forms of intermediation directly (Kivimaa and Martiskainen, 2018b) and as collateral damage of laws passed for other purposes (Torrance and von Hippel, 2016). We further suggest that innovation policy would benefit from having a versatile toolkit of action for supporting, transforming, setting and disbanding temporary and more permanent transition intermediaries. While such monitoring capacity and toolkits are something that some systemic intermediaries might already provide through their remit, such systemic competency regarding intermediary activities is by no means easy to attain or retain, or to communicate effectively into different policy-making arenas.

All in all, while we find that there are intermediaries that fit our tentative definition of a "transition intermediary", our systematic review is inconclusive regarding, for example, how governments can purposefully employ intermediaries to direct transitions. Yet we argue that a well-functioning ecology of intermediaries, in which each type of intermediary is deployed in the right way and at the right time, can speed up diffusion, further improvement and institutional reform needed for accelerating transitions. Supporting and establishing niche intermediaries can speed up some developments over others. It is, thus, a policy option for furthering transitions but also a dynamic that transition policy needs to be vigilant about. Supporting and setting up intermediaries that have a broader scope for creating space for a variety of niches and simultaneously destabilize existing structures across regimes, is an alternative policy option that takes a less selective approach on transformative change than the selection of specific niches and supporting intermediaries in that area.

Data access statement

This article has used as sources academic journal articles that are available through paid repositories of academic research.

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Appendix A. Codes used in systematic review

Theories used
Sector of empirical focus
Definition of "intermediary"
Conceptual foundation used for "intermediary"
Key focus on intermediaries (intentional, yes/no)
Use the term intermediary explicitly (yes/no)
Origin of intermediaries
Established to intermediate (yes/no/uncertain)
Assuming intermediary roles over time (yes/no/uncertain)
Changing intermediary roles over time (yes/no/uncertain)
Unaware they are intermediating (yes/no/uncertain)
Identity/emergence/position
Bridging what
Temporal observations
Scope of action (in time/in space or place)
Synergies/tensions and incoherence
Key observations regarding intermediaries

Insiders vs outsiders
Neutrality vs own gain

Appendix B. List of source articles in the systematic review

1 Audet, R., Gyonnaud, M.-F., 2013. See reference list for details.
2 Backhaus, J., 2010. See reference list for details.
3 Barrie, J., Zawdie, G., Joao, E., 2017. See reference list for details.
4 Berkvist, A.-K., Söderholm, K., 2011. See reference list for details.
5 Bush, R., Bale, C., Powell, M., Gouldson, A., Taylor, P., Gale, W., 2017. See reference list for details.
6 Cerf, M., Bail, L., Lusson, J.M., Omon, B., 2017. Contrasting intermediation practices in various advisory service networks in the case of the French Ecophyto plan. Journal of Agricultural Education and Extension 23(3).
7 Elzen, B., van Mierlo, B., Leeuwis, C., 2012. See reference list for details.
8 Fischer, J., Guy, S., 2009. See reference list for details.
9 Fischer, L.-B., Newig, J., 2016. See reference list for details.
10 Fontes, M., Sousa, C., Ferreira, J., 2016. See reference list for details.
11 Geels, F., Deuten, J., 2006. See reference list for details.
12 Grandclement, C., Karvonen, A., Guy, S., 2015. See reference list for details.
13 Hamann, R., April, K., 2013. See reference list for details.
14 Hamilton, J., Mayne, R., Parag, Y., Bergman, N., 2015. See reference list for details.
15 Hansen, T., Coenen, L., 2015. See reference list for details.
16 Hargreaves, T., Hielscher, S., Seyfang, G., Smith, A., 2013. See reference list for details.
17 Hodson, M., Marvin, S., 2009. See reference list for details.
18 Hodson, M., Marvin, S., 2010. See reference list for details.
19 Hodson, M., Marvin, S., 2012. See reference list for details.
20 Hodson, M., Marvin, S., Bulkeley, H., 2013. See reference list for details.
21 Holden, M., Li, C., Molina, A., Sturgeon, D., 2016. See reference list for details.
22 Horne, R., Dalton, T., 2014. See reference list for details.
23 Hyysalo, S., Juntunen, J., Freeman, S., 2013. See reference list for details.
24 Hyysalo, S., Johnson, J., Juntunen, J., 2017. See reference list for details.
25 Judson, E., Bell, S., Bulkeley, H., Powells, G., Lyon, S., 2015. See reference list for details.
26 Kampelmann, S., Van Hollebeke, S., Vandergert, P., 2016. See reference list for details.
27 Kanger, L., Schot, J., 2016. See reference list for details.
28 Kivimaa, P. 2014. See reference list for details.
29 Klerkx, L., Leeuwis, C., 2009. See reference list for details.
30 Lukkarinen, J., Berg, A., Salo, M., Tainio, P., Alhola, K., Antikainen, R., 2018. See reference list for details.
31 Martiskainen, M., 2017. See reference list for details.
32 Martiskainen, M., Kivimaa, P., 2018. See reference list for details.
33 Mattes, J., Huber, A., Koersen, J., 2015. See reference list for details.
34 McCauley, S., Stephens, J., 2012. Green energy clusters and socio-technical transitions: Analysis of a sustainable energy cluster for regional economic development in Central Massachusetts, USA. Sustainability Science 7(2), 213–225.
35 Medd., T., Marvin, S., 2008. See reference list for details.
36 Moore, M.-L., Westley, F., Broadhead, T., 2012. See reference list for details.
37 Moss, T., 2009. See reference list for details.
38 Normann, H.E., Hanson, J., 2018. See reference list for details.
39 Ockwell, D., Byrne, R., 2016. Improving technology transfer through national systems of innovation: climate relevant innovation-system builders (CRIBs). Climate Policy 16(7): 836–854.
40 Orstavik, F., 2014. See reference list for details.
41 Parag, Y., Janda, K., 2014. See reference list for details.
42 Polzin, F., von Flotow, P., Klerkx, L., 2016. See reference list for details.
43 Rohracher, H., 2009. See reference list for details.
44 Schot, J., Kanger, L., Verbong, G., 2016. See reference list for details.
45 Schreuer, A., Ornetzeder, M., Rohracher, H., 2010. See reference list for details.
46 Seyfang, J., Hielscher, S., Hargrieves, T, Martiskainen, M., Smith, A., 2014. See reference list for details.
47 Seyfang, G., Longhurst, N., 2016. What influences the diffusion of grassroots innovations for sustainability? Investigating community currency niches. Technology Analysis and Strategic Management 28(1), 1–23.
48 Silver, J., Marvin S., 2017. Powering sub-Saharan Africa's urban revolution: An energy transitions approach. Urban Studies 54(4), 847–861.
49 Smink, M., Negro, S.O., Niesten, E., Hekkert, M., 2015. See reference list for details.
50 Smith, A., Hargrieves, T., Hielscher, S., Martiskainen, M., Seyfang, G., 2016. See reference list for details.
51 Van Lente, H., Hekkert, M., Smits, R., van Waveren, B., 2003. See reference list for details.
52 White, R., Stirling, A., 2015. See reference list for details.
53 Wihlborg, E., Söderholm, K., 2013. See reference list for details.

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