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Conceptualising the systemic activities of intermediaries in sustainability transitions

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Highlights

- A framework to differentiate systemic from non-systemic intermediation is proposed.
- Three levels of systemic intermediation are conceptualised.
- Empirical cases from Finland, Germany, and Sweden are analysed.
- Intermediary roles are heterogenous and exist on multiple levels.
- *Systemic intermediation* is proposed to describe this heterogeneity.

Abstract

This article contributes to the literature on sustainability transitions, innovation systems and eco-innovation by addressing conceptual challenges regarding the systemic activities of intermediaries. Specifically, the article addresses a research gap pertaining to the ways in which the systemic activities of (eco-)innovation intermediaries can be conceptualised and empirically demonstrated. Empirically, the paper examines selected intermediaries in the context of support systems for eco-innovators in three regions across Finland, Germany and Sweden. Drawing from our empirical findings and the literature on intermediaries, we conceptualise three system levels within which intermediation occurs: (i) in-between entities in a network, (ii) in-between networks of entities, and (iii) in-between actors, networks, and institutions. Our discussion suggests a heterogeneity of roles that individual intermediaries take at multiple system levels, complementing an emerging, more nuanced perspective of intermediaries in sustainability transitions. Thus, we suggest the term *systemic intermediation* for describing the system-level activities of intermediaries.

Keywords: Systemic intermediation; Eco-innovation; Sustainability transitions; Eco-innovation intermediaries

1 Introduction

While research on innovation intermediaries began already in the 1990s (e.g., Bessant and Rush, 1995), in the last decade, intermediaries have received increased scholarly attention in relation to eco-innovation (Polzin et al., 2016) and sustainability transitions (Gliedt et al., 2018; Hargreaves et al., 2013). In eco-innovation, intermediaries undertake different sets of activities intended to validate the environmental benefits of eco-innovations and to tackle externalities in their development and diffusion (Kanda et al., 2018). In the sustainability transitions literature, intermediaries are proposed as key actors that can catalyse transitions towards sustainable socio-technical systems by articulating new visions, demands and expectations (Kivimaa, 2014), initiating new policy or market processes (Kivimaa and Martiskainen, 2018), and acting as an impartial voice for new networks of actors (Matschoss and Heiskanen, 2017). In the innovation systems literature, intermediaries have been described to fulfil brokerage roles addressing the flow of knowledge and the formation of networks to tackle system failures related to ineffective co-operation (Boon et al., 2011; Klerkx and Leeuwis, 2009). From an urban sustainability perspective, intermediaries circulate or aggregate lessons and transfer knowledge across local experiments, potentially contributing to the upscaling of experiments beyond niches and challenging the status quo (Matschoss and Heiskanen, 2017). In the diffusion of innovation literature, intermediaries influence the adoption rate of innovations by gathering and disseminating information and mobilizing and distributing resources that facilitate the diffusion of innovations between suppliers and potential adopters (Lichtenthaler, 2013).

Within these different strands of literature, extensive scholarly attention has been given to the different roles intermediaries assume (or should assume) in facilitating sustainability transitions, urban transitions, and (eco-)innovation (for recent reviews, see Gliedt et al., 2018; Kivimaa et al., 2019a). Even though full agreement in the literature regarding the different roles of intermediaries in different processes has not been achieved (Mignon and Kanda, 2018), there is a broad consensus that intermediaries have a catalysing effect on the processes within which they intermediate (Klerkx and Leeuwis, 2009). The literature presents conceptual and empirical examples of the contribution intermediaries make to individual entities through bilateral interactions (De Silva et al., 2018), for example, intermediation in-between individual actors and their related activities, skills and resources. Extending bilateral intermediation, Van Lente et al. (2003) introduced the concept of a 'systemic intermediary' based on the systems of innovation literature. They defined systemic intermediaries as 'a new type of intermediary organization, which functions at the system or network level, in contrast to traditional intermediary organizations that operate mainly bilaterally' (Van Lente et al., 2003 p. 247). Systemic intermediaries have since been studied, for example, by Klerkx and Leeuwis (2009), Hodson and Marvin (2010), Kivimaa (2014) and Barrie et al. (2017) in the contexts of agricultural innovation systems, urban transitions, energy transitions and the circular economy. Further, Kivimaa et al. (2019a p. 1068) elaborated on the concept of the systemic intermediary within sustainability transitions as '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'.

Yet, we argue that a particular gap exists in the literature regarding the analysis of the systemic activities of intermediaries (by systemic intermediaries or others). It remains unclear how the contribution of intermediaries beyond individual projects to the systems, within which they

intermediate, can be conceptualised and empirically demonstrated (Bergek and Mignon, 2017). First, even when ‘systemic intermediaries’ are mentioned, it is not always clear what system such intermediaries are trying to influence (Bergek and Mignon, 2017). Consequently, in-between what systemic intermediary activities occur has not always been specified in the sustainability transitions literature (Kivimaa et al., 2019a). Second, the fluctuation of intermediary roles across multiple system levels has received little research attention. Thus, we argue that, while systemic intermediaries are important, there are also different levels of systemic actions many kinds of intermediaries undertake. Hence, different types of intermediaries – (for example, systemic, regime-based, niche, process and user intermediaries (cf. Kivimaa et al., (2019a)) – operate at multiple system levels at any given point in time based on the underlying processes within which they exist and their intermediary characteristics.

To address this conceptual gap, we study intermediaries in support systems for eco-innovators in three regions across Finland, Germany and Sweden. These countries have been consistently ranked among the top five eco-innovative countries in the EU since 2010, suggesting a well-developed support system for eco-innovation (Eco-innovation Observatory, 2018). A support system is a sub-system within an innovation system and comprises ‘all actors, institutional settings, and resources that help entrepreneurs in successfully generating and implementing innovation’ (Fichter et al., 2013 p.75). The support system implies a holistic approach to providing support to companies and includes a range of entities, such as universities, funders, incubators, and technology clusters. Some of these entities within the support system can be regarded as intermediaries, that is, ‘*an organization or body that acts as an agent or broker in any aspect of the innovation process between two or more parties.*’ (Howells, 2006 p. 720). Rather than focusing on one specific intermediary actor, we study the support systems for eco-innovations and analyse how the systemic activities of several intermediaries within such systems can be conceptualised and empirically demonstrated.

The aim of this article is to explore systemic intermediary activities and conceptualize the entities in-between which they occur. We conceptualize three levels of intermediation in the context of systems: (i) in-between entities in a network, (ii) in-between networks of entities, and (iii) in-between actors, networks, and institutions. These system levels are based on (a) entities in-between which the intermediaries operate, (b) intermediation roles and (c) the scope of appropriation of the potential intermediation benefits. In doing so, we do not intend to develop a new typology of intermediaries as many such contributions already exist (see, e.g., Hodson et al., 2013; Kivimaa et al., 2019a; Klerkx and Leeuwis, 2009; Van Lente et al., 2003), but rather we seek to clarify the different entities in-between which systemic intermediary activities occur and can impact. This ‘in-betweenness’ approach, even though fundamental to the definition of intermediaries (cf. Howells, 2006; Moss, 2009), is yet to be applied in the conceptualization of systemic intermediary activities. Our conceptual clarification is relevant for policy makers and researchers struggling to extend the contribution of intermediaries beyond bilateral intermediation to entire innovations systems. For intermediaries, demonstrating their value generation beyond individual projects to the system level is fundamental for their long-term survival (Kant and Kanda, 2019).

The rest of the article is organised as follows: Section 2 summarises previous literature on intermediaries in innovation and transitions and presents a conceptual framework on the systemic activities of intermediaries. The research methods used to collect and analyse the

empirical data are presented in Section 3, followed by a presentation of the empirical findings in Section 4. In Section 5, we discuss the empirical results using the conceptual framework and then provide conclusions and policy recommendations on the research aim in Section 6.

2 Intermediaries in innovation and transitions

2.1 The concepts of intermediaries and intermediation

Intermediaries and their activities continue to receive scholarly attention. Some studies have focused on intermediaries as organizations, while others have focused on intermediation as a process (Howells, 2006). In focusing on intermediation as a process, previous studies often suggest a passive view on intermediaries as mainly focusing on the scanning, gathering and dissemination of information in-between different parties (Parag and Janda, 2014). Other studies present a more active role for intermediaries, implying that they have more complete knowledge of and shape the various domains in which they operate (Hodson and Marvin, 2010).

Intermediaries can be a specific actor category with a separate identity, either as an individual or an organization, a group of individuals and organizations, or even a platform for collaboration (cf. Hyysalo et al., 2018). While there are specific types of entities that are strategically established with the objective and mandate to operate in-between individual actors – and their related activities, skills and resources – other entities emerge to assume intermediation roles, and yet still other actors might be engaged in intermediation without acknowledging it (Moss, 2009; Kivimaa and Martiskainen, 2018). Intermediaries are complex and strategic entities, whose primary roles may often not be restricted to intermediation; therefore, care is needed in classifying an entity solely as an intermediary (Klerkx and Leeuwis, 2008a). Thus, different types of entities have been identified as or act as intermediaries (e.g., cities, technology transfer offices, internet platforms, architects, and industry associations) with different characteristics (e.g., different types of ownership, funding sources, governance structures, and mandates) (Mignon and Kanda, 2018). Intermediaries can range from short-term, project-based entities with clearly defined objectives and targets to more established entities that take on new roles as the domains within which they operate change (Moss, 2009). As a result, intermediation covers a spectrum from formal, self-recognized and defined forms to informal and emergent (or even mostly hidden) forms of intermediation (Kivimaa et al., 2019a).

Intermediaries operate within and in-between different contexts (e.g., geographical and administrative scales, between consumers and producers, between experimental local projects and global niches, and in overall systems comprised of niche and regime actors). They are often presented as seeking neutrality in the eyes of the parties in-between, which they operate to be regarded as reliable and legitimate (Matschoss and Heiskanen, 2017). Neutrality is crucial for gaining trust, gathering different parties into new networks, and maintaining personal relationships and informal contacts fundamental for intermediation (Klerkx and Leeuwis, 2009). However, some intermediaries adopt more normative positions, often through their source of funding and mandate, which means that they may champion certain innovations (Martiskainen and Kivimaa, 2017) or represent particular interests (Hyysalo et al., 2018).

Despite differences in the ways in which intermediaries and intermediation are defined, the types of entities identified, their attributes, and the associated typologies, the literature shares a fundamental understanding that intermediaries bridge between actors and their related activities, skills and resources in situations where direct interaction is difficult due to high transaction costs, information asymmetry or communication problems. Thus, intermediaries are often identified by their roles (sometimes referred to as functions) and their relational work in-between different entities (Moss, 2009). In the relational view, intermediation consists of three brokering mechanisms – *transfer* (transfer resources from one party to another), *matchmaking* (facilitating the formation of direct ties between one party and another), and *coordination* (facilitating parties to interact without forming direct ties) (Spiro et al., 2013). Finally, while the concepts of intermediaries and intermediation are useful, they remain essentially contested. The literature as a whole lacks consensus on how intermediation is defined, where it begins and ends, and where interaction, in general, becomes intermediation (Kivimaa et al., 2019a).

2.2 System approaches to intermediaries and intermediation

The concept of ‘systems’ is complicated with several associated meanings, understandings and applications. According to system theorists such as Heylighen et al. (1993), a system in its basic form consists of (i) several distinct components, (ii) some kind of relation exists between these components, and (iii) the relation between the components producing a new distinct entity. Actors are individual components within a system and include technology manufacturers, suppliers, research institutes, associations, public authorities, NGOs, and intermediaries, which altogether can form a new entity – for example, an innovation system. A system may simply be an analytical construct and does not have to be fully fledged, coherently functioning nor necessarily exist in reality (cf. Bergek et al., 2008).

The innovation systems literature (for an overview, see Carlsson et al., 2002) highlights the importance of actors, networks, and institutions that jointly interact and contribute to delivering the purpose of innovation systems: the generation, diffusion and utilization of innovations. The interaction between networks of actors and institutions is often characterised by phenomena such as path dependency, lock-in, interdependencies and non-linear dynamics (Markard and Worch, 2010). In the national innovation systems literature, Lundvall (1992) refers to a system as ‘...constituted by elements and relationships which interact in the production, diffusion and use of new and economically useful knowledge’ (p.2). Nelson (1993), on the other hand, understands a system as ‘...a set of institutional actors that, together, plays the major role in influencing innovative performance’ (p.4–5). In the technological innovation systems literature, a general definition of a system is a group of components (devices, objects or agents) working towards a common objective or overall function (Bergek et al., 2008). In the socio-technical transitions literature, systems are analysed in dynamic co-evolutionary terms, the causal interactions between actors, networks, institutions and material infrastructure often framed through dynamics on three structuration levels – niche, regime and landscape (Geels, 2002). These works of literature offer complementarity on the concept of systems as integrating interactions between social and technical components.

The sustainability transitions literature adopts a broader view of innovation as socio-technical change and focuses on systemic changes in production and consumption in energy, mobility,

water, and agri-food systems (Markard et al., 2012). The technological innovation systems literature recognises the existence of intermediaries and their changing influence along the life cycle of these systems (Markard, 2018). Furthermore, intermediaries contribute to several technological innovation system functions, especially resource mobilization (Kanda et al., 2019). Innovation occurs through interactions and interdependencies between scientific, technological, economic and political activities of different actors, their networks, and institutions (Markard and Truffer, 2008). Based on this systemic approach to innovations, the concept of a 'systemic intermediary' was introduced by Van Lente et al., who argued that such intermediaries emerged due to the increasingly complex nature of innovation (Van Lente et al., 2003). They claimed that systemic intermediaries focus their support activities on the strategic level in relation to systemic instruments such as the (i) articulation of options and demand, (ii) alignment of actors and possibilities, and (iii) support of learning processes (Van Lente et al., 2003).

The multi-level perspective posits that transformative change in socio-technical systems occurs through an interplay between processes occurring at three levels – niche, regime and landscape (Geels, 2005). The multi-level perspective on socio-technical change (e.g., Geels, 2002) and strategic niche management (e.g., Kemp et al., 1998) approaches has been explicitly applied to analyse intermediaries in sustainability transitions (Kivimaa et al., 2019a). Niches are depicted as protected spaces in which radical innovation and experimentation take place, while regimes are described as relatively stable configurations of technologies, practices and institutions. The landscape is the macro level of aggregation and incorporates forces exogenous to the regime such as natural disasters, economic recession and climate change. Sustained intermediation can be seen as essential for articulating new visions and expectations, initiating and managing new policy or market processes, enabling different forms of learning, and forming and maintaining new networks to support niche technologies (Kivimaa, 2014). Furthermore, intermediaries may take a more normative stance in promoting and championing certain innovations in sustainability transitions as opposed to the neutrality seeking stance depicted in the innovation intermediation literature (cf. Klerkx and Leeuwis, 2009). Altogether, intermediaries potentially contribute to transitions through niche creation and regime (de)stabilisation (e.g., Matschoss and Heiskanen, 2018). In niche creation, boundary crossing, the formation of new networks and aggregating learning across different domains are key intermediation activities (Hargreaves et al., 2013). Intermediaries may attempt to destabilise unsustainable regimes, for example, by aiming to decrease public legitimacy for existing regimes (cf. Klerkx and Leeuwis, 2009). Furthermore, intermediation and the need for it is not static but changes along the course of transitions (Kivimaa et al., 2019b).

2.3 Conceptual framework

Building upon previous contributions on systemic activities of intermediaries, we conceptualised three system levels and one comparative non-systemic level at which intermediation occurs (see Figure 1). The term 'system level' refers to levels of aggregation within an innovation system at which systemic intermediation activities can occur. To conceptualise these system levels, we started by reviewing previous articles on systemic intermediaries (e.g., Barrie et al., 2017; Kivimaa, 2014; Klerkx and Leeuwis, 2009; Van Lente et al., 2003). This gave us insights regarding how previous articles described intermediaries with regard to their roles in systems, characteristics (e.g., source of funding, ownership,

governance, mandate), and the context and objectives of intermediation. We also reviewed the literature on innovations systems, systems theory and socio-technical transitions (see Section 2.2). Given the prominence of the concept of systems in the innovation systems literature (Rakas and Hain, 2019), and the fact that Van Lente et al. (2003) introduced the concept of systemic intermediaries based on this literature, we adopted that literature (specifically, the interactions between actors, networks, and institutions) as a basis for conceptualizing the entities in-between which systemic activities of intermediaries occur. By identifying similarities and differences between different descriptions of systemic intermediary activities in the reviewed literature, we distilled three system levels of intermediation: (i) in-between entities in a network (Van Lente et al., 2003), (ii) in-between networks of entities (Klerkx and Leeuwis, 2009), and (iii) in-between actors, networks, and institutions (Matschoss and Heiskanen, 2018). These system levels are established units of analysis in the systemic intermediation literature (see, e.g., Van Lente et al., 2003). We numbered these levels as 1, 2, and 3 based on the number of different elements in each configuration and the linkages between them. However, in conceptual terms, the difference between some of the system levels (e.g., intermediation within a network, and across a collection of networks) can be rather small.

We then developed criteria that could be used to locate intermediation activities on the different system levels (see Table 1). First, intermediaries are often identified by their roles, based on which different typologies of intermediaries have been proposed (see, e.g., Klerkx and Leeuwis, 2009; Van Lente et al., 2003). Thus, the role was selected as one criterion. We observed that intermediary roles were not necessarily exclusive to specific system levels. Therefore, we needed to incorporate additional dimensions into our criteria. The concept of intermediaries in its basic form implies a role ‘in-between’ and is a characteristic for identifying intermediaries (e.g., Howells, 2006; Moss, 2009). Thus, we added the requirement to specify ‘in-between’ what intermediation occurs as our second criterion. Third, the scope and reach of intermediation benefits are important as they indicate the ability of intermediaries to facilitate systemic change (cf. Markard and Worch, 2010). In line with transition studies (e.g., Geels, 2011), we understand ‘levels’ as the heterogeneous configuration of entities into different degrees of structuration and complexity, with higher levels having more stability in terms of the number of actors and degrees of alignment in-between the elements. The conceptualized system levels can be identified in different contexts based on the underlining perspective, for example, a multi-level perspective, that is, niche, regime and landscape (Geels and Deuten, 2006) or a spatial perspective, that is, cities, regions and nations (Hodson and Marvin, 2010). These system levels are not mutually exclusive, and neither are they necessarily hierarchical but are embedded in each other and, thus, intermediaries may have multiple roles on multiple system levels at any given point in time. These system levels are elaborated on below based on previous literature.

Table 1: Criteria for characterizing system-level activities of intermediaries

Analytical dimension	Analytical question
Functional	What intermediation roles does the intermediary undertake?
Relational	In-between what does intermediation occur?

Appropriation of intermediation benefits

Who gets the benefits of the intermediation, and what are the potential spillovers?

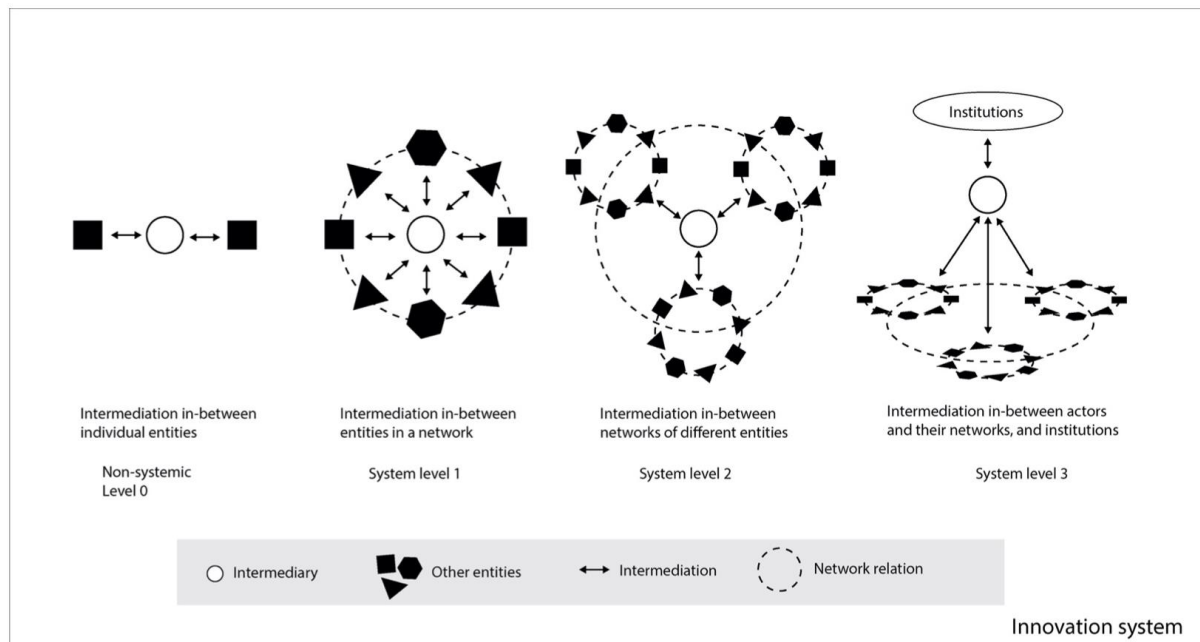


Figure 1: Conceptualisation of different system levels of intermediation (source: authors)

The Non-systemic Level 0, *intermediation in-between individual entities*, is characterised by intermediaries working in-between individual actors, organizations or projects and their related activities, skills, and resources. This level of intermediation is included in our conceptualisation as a comparison point and does not qualify as a system level considering the definition of a system (cf. Heylighen et al. 1993), the roles of intermediaries in this configuration, and the main scope of the potential benefits. Intermediation at this level is characterised by ‘one-to-one’ interactions, and intermediaries are typically (but not always) private organisations, for example, consultants who assist their clients in reaching their innovation objectives (Howells, 2006). These types of ‘one-to-one’ intermediation have typically been addressed in the open innovation literature where firms search for knowledge and resources outside their organizational boundaries (see Chesbrough, 2006). The parties in-between which these intermediaries operate can be similar to or different from each other, and often one of them is a paying client (Van Lente et al., 2003). Intermediaries in this configuration learn and build competence and experience from different cases, which can be applied in their subsequent intermediation activities (Mignon, 2017). In the early stages of the development of a system, these bilateral interactions are common since there are often no networks (Wieczorek and Hekkert, 2012).

In the first system level, *intermediation in-between entities in a network*, the intermediary focuses on mediating in-between different types of entities within a single network. This network can, for example, be a technology cluster with members who have a common interest, or a niche coalition around a particular innovation. For example, Hargreaves et al. (2013) analysed the roles of intermediaries in niche development in relation to community energy projects and found that intermediaries performed four main activities: (i) aggregating lessons from local community energy projects, (ii) establishing an institutional infrastructure

for energy through repertoires, (iii) framing and coordinating community energy action, and (iv) brokering and managing partnerships between local community energy projects and other actors outside the community energy sector. Within such networks, different forms of intermediary configurations exist, such as 'one-to-one-to-many', where the intermediary mediates from one entity unto many entities and vice versa, and 'many-to-one-to-many', where the intermediary mediates from many entities unto many entities (Klerkx and Leeuwis, 2009). These types of intermediation activities focus on learning and knowledge transfer, particularly between the different members of the network facilitated by the intermediary. The intermediary provides forums to facilitate learning and knowledge-sharing activities between the various actors and organizations, exchange of experiences, and collective action using conferences, seminars, workshops, journals and so on (Mignon and Kanda et al., 2018). The network of different entities often shares a common interest, which is facilitated by the intermediary and, thus, they work to build a brand and legitimacy for their network activities (Kanda et al., 2018).

The second system level, *intermediation in-between networks of different entities*, is characterised by intermediation activities that span across different types of networks. The intermediation activities take the form of the '*many-to-many-to-many*' type of interaction and collaborations. These different networks can, for example, represent different technological fields such as different types of renewable energy technologies, for example, members of a solar energy network or a wind power network, that come together to facilitate low-carbon energy transitions. In addition, networks around renewable energy and energy efficiency can be intermediated to facilitate zero carbon buildings. Networks of actors may, thus, realise collective interests and set up professional associations or industry associations to speak for the different networks as a whole (cf. Geels and Deuten, 2006). Intermediation activities at this level may include the creation of interaction spaces, information dissemination and brokerage support. These types of intermediation activities may emerge in response to market or innovation system failures, which result in sub-optimal connectivity between different actors and their networks (Klerkx and Leeuwis, 2009). Thus, organizations that were traditionally involved in bilateral one-to-one relationships or intermediation in-between entities in a network may evolve to engage with multi-lateral relationships across different networks.

What differentiates System Level 3, *intermediation in-between actors, networks, and institutions*, from the previous levels, is that the intermediation activities transcend the horizontal interactions between different types of networks to encompass vertical interactions between these actors and their networks and relevant institutions. Institutions can be conceptualised as informal (norms, values, mental categories, etc.) and formal (laws, regulation, technical standards, etc.) rules of the game that coordinate and structure the activities and decisions of actors (Scott, 2008). The interaction between institutions and actors seeking institutional change occurs when organized actors (often referred to as institutional entrepreneurs) with sufficient resources see an opportunity to realise interests that they highly value (DiMaggio, 1988). These actors engage in various types of individualised and organized purposive and strategic actions to create, maintain and disrupt institutions (Pelzer et al., 2019). These strategies include framing (the use of frames to give meaning to a contested phenomenon), theorization (providing a model to conceive how an innovation

should or could function in a particular context), stimulating collaboration, lobbying and negotiation (Lawrence and Suddaby, 2006).

Intermediation at this level connects networks and networks of networks with institutional change processes, such as agenda setting and new policy formulation or the framing and coordination of experimentation activities to change existing norms and practices (Matschoss and Heiskanen, 2017). Intermediaries engaging with institutions, such as stabilised policy mixes, have the ability to facilitate transitions by addressing complex societal challenges and intermediate in the context of, for example, urban sustainability transitions (Hodson and Marvin, 2010) or transitions in entire energy systems (Rohracher, 2012) which occur over long periods of time. They may be affiliated with the government through their source of funding and/or mandate or operate as non-profit civil society organisations. In the vertical intermediation between institutions and actor-networks, a particularly distinctive role they take on is policy or regime renewal in which they challenge existing structures and/or voice new visions and act as an impartial voice for new networks of actors to facilitate transitions (Kivimaa, 2014). Their intermediation activities often require a sustained period of time as the challenges they tackle require several decades, if not centuries, to address. These types of intermediaries are also active in translating policies and visions from top-down into action levels such as cities or networks and vice versa (Hodson and Marvin, 2010).

Intermediation activities at higher system levels are characterised by a higher number of potential beneficiaries (Barrie et al., 2019). Thus, intermediation activities that generate systemic sustainability benefits have a 'public good' nature and may not necessarily be undertaken by private actors (cf. Kivimaa, 2014). Furthermore, though systemic activities may not be a source of competitive advantage for the entities within the system, there could be differences in the appropriation of their benefits between entities in the system and also those outside the system. This raises the question about system boundaries, that is, what determines whether entities have access to the benefits of intermediation activities. In the case of networks, there may be clearly defined criteria such as membership, while in the broader innovation system, such criteria might not exist, hence the 'public good' nature of systemic intermediation activities. Nonetheless, the benefits of systemic intermediation activities might be limited to certain actors because of their characteristics and the dynamics of the given context.

3 Research Method

The research approach was a qualitative analysis of intermediaries supporting firms in the development and adoption of eco-innovations. It offered us the freedom to explore insights on the systemic activities of intermediaries, which we did not anticipate during our initial research design (cf. Bryman, 2015). Thus, the idea to conceptualize the system-level activities of intermediaries emerged after analysing the empirical data and was later anchored in theoretical concepts. By iterating between the empirical data and previous literature, our study was explorative, remained theoretically sensitive and did not impose analytic frameworks a priori (cf. Timmermans and Tavory, 2012). Since dedicated and tailored intermediary support for eco-innovations is emerging and not mainstream, in many countries, this exploratory approach was particularly relevant (cf. Fichter and Tiemann, 2018). In

particular, we explored how different intermediaries work to support companies in eco-innovation in Finland, Germany, and Sweden.

We conducted interviews, document analysis, and, in some cases, observations of the activities of selected intermediaries in autumn 2014 (see Table 2). We focused on three kinds of entities acting as intermediaries in eco-innovation – agencies supporting companies with material and energy efficiency, business development organizations, and clusters and collaborative networks for eco-innovations – because they support firms with a broad portfolio of intermediation roles, including resource mobilization, facilitating networking, developing strategic visions, and advocating for favourable policy. This focus was essential for developing an overview of intermediation in eco-innovation compared to focusing on intermediaries with a more limited scope of activities in eco-innovation, for example, financial resource mobilisation (cf. Polzin et al., 2016). In hindsight, the studied cases possess certain characteristics (e.g., human and financial resources capacity) that make them more likely to undertake or refrain from systemic activities. This mix of different cases and their characteristics allowed us to analyse how intermediaries combine systemic and non-systemic activities on different system levels and how that relates to their specific characteristics such as resources and given mandate.

To identify potential intermediaries to study in each country, we used a chain referral sampling approach (including interviews with experts, companies, and information from industry and regional reports) in which referrals were made among intermediaries who know other intermediaries who possess characteristics that were of interest to our research aim (cf. Biernacki and Waldorf, 1981). The studied intermediaries were identified as key actors supporting eco-innovations, and due to the different characteristics of each region, the selected cases are not directly comparable. The interviews were conducted face-to-face guided by a semi-structured interview guide, lasting 1-2 hours, recorded and transcribed. Questions covered the background of the intermediary organizations (e.g., objectives, size of organization, sources of financing), characteristics of the intermediation support (e.g., their target companies and the eco-innovations they developed and/or adopted, types of intermediation activities, how the intermediation activities were undertaken, evaluated and also challenges in intermediation), good intermediation practices and possibilities for improvements. To complement the interview data, we read webpages and newsletters of the studied intermediaries, participated in some of their events, and read reports on their intermediation activities and regional (eco-)innovation reports and evaluation reports of the intermediary activities when available.

Table 2: Overview of studied intermediaries in Finland (FI), Germany (DE), and Sweden (SE).

Name of intermediary	Position of interviewee(s)	Information on intermediaries (in autumn, 2014)
Cluster organizations and collaborative networks		
The Finnish Clean Energy Association, (FI)	<ul style="list-style-type: none"> Professor of innovation and environmental management at Aalto University School of Business (a key facilitator of the collaboration) 	<p>Type of organization: A collaboration between technology suppliers, renewable energy sector associations and consumers in Finland.</p> <p>Size: 3 key persons working with collaborative activities; Over 40 companies involved in FinSolar (25 of which are SMEs and start-ups, 12 established companies) and 8 associated municipalities.</p> <p>Funding: Public funding (Sitra, Tekes) and private (the collaborating SMEs and incumbents).</p> <p>Year established: 2013.</p> <p>Mandate: To serve as a common voice for the renewable energy sector with a focus on sustainable local energy production, energy efficiency and smart energy solutions.</p>
TELAKKA®, (FI)	<ul style="list-style-type: none"> Chief executive officer at design plus a key person in Telakka 	<p>Type of organization: A collaborative network focused on design entrepreneurship in the fashion industry.</p> <p>Size: Support services based on long term-experience of one fashion designer-entrepreneur; 6 showrooms and brand development partners and associated designers outside of this core.</p> <p>Funding: Private funding from founder and investors, and public funding (Tekes, the Finnish Funding Agency for Innovation).</p> <p>Year established: 2011.</p> <p>Mandate: To provide business development support to (eco)fashion start-ups.</p>
Peloton Club, (FI)	<ul style="list-style-type: none"> Executive director at think thank Demos Helsinki: the founders of the Peloton club 	<p>Type of organization: A collaboration between organisations from different industries to develop environmentally friendly products and services, particularly resource-smart solutions, through sharing, optimization, upcycling and recycling, and dematerialization.</p> <p>Size: Founding organization (Demos Helsinki) had 12 full-time employees with more than 10 part-time employees focusing on co-creation; 50-100 emerging and existing businesses involved in club events.</p> <p>Funding: Public funding from Sitra (The Finnish Innovation Fund).</p> <p>Year established: 2009.</p> <p>Mandate: To provide business development support to start-ups addressing contemporary environmental problems such as climate change and natural resource depletion.</p>
The Greentech Cluster in North Rhine-Westphalia, (DE)	<ul style="list-style-type: none"> Principal Intermediation programme (Innovation radar) coordinator 	<p>Type of organization: Non-membership-based cluster initiative focused on the environmental goods and services sector.</p> <p>Size: 5-6 employees working variably in time.</p> <p>Funding: Ministry of Environment, European Union and regional development funds.</p> <p>Year established: 2009.</p> <p>Mandate: To form a cluster initiative that can support the development of future technologies and as well as regional development.</p>
Sustainable Business Hub in Region Scania, (SE)	<ul style="list-style-type: none"> Project leader for R&D and innovation Business developer 	<p>Type of organization: Membership based, non-profit organization.</p> <p>Size: 6 employees working full-time, 130-member companies within the environmental goods and services sector.</p> <p>Funding: Region Scania, European Union projects, Private sources (e.g., membership fees).</p> <p>Year established: 2002.</p>

	Development manager and Business manager from cluster co-financer (regional council of Scania, Sweden)	Mandate: To foster regional development by supporting the growth of companies in the cleantech sector.
Malmö Cleantech City, (SE)	<ul style="list-style-type: none"> Project manager 	<p>Type of organization: Non-membership-based organization supporting companies mainly within the environmental goods and services sector.</p> <p>Size: 2 employees working full-time.</p> <p>Funding: 100% from Malmö city.</p> <p>Year established: 2010 as a project.</p> <p>Mandate: To support the creation of jobs and employment in the cleantech sector in the city of Malmö.</p>
Energy and material efficiency agencies		
The Efficiency Agency in North Rhine-Westphalia, (DE)	<ul style="list-style-type: none"> Head of consulting 	<p>Type of organization: Government-mandated organization with technical experts on material and energy efficiency in different sizes of companies and sectors.</p> <p>Size: 30 employees working full-time in six locations.</p> <p>Funding: Ministry of Environment, North Rhine-Westphalia.</p> <p>Year established: 1998.</p> <p>Mandate: To support SMEs in the manufacturing sector regarding cleaner production technologies.</p>
The Energy Agency, (DE)	<ul style="list-style-type: none"> Manager of the Department for Information and Advice 	<p>Type of organization: Government-mandated organization with technical experts on energy efficiency in different sizes of companies from different sectors.</p> <p>Size: 120 employees working in Düsseldorf, Gelsenkirchen and Wuppertal.</p> <p>Funding: State of North Rhine-Westphalia, regional development funds.</p> <p>Year established: 1990.</p> <p>Mandate: To support companies with information and technical consultancy about energy efficiency.</p>
Business development organizations		
Agency for business promotions, Duisburg, (DE)	<ul style="list-style-type: none"> Two project managers 	<p>Type of organization: Shareholders are the city of Duisburg, 50%, and 50% private companies. A general focus organization supporting different kinds of companies.</p> <p>Size: 20 employees.</p> <p>Funding: City of Duisburg and private companies.</p> <p>Year established: 1988.</p> <p>Mandate: To stimulate business development activities in the city of Duisburg.</p>
Essen Economic Development Agency, (DE)	<ul style="list-style-type: none"> Responsible for energy, water and environment 	<p>Type of organization: 50% owned by the city of Duisburg and 50% owned by the association of businesses, e.g., utilities, savings banks, real estate companies. A general focus organization supporting different kinds of companies.</p> <p>Size: 30 employees</p> <p>Funding: 95% by the city of Essen, the association of businesses.</p> <p>Year established: 1991.</p> <p>Mandate: To stimulate business development activities in the city of Essen.</p>

ALMI Scania, (SE)	<ul style="list-style-type: none"> Innovation advisor 	<p>Type of organization: Non-membership based regional branch of the national business development organization with support targeted at all types of companies.</p> <p>Size: 26 employees, a subsidiary to Almi Företagspartner AB, owned by the Swedish government.</p> <p>Funding: Parent company and regional owners (e.g., regional councils)</p> <p>Year established: Parent company started in 1994.</p> <p>Mandate: To create growth and renewal within Swedish businesses and industries.</p>
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Following data collection, we sent the transcripts of the interviews to the respondents to check for content accuracy. A thematic analysis was used to identify the major themes regarding the intermediation roles and how they were undertaken for each intermediary case studied (cf. Fereday and Muir-Cochrane, 2006). Themes in this instance refer to recurring motifs and statements from the interview transcripts which relate to intermediation roles and how they were executed. In data analysis, we focused on the support activities of intermediaries for eco-innovation and, in particular, how those activities were undertaken in reference to our conceptual framework (functional, relational and potential scope of benefits). From this analysis, a discussion on the system-level activities of intermediaries and their categorisation on different levels is presented in the subsequent chapters.

To use our proposed criteria (Table 1) for characterizing system level activities of intermediaries in our analysis, we departed from the argument that intermediation roles alone were not a robust basis for determining whether an intermediary activity is systemic or not. This is because roles defined in previous literature as systemic were oftentimes also undertaken by other types of intermediaries, for example, innovation intermediaries, and were not necessarily exclusive to the highest level of system aggregation. For instance, demand articulation, a role stipulated as systemic, can also occur at lower levels of aggregation between individual technology users and developers in bilateral intermediation. We thus compiled the different roles that the studied intermediaries undertook and subjected them to the relational (in-between what does the intermediation occur) and appropriation of benefits criteria (who gets the benefits of the intermediation). When intermediation roles were in-between a (i) network of actors, (ii) different networks, and (iii) in-between actor-networks and institutions together with the condition that the activities were potentially beneficial for other entities beyond the immediate intermediary configuration – that is, supporting a collective good (Geels and Deuten, 2006) – they were classified as systemic.

4 Empirical results

In this section, we present the empirical data covering essentially intermediation activities and the entities in-between which it occurs. These results are summarised in Appendix 1.

4.1 Non-Systemic Level 0 – Intermediation in-between individual entities

At this level, the intermediary operates in-between individual entities. For example, the Finnish Clean Energy Association (FI) serves as a bridge between technology suppliers and consumers by gathering and providing information on renewable energy technologies (e.g., installation costs, technical specifications). On the other hand, TELAKKA® (FI), which focuses on supporting start-ups in (eco)-fashion, provides business planning and development support by facilitating networking in-between start-ups and also bridging start-ups to funders.

The Efficiency Agency (DE), focusing on supporting SMEs in the manufacturing sector regarding cleaner production practices, provides one-on-one technical advice to SMEs including bridging SMEs to consultants and expertise on energy and material efficiency, and linking SMEs to financial organizations, such as banks, that can finance energy and material efficiency improvement projects. Similarly, the Energy Agency (DE) focuses on information gathering and dissemination, providing technical expertise including linkages to consultants and other support organizations, such as local business development agencies e.g. Essen Economic Development Agency (DE), and finding financing to facilitate energy efficiency improvements in the production processes of individual companies.

In the case of Malmö Cleantech City (SE) similar to Sustainable Business Hub (SE), they provide linkages between companies and tests beds in the city for early-stage testing, demonstration and evaluation of eco-innovations as a way to gain legitimacy and publicity. ALMI Region Scania (SE) provides one-on-one business development coaching and serves as a bridge between individual companies (including entrepreneurs and start-ups) and other entities (e.g., universities, science parks) to access eco-innovation specific competence.

4.2 System Level 1 – Intermediation in-between entities in a network

In System Level 1, the intermediary mediates in-between entities in a network. The network can be a closed network with membership or an open network without membership, but with some common interest among participants. For example, the Finnish Clean Energy Association (FI) facilitates networking between different companies (e.g., start-ups and established) within a renewable energy niche (e.g., solar energy) by providing interaction arenas through meetings, workshops and seminars. Another example relates to the local business development agency in Essen (DE), which facilitates interactions between different entities such as banks, consultants, companies and cities that form an open network working on biomass and environmental remediation of polluted sites.

Malmö Cleantech City (SE) focuses on facilitating networking activities among companies within the environmental goods and services sector within the city of Malmö, Sweden. Also adopting an open network approach with no membership (the organization maintains a mailing list of active companies within the sector in the city), the intermediary supports companies by using arenas, such as meetings, seminars, conferences and newsletters, to facilitate networking between different actors in the city. It gathers and disseminates

information about eco-innovation, and also educates and trains companies on different themes, such as accessing financial resources and technical competence for eco-innovation. Similarly, the Greentech Cluster (DE) has no membership but maintains a mailing list of 3000-5000 companies across different industrial sectors. The Greentech Cluster provides linkages between the companies in this open network and other organizations outside the network to access resources such as competence and finance essential for eco-innovation.

The Sustainable Business Hub (SE) in region Scania, Sweden, manages a closed network with member companies from the environmental goods and services sector located in the region. The hub bridges the network with other entities, such as universities and research institutions, to access specific competence to support its innovation and research and development activities. Regarding its other focus area, that is, foreign and domestic market development, it links its member companies to potential customers and partners and provides information and education at the network level through seminars, newsletters on different sources of financing, and even general business coaching. Furthermore, the Peloton Club (FI) also facilitates networking among both public and private organizations from different industries through regular meetings and providing support (e.g., bridging to investors and established companies, publicity events, developing business plans and ideas) for business development for resource-efficient solutions in a network.

4.3 System Level 2 – Intermediation in-between networks

At System Level 2, the intermediary mediates in-between different networks. For example, the Finnish Cleantech Association (FI) facilitates networking between different renewable energy niche associations through its joint activities, such as collaboration between start-ups and established companies from different niches.

The Energy Agency (DE) is engaged in facilitating networking activities between companies and research institutions active in networks for different renewable energy technology niches, such as biomass, fuel cells and hydrogen, solar energy, geothermal energy and wind energy to initiate innovations and speed up their market readiness, including an exploration of their potential on the domestic and foreign markets.

On the other hand, the local business development agency in Duisburg and Essen (DE), Duisburg agency for business promotions and Essen economic development agency each run an intermediation program called Ecoprofit® (ECOlogical PROject For Intergrated Environmental Technology), to improve the eco-efficiency of processes, products practices and services in organizations. In this program, the intermediary brings together different categories of actors such as companies, technical consultants, local authorities and other support actors through workshops on cleaner production and consulting by technical consultants. In this collaborative scheme, the intermediary and different collaboration partners (e.g., local authorities, SMEs and consultants) work together to establish learning networks.

4.4 System level 3 – Intermediating between actors, networks and institutions

In System Level 3, the intermediary operates between actors-networks and institutions such as norms, laws, regulations, guidelines, contracts, values, culture, and policy. An example of such intermediation activities can be found in the case of the Finnish Clean Energy Association

(FI), a collaboration between technology suppliers (both start-ups and established companies), member associations of renewable energy technology niches (e.g., the association of Solar Technology ATY, Finnish Biogas Association, Finnish Wind Power Association, Small Hydro Association in Finland, Finnish Heat Pump Association), and consumers. By operating at this system level, the intermediary aggregates the views and opinions of different renewable energy actors to lobby for national policy changes to support renewable energy production in Finland. The intermediary also serves as a common voice for renewable energy, energy efficiency and smart energy solutions on the national level in Finland. Furthermore, the intermediary provides information to consumers with the ambition to create better domestic market conditions for renewable energy technology niches in general. The intermediary also advocates renewable energy technologies to political decision makers, because their individual member companies and their networks may not have the access. For example, the association through its FinSolar project has shown explicit political action by publishing a 'solar energy proposal' in the Finnish Parliament in November 2014.

In addition to aggregating the views of various networks of actors to influence higher-level formal institutions, intermediation on System Level 3 also focuses on influencing informal institutions such as norms, culture and public opinion. For example, TELAKKA® (FI) aggregates the activities of (eco)-fashion start-ups through various campaigns, including information dissemination, to gain credibility and to improve its image among the general public, that is, attempting to change fashion norms towards sustainability.

The empirical data that we gathered enabled us to illustrate the main argument in this article about the heterogeneity of intermediation roles across different system levels; see Table 3 below for a comparison of the three system levels and a non-systemic level of intermediation. Appendix 1 presents a case-by-case summary of intermediation roles on the different system levels.

Table 3: Comparison of the three system levels and a non-systemic level of intermediation

Characterizing system-level intermediation	Non-Systemic Level 0 Intermediation in-between individual entities	System Level 1 Intermediation in-between entities in a network	System Level 2 Intermediation in-between networks of different entities	System Level 3 Intermediation in-between actors, networks, and institutions
Relational	In-between individual entities (e.g., actors, organizations, projects)	In-between participants in a particular network (e.g., a technology cluster)	In-between networks of different entities	In-between actors, networks, and institutions
Functional	<ul style="list-style-type: none"> Gathering and disseminating information and providing advice to assist an entity to access resources or conduct (eco-) innovation activities Bridging and networking activities to assist an individual entity to access resources or jointly contribute to an (eco-)innovation process 	<ul style="list-style-type: none"> Facilitating networking activities and information dissemination within a network to assist entities access resources for (eco-)innovation Bridging networks to other external entities to access resources for (eco-)innovation 	<ul style="list-style-type: none"> Building coalition to provide a common voice for the agendas of members in a supra-network Facilitating networking activities between different networks to access resources 	<ul style="list-style-type: none"> Aggregating views and opinions of actors and networks to induce institutional change or the building of new institutions Building credibility and legitimacy for a set of actors, their networks and visions Intermediaries as institutional agents in innovation promotion
Appropriation of intermediation benefits	Individual parties realise the benefits but may share benefits with other parties	Network participants realise the benefits but not necessarily to the same degree	Potential benefits spread across participants in different kinds of networks but not necessarily to the same degree	Innovation system members realise benefits but with heterogeneity

5 Discussion

This article provides a conceptual distinction of three system levels of intermediation in an attempt to explicate ‘systems’ within which intermediaries operate. By conceptualizing these system levels, this contribution forms a basis to address research gaps regarding how to extend the impact of intermediaries beyond individual firms and projects to the system level.

On System Level 1, intermediaries operate in-between entities in a network. Membership-and non-membership-based networks are often established for strategic purposes or emerge to fill gaps and intermediation needs during transitions (Kivimaa et al., 2019b). The intermediation roles are largely, on the network level, provided to all participants even though there may be instances of bilateral intermediation in-between individual entities. The roles of intermediaries on this system level relate to facilitating networking in-between entities in a niche network, and facilitating linkages between the network and other entities outside the network mostly to access resources and exchange information (e.g., The Finish Clean Energy Association, Peloton Club, The Greentech Cluster). Facilitating networking through regular

meetings and interactions is important to mobilize resources and commitment necessary for niche development, alignment of visions and efforts, needed to destabilize unsustainable regimes (Kivimaa, 2014). When it comes to the appropriation of the benefits, the network members should perceive the potential benefits of such memberships to remain committed to the network and contribute (e.g., membership fees, time for meetings) even though the realized potential benefits are not necessarily the same for all members. These benefits may occur at the expense of competing niches.

In System Level 2, the intermediary operates in-between networks of different entities. For example, these networks can represent niche associations for different types of renewable energy technologies such as solar, wind, and biogas. The intermediation activities are thus in-between these different networks that share a common agenda, for example, destabilizing an existing fossil-based energy system. These networks may share attributes, such as mutual trust, culture, shared expectation and proximity, which may be highly valuable assets beyond a single network (Markard and Worch, 2010). The intermediation roles at this system level are dominated by roles that seek to aggregate the resources, competence and agendas of different networks to realize certain higher-level objectives beyond the reach of the individual networks. Thus, mediating in-between different networks is important in sustainability transitions that aim to reconfigure complete systems of production and consumption, and in which case transformations in isolated niches are not sufficient, for example, the transformation of entire production and consumption systems towards a circular economy (Barrie et al., 2019). The benefits of the intermediation are shared among the different kinds of network entities, but there may be heterogeneity in the degree to which different networks and their members benefit. For example, facilitating networking activities between different renewable energy niches such as solar, biogas, wind, and hydro (e.g., The Finish Clean Energy Association, The Energy Agency) would benefit the niches differently because of their different characteristics and the phase of development of the underlying innovation system.

Intermediation in System Level 3 can be regarded as intermediation at a higher innovation system level (in-between actors, networks, and institutions) (cf. Van Lente et al., 2003). What characterizes this level of intermediation is the aggregation of the views and opinions of different actors and networks to influence formal and informal institutions and the need to change them in support of transitions (as undertaken by the Finish Clean Energy Association and TELAKKA®). Thus, intermediation includes the articulation of new visions and expectations, initiating policy renewal, and acting as an impartial voice for new networks of actors (cf. Kivimaa, 2014). While similar influence can occur within specific niche-oriented networks, the higher system-level intermediation may be more beneficial to transitions by not advancing the interests of a specific network (e.g., Geels and Deuten, 2006; Smith et al., 2015), advancing regime destabilisation by influencing incumbent activities (e.g., Matschoss and Heiskainen 2018), and appropriating benefits beyond those involved in networks to the society as a whole. These intermediaries do not only aggregate opinions and visions onto higher systemic-levels but may also translate higher-level institutional policies to the local contexts of actors (Hodson and Marvin, 2010). Similarly, there are aggregation activities to influence informal institutions such as public norms and values, which are essential for gaining legitimacy and resource mobilization around particular niches (e.g., TELAKKA®). When it comes to the appropriation of potential benefits, although the intermediation activities are intended to generate system-wide benefits (e.g., favourable policies for several niches, cities),

the benefits that they provide may not be realized by all actors and networks in an innovation system to the same degree. Certain intermediation activities may favour certain actors and networks due to their specific characteristics and position within the innovation system. Over time, intermediaries may themselves become institutions with vested interests in the system (cf. Kivimaa et al., 2019a). This system level may be characterised by technological neutrality, that is, not choosing a particular niche technology to promote in order to support a wide portfolio of niche technologies (e.g., Finish Clean Energy Association). However, even by remaining technology-neutral, the intermediary may take a position with regard to its source of funding and which parties to cooperate with (e.g., certain types of renewable energy niches), aspects which can influence their freedom to set agendas and avoid lock-in to existing unsustainable regimes.

Among our cases, non-systemic intermediation activities, such as resource mobilization and information gathering and dissemination in-between individual entities, are dominant (Appendix 1). The dominance of non-systemic activities is an empirical rather than a conceptual challenge. With reference to the resource characteristics of our cases (e.g., number of employees, size of networks, project-based organization), the dominance of non-systemic intermediation reflects the resource intensity, complexity, and public good nature of systemic intermediation activities. Systemic intermediation requires intermediaries with financial stability, longevity and sometimes neutrality (Hodson et al., 2010). Both systemic and non-systemic intermediation activities are necessary to facilitate sustainability transitions (cf. Kivimaa et al., 2019a). For example, while bilateral intermediation activities, such as resource mobilization, gathering and dissemination between supplies and users (e.g., as undertaken by Sustainable Business Hub, The Energy Agency, The Efficiency Agency) are important for niche formation and development through the building of social networks, systemic activities such as policy advocacy and aggregating the voices of different niches (e.g., as undertaken by the Finish Clean Energy Association) are necessary to destabilize unsustainable regimes through the articulation of new visions and expectations, and policy renewal.

Our empirical cases suggest that resource capacity in terms of the number of employees and the size of network gives an indication about the likelihood of intermediaries to undertake systemic activities. However, the mandate given to the intermediary is equally important, as intermediaries with limited resources can have a mandate towards systemic activities such as institutional change (e.g., The Finnish Clean Energy Association), which can provide system-wide societal benefits. Equally, by their given mandate, intermediaries with relatively high resources (e.g., the material and energy agencies) can concentrate on bilateral intermediation activities. Thus, for intermediaries to be effective, it will be essential to establish a dynamic balance between the given mandate, resources available and the expected outcomes (Kant and Kanda, 2019).

Our conceptualisation complements earlier typologies of systemic activities of intermediaries by adopting an activity focus and conceptualizes and illustrates how intermediaries can carry out multiple activities placed on different system levels. For example, Van Lente et al. (2003), taking an actor focus, distinguished between three types of intermediaries – hard, soft, and systemic – based on their functions. Klerkx and Leeuwis (2009) made a similar contribution of seven types of intermediaries empirically operating in the Dutch agricultural innovation systems based on their functions. Kivimaa et al. (2019a) developed a typology of five

intermediary types in sustainability transitions based on their emergence, neutrality, and intermediation goals, as well as their context and level of action. Hodson et al. (2013), taking a process focus, conceptualised four modes of urban energy intermediation based on whether intermediaries initiate or implement externally produced or context-specific priorities, and whether their responses were episodic or systemic. This shows the different meanings and approaches to systemic intermediation in the previous literature. Our contribution shows that intermediaries are hybrids of several functions operating on multiple levels at a given point in time. Thus, we suggest the term *systemic intermediation* for describing the system-level activities of intermediaries.

This contribution is relevant because for intermediaries to contribute to sustainability transitions, their impact needs to reach different systems levels beyond individual entities – thus supporting the work of Kivimaa et al. (2019a). Furthermore, intermediaries may strategically engage in non-systemic intermediation activities together with even non-intermediation activities to generate resources such as funding and competence necessary to sustain systemic intermediation activities. In practise, intermediaries are likely to have a larger share of activities on a particular system level than equally operating on all system levels, which would be resource-intensive and challenging for differentiation purposes in an ecology of intermediaries. Thus, complementing an emerging, more nuanced perspective of intermediaries in sustainability transitions, our discussion suggests a heterogeneity of roles that individual intermediaries take at multiple system levels.

6 Conclusions and policy implications

In this article, we conceptualised and empirically demonstrated the system-level activities of intermediaries and, in particular, how one intermediary may operate in multiple system levels based on a relational and functional view, and the appropriation of intermediation benefits. This contribution is intended to shed more light on intermediation for researchers and policy makers who may be struggling to grasp the potential impact of intermediaries beyond firms and projects. Our conceptualisation, based on previous literature as well as empirical findings, strengthens the view that intermediaries are not homogenous entities operating at a particular system level and, thus, could be conceptualised as strategic actors operating on multiple system levels. It also highlighted differences between particular intermediaries operating in support systems for eco-innovation, in that some operate in many more system levels, while others may be limited to intermediating between bilateral relations or within specific networks. Thus, to support more systemic societal change towards sustainability transitions, there is a need for intermediaries to consider improving their activities between multiple networks and towards institutions.

However, a potential limitation of our study is that the intermediation roles on these system levels are dependent on our empirical cases and, thus, additional roles can be identified in different contexts. Furthermore, a more systematic questioning among case organisations as opposed to the exploratory research might have revealed further intermediary roles.

For future research, so far, assessing the impact of intermediaries has often been based on assumptions or descriptive statistics (Klerkx and Leeuwis, 2008b). The various stakeholders of intermediaries such as their funders, owners, and clients appreciate their activities in hindsight but struggle to grasp the specific impact of intermediaries due to attributional

challenges and the complex dynamics and multiple causalities of innovation and transition processes. Similarly, it is challenging to unequivocally specify the impact of intermediaries on a given system level. Thus, analysing the system-level impact of intermediaries will require approaches such as structural and functional analysis (cf. Wieczorek and Hekkert, 2012), which are beginning to be explored in the intermediary literature (Barrie et al., 2019; Kanda et al., 2019; Lukkarinen et al., 2018). A specific question to explore would be how intermediary roles contribute to the overall functions and structure of a system level over time.

For policy makers interested in using intermediaries as instruments to facilitate sustainability transitions, our conclusions have some implications. Intermediaries often emerge in response to knowledge, coordination or service gaps in systemic change and transition processes and sometimes lack sufficient direction, willingness and capacity. This may lead to intermediaries often complementing but also competing with each other for resources, mandate and relevance, leaving gaps with respect to a given innovation process or system. Thus, policy makers have to nurture a mix of intermediaries on different system levels undertaking different roles and activities. This is because intermediation roles expand from very specific and tailored activities for a (paying) client in bilateral relations to the interests of particular networks through to broader roles that potentially benefit entire innovation systems. These different system levels of intermediation are needed for innovations to emerge and related networks to be formed and create favourable institutions to facilitate sustainability transitions. Thus, policy makers need to continuously monitor the dynamic mix of intermediaries in a given process or system and strategically support existing intermediaries to take on new or missing roles and establish new intermediaries to fill missing gaps on different system levels. However, policy makers need to be aware that intermediation roles on multiple system levels can create tensions and conflicts within and between intermediaries since different roles require different resources and competencies to fulfil. Thus, policy formulations should also facilitate synergies and address conflicts between intermediaries. Finally, intermediaries should be analysed as strategic entities with the potential to fulfil a variety of roles and activities on multiple system levels.

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Appendix 1:

Summary of intermediary cases in relation to the conceptual system levels of intermediation.

Case	Non-Systemic Level 0 Intermediation In-between individual entities	System Level 1 Intermediation in-between entities in a network	System Level 2 Intermediation In-between networks of different entities	System Level 3 Intermediation in-between actors, networks and institutions
Cluster organizations and collaborative networks				
The Finish Clean Energy Association	<ul style="list-style-type: none"> Gathering information on renewable energy technologies (e.g., installation costs, technical specifications) from technology suppliers and providing it to individual consumers. 	<ul style="list-style-type: none"> Facilitating networking between entities within a renewable energy niche, e.g., start-ups and incumbents in a solar energy network. 	<ul style="list-style-type: none"> Facilitating networking between different renewable energy niche associations through its joint activities, such as collaboration between start-ups and established companies from different niches. 	<ul style="list-style-type: none"> Aggregating the views and opinions of different renewable energy niches and their networks to lobby for national policy changes to support renewable energy production in Finland. Serving as a common voice for renewable energy, energy efficiency and smart energy solutions in Finland.
TELAKKA®	<ul style="list-style-type: none"> Focuses on supporting start-ups in (eco)-fashion, provides business planning and development support by facilitating networking in-between start-ups and also bridging start-ups to funders. 			<ul style="list-style-type: none"> Aggregating the activities of (eco)-fashion start-ups through various campaigns, including information dissemination, to gain credibility and to improve its image among the general public, that is, attempting to change fashion norms towards sustainability.
Peloton Club		<ul style="list-style-type: none"> Facilitating networking through regular meetings and providing support (e.g., bridging to investors and 		

		incumbents, publicity through events) for business development for resource-efficient solutions in a network.		
The Greentech Cluster		<ul style="list-style-type: none"> Bridging companies to other actors and organizations (e.g., universities, funders) to access essential resources (e.g., knowledge, finance). Scanning and forecasting new ideas of eco-innovations and bringing together selected stakeholders (e.g., companies, universities, public authorities and funders) to develop it further. 		
Sustainable Business Hub	<ul style="list-style-type: none"> Connecting member companies to arenas (e.g., municipalities) to demonstrate and test their innovations. 	<ul style="list-style-type: none"> Supporting innovation and R&D by bridging member companies to universities and research institutions to access specific competence, support for developing strong domestic market and export by bridging member companies to potential customers and partners, and education and training about 		

		<p>marketing activities.</p> <ul style="list-style-type: none"> The cluster also support member companies by providing information on different sources of financing, providing business coaching and identifying potential partners and customers at the network level. 		
Malmö Cleantech City	<ul style="list-style-type: none"> Providing linkages between companies and testbeds in the city for early-phase testing, demonstration and evaluation of thier innovations. 	<ul style="list-style-type: none"> The intermediary supports environmental technology companies through information provision, education and training (e.g., on using networks, finding finance), networking at a city level. 		
Energy and material efficiency agencies				
The Efficiency Agency	<ul style="list-style-type: none"> Intermediation activities include providing one-on-one technical advice and expertise to SMEs on energy and material efficiency, assistance to implement resource efficiency projects (including new 			

	product development), translating resource efficiency projects into financial applications.			
The Energy Agency	<ul style="list-style-type: none"> An agency that supports SMEs from different sectors one-on-one through information provision, technical consulting, education and training, networking and cluster activities, finding financing to improve their energy efficiency in production processes. Acting as a knowledge resource, the agency sometimes supports energy consultants in their activities. 		<ul style="list-style-type: none"> The agency is engaged in facilitating networking activities between companies and research institutions active in networks for different renewable energy technologies. The focus of this support is to initiate innovations, speed up their market readiness and exploit their commercial potential including export. 	
Business development organizations				
Agency for business promotions, Duisburg			<ul style="list-style-type: none"> The main eco-innovation support is Eco-profit®, a registered trademark programme to improve eco-efficiency of processes, products, practices and services in organizations. The support activities include bridging between selected companies, technical 	

			consultants and public authorities, education on regulations to improve eco-efficiency among companies in selected sectors.	
Essen Economic Development Agency	<ul style="list-style-type: none"> Acting as a bridge between individual companies, and efficiency agencies to provide technical expertise on energy and material efficiency to companies. 	<ul style="list-style-type: none"> Acting as a link between banks, consultants, companies and cities who form a network working on biomass and environmental remediation of polluted sites. 	<ul style="list-style-type: none"> Acting as a link between selected participant companies, local authorities, support organizations and consultants to assist companies improve their eco-efficiency through a trademark program called Eco-profit®. 	
ALMI Region Scania	<ul style="list-style-type: none"> Providing one-on-one business development coaching to companies. Serving as a bridge between individual companies and other support actors to access eco-innovation specific competencies. 			

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