

The local embedding of low carbon technologies and the agency of user-side intermediaries

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Abstract

‘Local embedding’ is a term increasingly used by transition researchers but in a variety of ways. As a concept it is emotive but lacks clarity. The first contribution of this paper is to explore and substantiate the concept of local embedding by drawing on three theoretical fields: socio-technical transitions, domestication studies and research on innovation intermediaries. Emphasis is placed on the work required to integrate low carbon technologies into local contexts of use by aligning multiple system elements into configurations that work. This points to a particular form of actor – those performing relational work between multiple actors and technologies, commonly known as intermediaries – as being central to the process. Three key intermediary processes – of facilitating, configuring and brokering - are thought to define the work that intermediary organisations do. Nonetheless, understanding how these key intermediary processes relate as well as the agency of intermediary organisations in local embedding is still largely uncharted territory. The paper’s second contribution is the development of a process perspective on the agency of intermediary organisations in local embedding. The resulting perspective offers a means to situate and understand the agency of user-side intermediaries in local embedding and insights into later phases of transition processes.

Keywords: intermediary organisations; innovation intermediaries; local embedding; socio-technical transitions; Domestication;

Highlights:

- The concept of ‘local embedding’ is examined and substantiated
- A new process perspective on agency of intermediaries is developed
- The paper finds their primary role to be the alignment of multiple system elements
- Paper extends attention to the development and use of low carbon technologies

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1. Introduction

Many of the technologies required to deliver substantial reductions in emissions over the short to medium term already exist (CCC, 2008; IPCC, 2014). For such technologies it is not their technical feasibility that holds them back nor their economic viability but a range of social, cultural and institutional barriers (Sovacool and Watts, 2009). As a result, realising their potential is not simply a question of diffusion. Singular technological innovations need to be integrated into existing lifestyles, embedded within new systems of provision at local through to national systems in order for them to have wider, transformational impact (Steward, 2012).

How fundamental changes to societal systems of provision occur has been addressed through the study of sustainability transitions (e.g. Markard et al., 2012; Smith et al., 2010). Research on sustainability transitions emphasises long-term, multi-actor change processes and for the most part has focussed on the development of alternative, increasingly sustainable technological trajectories (Geels et al., 2016; Hekkert and Negro, 2009; Hoogma et al., 2002). This is understandable given how the search for radical solutions was at an early stage during the last decade. The field has also been highly productive, producing multiple insights into how momentum can be built behind radical configurations with the potential to challenge incumbent systems. However, new socio-technical trajectories have now emerged and there remains important learning about the adaptation of commercially-proven low carbon technologies to diverse local contexts of use (Heiskanen et al., 2015; Späth and Rohrer, 2012). In short, less attention has been given to what happens beyond the experimentation and development of innovative technologies and specifically, about the systemic innovation required to integrate commercially-proven singular innovations into diverse, local contexts of use.

‘The integration of technologies into local contexts of use’ is defined by Russell and Williams’ (2002) as a process of embedding. The term ‘local embedding’ is increasingly used by transition scholars, but in a variety of ways. For example, Raven et al. (2008, 469) claim “sensitivity to local context and the local embeddedness of a project” are key to determining the successful deployment of experimental projects. Schreuer et al. (2010, 741) argue “relatively little attention has so far been given to the process of setting up and locally embedding niche [experiments]”. Jalas et al. (2014, 76) have explored self-building courses as a stimulus for “local embedding and diffusion of renewable energy technologies” and Sengers and Raven (2015) have argued for a spatial perspective on niche development that suggests niches need to be territorially embedded in particular local places. The term has been used in both an ordinary language sense – to fix an object firmly and deeply into a surrounding mass – and a technical sense, to evoke a concept and, in particular, a process. Consequently, ‘local embedding’ has characteristics of what Billig (2013) calls a ‘semi-technical’ term: a term that is neither properly technical (including being clearly defined) nor properly ordinary.

The first contribution of this paper is to develop the term local embedding using insights from sustainability transitions, domestication studies and research on innovation intermediaries. Local embedding is subsequently defined as the process through which multiple system elements are increasingly aligned into place-specific configurations that work. In doing so the paper extends attention downstream to the *deployment* and *use* of commercially-proven low carbon technologies (innovations). Emphasis is placed on the work required to align multiple system elements. This directs attention to a particular form of actor, typically performing relational work and operating between others to create connections (Moss, 2009). These actors are commonly referred to as intermediary organisations (Kivimaa and Martiskainen, 2017).

The literature on intermediaries is most developed around innovation intermediaries (Bessant and Rush, 1995; Howells, 2006; Stewart and Hyysalo, 2008). For instance, Howells (2006, 720) defines an intermediary as “an organisation or body that acts as an agent or broker in any aspect of the innovation process between two or more parties”. The role of intermediaries in facilitating transition processes has gained increasing attention, particularly since 2009 (Fischer and Newig, 2016; Gliedt et al., 2018; Hodson and Marvin, 2009;

Kivimaa and Martiskainen, 2018; Matschoss and Heiskanen, 2017; Moss, 2009). Such work has focussed on the role of intermediaries operating at a network or system level (Kivimaa, 2014; Lente et al., 2003; Lukkarinen et al., 2016), on intermediaries supporting niche development processes (Geels and Deuten, 2006; Hargreaves et al., 2013) and on intermediaries supporting niche-regime interactions (Elzen et al., 2012). ‘Transition intermediaries’ have subsequently been defined as those that mediate a sector (such as electricity) or a region (such as a city) towards a systemically new and more sustainable socio-technical configuration (Kivimaa et al 2017).

Common across such research is a focus on the early stages of innovation processes. For instance, Stewart and Hyysalo (2008, 319) argue, “highly visible supply-side intermediaries..., and the easily identifiable middle-ground agencies ...tend to overshadow the often more informal yet just as crucial intermediaries at the user-end of the supply-use relation”. Meanwhile, Moss (2009, 1489) argues more research is needed into “intermediaries seeking to embed technologies in particular social contexts of application”. Kivimaa et al (2017) have also come to a similar conclusion in a review of intermediaries in transitions, arguing more empirical and theoretical work is required on how intermediary activities contribute to latter phases of transitions. The second contribution of this paper is to help address this gap by investigating the key processes through which intermediary organisations seek to facilitate the local embedding of low carbon technologies. Two questions subsequently guide the research: (1) what is the role and agency of intermediary organisations in the process of local embedding? and (2) are there patterns to key intermediary processes in local embedding?

To answer these questions insights from the three literatures above are combined in a new process perspective on the agency of intermediary organisations in local embedding. The resulting model suggests an ideal-typical sequence and offers an explanation as to how intermediary activities may contribute to latter phases of transitions. The model is subsequently tested and refined through two case studies of intermediary attempts to embed solid-wall insulation within the city of Bristol, southwest England.

The remaining paper is structured as follows. Section 2 begins by reviewing work on sustainability transitions and domestication studies in order to substantiate and situate the process of local embedding. The role of intermediary organisations in local embedding is then reviewed before an analytical framework to understand the agency of intermediary organisations in locally embedding low carbon technologies is constructed. Section 3 explains the research approach before section 4 examines two attempts to locally embed solid-wall insulation. Section 5 answers the research questions and refines the process perspective. Section 6 concludes.

2. Theoretical background and analytical framework

2.1 Situating local embedding

Both sustainability transitions research and domestication studies view innovation and change as a process of co-construction between technology and society. A primary difference is their focus on different scales of analysis.

Sustainability transitions research examines how new technologies in emergent socio-technical configurations get embedded in wider society and potentially result in largescale system change. The prominent *multilevel perspective* (MLP) situates these processes across three interlinked levels: ‘niches’ where novelties are created and developed, ‘regimes’ as semi-stable socio-technical systems of provision and ‘landscapes’ providing slower changing context conditions (Geels, 2005). The levels are linked together through structuration (Fuenfschilling and Truffer, 2014; Geels, 2002) but their value, often overlooked, also points the situatedness of local practices within wider institutionalised structures, with their own particular history, culture and dynamics (Rohracher, 2005). A key insight is that the co-construction of technology and society must be placed within broader contexts of social structures and ‘dynamically stable’ (Geels, 2005)

systems of provision. The MLP can subsequently be thought of as explaining innovation processes and sustainability transitions at the macro or societal level: it conceives of embedding as resulting from interactions between firms, policy-makers, consumers, suppliers, civil society, social movements and so forth, each with their own perceptions, motivations, aims and resources (Geels et al., 2008). As a consequence, sustainability transitions research can be thought of as explaining the *social embedding of technology into wider society*.

The MLP's focus on explaining change from one system to another means it is often critiqued for emphasising the aggregated outcomes of actors (c.f. individual agency) (Farla et al., 2012; Fischer and Newig, 2016; Shove and Walker, 2007; Smith et al., 2005). However, agency and local context conditions are frequently recognised as having played major explanatory roles in historical transitions. Agency and context conditions subsequently feature prominently within the study of niche development processes. For instance, Strategic Niche Management (SNM) focusses on the core processes by which inventions and ideas develop into robust socio-technical configurations, how they grow and then translate into or adapt prevailing regimes (e.g. Hoogma et al. (2002), Kemp et al. (1998), Schot and Geels (2008)). In part this reflects the practical challenge of the time: SNM emerged in the late 1990s as a means to understand and support radical, socially desirable innovations serving long-term goals. However, SNM also provides important insights into local embedding. Raven et al. (2008, 467) argues SNM is useful "for analysing the relationship between processes of the local embedding of technologies and the lessons that can be taken from this at the level of emerging niche trajectories". Local embedding, they propose, can be understood as variation (through potential affordances of generic technology to different context specific expectations) and selection (alignment of technological affordances and actor expectations), leading to experimental projects with concrete artefacts (Figure 1).

The work of Raven et al. (2008) is useful for a number of reasons. It conceptualises local embedding processes as interactions between multiple levels. It also emphasises the importance of projects establishing continuity with existing physical, social and cognitive structures. A weakness is Raven et al. (2008) primary concern with niche accumulation. Their work subsequently has limited understanding of the local embedding process itself nor does it open up for investigation actor strategies or the work required to negotiate expectations.

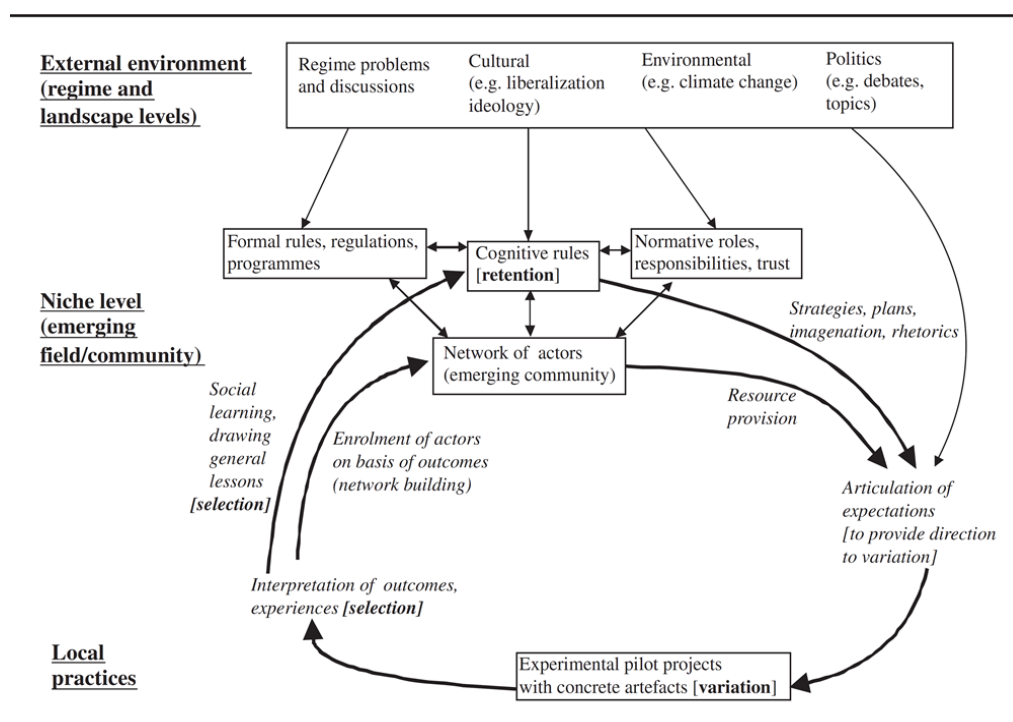


Figure 1: Dynamics in the relation between projects and socio-cognitive technology evolution (Raven et al., 2008)

The more pervasive qualities of the MLP and the focus on early phases of transition processes within SNM can be complemented by insights from domestication studies (Lie and Sorenson, 1996; Silverstone et al., 1992). Domestication studies emphasises the active side of technology use and takes users as its point of departure. Domestication is conceived as a multidimensional process where the technology must be: acquired, (brought or made accessible in some way); placed (physically and mentally); interpreted (given meaning and symbolic value) and; integrated within social practices (Sorenson et al., 2000). Strategies of domestication are thought to involve practical work (users need to develop patterns of use around technologies), symbolic work (through giving meaning to technologies), and cognitive work in order to learn about technologies (Lie and Sorenson, 1996).

Early domestication research was principally concerned about making the technology 'one's own' and concentrated on 'the moral economies of the household' (Silverstone et al., 1992). Since then, the approach has also been applied at larger scales, such as cities and regions (Berker, 2011; Lægran, 2005; Lamvik, 1996; Sorenson, 1996). Within this later work, key individuals or 'local experts' (Stewart, 2007) were identified as supporting domestication processes – such as interpreting new technologies and providing information and ongoing support. These individuals, working between technologies and users can subsequently be thought of as intermediary actors, which I will turn to shortly.

One of the most important insights from domestication studies is that new technologies do not simply diffuse but must be integrated within user practices, negotiated in local rules and socially and culturally adopted. For our understanding of local embedding the approach is useful for backgrounding technological development, to focus solely on the use of market-ready technologies. It is also useful for highlighting questions not addressed by 'broad-brush' evolutionary approaches, such as the MLP and SNM: it asks about the detailed processes involved in the co-construction of technology and society, it introduces a stronger role for agency in the creation of socio-technical systems and creates space for contingency and alternatives. However, moving beyond the household as the unit of analysis has resulted in a challenging and weakening of the conceptual frame (Haddon, 2011). One means to overcome this issue is to draw on the idea of structuration and of multiple context layers from the MLP. This approach is employed below.

In sum, we can analytically locate local embedding as occurring between the societal embedding of technology in wider society and the domestication of technology by users. As a concept local embedding analytical 'sits below' studies on the social embedding of technology (i.e. studies that address national policies, national market formation or deployment, aggregate user experiences and so forth), whilst 'sitting above' studies that address the domestication of technologies by individual users or households. In practice this suggests local embedding occurs in relation to a local 'context', for instance a region, city or community. It is also, most clearly, a process through which singular technologies get integrated in local contexts of use through the alignment of multiple system elements, or what science and technology scholars call socio-technical configurations that work. The 'local' of local embedding can thus emphasise both the geographical situated-ness of the embedded technology as well as the local alignment of technologies, actors and institutions around new socio-technical configurations.

Local embedding can subsequently be conceived as involving multiple system elements that co-evolve over time but not necessarily at the same pace. For instance, there may be end-user demand for a technology but no qualified or trained firms able to fulfil that demand. This points to local embedding as an ongoing process: whilst singular technologies can be appropriated, the multiple system elements that variously comprise local embedding, such as knowledge and knowhow, local market formation processes, policies and so forth, continue to evolve. Local embedding can also be conceived as a contextually and temporally contingent process: broader context dynamics (made up of multiple system elements such as national policy

and industry structures) evolve whilst local policy and culture also develop, changing opportunities spaces.

On the other hand, the inevitable disjuncture between system elements (fitting seamless together) creates a variety of openings for different actors to make moves and interact. This suggests that actors who work between others to broker connections and configure emerging collections of actors, technologies and institutions are particularly important to facilitating local embedding processes. In the following I turn to explore research on these actors, referred to as intermediary organisations.

2.2. Intermediary organisations and local embedding

Interest in innovation intermediaries emerged in the 1990's as the innovation process was realised to be more dynamic and fluid than previously thought (Bessant and Rush, 1995). To date much of the work on innovation intermediaries has been concerned with what they do. As a result, several influential typologies have emerged. The most frequently cited are those by Howells (2006) and Stewart and Hyysalo (2008). Howells (2006) lists 10 functions of intermediaries within the innovation process. He is primarily concerned with intermediation up to the point of commercialisation (sale) and so is less relevant here. In contrast, Stewart and Hyysalo (2008) identify three intermediary processes, which, they argue, can be applied to intermediaries working across an innovation's supply *and* use. In doing so they advance the notion of user-side intermediaries, defined as actors "grounded in an institutional, technical and often physical context" that "attempt to configure the users, the context, the technology and the 'content' [of innovations]". User-end intermediaries thus seek to influence users and developers but do not have a final say in how an innovation is used. Their identification of user-side intermediaries is useful here because they begin to outline the place and purpose of intermediaries in the local embedding processes and offer three succinct, key processes that are thought to define what intermediaries do.

The first of Stewart and Hyysalo's (2008) three intermediary processes is *facilitating*, described as "providing opportunities to others by educating, gathering and distributing resources, influencing regulations and setting local rules". This is achieved, they suggest, by 'creating spaces' of various forms: social spaces where new communities or networks can be formed, knowledge spaces where skills and know-how can be shared, economic spaces where funds can be provided or regulatory spaces where alternative rules may guide actions. Their second process, *configuring*, is conceived as the process through which technologies, projects, users and producers are aligned within networks or projects within a particular place. Configuring, they suggest, can be both technical (aligning multiple technologies into working configurations) and symbolic (providing an interpretation of a technology and its use). Their third process, *brokering*, describes the activities of intermediaries in seeking to raise various forms of support from others (often thought of as sponsors or suppliers). In brokering projects intermediaries may attempt to represent end-users and negotiate on their behalf, they may broker the entry of actors into projects or attempt to maintain influence over emerging rules and practices around a technology, project or vision. Brokering is thought to be one of the most direct ways actors can be brought together (Stewart and Hyysalo, 2008, 306-308). Together these three processes are thought key to understanding what intermediaries do. What remains unclear is whether all three processes need to be performed by the focal intermediary or others for innovation to occur or local embedding to take place.

Within the study of socio-technical transitions similar explorations into the role and functions of intermediaries have occurred. Here, the majority of attention has focussed on intermediary support for the development of alternative niche configurations (Geels and Deuten, 2006; Hargreaves et al., 2013; Kivimaa, 2014). Within this literature only five studies were found which engage with later stages of transition processes. Lente et al. (2003) discuss the potential roles of systemic intermediaries across four phases of transition processes (exploration, take off, embedding and stabilisation). They suggest the embedding phase involves creating system 'momentum', building new/deconstructing old actor networks, the alignment of system elements and learning-by-doing. Within this phase they suggest the following roles: strategy development, pilot projects, project management, preventing strategic games, analysis and advice.

Backhaus (2010, 88) regards the role of ‘independent’ intermediaries in energy transitions as “one of bottom-up policy implementers” and describes their role as specialising in the development, implementation and management of projects and programmes. Schot et al. (2016) argue user intermediaries (intermediaries that are also users of the innovation) play an important function scaling up and mainstreaming niche technologies by creating spaces for appropriation and by aligning elements of emerging socio-technical systems. They do not investigate how this work is undertaken in practice. In a similar vein, McCauley and Stephens (2012) suggest a potential role for intermediaries in diffusing technologies but do not explore how. Finally, Hodson and Marvin (2009) focus on systemic intermediaries working within cities. They argue intermediaries may actively seek to position others and build actor networks to pursue local transitions and that intermediaries may help develop place-based images of technological transitions (and subsequently play a critical role mediating between these technological possibilities and local contexts) (Hodson and Marvin, 2009). Collectively, this research provides useful insights into the work intermediaries do and, specifically, their potential to support local embedding processes.

Less developed within research on innovation or transition intermediaries, is an understanding of the context in which they operate. Stewart and Hyysalo (2008) argue two features of an intermediary’s environment that make them stand out from other actors: (1) they operate in an environment in which technological change, market organisation and user uptake is unpredictable and (2) they operate in the absence of existing linkages between potential users and suppliers (Stewart and Hyysalo, 2008). These features conceptually situate intermediaries within the innovation process and point to their role in configuring actors and technologies. In contrast, Backhaus (2010) has developed a practical conceptualisation of intermediary activity as taking place within a ‘multi-layered’ context (Figure 2). Each layer consisting of stakeholders and ‘conditions’ that may influence an intermediary’s success or failure: the targeted activity sits at the centre, surrounded by the target user group, followed by the local project context and finally broader context. This conceptualisation offers a means to situate intermediary organisations and in doing so links to the idea of structuration within socio-technical transitions research. A weakness is a disregard of time: here, context is static.

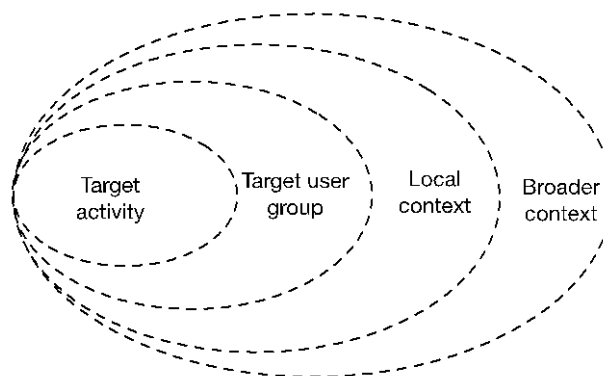


Figure 2: Conceptualising the context of intermediaries
(Author’s own visualisation based on Backhaus, 2010)

Overall, this research shows intermediaries can take a variety of forms, including as individuals or networks as well as being public, private or third sector organisations (Bird and Barnes, 2014; Gliedt et al., 2018). They can operate at various geographic scales (Bush et al., 2017) and at different stages of a transition (Kivimaa et al., 2017). This suggests a plurality of actors may perform the functions of an intermediary at any given point in time. For this reason, it is generally agreed that it is not the type or size of actor that makes it an intermediary but, rather, the relational work it performs and in what context (niche development or domestication for instance). In local embedding intermediaries can subsequently be defined as any actor seeking to mediate between others and align multiple system elements into place-specific configurations

that work. In practice, this suggests intermediary organisations can be thought of as working between technologies, infrastructures, governance actors, regulations, producers and end-users. It suggests they may undertake a variety of roles, such as the provision of advice, project management, finance and coordination, coordinating demonstrations or lobbying, supporting network-building, knowledge dissemination, or providing training and skills development. It also suggests that they may work over short or long timescales (a few months to years or even a decade) and that they may operate on a project basis or take up more systemic coordination and governance roles.

2.3 Analytical framework: local embedding by user-side intermediaries

To understand the agency of intermediaries in local embedding I combine insights from the three literatures discussed above. The resulting analytical framework proposes an ideal-typical sequence (or pattern) to intermediary processes.

The intermediary's context of action can be conceptualised as comprising three interlinked analytical layers. The local socio-technical system constitutes the primary focus of analysis and is particular to the local geography, natural resources, local governance structures and actor networks. Due to existing social, economic, political and ecological relations each system is endowed with different resources and capacities (Hansen and Coenen, 2015; Hodson and Marvin, 2009; Sengers and Raven, 2015). The local socio-technical system encompasses other stakeholders (such as local governments, local industry, housing associations, social groups and social movements) as well as target end-users. It is subsequently defined by all those elements that directly influence the emerging socio-technical configuration. Second, communities of end-users sit nested within the local system. End-users are neither static nor homogenous and have multiple ways of thinking and acting (Backhaus, 2010). Through their energy activities and daily practices, end-users can change tangible elements of the local system. The local system is in turn situated within larger system aggregations and influenced by broader social, economic and institutional structures which constitute the third layer or 'external environment' (following Raven et al., 2008). This level includes regime problems and discussions, culture and politics and debate, which exert influence on all other layers. National government policies and regulations alongside market institutions exert influence (Raven et al., 2008) whilst broader dynamics of technological change and user uptake are expected to influence local contexts of action (Stewart and Hyysalo, 2008). Together these layers function as an affordance, enabling and constraining the local embedding of technologies by intermediaries.

To understand the agency of intermediary organisations in local embedding I mobilise Stewart and Hyysalo's (2008) three key intermediary processes. To situate these processes contextually and temporally two additional elements are introduced. First, intermediary activity is initiated by an identified opportunity. Actions are rarely arbitrary but are undertaken with intent following the identification of a perceived opportunity. Second, intermediary activity produces outcomes, whether intended or unintended or of major or minor significance.

With these two additions, I propose an ideal-typical sequence to user-side intermediation for local embedding:

1. From a basic set of aims intermediaries draw upon their knowledge and experience to identify opportunities. This involves interpreting and contextually situating national policies and market dynamics within their local system and drawing on their experience of and connection to end-users.
2. From an opportunity, a project is *configured*. Configuring involves interpreting the technology and its use within the local system, the development of place-based images of potential socio-technological futures and the configuring of users and stakeholders (Hodson and Marvin, 2009). Technologies have to be assembled in particular configurations within the local context: such configuration is technical but also symbolic (providing an interpretation of the technology and its use), social and institutional (creating new ownership and management structures) (Stewart and Hyysalo, 2008).

3. Having configured a project, intermediaries seek to *broker* support from various local and external stakeholders as well as their target audience. Brokering is important for a variety of reasons. In the early stages of local embedding, technological visions are explored with local stakeholders and expectations are developed (Raven et al., 2008). Intermediaries may broker the entry of local actors into their place-based technological vision (Hodson and Marvin, 2009), increasing credibility and access to resources. Brokering negotiates resources with which to undertake projects. However, brokering is not simply one-way. Interactions with stakeholders may reveal alternative interpretations of the technology, local contexts and visions and may reveal competing ideas about the appropriate form of projects. Brokering, therefore, is likely to result in alterations to the design and aim of projects. It is in this sense that brokering can often result in the *re*-configuring of projects because intermediaries have to be responsive to others.
4. Following a period of configuring and brokering, intermediaries undertake their projects and in doing so begin creating a variety of *facilitation* spaces. Examples might include events, awareness raising campaigns, workshops, demonstration projects and so on.
5. Finally, facilitation activity results in outcomes on local embedding, such as increasing user knowledge or awareness and creating new socio-technical configurations.

This sequence can be characterised as ideal-typical because (1) each step accentuates a distinct intermediary process, (2) it situates key intermediary processes according to what necessarily comes before, and (3) it encompasses what might be expected in a theoretical case. This sequence adapts and extends Stewart and Hyysalo's (2008) framework by situating key intermediary processes over time. Figure 3 is a visual depiction of this framework. In the next section the research approach is outlined before this framework is tested against two case studies.

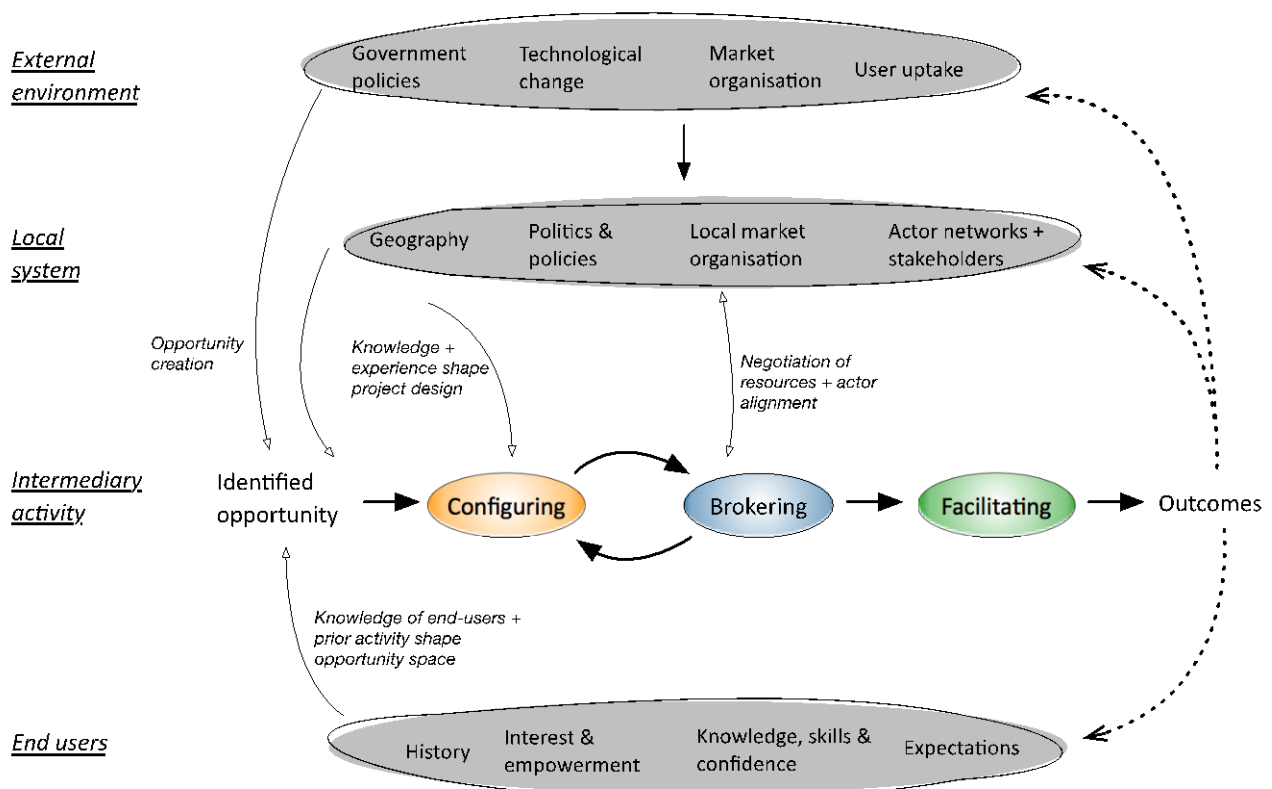


Figure 3: Intermediary processes in local embedding (Authors own figure)

3. Research methodology

Research seeking to understand how innovation and change unfolds typically employs a ‘process approach’ (e.g. Geels and Schot, 2010; Verhees et al., 2015). Process theories are particularly suited to understanding how processes unfold. Their strength lies in following actors over time as they interact in sequences of events embedded within particular contexts, which limit their information and influence (Abbott, 1992; Pettigrew, 1997). Process theories subsequently focus on constructing narratives (c.f. identifying variables) but rather than simply writing descriptive narratives, process theories aim at case studies that interpret and explain the process under study through analytical concepts. Process theories subsequently seek to explain outcomes in terms of patterns and mechanisms (Pentland, 1999; Pettigrew, 1997).

To illustrate and refine the concept of local embedding and the agency of intermediary actors in the process two case studies are employed below. The cases were chosen as two instances where a focal actor operating between others sought to deploy the same focal technology but using different means, whilst also seeking to influence the wider context of action. The two cases also display differing outcomes and thereby create a space through which to refine understanding. Each case study was built up through (1) a series of semi-structured interviews with intermediary actors, project partners and citywide actors, (2) document analysis, both internal to the project and relevant external documents from the local system and external environment, and (3) participant observation. By ‘following the actors’, the local embedding processes was observed as it unfolded. Key intermediary processes were identified from the activities intermediaries undertook whilst analytical context layers were allowed to emerge from each case.

In the following each case is introduced through the use of visual mapping (Langley, 1999) and a case narrative, which uses the proposed ideal-typical sequence to key intermediary processes as the analytical guide. The aim is twofold: to illustrate and refine the process perspective and to further substantiate the concept of local embedding.

4. Comparative analysis of two intermediary projects: locally embedding solid-wall insulation

The following case studies explore two actors’ attempts to locally embed solid-wall insulation within Bristol, UK. Solid-wall insulation (SWI) covers a variety of technologies that reduce heat loss through walls of a solid construction, a building technique prevalent in the UK up to the 1930’s². In 2014 seven million solid-walled houses were estimated to be in need of insulation in the UK (CCC, 2014). Since then deployment has remain low (CCC, 2018) and the UK market for SWI has remained ‘embryonic’ (DECC, 2012). Current challenges include reducing the cost of installation, creating user awareness and demand for the technology, supporting the formation of new installation contractors and streamlining the planning process. Further installation challenges include overcoming weather-related delays and effective project management. There is a growing consensus that SWI will require area-based, local action to develop necessary linkages between system elements (Banks and White, 2012; Boardman, 2008; CCC, 2012; DECC, 2013; Mallaburn and Eyre, 2013).

4.1 Tackling a Terrace

Between December 2011 and August 2012, Bristol Green Doors (BGDs), a Community Interest Company, designed and oversaw the deployment of a SWI demonstration project, on a terrace of six houses. BGDs had been formed a year earlier to promote the retrofitting of households in Bristol. The demonstration was designed to run alongside existing activity (the holding of eco-open home events in which householders who have installed retrofit measures open their doors to the public to share their experience). Figure 4 provides a visual map of the project (a key to the map is provided in annex A).

² SWI can be undertaken internally resulting in reduced living space or externally requiring planning permission and potentially altering the appearance of the property. Hybrid systems combine both internal and external insulation.

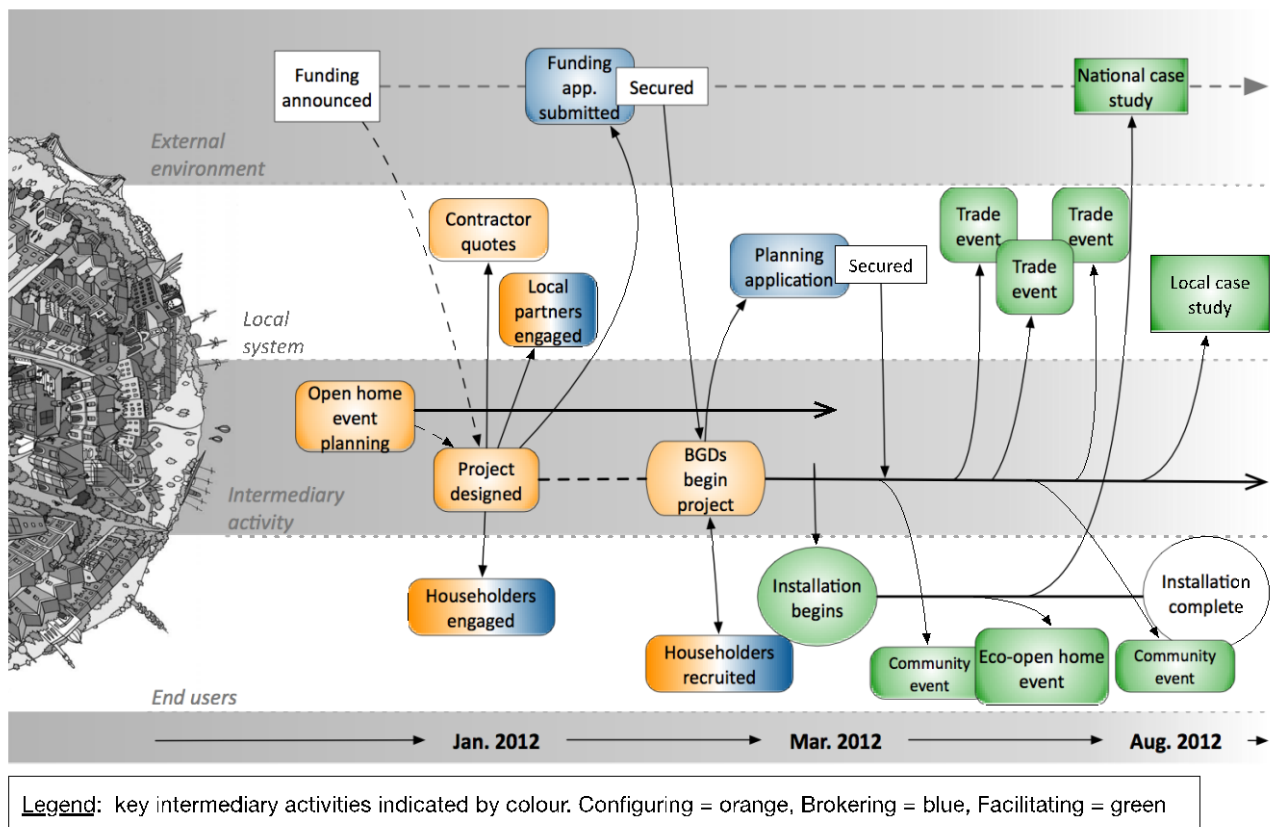


Figure 4: A visual map of the Terrace project, including key intermediary processes
(Authors own figure, image: Bristol Green Doors CIC)

4.1.1 Identifying an opportunity

In December 2012 the UK Department of Energy and Climate Change (DECC) announced short-term funding to support energy efficiency activities. For BGDs the funding presented an opportunity to demonstrate SWI to residents, to trial multi-property installations and to engage and educate additional householders, communities, local industry (specifically building trades) and local and national policy-makers in the technology. The demonstration was thought essential in a city where there were few certified installers and where 36% of properties were solid-walled terraces. A demonstration project, they believed, had the potential to raise interest in the technology and prepare the city for the planned launch of the Green Deal (a new national government policy) in 2013.

In identifying this opportunity, BGDs drew on knowledge of material characteristics of the city and of national government policy and ambitions as well as knowledge of prior deployment rates. They also drew on their experience of holding eco-open home events and ideas about what was required to support the further deployment of the technology (e.g. local industry formation).

4.1.2 Designing a SWI demonstration

BGDS led the funding bid. The project had three aims: (1) install external SWI to a terrace of six hard-to-treat properties, (2) engage 300 members of the public in the project during an open-home event, and (3) engage community groups, local authorities, local businesses and professional bodies in multi-property SWI installations and how to deliver them. To submit a bid BGDs secured interest from householders on the terrace, negotiated with potential contractors and secured letters of support from the local authority, trade associations and community partners. The bid was submitted within two weeks. It included three quotations to deliver the works but argued the preferred contractor could not be agreed without further input and consent of householders, who were asked to contribute 20% to the works. Funding was awarded in mid-

January 2012.

In this period BGDs configured the technology and project in the local context and brokered financial support. The design of the project was influenced by the funding they sought, the existing material characteristics of the terrace and resident expectations. Combined with ideas about what the project should achieve (e.g. engage multiple actors), BGDs interpreted the technology and its use within the local system.

4.1.3 Negotiating the project with householders and local planning rules

With funding BGDs then had to secure formal agreement from householders. On the 19th of January 2012 the project plan, financing, expectations of their involvement and next steps were discussed with terrace residents. Contracts were sent out a few days later. A contractor (who agreed to the award payment schedule) was then chosen. For householders, one contentious issue was extensions to existing window sills. The Victorian terrace included stone windowsills (plus some concrete replacements), which the householders were keen to retain. As a compromise the contractor suggested using concrete extensions using steel Reid bars, whilst the alternative, to add new sills by removing and then replacing the windows, required additional time and disruption, plus rising costs. Concrete windowsill extensions were agreed as a compromise solution between contractor, residents and BGDs.

Local planning regulations also had to be negotiated. The terrace was not in a conservation area nor were the houses listed. Despite this, planning permission was required on the side elevations. An application was submitted on 30th January and a positive decision received on 9th March, two weeks earlier than expected and helped through by supportive local councillors making 'judgment calls' about the project's limited visual impacts and its compliance with local sustainability criteria (brokering).

Each of these instances presented further detailed configuring and brokering of the project, against householders and then local planning rules. Each instance provided further detail to the form and shape of the project. They did not, as such alter the broader design of the project (how it was configured) nor its financial basis (how it was brokered), which came before.

4.1.4 Installation and engagement

In mid-February and whilst planning consent for the side elevations was secured, work commenced on the rear elevation. Scaffolding was erected and supporting works undertaken. Completing the works took longer than expected due to the weather being too cold in spring and too wet in summer, both incidents delaying the application of render. The works were finally completed in August 2012, five months behind schedule. Post installation surveys were undertaken and revealed modest improvements in building energy performance.

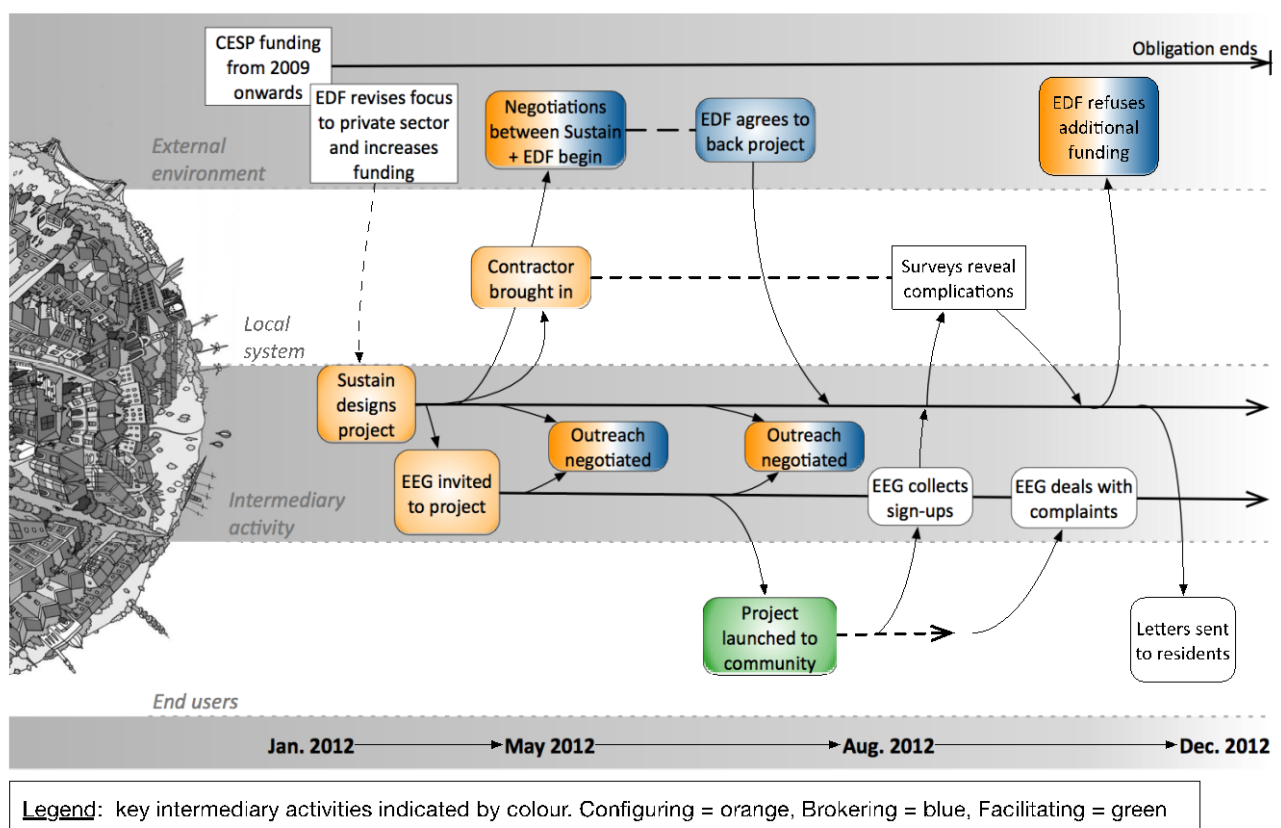
From late February onwards, events to engage community groups and local building trades began in earnest. Regular newsletters and a blog communicated progress and lessons as the project got underway. A local newspaper covered the start of the project and promoted the eco-open home event. Then, in mid-March two of the terrace households opened their doors to the public as part of BGDs' citywide open homes event. Approximately 150 people visited the terrace over two days, including the local MP. In addition, 2,700 people visited the demonstration project website in the run up to the event. The following week the terrace was visited by the fund administrator and resulted in two national case studies. Two further events were held with local and regional buildings trades in mid-April and late June. In May, a second event to local community organisations communicated progress and lessons about the terrace, whilst broader lessons were shared at a meeting with DECC. Two further case studies were produced by national intermediaries to disseminate lessons as well as two videos, receiving 700 and 900 views respectively over the following two years.

This final period is dominated by facilitation processes. The installation of SWI at the terrace being BGDs'

primary facilitation activity: BGDs provided terrace residents with the opportunity to participate and have subsidised SWI installed. They mediated between government funding, the technology and the terrace residents, facilitating the deployment of technology by introducing the opportunity (the technology, financing and energy saving) to residents. This involved channelling funds to the benefit of householders (financial facilitation), the support of an existing community (terrace residents) and the creation of rules for the duration of the project such as 20% householder contribution, the monitoring of energy use and householder involvement in the open home event and external publicity (regulatory facilitation). A second form of facilitation can be observed in the city-wide open home event, in which two households from the terrace participated. The event disseminated knowledge about the demonstration project and the technology to local residents, providing an opportunity to learn first-hand and during construction about the technology and its implementation. The event turned the terrace into a material demonstration, it created a space in which knowledge, learning and experience could be shared between users and non-users and it attempted to create new social networks (between participating homeowners, event volunteers and visitors). A third and final form of facilitation is evident in the range of further events undertaken. Different events targeted different audiences. As a means of facilitation each event was defined by the transfer of knowledge to others: each event provided an opportunity to others to learn about SWI and its deployment.

4.2 Insulating a community

Between May and December 2012, Sustain, a Bristol-based SME and Easton Energy Group (EEG), a community group, attempted to design and implement an efficiency project in the Easton, a neighbourhood in Bristol. The project sought to utilise government-obligated funding from a national energy supplier to deliver a range of energy efficiency measures to local households. SWI was primary measure on offer. Figure 5 provides a visual map of the project.



4.2.1 Identifying and configuring the project

The project was designed and led by Sustain, a consultancy who had 15 years' experience in carbon reduction projects, on behalf of EDF, in order to help EDF meet their obligation under the Community energy saving program (CESP), a government obligation on large energy suppliers to improve the energy efficiency of houses in the most deprived geographical areas in the UK. The project focussed on tackling the private sector (previous work under CESP had tended to focus on social housing) and aimed to install SWI on 100 households. SWI was central to the project viability: for reducing carbon emissions, meeting government targets and making the project financially viable, SWI had to be installed at each property.

To engage local residents, Sustain invited EEG to act as their outreach and engagement partner. EEG were approached as a trusted local actor and potential bridge between the project and local residents. To EEG the project allowed them to scale up activity and potentially make a significant material difference to their local community. They also saw the project as an opportunity to (a) learn about private sector retrofit, and (b) engage the community in retrofit and the government's new policy programme, the Green Deal.

In identifying and configuring the project Sustain drew on their prior experience of deploying SWI, their knowledge of the city and of the national funding programme as well as energy company activity.

4.2.2 Negotiating and re-configuring the project

Over the following months the project was negotiated in two parallel tracks. First, between Sustain and EDF. Debate centred on the scope and financing of the project, how many households would be involved and how much carbon would be saved (thereby fulfilling EDFs obligation under CESP). Costs were modelled on Sustain's prior experience of deploying SWI on social housing and a limited number of household surveys. Agreement was finally reached in mid-September, leaving less than three months to recruit and install SWI at 100 households.

Within the second track Sustain and EEG negotiated the means to engage local residents, remuneration for such work and whether the project could create any additional benefit to the community beyond the material deployment of SWI to 100 households. Two distinct rounds of negotiation were held. Between May and June EEG proposed to assemble a network of locally-based 'energy champions', sourced from various sections of the local community (Muslim, Somali, elderly etc), in order to engage local residents and sign-up households to the project offer. Sustain liked the approach but refused to finance it, viewing it as beyond project needs. Then, between September and October and as a result of time pressure, EEG proposed to use community door knockers to sign up local residents.

During this period the project was negotiated by Sustain against EDF and EEG. Sustain sought to enrol these actors to the project and configure a viable insulation offer. For their part, EEG drew on knowledge of the local community to propose an outreach method thought most appropriate and attempted to negotiate the resources to back it. Shortening timeframes then forced EEG to redesign its approach.

4.2.3 Delivering the project

In mid-August EEG launched the project to the community (before Sustain had secured agreement from EDF). To EEG street parties, festivals and community events all provided a good opportunity to engage local residents. Sustain reluctantly agreed and a 'soft' launch was undertaken. 30 households quickly signed up as a result of this activity with a further 20 trickling in over the following month.

Household surveys began in October and revealed a number of issues. Prime amongst these was the range and extent of modifications to the rear of each property, increasing the price of installing SWI. Asbestos was also identified at some properties and in many cases the proposed works failed to meet residents' expectations of finish quality. Collectively, the range and extent of these complications was described as 'unforeseen' and attributed to the difference between social and private housing. Without SWI, the project

was unviable. In early December letters were sent to households explaining why the project had been halted. Prior to this EEG had to deal with multiple inquiries and complaints about why there were delays and when installation would begin. For their part, Sustain were reluctant to pull the plug and tried, unsuccessfully, to negotiate a higher price per install with EDF.

This final period features some limited facilitation activity, primarily undertaken by EEG through engagement of the local community, followed by further configuring and brokering before the project collapsed. EEG used local events to create a space in which local householders could learn about SWI and the project. Such facilitation was curtailed, first by Sustain's reluctance to fully launch the project and second, by the complications revealed in householder surveys. Such facilitation activity as there was, nevertheless resulted in some householders signing up, which in turn led to a reconfiguring and brokering of the project when complications arose. These latter instances of configuring and brokering represent a return to the original project plan and its negotiation. They also suggest the development of a new cycle of intermediary activity.

5. Discussion

In the following I return to the two research questions posed: what is the role and agency of intermediary organisations in local embedding and can key patterns be observed?

5.1 Intermediary organisations in local embedding

From the three literatures discussed above I argued intermediary organisations can be identified by the relational work they perform in a particular process. As a result, intermediary organisations in local embedding were defined as any actor operating between others to align multiple system elements into place-specific configurations that work. On this basis, a variety of intermediary organisations can be identified within the case studies.

Within the Terrace project a single, focal intermediary can be identified. BGDs initiated and configured the project, brokering the engagement of stakeholders and participants and creating a variety of facilitation spaces in which others could learn about the technology and its deployment. BGDs operated between these parties, seeking to create connections for both the material deployment of the technology and the wider embedding of the technology within the local socio-technical system. Whilst, BGDs can be identified as the primary intermediary, others are also identifiable playing supporting roles. Trade events were co-organised with local build suppliers, whilst project case studies were written by others at both local and national scales. These additional actors can also be conceived as intermediaries in the local embedding process because they operate between others and seek to support the embedding of the technology. Within the community project, two actors can be identified as intermediaries. Sustain configured the project, building a coalition of actors to deliver it and negotiating finance from EDF. Meanwhile, EEG was brought in as 'a bridge' between the project and the local community. EEG were responsible for engaging local residents with the project and the technology. They also sought to extend the project by attempting to negotiate additional resources to support the wider embedding of the technology beyond its material deployment.

As a result, multiple intermediaries can be identified within the two case studies. Each share distinct characteristics of mediating between others in an attempt to facilitate connections that will aid the local embedding of the technology. This supports and extends prior work on intermediaries (e.g. Kivimaa and Martiskainen, 2017) where a range of actors have been found to undertake activities that can be conceptually described as intermediaries. It also suggests it's not who the particular actor is, that makes it an intermediary but how it operates within a particular process. In turn, this suggests that an intermediary's primary role in local embedding is to facilitate the alignment multiple system elements. To understand the agency of intermediaries I turn to the proposed process model.

5.2 Examining the process model

As well as beginning to unpack the agency of intermediary organisations in local embedding the proposed

model provides an answer to the second question. Below I answer this question on the basis of the case studies. Particularly useful here are the two visual maps, which present overviews of the two projects and in which key intermediary processes are distinguished by colour.

Overall, the two cases present a strong fit to the process model. Both were catalysed by the identification of an opportunity by an intermediary organisation, before each project was designed (that is configured) and brokered against others. Facilitation spaces in which opportunities were created for others, then followed. This sequence is more easily identified in the Terrace project than within the Community insulation project. The central explanation for this is that the second case was unsuccessful. The Community project features multiple rounds of configuring and brokering, first in designing the overall project, later in the particular outreach approach adopted and finally as a result of complications. Only one period of facilitation occurred when the project was introduced to local residents.

Together, the two case studies suggest the proposed sequence has validity and is able to explain a variety of developmental sequences without modification of its central character. They also demonstrate how the sequence is not linear: there can be movement backwards and forwards or a cycling of key intermediary processes. Particularly prominent was a cycling between configuring and brokering activities. In the Terrace project this manifested as a move from broader project design, through negotiation with others to more detailed project negotiation. In the Community project such cycling between activity occurred in response to changing project conditions (principally shortened timeframes) and complications. Overall, the degree to which the model explains the case studies suggests the proposed intermediation sequence can be predominant. Alternative or different orderings of configuring, brokering and facilitating may occur in other projects or there may be feedback loops between key processes (e.g. Hakkarainen and Hyysalo, 2016). To substantiate and extend this sequence further work with alternative technologies and in alternative contexts is required.

Thus, one story told through the model is about user-end intermediation processes: how intermediaries identify opportunities, and then configure and broker projects, technologies and actors to facilitate the local embedding of a focal technology. Each of the five steps can be viewed as typical stages to intermediary project development. Each step builds on the former: facilitation spaces, whether material, social or knowledge-based require some degree of configuring and decisions have to be made about their purpose and form. Meanwhile, and at the very least, resources must also be brokered in order for the spaces to be realised. The Terrace project presents one cycle of this sequence, the Community project one and half cycles.

Situating intermediary activity within a dynamic layered context helps demonstrate the limited agency of intermediaries in local embedding. Intermediary actions are enabled and constrained by dynamics across layers. The external environment acting as a background influence. The design and implementation of government policy or funding provide examples of events and dynamics that are clearly beyond the control of intermediaries but provide opportunities which can be seized. In turn, these broad events and dynamics are situated by the local system according to local conditions (geography, politics, market conditions etc.). Intermediaries have greater, although still constrained influence over developments at the level of local socio-technical systems. Target users further enable and constrain intermediation in subtle but significant ways. Overall, this suggests that intermediary organisations have constrained agency to influence the development of new socio-technical configurations. It also suggests intermediaries need to be flexible and adaptable to evolving context dynamics and opportunities. Thus, a second story told by the model is about multiple layers creating a dynamic context for local embedding. Each layer interlinked but evolving in its own way, exerting influence over the opportunities and possibilities for intermediation.

In sum, I conclude the proposed model holds value for understanding the role and agency of intermediary organisations in local embedding, the model linking key intermediary processes temporally and situating

intermediary activity contextually.

6. Conclusion

This paper started by identifying a key societal issue: a variety of low carbon technologies currently exist that could, if deployed throughout society, make a substantial contribution to reducing the carbon intensity of existing lifestyles (Afanador et al., 2015). Realising this potential, it was argued, is not simply a question of diffusion but of learning about how technologies may get taken up and integrated into increasingly sustainable socio-technical configurations. This process was defined and substantiated as local embedding. Intermediary organisations were subsequently identified as influential actors in the process working to connect system elements.

The paper subsequently posed two related questions: what is the role and agency of intermediary organisations in local embedding? And are there patterns to key intermediary processes? To answer these questions a process model on the agency of intermediary organisations in local embedding was developed. Applying the proposed model to two case studies we learned that deviations exist. Together the cases suggested the sequence to key intermediary processes is semi-linear. It can thus be thought of as ideal-typical, in the sense it has internal logic and might be expected of an exemplary case. Alternative orderings may also occur, as might additional feedback loops between processes. At its centre the proposed model, intermediary organisation's primary role is conceived as seeking to align multiple system elements into configurations that work. Their agency was explained through three key intermediary processes – facilitating, configuring and brokering – and through situating these three processes temporally and contextually, within a dynamic, multi-layered context. Because user-end intermediaries operate between others and within a dynamic context, they have limited control over the various elements they are trying to align. To further qualify and extend the model more case study work is necessary.

More broadly, insights from socio-technical transitions research and domestication studies have also proved valuable in enriching and substantiating the process of local embedding. Conceptually, local embedding concerns how technologies get taken up, are adapted and used at a scale above the appropriation of technology by households but below the social of embedding of technology in wider society. More specifically, it concerns the alignment of multiple system elements within emerging place-specific socio-technical configurations. In this sense, local embedding thus builds upon the shared foundational notion of the co-construction of technology and society. Focussing on the role of intermediaries in local embedding the paper foregrounded key intermediary processes over local embedding processes. As a result, future research could inquire into and refine key local embedding processes (momentum building, alignment etc.) or it could explore socio-spatial conditions that enable specific locations (cities or regions) to build momentum behind particular, low carbon socio-technical configurations. Either way, a focus on local embedding will helpfully extend attention downstream, away from the development of the new, to the utilisation of existing low carbon solutions.

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Annex A: Guide to visual map

The visual maps provide an overview of the main events, installations and activities within each case study on a single figure. Each map is composed of:

- 1. Boxes** - each box containing brief descriptions of the main events within the case study relevant to the local embedding. Round-cornered rectangles present activities carried out by intermediary organisations. Ovals represent material installations of the focal technology. Square-cornered rectangles present events and decisions taken by others.
- 2. Four horizontal bands** - Each event, installation and activity can be classified as occurring in relation to an analytical context layer, represented by the four different horizontal bands on the map. The lower central band to which all boxes are connected contains the activity of the intermediaries.
- 3. Arrows** - Vertical arrows leading from one domain to another indicate direct influences from events, installations and activities on subsequent events, installations or activities. Horizontal arrows within bands are used to indicate continuity of activity over time. Continuous arrows show strong and stable activity over time. Dotted horizontal arrows show disruption and disturbance within the activity.
- 4. Time scales** - the time scales along the bottom is distorted in order to keep the size of the charts to a minimum whilst including periods of high velocity events.

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