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# Emerging linked ecologies for a national scale retrofitting programme

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# Emerging linked ecologies for a national scale retrofitting programme: the role of local authorities and delivery partners

**Abstract**

Energy Efficient Scotland (EES) is the Scottish Government's flagship programme for the national-scale retrofitting of buildings over the next 15-20 years. This is a critical component of Scotland's commitment to net zero greenhouse gas emissions by 2045, that will also help to reduce fuel poverty and improve local economies. The success of EES is reliant on partnerships between local authorities, arms-length external organisations, charities, and social enterprises. However, little is known about how these organisations collaborate for the delivery of building retrofit. This paper analyses interview data from local authorities and these delivery partners, conceptualising them as part of *linked ecologies*, or interconnected networks of professional groups. EES is identified as a *hinge* that holds distinct meanings for different parties; it supports learning between local authorities and delivery partners, but does not guarantee the alignment of priorities. The concept of *avatars*, or individuals and skills that travel between organisations, reveals the search for relevant internal knowledge amongst local authority officers, whilst external delivery partners amass expertise for retrofitting. To ensure successful national-scale building retrofit, policy makers will need to develop shared databases, and clear guidance for the allocation and distribution of resources and responsibilities between local authorities and delivery partners.

**Highlights**

- Local authorities and third sector organisations partner to deliver building retrofit.
- These influential middle actors form networks defined here as linked ecologies.
- Local authorities and delivery partners have differential expertise and priorities.
- Policy guidance should include clarity over division of responsibilities.
- Policy makers should develop shared building energy efficiency databases.

## 1    Introduction: retrofitting for energy system transformation

Meeting the Paris Agreement goal of limiting global temperature increases to less than 1.5°C above pre-industrial levels means rapid reductions in carbon dioxide emissions. A major contribution must come from retrofitting the entire building stock to radically reduce the need for energy for heat and power (CCC, 2019). Even in Europe, which has taken a lead in policy and incentives, changes have been incremental and mostly focused on one-off low cost measures such as loft insulation, rather than whole building solutions. This is despite "the deep and almost complete renovation of the existing European Union (EU) building stock by 2050" being an essential component for meeting long-term energy and climate goals (BPIE, 2013: 52). No European country has yet devised a comprehensive policy and institutional framework to achieve the scale and standard of retrofitting needed (Rosenow, Kern & Rogge, 2017).

There is however a unique experiment in Scotland: building energy efficiency has been designated a national infrastructure priority. The Energy Efficient Scotland (EES) programme is the cornerstone of efforts to meet carbon budgets through the large-scale centrally coordinated upgrade of every building over the next 15-20 years (Scottish Government, 2018a; Scottish Government, 2018b). Currently in its pilot phases, the programme aims to reduce emissions by 23% and 59%, and achieve 15% and 20% reductions in heat demand, on 2015 levels in residential and services buildings respectively, by 2032 (Scottish Government, 2018b). Local authorities are being positioned as the primary actors to deliver EES: they will coordinate retrofit in the social rented sector and non-domestic properties that they own or manage; they are explicitly tasked with developing engagement strategies to encourage retrofit of businesses, private rented and owner occupied homes; and they will develop strategic plans which cost and prioritise areas for retrofitting and heat decarbonisation, based on socio-economic assessment (Scottish Government, 2019a).

Energy Performance Certificates (EPC) are the primary metric through which the programme's success is being monitored. EPCs provide a rating for the energy performance of a building on an A-G scale, with A being the most efficient; the overarching aim is that all Scottish homes achieve an EPC of C (where technically feasible and cost effective) by 2040 (Scottish Government, 2016a). Phased EPC targets for different building sectors are outlined in Appendices 1 and 2. Programme progress will be monitored through an EPC database, and proposed revisions to the Climate Change (Scotland) Bill, and Building Regulations will help to enforce activity (see Appendices 1 and 2 for timings of these). This paper focuses on the retrofitting aspects of the EES programme. The measures supported by EES to date include: External Wall Insulation; glazing; heating replacements and control upgrades; lighting replacements and upgrades to Building Management Systems; the installation of heat pumps; and the extension of district heating networks (see Appendix 3).

For the delivery of the EES pilot programme, the majority of local authorities have bid for funding to perform area-based retrofit projects, and then organised a network of delivery partners and contracted installers. This paper does not consider the building professionals and installers that may be procured to perform works. Instead, it focuses on organisations that work *alongside* local authorities for strategic planning and management. These partners include third sector organisations such as charities and social enterprises, and arms-length external organisations (ALEOs). Although local authorities have been recognised as important for energy retrofitting in different contexts (see Literature Review), the relationship dynamics between local authorities and these delivery partners, and the implications for energy retrofitting, have not been discussed in previous research. This includes the ways in which knowledge, skills, and responsibilities are distributed amongst these groups, and how this is likely to shape the design and delivery of large scale building retrofit. Such insights are crucial for scaling up these pilots into a comprehensive national programme, identifying lessons for retrofitting schemes in different contexts, and achieving climate change targets.

This paper positions local authorities and delivery partner organisations as middle actor groups critical to the

development and delivery of the EES pilots (Parag & Janda, 2014). Local authorities and delivery partners are middle actor groups in that they are influentially positioned between national government and the property owners and occupants affected by retrofitting. The paper applies concepts from Abbott's (2005) *linked ecologies* in order to understand the interlinkages, roles, and responsibilities at play between local authorities and third sector organisations in their middle position. The paper first elaborates on local authorities' and partner organisations' changing roles in energy retrofitting, before outlining the interview strategy used for data collection and subsequent analysis. Two specific ideas are explored through the results section: *hinges*, the issues or strategies that can operate within different ecologies at the same time, and *avatars,* or the replication of the ideas and skills of one profession into a new ecology. The *hinges* and *avatars* at play between local authorities and delivery partners offer a lens through which to understand the complex relationships emerging amongst the middle actors responsible for coordinating retrofit projects. The implications for effective retrofit and future research are discussed towards the end of the paper. The conclusions identify suggestions for policy makers developing wide scale retrofitting programmes.

## 2    Literature review

### 2.1    Local delivery of national policy

Much recent policy development in Europe has stemmed from the EU Energy Efficiency Directive (EED) 2012 (amended 2018). The EED requires EU Member States to develop and implement national energy retrofitting strategies. However, the development of programmes and evaluation of effectiveness based on actual energy performance of buildings have been limited, leading to calls for integrated policy frameworks and delivery structures (Kern, Kivimaa & Martiskainen, 2017). A common pattern is for policy instruments to accumulate over time, with varying levels of commitment to local planning and implementation, and limited coordination across local and central governments (Kivimaa & Martiskainen, 2018). An overview of compliance with the EU EED and progress towards retrofitting in five European countries: Bulgaria, Croatia, Germany, Romania

and Slovenia identifies differential consideration of devolved strategies (BPIE, 2018). Planning in Romania and Bulgaria incorporates funds to support training, and the development of administrative capacity at the municipal level, whilst in Slovenia local energy planning policy enables communities to tailor solutions to their needs. Galvin (2012) finds that low uptake of the German Federal government's Energieeinsparverordnung (EnEV) thermal standards in domestic buildings is a consequence of a push to mandate standards without developing detailed understandings of the existing building stock, for which local knowledge might have been beneficial. He also notes that German municipalities have additional programmes for promoting retrofit, with some following the Federal programme whilst others "contradict or circumvent this logic" (2012: 58), but provides little detail on how this variation influences the outcomes of retrofitting programmes. In addition, the failure of the UK Government's Green Deal national retrofitting programme has been attributed in part to central government not supporting the development of supply chains or engaging with local actors (Rosenow & Eyre, 2016; Gillich, Sunikka-Blank & Ford, 2017).

The prevalence of highly distributed, small and medium scale actors in retrofitting supply chains, and diversity of the building stock means that "regionally flexible policy implementation" is appropriate for wide scale energy retrofitting (Kerr & Winskel, 2018: 47; Killip, 2013). Within the Repair, Maintenance and Improvement (RMI) market, with works primarily delivered by sole traders, local networks are important for securing jobs, gaining knowledge and collaborative working across trades (Maby & Owen, 2015). In addition, activities at local levels can surpass ambitions at national level and catalyse activities in neighbouring regions (BPIE, 2013). Retrofitting schemes customised to local circumstances can also be more successful than nation-wide strategies (Gillich, Sunikka-Blank & Ford, 2018), and it has been suggested that national schemes need to provide room for facilitating municipal action (Gram-Hanssen, Jensen & Friis, 2018). Localities were found to be most active for retrofitting in Sydney, Australia, whilst federal and state level responses were more reserved amidst national climate change debates (Dowling, McGuirk and Bulkey; 2014). In Canada, the success of the Residential Energy Efficiency Project in the Waterloo region has been attributed in part to "local community-based partnerships

that were outlined in pamphlets" (Hoicka, Parker & Andrey, 2014: 596).

In keeping with this, the CCC have suggested that "local and regional authorities are well placed to drive and influence emissions reductions" (2019: 127). Modelling of city-scale retrofitting suggests that local authorities will have a role to play, whether through financing, entering into public-private partnerships, or supporting private sector investment through creating favourable planning conditions (Gouldson et al., 2014). Public authorities and non-governmental organisations can normalise retrofitting, setting an example by improving the energy efficiency of their own building stock (Castán Broto, 2012), encouraging wider uptake (Bartiaux et al., 2014), and raising awareness amongst local communities (Kivimaa et al., 2019). Caputo and Pasetti (2017) highlight the value of local authority energy planning to stimulate and support a market for retrofitting in Italy, aligning business opportunities within an area, and improving economies of scale. This is echoed by the suggestion that authorities can support retrofit through the coordination of new business models and markets (Kivimaa & Martiskainen, 2018; Brown, 2018). In addition, the authority of local governments and energy cooperatives help to foster homeowners' trust in private contractors (de Wilde & Spaargaren, 2018).

There is therefore ample evidence that local actors can play a crucial role in the delivery of wide scale retrofitting activities. In Scotland, local authorities are being positioned as central to the delivery of EES, and a Local Governance Review is taking place with a view to "devolv[ing] more power to local levels" (Scottish Government, 2018c). Despite this, little is known about the capacity and readiness of local authorities, or the partnerships they form to manage such programmes.

## 2.2    Local authorities and third sector partnerships for the delivery of retrofit

### 2.2.1    Local authorities

Local authorities' responsibilities, coupled with their democratic status, long-term commitment to a region, and

relationships with civil society and businesses, make them well placed to deliver retrofitting services (Webb, Tingey & Hawkey, 2017: 6). They already deliver a range of energy services, have obligations to reduce their own carbon emissions, and tackle fuel poverty. In addition, they exercise critical planning and enforcement functions, including Building Control (CCC, 2019), with oversight of homes, non-domestic buildings, and infrastructure central to retrofit (Eames et al., 2013). These functions have however been eroded by austerity-driven restructuring, and now need to be re-invigorated, particularly ensuring that personnel have practical experience on site, to be 'fully effective' in supporting retrofit (Maby & Owen, 2015).

Although governed by a framework of statutory duties, no United Kingdom local authorities have any statutory powers over energy retrofitting, and they have only limited financial resources to implement schemes (Morris et al., 2017).. Indeed, the CCC (2019) have highlighted that local authorities "do not have sufficient resources to make progress on climate change mitigation or adaptation" (p.12). Greater local control over budgets for retrofitting would help authorities to plan on an area-wide basis rather than home-by-home (Fylan et al., 2016). In Scotland, local authorities receive approximately 80% of their income from Scottish Government (Scottish Government, 2018b). However, between 2010/11 and 2018/19, this funding fell by approximately ten per cent in real terms (Audit Scotland, 2018: 15). Declining revenues have led to constant restructuring, and problems of workforce retention. Staff numbers within local authorities across Scotland have fallen every year since 2009: the total workforce fell by approximately 31,000 (15 per cent) during the period from 2009-2017 (Audit Scotland, 2018). These declining revenues and staff numbers are not conducive to developing the necessary in-house expertise and skills to support and manage area-based building retrofitting. Local authorities are managed according to the principle that they will operate more efficiently if broken down into disaggregated units, structured around market competition and outsourcing (Hood, 1991). Thus, hand-in-hand with budget reductions is the marketisation (or 'doing more with less') model of public service delivery. Marketisation has made new ways of working an "essential part of the agenda for councils" in Scotland (Audit Scotland, 2018: 6); this includes partnerships with third sector organisations. Although local authorities have been identified as

potentially critical for delivering retrofit, the impacts of such partnerships have not been considered.

### 2.2.2    Delivery partners

Delivery partners for retrofitting can include private contractors and commercial consultants; however, the roles of third sector organisations are expanding as "more plural and pluralist forms of public service delivery" continue to evolve (Lindsay, Osborne & Bond, 2014: 192). For the purposes of this paper, third sector organisations are defined as self-governing bodies that are "formally organised, independent from the state, non-profit-distributing, and benefit from some sort of voluntarism in their work" (Lindsay, Osborne & Bond, 2014: 195). The term third sector includes charities, non-profit organisations, social enterprises. In addition, ALEOs are "companies, trusts and other bodies that are separate from the local authority but are subject to local authority control or influence" (Audit Scotland, 2011). They are often set up as non-profit making, which can ring-fence resources for particular activities (for example, energy efficiency advice). Like third sector organisations, ALEOs were contracted by some local authorities for aspects of the EES pilots, and so are considered together with other non-profit and charitable organisations in this paper under the term 'delivery partner'.

These organisations are often praised for their ability to innovate, facilitated by their independence and lack of institutional or political baggage. They possess distinctive features that might make them well positioned to support building retrofit, including: strong relationships with local communities; awareness of local needs; and being trusted (Macmillan, 2010). However, over-reliance on public funding may contribute to an erosion of the third sector's flexibility (Macmillan, 2010). This could be detrimental to national-scale building retrofit which will rely on innovation to achieve deep carbon emission reductions. In addition, contractualism can undermine the collaboration and cross-organisational working that the third sector is built upon (Rees, 2014). This is particularly problematic for the development of integrated solutions to policy problems, and risks the fragmentation of localised policy agendas (Lindsay, Osborne & Bond, 2014). At present there is a lack of

systematic evidence to examine the strengths and weaknesses of reliance on third sector organisations for significant components of local authority programmes (Macmillan, 2010). Consequently, it is critical to examine their role and effectiveness as local authorities' partners for national energy retrofitting.

## 3    Theory: Middle actors and linked ecologies for the delivery of building energy retrofit

The Middle-Out Perspective (Janda & Parag, 2013) draws attention to the variety of actors that sit between top-down governance, and bottom-up change; it seeks to examine the agency and capacity of middle actors, defined as "active participants in the system, capable of creating (and sometimes preventing) change above, below and across other actors" (Janda & Parag, 2013: 103). There are various ways to understand energy system transitions like the EES programme, for example the Multi-Level Perspective and Strategic Niche Management (Geels, 2019). These ideas provide a framework for considering the roles of numerous actors at a system level; however, this paper is concerned with the detailed dynamics of relationships between actors that work to deliver change. With its focus on agency and capacity, the MOP offers a useful framing device for understanding such dynamics. However, it has not yet been used to explore the relationships between local authorities and third sector delivery partners in the organisation and coordination of large scale energy retrofitting.

In developing the MOP, Janda, Parag, and others (Stanislas, Killip & Janda, 2011; Janda & Parag, 2013; Parag & Janda, 2014) drew on Abbott's *System of Professions* (1988) which suggests that professions define their work tasks and develop or maintain their professional standing within an evolving dynamic system. Each profession is distinct, but linked to a set of tasks identified as its jurisdiction. These ideas have been used to consider the emergence of new professions for low carbon building retrofit (Stanislas, Killip & Janda, 2011) and the ways in which the professional identities of heating engineers and architects shape domestic energy consumption (Wade, Murtagh & Hitchings, 2017). The MOP suggests that such actors are agents of change that can have upstream, downstream, and sideways influences (Janda & Parag, 2013). 'Sideways' interactions allow professionals to influence those within their profession, but also those operating in a similar area (for example,

an architect might influence a mechanical engineer where they are working on the same project). As two middle actors working together to deliver energy retrofits, it is the sideways interactions between local authorities and delivery partners that provide the focus of this analysis. However, the MOP does not currently detail *how* such sideways interactions take shape, and further exploration of the negotiations and tensions that might take place when middle actor groups are defining 'who does what' is required.

For this, it is useful to incorporate aspects of Abbott's (2005) later work on the ways in which professions operate in distinct but *linked ecologies*. A linked ecology is a "set of social relations…best understood in terms of interactions between multiple elements that…constrain or contest each other" (Abbott, 2005: 248). Abbott suggests that an ecology is constituted of three components: *actors*, *locations*, and the *relations* (or linkages) that connect actors to locations. In the case of the ecology of professions, actors are the professions (e.g. local authority energy planner); locations are the tasks within their jurisdiction (e.g. the prioritisation of energy projects), and the links are the connection between professions and their tasks (e.g. government funding allocated for energy retrofit). What makes the *linked ecologies* idea useful here is that it takes "into account the simultaneous existence of numerous adjacent ecologies, all of whose actors seek alliances, resources, and support across ecological boundaries" (Abbott, 2005: 247). Events within one ecology are influenced by events in adjacent ecologies, with consequences for claims to jurisdiction and political efficacy. This allows the consideration of relationships between local authorities and delivery partners, and their implications. In addition, the ecological metaphor is a reminder that interlinked elements do not necessarily move together; they constrain and contest one another (Mennicken, 2010).

## 3.1 Hinges and avatars within linked ecologies

With reference to urban development projects, Abbott notes that any successful project must bring together across different ecologies. Connected by the project, these actors may nevertheless have distinct agendas and motivations. In particular, this idea helps to interrogate the sideways interactions between local authorities and

delivery partner organisations in the ecologies that form around particular retrofitting projects, and to consider how practices emerge across ecologies that might otherwise be treated as disconnected (Seabrooke & Tsingou, 2009). Traditionally, both groups are responsive to, and able to influence, political activity, but from quite different positions. Whilst local authorities might have been considered as delivering key services to communities as an arm of government, charities and social enterprises were known to hold government to account. However, their boundaries have become blurred, and although occupying distinct ecologies, these groups are also working closely together in the ecology of a retrofitting project. Two of Abbott's ideas sensitise us more directly to the co-existence and connectivity at play between local authorities and delivery partners within these *linked ecologies*: hinges and avatars.

*Hinges* are issues or strategies that can operate within different ecologies at the same time. Abbott (2005) suggests that a hinge is a strategy that is mutually beneficial, and works equally well in each ecology, but might provide quite distinct rewards. Seabrooke & Tsingou (2009) use the idea of hinges to explore how actors from different financial ecologies develop alliances with one another in order to control relevant policy 'locations' (for example, averting a financial crisis). In his application of the hinges concept to the links between ecologies of politics, trading, and financial regulation, MacKenzie (2018: 1642) emphasises the "transient…contingent, even idiosyncratic" nature of hinges. This is especially relevant in the case of the recently introduced EES programme, which operates across local authority and delivery partner ecologies, but is still subject to definition by those developing and delivering it.

*Avatars* describe the replication of the ideas and skills of one profession in a new ecology. These might be individuals or groups that move between different ecologies, or transpose the expertise of one profession into a different ecology. For example, Stone (2013) suggests that the ecologies of academia and international development policy interact via avatars. She explains that economists might move between the worlds of universities and banks, whilst epidemiologists may work across Non-Governmental Organisations and United

Nations agencies. Avatars provide a particularly interesting concept in the case of local authorities which have adopted myriad ways to manage shifting staff budgets, including the development of ALEOs subject to local authority control or influence (Audit Scotland, 2011: 6). Audit Scotland highlight that the movement of local authority employees into ALEOs and other organisations makes it difficult to track local authority workforce reductions (Audit Scotland, 2018). Similarly, local authority staff might also move into commercial organisations, displacing skills and shifting project management to a for-profit basis.

Critically, the production of hinges and avatars is neither straightforward nor automatic (Stone 2013); instead, it is a political process emerging from the mobilisation of individuals and institutions around particular projects and strategies of legitimation. Numerous factors are crucial to the success of energy retrofitting including finance, regulations and tradespeople's skills and networks. Although these elements are not directly analysed here, they are all filtered and interpreted through the relationships and interactions between the two groups analysed as critical to the retrofitting linked ecology: local authorities and delivery partners.

## 4 Method: capturing organisational perspectives on retrofit delivery

The Scottish Government have confirmed a minimum of £0.5 billion public investment for EES over the four years from 2017-2021 (Scottish Government, 2018a: 93). To date, they have funded two phases of pilot projects across 22 local authorities; they awarded £9 million to ten local authorities in 2016-2017 under Phase 1, and a further £4.6 million to 14 local authorities in 2017-2018 under Phase 2 (Scottish Government, 2018a: 93). These pilot phases act as opportunities to establish delivery mechanisms for large scale building retrofit, and feed into the wider rollout of the EES programme. Data from the Phase 1 pilots are presented in this paper; the Phase 2 pilots are still underway.

To secure funding for the pilot projects, local authorities developed a proposal and budget which detailed how they would spend the money to perform energy efficient retrofitting, including partnerships and outsourcing. In

several cases, local authorities recruited delivery partners early in the development of the bid. Some of these partners operated in a single region (for example, the ALEOs), whilst others operated across several local authority areas (for example, large charities). A requirement of the funding is that local authorities must include monitoring and evaluation of both social and technical aspects of the pilots; see Bush et al. (2017) for details of the full evaluation. The authors have been managing the social evaluation, which explored the influence of programme design, the experiences of building occupants, and project delivery approaches.

The data presented are from 21 semi-structured interviews conducted with the nine local authorities and delivery partners taking part in Pilot Phase 1. Interviews are a valuable tool for capturing the perceptions and experiences of public sector organisations involved in energy and retrofitting projects (for example, see: Bale et al., 2012; Gram-Hanssen, Jensen & Friis, 2018; Morris et al., 2017). The interview schedule was informed by a series of group workshops with local authority officers; it explored project delivery; project funding; engagement and recruitment of building owners and occupants; and reflections and lessons from the pilot. Each local authority was interviewed twice, once towards the beginning of the pilot (March/ April 2017), and again towards the end (February/ March 2018). Project leads were identified through the submitted application materials, and were approached for interview. In some cases, additional members of the project teams were invited to take part in the interview at the request of the pilot lead. Thus, some interviews included one participant, but others included up to six people from both the local authority and delivery partners. In total, 23 people took part in the interviews. In cases where different teams were involved in the project, and the pilot lead suggested it, separate interviews were carried out for domestic and non-domestic aspects of the work. The data analysed focus on projects where delivery partners were recruited to manage at least some aspects of the pilot work, and were either included in the interview or were discussed during it. The interviews were conducted in a location convenient to the participants, usually local authority offices. Two interviews were conducted remotely, because of distance and time limitations. The interviews lasted between 60 and 90 minutes; they were audio recorded and transcribed verbatim. The data has been stored and coded in Nvivo, and analysed thematically using the

concepts of hinges and avatars (Abbott, 2005). Together, these concepts offer a way to develop our understandings of the sideways interactions between these two groups who play a critical role in 'the middle' of building energy retrofit.

## 5    Results

### 5.1    Energy Efficient Scotland as a hinge between and within local authorities and delivery partners

#### 5.1.1    Local Authorities

Energy Efficient Scotland is conceptualised here as an object or hinge around which myriad actors coalesce. The Programme has undergone evolution through initial policy proposals, two rounds of public consultation and associated workshops incorporating the perspectives of stakeholders including local authorities, their representatives, and delivery partners. In this way, a process of negotiation between central and local governments is 'qualifying' EES as a feasible object of shared interests and action at the local scale. In keeping with its unsettled position, the potential for EES to work as a hinge between and within central and local governments and delivery partners was subject to multiple interpretations.

For Government, EES is part of a political programme which needs a means of realisation. The pilot funding serves as a 'test bed' for the development of a shared strategy, structured around values which are intended to serve national and local goals. This connection is demonstrated by one authority mirroring Scottish Government's phrasing in recognising retrofit as a 'strategic priority', which presented an opportunity to: "reduce carbon, alleviate fuel poverty…reduce energy bills" (Sustainable Development Officer, City Council 1). In keeping with this, EES pilots were seen as a 'learning process' or pathfinder for the final programme (Domestic Energy Efficiency Officer, Council 2). In the context of resource-restricted local authorities, accessing EES funding was simultaneously an economic necessity, with one participant stating that they "can't be seen to be not applying for funding" (Housing Strategy Officer, City Council 3). Energy teams tended to

frame their actions in terms of political priorities to maximise local budgets, highlighting the need to be visibly active:

> "Well, we kind of felt duty bound to do that. If there's funding available we've got to kind of maximise income we've got to be seen to be doing it…so we have a duty to the public…that we're going to… pull in the measures and then do it…" (Legal Officer – Sustainable Housing Rural Council 1)

As a hinge, EES contributed to national and local goals while being amenable to multiple ends. The Programme was, for example, an opportunity to leverage additional local funding for specific purposes – particularly hard-to-treat, or historical buildings – and to deliver projects of a larger scale than isolated funding pots allow (Building Surveyor, Rural Council 2). Alternatively, it provided an opportunity for local authorities to invest in buildings with significance for local communities, offering the potential to build community awareness through "political media and other routes" (Officer, City Council 3). Thus, as a hinge the benefits of EES for local authorities include opportunities to develop reputational capital, while increasing community awareness of energy saving.

The Programme was not yet, however, functioning as a powerful hinge bridging different local authority teams with distinct remits, for example: housing; public estate services; low carbon management; and economic regeneration. The mixed-sector, area-based pilot projects required cross-departmental collaboration that was challenging to realise. Colleagues from the same authority might apply different understandings of the programme: one officer described how colleagues in other departments saw it as "more of a thorn in the side than anything else", or "another scheme from Government" which was akin to a box ticking exercise (Building Surveyor, Rural Council 2). In addition, local authority structures were identified as a hindrance: "Councils are not set up to deliver these type of mixed programmes" (Energy Efficiency Strategy Officer, City Council 2). Distinct operational and strategic roles across the council require distinct mindsets: "if you're operational, you

want to go quickly, get it done and dusted. But if you're policy and strategy...[you] spend a lot of time filling out plans and frameworks and strategies on how you're going to do it" (Local Housing Strategy Officer, Rural Council 3). Project management was split between different teams with specific tasks, but none had the required oversight of the whole building stock needed for large scale cross-sector retrofitting, and trust could be lacking:

> "It's getting better but you've still got a council with three distinct teams, a private sector team, a housing management team and repairs. And getting them to come together to get projects delivered is just a huge problem. None of them trust or like each other. ...it's difficult to pull them all together. ...different budgets, different targets, so there is a lot of, 'That should come from you,' 'No, that should be you'" (Energy Efficiency Strategy Officer, City Council 2)

This continued negotiation of responsibilities illustrates the intensive work required to make the EES programme serve as a hinge with mutual benefits for different local authority service teams. In this case, the officer noted how challenging it can be to communicate across teams and establish sufficient levels of trust for the works to proceed. When a national programme is launched inter- and intra- organisational responsibilities are negotiated and new local authority ecologies begin to emerge. However, this need to establish new roles and relationships, and identify the benefits to be gained by different teams, can limit the ambition of projects taken on.

### 5.1.2      *Delivery partners*

The extent to which EES acts as a hinge between local authorities and delivery partners, and what this enables or hinders, also requires consideration. Some partner organisations operated across Scotland and provided more standardised services to multiple authorities; others were recruited because of their knowledge of target areas or buildings suited to Government funding criteria. The latter might have an established role in use or maintenance of particular buildings (for example, community trusts), or investment in the local area and

infrastructure (for example, operating a district heating network). Depending on the local or national status of the organisation, EES served as a variable form of hinge between them and local authorities.

First, all shared an appreciation of the value of EES for leveraging additional funds. The scheme allowed one ALEO to extend the district heating network they owned and managed:

> "we want to expand the district heating through the city by any means we can really… hopefully if the full [EES] programme is rolled out…the work done now is going to benefit that application process in the future, because I'm sure we'll want to apply to that…whether it's directly through the Council or…by other means." (Chief Executive Officer, ALEO working in partnership with City Council 2)

Although associated with the local authority, the ALEO has a specific remit and focus. With its ability to contribute to extending the district heating network, EES carried meanings of convenience and utility for this delivery partner. Collaboration with the local authority was beneficial this time, but the participant notes that they would seek 'other means' in future if need be. For some ALEOs, EES also provided scope to develop and extend existing partnerships and understanding of Council priorities. This ALEO for example shares an office building with the Council, but operates on an independent basis and was contracted to work on specific aspects of the pilot:

> "through the energy programme work I've got an understanding of what the main priorities are for the council in terms of domestic buildings…we also put through another piece of work with our colleagues that have commercial buildings…so that was an opportunity to hook them in as well." (Energy Programme Manager, ALEO working in partnership with Rural Council 1)

A national scale third sector delivery partner provides a contrast. While benefiting from EES funds, its greater

reach resulted in a degree of tension with councils over shares of resources and expertise. Operating as a charity, it provides a range of services including: energy efficiency advice; data analysis and research; and campaigns to inform national government policy on reducing carbon emissions, fuel poverty, and waste. EES created a need for the charity's data analysis skills, which were used by multiple local authorities, but lack of such expertise in councils was also a potential source of conflict:

"In terms of access to a lot of housing information that [the charity] have, the council is out-sourced nearly. Just putting them in that position to be the natural partner that can come in and say, "Well look, you can do this here." And not having that in-house function was limiting as well, I think." (Sustainable Development Officer, City Council 1)

EES calls on very different forms of knowledge to traditional retrofit, including area-based analysis of the whole building stock and prioritisation for retrofit. The council officer identifies how their lack of in-house expertise made them over-reliant on the third sector organisation. The necessary knowledge about the building stock is thus distributed across different organisations and accessing reliable data can be problematic. Indeed, in some of the pilot projects this distribution of knowledge and the complexity of the projects resulted in not achieving the number of retrofits planned, and the cancellation of some aspects of the work (see Appendix 3). A lack of framework for the management and sharing of data, and restricted availability of skills within local authorities for the analysis of large datasets, are limitations in current governance structures for comprehensive retrofit.

As an issue or strategy "mutually beneficial for each ecology" (Abbott, 2005) EES served as a hinge between local authorities and a range of organisations recruited to manage aspects of the pilot work. While raising additional funds for both local authorities and delivery partners, EES also supported the diversification of roles across the latter organisations. However, EES simultaneously created additional responsibilities for local authorities, and the need to develop new ways of working, as well as potential tensions with delivery partners,

resulting in a struggle to define mutual gain. Its status as a hinge was thus tenuous.

## 5.2 Avatars: mobility of expertise across local authority-delivery partner boundaries

### 5.2.1 *Local authorities*

As the EES programme develops, necessary skills and knowledge are being identified, developed and reformed within and across local authorities and their external partners. Despite recent reductions in local authority staff and resources, many have retained significant expertise for building retrofitting. Interviewees included in-house mechanical and electrical engineers with responsibility for energy management of local authority buildings, who were integral to decision-making in EES pilots. This kind of expertise was demonstrated by the sustainability housing officer at one council, who detailed their fabric first approach to retrofitting:

> "And I'm always on a kind of fabric first approach to reducing the demand for the heat as opposed to putting in more innovative or cheaper heating systems…I'm not saying we shouldn't be putting in boilers, because we do. But if a boiler you fit is 10% more effective you're better actually doing the [External Wall Insulation] that reduces the demand by half; so it's obviously a fabric first approach is kind of what we have" (Legal Officer – Sustainable Housing, Rural Council 1)

Officers in a dedicated sustainability role can be mobilised to engage in the EES project, rather than relying on external organisations. In a smaller authority an officer might also take on multiple roles as required for a project like EES. A local authority building surveyor (from Rural Council 2) for example highlighted that his project tasks included: preparing the bid and contract administration, as well as the quantity and building surveying works reflected in his job title. Alongside technical expertise, some local authority officers reported on their skills in community engagement. In one case, a specialist 'energy promotion and development officer' managed interaction with occupants of non-domestic buildings subject to retrofit. She noted that her council role was

valuable because "it's seen as a kind of trusted brand" enabling the council to "mediate between the contractor and the homeowner or tenant" (Sustainable Housing Officer, Rural Council 1). Thus, local authorities can be locations of high levels of expertise among officers holding a wealth of knowledge about energy in buildings, retrofitting, and community engagement.

However, relevant expertise in non-energy teams is often distributed across authority structures, making it difficult to access and harness. This leads officers to rely on existing relationships within their teams or across the council, resulting in opportunistic and improvisatory project development within those sectors that are already familiar. For example, one local authority officer discussed incorporating work on energy management systems into the pilot because he knew that this resource was available:

> "…it was a bit of a retrospective look at resource… we have this [Building Management Systems] project manager in place which makes it easier from a controls perspective because we have that resource… I mean you know we'll pick off individual work packages, lighting and things like that and project manage it; the control side we've got the project manager for that, so that's, that's really how we look at it from a resource point of view." (Sustainable Development Officer, City Council 1)

This officer also noted that colleagues in non-energy teams, although having relevant skills and expertise, were not resourced to work on energy projects, which made it difficult to engage them in the pilot. This reduced the Authority's flexibility with in-house skills and promoted the need to involve external organisations. It is through this mechanism that boundary-crossing emerged between local authorities and delivery partner organisations, with expertise moving between different types of organisation.

One way for authorities to ring-fence resources and develop expertise protected from political and budgetary pressures is the development of ALEOs. Authorities may rely on these organisations; in one case, the project's

lead officer noted that they would not have submitted an EES funding application without this partnership (City Council 2). Further, the restructuring of local authorities and movement of people between adjacent organisations can also produce the avatar-like translation of skills and knowledge into new and evolving forms. There is significant multi-directional mobility between local authorities, ALEOs, and the third sector. For example, in the course of the EES pilots, a local authority official moved to a new job with a local non-profit energy company, originally set up by the Council. This had mutual benefits for the local energy company, which gained new knowledge about local authority strategy, and for the authority, which potentially gained more direct access to the workings of the energy company.

In addition, in the local authority ecology with limited resources, actors can be so embedded in particular departments with restricted scope for discretionary work that it becomes easier to commission and contract energy retrofitting expertise externally; six of the nine pilots in the first round of EES funding recruited a delivery partner to help with different aspects of the work.

### 5.2.2    Delivery partners

Delivery partner roles in the retrofit pilots encompassed bid development; the procurement of work; and quality control and assurance. Local authorities referred to their experience as helpful for drafting applications to fulfil Scottish Government's expectations. Particularly when local authorities were uncertain of the requirements (Rural Council 2, City Council 1), working "hand-in-hand" with the delivery partner could support development of a suitable application (Building Surveyor, Rural Council 2); this was especially true where short timescales meant that local authorities struggled to find resources: "What is shelf ready, and what we could actually deliver in the timescale. That's what we had to talk to our partners within the council, and some of the external partners, to say 'what projects could we submit here?'" (Principal Officer – Housing Strategy, City Council 3). In some cases, contracts for joint working were already in place for a range of energy services, including energy efficiency advice and area-based Home Energy Efficiency Programmes for Scotland (HEEPS). Established

relationships were recognised as particularly beneficial for working to tight timeframes. Thus, a linked ecology meant that partners were able to quickly draw on one another's knowledge to identify projects that would fit within the EES remit.

In several cases, third sector organisations managed householder engagement:

> "[the initial contact letter] goes through [us]. [We] are the ones that contact [householders]. And they put back a note addressed to [us] … the infrastructure is there. The phone line is there, it's free to phone, they'll always get answered from eight in the morning to eight at night…even at weekends. So that makes it kind of easy." (Business Development Manager, Third Sector Organisation in partnership with Rural Council 3)

Thus, third sector organisations can have established and dedicated procedures for managing communication. Public collaboration and the co-branding of local authority and third sector partner services was seen as beneficial for recruiting people to take part in the pilot scheme. For example, one local authority ran joint open days with their different delivery partners, which leveraged public interest (Building Surveyor, Rural Council 2). Some delivery partners also hold separate contracts to deliver domestic energy advice across different parts of Scotland. It was noted that, although working in separate teams, those delivering the advice service are "in the office next door…so it's quite a close working relationship…and it makes it quite easy for any questions the advisors have, we're often back and forth speaking to each other" (Project Manager, third sector organisation in partnership with City Council 1). In this way, third sector organisations serve as avatars that move between different local authorities, accumulating and sharing knowledge as they go.

To plan and target buildings for retrofitting, the pilot projects utilised available data on the building stock (SAP[i] ratings) and socio-economic status of residents (via SIMD[ii] data). Access to and understanding of this data was essential for shaping the pilot projects; it was critical for prioritising areas of greatest need. Much of the data is available at a national level; however, local authorities did not always have in-house expertise to perform analysis (City Council 2, City Council 1, Rural Council 1):

> "myself and my colleagues could have named another 40 or 50 areas ourselves that had that type of stock, that we would have put well above the pecking order of [the selected town] … Turns out, you know, it's not a high SIMD or anything, but it has quite a high fuel poverty density and kind of low rural wages, retired, that type of thing. So it just shows you that putting a little bit of…analysis to the data [can] give you priorities, it's a much fairer way of doing it type thing, you know?" (Legal Officer, Sustainable Housing, Rural Council 1)

Without the support of a delivery partner avatar for data analysis, it was unlikely that the local authority would have selected the most relevant area for upgrade. In this way, relevant knowledge is dispersed across organisations with both positive and negative outcomes. One local authority participant recognised the value of performing such analysis, but noted that "we need to have the capability in-house…someone who understands energy efficiency and can access GIS [Geographic Information Systems] and pull in all these different sets of data" (Sustainable Development Officer, City Council 1). The expertise from third sector avatars is paired with diminishing in-house expertise amongst local authorities, and a subsequent reliance on delivery partners for critical aspects of the retrofitting pilots. Within this system of professions, then, there is the potential for tension in the control of expertise to perform analysis and subsequent shaping of the retrofit activities.

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[i] The Standard Assessment Procedure (SAP) is the methodology used to assess and compare the energy and environmental performance of buildings (UK Government, 2014).
[ii] The Scottish Index of Multiple Deprivation (SIMD) is a tool developed by the Scottish Government for identifying areas of poverty and inequality across Scotland (Scottish Government, 2016).

Further, for joint working, third sector organisations needed to align their priorities with those of the local authority, often becoming embedded in their ways of working. This became apparent when individuals from third sector organisations spoke on behalf of local authority partners. For example:

"This Council are a bit more risk averse than others as well so you find that, they find that, maybe sometimes the ECO [Energy Companies Obligation] goes through a more kind of drawn out approval process to get the permissions in place and … in some of the other smaller local authorities their teams have a bit more empowerment to kind of push things through on their own, that's something definitely we find." (Project Manager, third sector organisation in partnership with City Council 1)

This partner describes their experience of working across local authorities with different capacities, facing different pressures, which affect their ability to respond to retrofit funding opportunities. It was suggested that this distribution of expertise can be beneficial, because the local authorities "get quite a range of our different staff's time and expertise" (third sector organisation in partnership with City Council 1); they noted that the alternative would be to recruit in-house and have only a couple of people doing the work. By entering into local authorities' working structures, delivery partner avatars are absorbing knowledge and skills of the local authority ecology such that they are better positioned to deliver retrofitting. Authorities can then come to rely on the avatars' skills and understandings of the EES programme. Managing retrofit through third sector organisations in this way, with skills developed and deployed in multiple geographical areas, could be cost and resource efficient. However, it also places considerable responsibility for a national infrastructure priority on third sector organisations, who often operate at lower cost, but with more precarity and higher risk, than local authorities and civil servants (for example, using staff on fixed term project-based rather than permanent contracts). Third sector organisations have expertise that can be beneficial for engaging and working in communities for building retrofit (Macmillan, 2010); however, whether this is the ideal arrangement for a

national scale programme requires further consideration.

## 6    Discussion

Local authorities and delivery partners are expected to be critical middle actors for the delivery of national-scale building retrofit, and they are positioned as central in design and implementation of the Energy Efficient Scotland programme. How this works in practice, with what material consequences, has however been under-examined. The lens of *linked ecologies* (Abbott, 2005) was utilised here to extend the analytical power of the Middle-Out Perspective (Janda & Parag, 2013), and hence address this gap. The paper has examined the intricacies of sideways interactions between local authorities, ALEOs and third sector organisations which govern the partnerships influencing the delivery of building retrofit. In the EES pilot projects discussed, this complex of middle actors determined which buildings would receive interventions; commissioned construction firms and tradespeople to perform works; coordinated financial support for householders and business owners, and managed strategies for engaging with residents. Exactly how the 'sideways' interactions between local authorities and delivery partners take shape has been explored by incorporating Abbott's (2005) concepts of *hinges* and *avatars*.

*Hinges* operate across different ecologies, providing distinct meanings and rewards for different parties. For local authorities, EES acted as a hinge for leveraging additional funding to serve local political goals, including projects that could build their reputation locally, and enabling learning about management of area-based retrofit. With such benefits recognised by local authorities, this finding supports the assertion that they have a core role in the delivery of building retrofit programmes across sectors (Kerr & Winskel, 2018; CCC, 2019). For some authorities, EES was simultaneously a burden requiring recruitment of people with new skills and expertise into a hard to manage, time-constrained process. The recognised need to act systematically on retrofit of buildings, coupled with the challenging reality of identifying people with the necessary skills and expertise to perform specific tasks, is symptomatic of the imbalance between responsibilities placed on local authorities and

resources available to enact these (Morris et al., 2017). This led most of the local authorities in this study to procure external support for pilot delivery. These ALEOs and third sector organisations recognised EES as an opportunity to pursue existing priorities, and build partnerships that could contribute to future work and revenues.

The analysis shows that these structures are tenuous, and only partially working. This is evidenced by changes to planned pilots including the completion of fewer projects than planned and the cancellation of some aspects (as detailed in Appendix 3). For local authorities, the pilot requirements and funding structure presented challenges relating to limited management capacities and siloed organisational structures that did not promote the boundary-crossing work necessary. In addition, the pilots were not prioritised amidst declining council budgets and limited scope for discretionary work on energy management. The contrasting perspectives of local authorities and delivery partners suggest that EES currently acts only as a 'weak hinge', for joint working in a programme of building retrofit. The programme will need to develop as a stronger hinge in order for these organisations to coalesce effectively around a shared definition of EES, which serves their varied interests. As the pilot stages are completed and the full programme commences, it is essential that awareness is developed through marketing and engagement across sectors, including public authorities and the third sector. This is something that the unsuccessful Green Deal programme failed to do (Rosenow & Eyre, 2016). In addition, the programme requires consistency with long-term targets for increasing building standards (currently proposed EPC C by 2040; see Appendices 1 and 2).

Central government decisions are needed on allocation of resources against a responsible division of labour (or, to use Abbott's terms, to more clearly delineate between *actors* and their *locations* in the ecology, or jurisdictions). Reliance on third sector organisations could result in less scope for local authorities and national government to shape programmes according to strategic priorities. For example, where a national scale external organisation applies the same data analysis and consumer engagement strategies across several councils, as was

the case for several pilot projects discussed. If this data and associated analysis strategies are not then shared with local authority officers, this leads to uneven distribution of skills and knowledge which has the potential to weaken local knowledge of the building stock and strategies for integration with community organisations. Through its development the programme thus needs to retain the ability for actors to develop local framings and strategies, as in Australia and Canada (Dowling, McGuirk & Bulkley, 2014; Hoicka, Parker & Andrey, 2014). This could be made efficient and effective if partnership and procurement is systematically coordinated and managed according to nationally-agreed standards, which ensure data sharing, for example. This is not currently in place for large scale building retrofitting in Scotland, and requires further investigation.

*Avatars* describe the replication of ideas and skills of one profession in a new ecology; the concept offers a way to understand the mobility of expertise across ecological boundaries. For the retrofitting pilots, lead officers needed to move around the council ecology, seeking out relevant knowledge, sometimes without the line management authority to require participation of other teams. Additional support for enforcement of Building Regulations (Maby & Owen, 2015; CCC, 2019) would have the added benefit of ensuring that local authorities hold a current record of the status of the building stock in their area, which is advantageous for retrofit planning. However, this paper has shown that sharing information across different local authority teams is often difficult amidst siloed departmental structures. Local authority project leads were not in a position to act as avatars promoting the sharing of information, often because the retrofitting work was not prioritised within the council and was not formally embedded in specific roles. Consequently, any development of Building Control services must be coupled with capacity for and line management authority over communication and information sharing across local authorities.

Third sector organisations and ALEOs have sought to establish jurisdiction over some retrofit tasks, complementing, but also competing with, local authority skill sets. In particular, the former organisations had systems for community engagement, and expertise in analysis of datasets that were critical for prioritising

retrofit. In some cases, they had worked to make themselves indispensable, such that authorities were reliant on these partnerships. In one regard, the creation of ALEOs and development of expertise within third sector organisations could mean that specific skills and resources are accessible to local authorities even if their own capacity is reduced (for example through funding cuts). However, this also means that local authorities' autonomy, expertise, and capacity for managing complex retrofitting is diminished. In this way, delivery partners' role and subsequent power to shape decision-making and retrofitting could extend far beyond that of a contractor with a circumscribed brief. This reflects the accumulation of skills within third sector organisations and ALEOs (Davies, 2011; Lindsay, Osborne & Bond, 2014), which is reinforced by the Scottish Government's decision to open the most recent round of pilot funding to applications that do not include local authorities (Scottish Government, 2018d). The significance of local authorities for national-scale building retrofit has been identified (Caputo & Pasetti, 2017; BPIE, 2018; CCC, 2019). However, this paper shows how local authority outsourcing and partnership structures make third sector organisations and ALEOs increasingly important. Analysis of management structures for retrofit programmes therefore needs to consider how different combinations of local authorities and other organisations affect project success. The development of EES thus requires governance structures sensitive to the need for management innovation, for example, developing coherent, streamlined procurement and partnership working arrangements.

The concept of *linked ecologies* has traditionally been used to consider distinct professions, exploring the complex and contingent social processes that take place when professions are defining 'who does what'. Here, these concepts have been used in a new way to examine the forming of partnerships and distribution of expertise for Scottish Government's ambitious strategy to retrofit the entire building stock: EES. This large scale programme is at a very early stage, while Abbott's model tends to relate to a longer historical evolution of professions. The emerging sideways interactions identified are necessarily tentative, and the validity of the model in this context can be usefully tested with future longer term data. The concepts of *hinges* and *avatars* capture two aspects of the sideways interactions between local authorities and delivery partners; they are useful

for understanding the transfer of information within partially stabilised relationships. However, future work could explore how these take shape over the longer term, and whether the framework could also capture, for example, the 'influencer' roles that the MOP identifies.

This paper has considered only two middle actors in the emerging linked ecologies associated with building retrofit. Further research should build a picture of the wider networks that need to be recruited and built for national-scale retrofit. These might include: engineering consultancies who import specific technical models into local authority practices of valuation for area-based building retrofit; financial consultancies who introduce financial tools into central and local government practices; big utilities with energy supplier obligations to invest in energy efficiency; and building professionals who share knowledge from their specialist areas with local authorities, third sector organisations, and ALEOs. In addition, this research is limited to a Scottish case, and could be developed through international comparisons of local retrofitting delivery models. For example, Germany and The Netherlands both have comparable federal and municipal governance structures and are actively engaged in wide scale retrofitting activities; comparisons here could help to identify the most effective delivery models. In addition, in England, Local Enterprise Partnerships are receiving funding to develop local energy strategies (Hampton & Fawcett, 2019). Whilst these may include local authority representatives, they cross local authority boundaries and so include very different actors and delivery models. Abbott (2005) suggests that where ecologies begin to lose their separation they might more effectively be analysed through the flow of resources to bundles of work, rather than professional locations. In this case then, instead of thinking of the different tasks for local authorities and delivery partners, it would be beneficial for policy makers to consider the direction of resource flows and necessary supporting structures for partnerships between these groups to ensure high standard, cost-effective national building retrofit. This would take the shape of outcome-oriented governance, with responsive funding schedules, streamlined, transparent procurement systems and a unified quality assurance and enforcement system.

## 7    Conclusions and policy implications

Local authorities and third sector organisations are increasingly recognised for their role in the coordination and promotion of wide scale, but locally-tailored, building retrofit. Energy Efficient Scotland is an example of one such programme. In Scotland, established ways of working have resulted in expertise becoming concentrated in a few partner organisations, which work across multiple regions. These partners complement the skills and resources of local authorities, but are also associated with declining local authority expertise for energy planning contingent on increasingly constrained resources. ALEOs and third sector organisations are also becoming more dependent on income from local authority outsourcing. As national policy requires new, more flexible, ways of working, existing divisions of responsibility and skills are being challenged and re-negotiated. At a national policy level, there is still a need to recognise gaps in expertise (for example, in the analysis of complex building data sets), and to develop clear frameworks governing the responsibilities of different groups.

Policy needs to support the organisational innovations to make ambitious and essential retrofitting programmes work; it can do this in three ways. First, policy makers need to ensure that resources support the development of essential substantive expertise. Short term pilot funding directs participants towards the fastest and most convenient solutions; this limits the development of institutional knowledge required for creation of a low energy building stock. Second, policy makers need to set a clear and consistent trajectory through long term increases in building standards. This would help to prioritise the development of skills within resource constrained local authorities, ensuring that local actors are equipped to support the transition to low carbon buildings. Third, policy makers should consider the development of centralised support for locally-coordinated retrofit delivery, including procedures for procurement and partnership working, and the development of standardised, accessible building stock databases to support local planning and decision making.

## Acknowledgements

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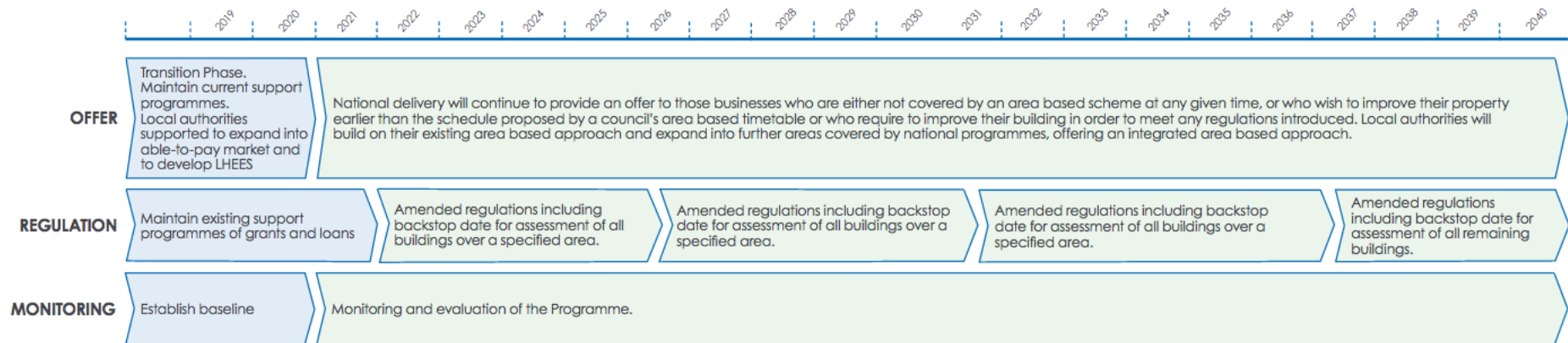
**Appendix 1**

Programme summary for improving the energy efficiency of domestic buildings through Energy Efficient Scotland, to 2040. Diagram highlights actual and proposed regulation within the privated rented, owner occupied and social housing sectors, supporting legistlative documents and additional delivery and support mechanisms. Source: (Scottish Government, 2018b: 13)
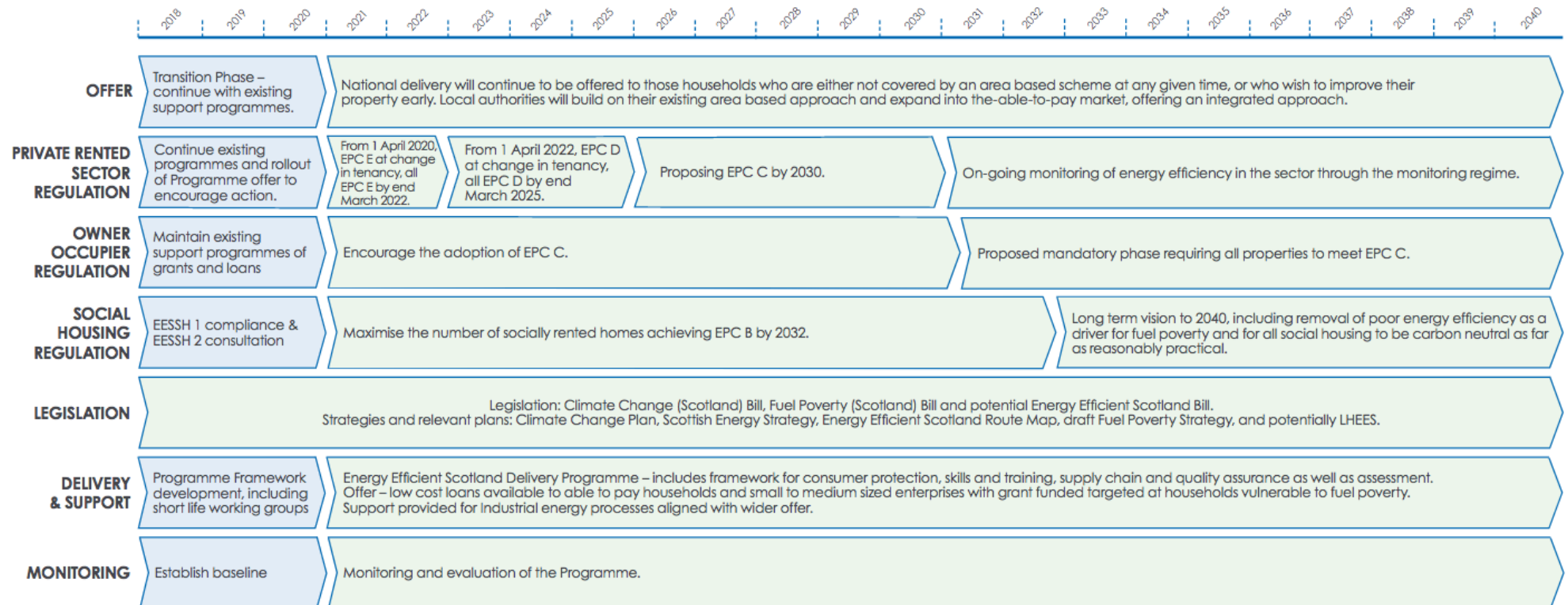
**Appendix 2**

Programme summary for improving the energy efficiency of non-domestic buildings through Energy Efficient Scotland, to 2040. Diagram highlights proposed regulation within the non-domestic sector, and additional delivery and support mechanisms. Source: (Scottish Government, 2018b: 15)

**Appendix 3**

Table detailing the local authorities that took part in the pilot projects discussed herein, along with the measures installed for both domestic and non-domestic buildings and the number of planned and completed retrofits. See Bush et al. (2018) for further details.

| Local authority | Domestic buildings | | Domestic measures | Non-domestic buildings | | Non-domestic measures |
|---|---|---|---|---|---|---|
| | Planned | Completed | | Planned | Completed | |
| **Aberdeen City Council** | 781 | 781 | External solid wall insulation. | 7 | 4 | External solid wall insulation, connection to district heating network, installation of large scale heat pump |
| **Aberdeenshire Council** | 100 | 100 | External solid wall insulation. | 4 | 3 | Underfloor heating, loft insulation. |
| **City of Edinburgh Council** | 340 | 287 | Cavity extraction and refill, internal solid wall insulation. | 8 | 15 | Building energy management systems, LED lighting, draught proofing. |
| **Fife Council** | 44 | 52 | External solid wall insulation, loft insulation, draught proofing. | 5 | 4 | LEDs, biomass network extension and installation of a biomass boiler on additional heat network |
| **Glasgow City Council** | 106 | Project cancelled | Mix of internal wall insulation and external wall insulation | 16 | 3 (remaining projects cancelled) | External solid wall insulation, connection to district heating network, installation of heat pump |
| **Midlothian Council** | 111 | 83 | External solid wall insulation. | 2 | 2 | Replacement windows, loft insulation and upgrading of lighting |
| **Shetland Islands Council** | 30 | 30 | Top-up loft insulation, internal wall insulation, underfloor insulation, double glazing, and door replacement | 10 | 9 | Heat exchanger maintenance, building energy management systems, LED lighting, TRVs and loft insulation. |
| **South Lanarkshire Council and NHS Lanarkshire** | 68 | 68 | External solid wall insulation. | 4 | 4 (Including 3 NHS buildings) | Replacement of lighting with LED lighting. |
| **West Lothian Council** | 43 | 43 | External solid wall insulation. | 2 | 2 | Flat roof insulation, external solid wall insulation. |