Intermediation in a low energy building project: A case of One Brighton housing development

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Abstract

Many experimental local projects have been carried out in low energy buildings that integrate a range of energy efficiency and renewable energy technologies and solutions. These have been important in showing how low energy building can be carried out and stimulating future expectations on energy demand reduction through buildings. However, a key question remains as to how we can spread these experiments to other localities and, importantly, into commercial applications, and who are important actors in these processes.

This paper presents an in-depth case study of One Brighton, a new build housing development in England offering 172 apartments and a community space, constructed during 2007–2010. One Brighton was developed with an objective of creating a residential building complex that enables sustainable, healthy and happy lifestyles. It in many ways stems from Bioregional – an environmental charity, social enterprise and an intermediary organisation championing more sustainable ways of living – and its pioneering BedZed housing development in London. However, also other intermediary actors were needed to initiate and pull through this innovative low energy building project. Triangulation of data sources including interviews, attendance in an on-site learning tour, and written material were used to construct the in-depth case.

Through a detailed analysis of this case, the paper shows (1) the role of a key intermediary actor in advancing systemic innovation in low energy housing beyond its initial experimental stage, and (2) how an ecology of intermediaries and champions advanced energy efficiency and sustainability during different phases of a building project. Intermediation in this case was crucial, taking different forms by different actors and at different periods. For policymakers this highlights the need to support the existence and activities of such intermediaries.

Introduction

Improving the energy efficiency of buildings and, as a result, lowering building energy use is increasingly important to tackle issues related to climate change mitigation and fuel poverty. Developments towards passive house standards, zero carbon buildings and whole house energy retrofits have been a vibrant space for experimentation. Many experimental projects have been carried out in low energy buildings that integrate a range of energy efficiency and renewable energy technologies and solutions (e.g. Lovell, 2008; Mlecnik, 2010; Holm et al., 2011; Castan Broto, 2012; Pässilä et al. 2015). These have been important in showing how low energy building can be carried out and stimulating future expectations on energy demand reduction through buildings. However, a key question remains as to how we can replicate these experiments to other localities and, importantly, into commercial applications that gradually change the construction regime, and who are important actors in these processes.

This paper explores this question through presenting an in-depth case study of One Brighton building project, a new build housing development in the City of Brighton and Hove, England. The development offers 172 apartments and a community space. It was constructed during 2007–2010 on an old railway

site in close proximity to Brighton Railway Station in the heart of the city. One Brighton was built to the aspirations of the zero carbon definition of the UK government but it only became 'zero carbon' in 2016 once a new biomass boiler was installed. One Brighton was also developed with an objective of creating a residential building complex that enables sustainable, healthy and happy lifestyles. It in many ways stems from Bioregional – an environmental charity, social enterprise and an intermediary organisation championing more sustainable ways of living – and its pioneering BedZED housing development completed in 2002 in London (cf. Lovell, 2007; Chance, 2009; Williams, 2016). For Bioregional, One Brighton was the next step from BedZED, a more commercially oriented development of low energy housing. Connecting to sustainability transitions literature, and adopting a lens of innovation intermediaries, we analyse the development of One Brighton and the role of intermediation in the building process.

Through a detailed analysis of the One Brighton case, the paper shows (1) the role of a key intermediary actor in advancing systemic innovation in low energy housing beyond the experimental stage, and (2) how an ecology of intermediaries advanced energy efficiency and sustainability during different phases of a building project. In addition, the dynamics with local politics and planning, on the one hand, and commercial construction, on the other hand, are explored.

Conceptual setting: Sustainability transition and intermediaries

According to the multilevel perspective (MLP), sustainability transitions within socio-technical systems can be studied through interactions within three different domains: (1) niches that represent emerging new innovations and protective spaces around them, (2) regimes that are dominating socio-technical arrangements including the underlying institutions and practices, and (3) landscape including prevailing cultural, political and economic settings. These domains are interlinked, providing insights into how innovations can emerge and be protected within niches, and how windows of opportunities allow niche innovations to diffuse and potentially transform existing, dominating regimes (Geels, 2002). The MLP suggests that radical change takes place within niches that act as spaces in which networks of actors can develop path-breaking niche innovations away from the pressures of the dominating regime (Geels, 2002). Such niche actors can develop disruptive innovations, such as zero carbon buildings, with niches providing protected space and containing guidance, technical knowhow, financial support, networking opportunities and development of new standards. In this literature two scales of niches have been illustrated: a local 'concrete' niche where actors work together, and a global or cosmopolitan niche that is an abstract and imagined broader community in which the experiences of multiple local niches working on the same technology or issue are aggregated (Geels and Deuten, 2006; Geels and Raven, 2006; Seyfang et al., 2014). We argue that low energy building projects are influenced by both.

In exploring One Brighton, we will pay specific attention to innovation intermediaries. Innovation intermediaries facilitating, configuring and brokering innovation processes (Stewart and Hyysalo, 2008), have been argued important in sustainability transitions through supporting the development of new niches and the opening up of spaces for these niches to expand and eventually change socio-technical regimes (Hargreaves et al., 2013; Seyfang et al., 2014; Kivimaa, 2014). According to Howells (2006), an innovation intermediary "acts as an agent or broker in any aspect of the innovation process between two or more parties. Such intermediary activities include: helping to provide information about potential collaborators; brokering a transaction between two or more parties; acting as a mediator, or go-between, bodies or organizations that are already collaborating; and helping find advice, funding and support for the innovation outcomes of such collaborations." In sustainability transitions, such intermediaries additionally promote sustainability and may also add a more systemic outlook to the change process (Kivimaa, 2014).

The literature on intermediaries in sustainability transitions has in recent years received increasing attention, particularly for niche development (e.g. Hargreaves et al., 2013; Seyfang et al., 2014; Kivimaa, 2014; Bush et al., 2017). In addition, intermediation in building energy efficiency has been explored outside the transitions literature (Fischer and Guy, 2009; Parag and Yanda, 2014; Grandclement et al., 2015). Neither literature has been explicit about intermediaries working in different scales of niches (local, cosmopolitan) and how these intermediaries link to the level of building projects. Drawing on a new opening made by the authors elsewhere (Martiskainen and Kivimaa, 2016) to divide intermediaries influencing low energy building projects into three types: project intermediaries (actors in specific projects), local niche intermediaries (actors influencing multiple local projects) and cosmopolitan niche intermediaries (actors in a wider community that aggregate learning from multiple local niches), the paper analyses intermediation in the One Brighton case. Following from that, we argue that intermediary actors have important roles in both facilitating individual building projects and linking between projects, the latter being crucial for achieving broader transition towards low energy buildings.

Method

The research approach used here was case study research (cf. Gerring 2004) based on qualitative data collected via seven semi-structured interviews, an author's attendance in an on-site learning tour of One Brighton, and previous written material on One Brighton. Semi-structured interviews were chosen as a method of data collection, because they provided the necessary in-depth qualitative information on the process and its intermediary actors from multiple perspectives on the building project studied. Key organisations and individuals involved in different phases of the project development were chosen to be interviewed to provide a full picture of the case (developer × 2, sustainability consultant, architect, local authority, resident, community sector tenant). Three interviews were conducted face-to-face, three over the phone and one via email in January and February 2016. The interviews lasted on average of 1–2 hours. Six interviews were digitally recorded and transcribed, while one was a written email response. The interview data was used to develop a case history (see Douthwaite and Ashby, 2005), tracing key stages of project development. The case history was sent back to all interviewees to check for

accuracy. Two researchers coded the case history and traced intermediation in different project phases, in planning, construction and post-development.

Developing One Brighton: aspirations towards zero carbon, car-free development

THE BEGINNING: COMMUNITY DRIVE TOWARDS CREATING A SUSTAINABLE DEVELOPMENT (1995–2003)

The development of One Brighton can be traced back to the mid-1990s with plans to redevelop an old railway site, later to be known as the 'New England Quarter', that had been derelict since 1968. The development of the site took several years, and numerous changes were made to the initial master plan that included new homes and a large supermarket with a car park. These were opposed by the local community who saw the plans as disruptive in terms of increased traffic. There were also concerns that new homes included in the master plan would not be affordable. In 1997, a local community group Brighton Urban Development and Design (Budd) formed to challenge the master plan and ensure that the local community's views were taken on board in the development of the site. In 1999, Budd contacted sustainability organisation Bioregional to seek their help in proposing sustainable alternatives to the existing master plan. Both Budd's and Bioregional's involvement meant that planning authority Brighton and Hove City Council and the developer QED Property rethought the plans, and as a result New England Quarter became "a much more interesting and mixed use development instead of a supermarket" (interview comment, sustainability consultant). QED Property also commissioned URBED (Urbanism, Environment and Design) to help with the design and sustainability aspects of the site and following local consultation, the planning brief was based on creating a new sustainable neighbourhood. New proposals for the master plan were submitted in 1998, and a new site brief was adopted by Brighton and Hove City Council in 2000, calling for an exemplar sustainable development, which had key principles of high density, proximity to public transport, low or car free parking and energy saving measures. The proposed new master plan was finally approved in 2003 and as a requirement of the planning application approval, legally binding sustainability requirements were set for the site (interview comment, Brighton & Hove City Council).

PLANNING: CREATING A TEAM AND ENGAGING WITH KEY STAKEHOLDERS (2005–2007)

Initial plans for One Brighton started to form in 2005, when a Brighton-based sustainability consultant heard that Brighton and Hove City Council was looking for solutions as to how to meet certain requirements pertaining to the community aspects of the development for the New England Quarter site. Through his consultancy work, the sustainability consultant was aware of Ethical Property, a local building management company. The sustainability consultant suggested to the Council that Ethical Property might be interested in becoming involved in the One Brighton community scheme too. He went on to arrange a meeting between the Council, a developing company QED Property and Ethical Property. From that meeting it was clear that the developer QED Property was not "interested in developing the site which then ultimately became One Brighton" (interview comment, sustainability consultant). Instead the sustainability consultant and Ethical Property contacted Bioregional, who in fact then came to visit the site and ended up becoming the lead developer for the One Brighton project. For the sustainability consultant, the prospect of working with Bioregional was a welcome occurrence, giving them an opportunity to work with a green developer who shared their values (interview comment, sustainability consultant).

Bioregional and Crest Nicholson come on board as main developers

Bioregional started working as a potential developer on the site in 2005, and secured funding from South East England Development Agency (SEEDA) to conduct an initial feasibility study. They later secured backing from Crest Nicholson PLC, one of the UK's largest upper-middle range housing developers, as well as 50 % of Bioregional's equity from Quintain Estates and Development, another property developer. Together the three organisations – Crest Nicholson, Bioregional and Quintain – formed a joint venture 'Crest Nicholson Bioregional Quintain' for the One Brighton project. They contracted Feilden Clegg Bradley Studios (FCB Studios) as the architect for the site, who were attracted to the project due to its sustainability motives (interview comment, FCB Studios).

While Bioregional was familiar with sustainable building construction following BedZED, One Brighton was the first of its kind for Crest Nicholson, which also took on board learning from One Brighton in their later projects. At the time, there was an increasing interest in sustainable buildings: "there was a lot of interest, not necessarily from the volume house builders, but from government, in particular the Labour government at the time, towards a zero carbon agenda" and a company like Crest Nicholson, which is more a design-led rather than volume-led house builder, was keen to explore potential for zero carbon homes (interview comment, Crest Nicholson). What attracted Crest Nicholson to the One Brighton project was personal commitment from their CEO – an architect with an interest in design – as well as a general feeling that their customers would be interested in a project such as One Brighton (interview comment, Bioregional). The CEO of Crest Nicholson had in fact met Bioregional on a trip to Scandinavia, which showcased sustainable and zero carbon homes. During that trip, Bioregional mentioned to Crest Nicholson that they were involved in the One Brighton project and that they were looking for a likeminded development partner for the site (interview comment, Crest Nicholson). Crest Nicholson and Bioregional met following the trip and "entered into an agreement to cooperate and work together" (interview comment, Crest Nicholson).

For Bioregional, the government's zero carbon policy objectives, while they were welcome, were never the reasons to develop a project like One Brighton, but rather the company looked at each project individually in terms of what it required (interview comment, Bioregional). Especially the experience from BedZED had shown that reducing carbon from housing required a lifestyle approach, rather than a focus on building-related emissions only (interview comment, Bioregional). Furthermore, while BedZED had inspired the UK's zero carbon homes policy – an aspiration set in 2006 that from 2016 onwards all new homes should be zero carbon, but subsequently this was removed by the government in 2015 – the policy had

been implemented in a way that was not consistent with Bioregional's recommendations and it was developed by people who did not have practical experience (interview comment, Bioregional).

Cooperating with Crest Nicholson provided Bioregional the opportunity to work with a large housing developer, who was supportive of Bioregional's strong sustainability objectives and could provide financial backing and marketing skills. Crest Nicholson, on the other hand, recognised that the One Brighton project would also provide an exciting opportunity for them to learn about zero carbon building (interview comment, Crest Nicholson). The company's own research at the time had shown that, in certain locations, concepts such as zero carbon homes were likely to be popular amongst house buyers, with Brighton – along with Cambridge, London and Oxford - being one of them (interview comment, Crest Nicholson). The company also realised that as the billed costs were higher they needed an area that "would both buy into the sustainability agenda and pay for it" (interview comment, Crest Nicholson). Working with Bioregional also provided an opportunity for Crest Nicholson to move further with a sustainability agenda and build on some of the projects that they had already completed. However, none of the previous projects of Crest Nicholson had had as high sustainability objectives as the One Brighton development did. It was their "first project that actually embraced not just zero carbon reduction on site through design, but also the lifestyle" (interview comment, Crest Nicholson). The lifestyles aspect especially was one of the key objectives of One Brighton, to ensure that the development would meet the vision of One Planet Living "of a world in which people enjoy happy, healthy lives within their fair share of the earth's resources, leaving space for wildlife and wilderness" (Bioregional, 2017). Developing One Brighton to the One Planet Living principles meant that all the ten principles of the concept were taken into consideration at all stages of project development, including design, use of materials, construction process and a whole lifestyle approach for occupants.

Bioregional created a One Planet Living story, which "is easy to engage people with, and to drive through the project" (interview comment, Bioregional). This approach was different and set One Brighton apart from other developers in the New England Quarter area. Key objectives for the One Brighton development were both to meet sustainability criteria and be affordable. Architects from FCB Studios had a part to play in ensuring that the design of the building project could meet the criteria, especially in terms of proposing a higher density for the development than was initially planned so that "the client could afford to build to a higher standard from an environmental design point of view" (interview comment, FCB Studios). FCB Studios started an early consultation with the planning department.

Community engagement

To ensure that One Brighton took on board the views of local people, the pre-planning stage involved two years of active community and stakeholder engagement, facilitated by the sustainability consultant. The sustainability consultant had previous experience in community engagement and fundraising, and he had won a contract to coordinate stakeholder engagement for the site, to "really inform the overall design of the project" (interview comment, sustainability consultant). As a result, during 2005–2007 the sustainability consultant held meetings with local community groups, finding out what their views were for the One Brighton site, and organised public meetings, conducted surveys and placed display boards of the proposed development in key locations such as a city centre library (interview comment, sustainability consultant). He also wanted to show the local community the links to the heritage of the One Brighton site.

A key outcome from the community engagement activities was the importance of including usable community space in the One Brighton development, having also community and social benefits. The One Brighton area has been ranked high on a multi-deprivation index (Brighton and Hove City Council, 2014). The community meetings that the sustainability consultant held resulted in suggestions to include rooftop allotments, a café and a community kitchen in One Brighton. The focus on local food growing especially was key to many community groups (interview comment, sustainability consultant).

Applying for planning permission

Final planning application for the One Brighton development was submitted in 2006 and agreed in 2007. The Council's planning department was supportive of the One Brighton development, and especially the Head of Planning championed the project (interview comment, sustainability consultant). However, the actual planning committee decision was close and had to be decided with the planning committee chair's casting vote. Especially the car-free aspect of the development drew opposition from Conservative councillors who questioned it at the planning meeting. The Green party, Liberal Democrats and Labour councillors, however, were supportive of the development. The Green party councillors especially supported the car-free concept. At the time, all three councillors of the St Peter's and North Laine ward, in which One Brighton is located, were Green party councillors.

From the planning authority's point of view, One Brighton project went beyond minimum required standards, which was unusual and provided the Council an opportunity to work with an innovative developer. In a city, where 42 % of emissions come from housing and there is a high proportion of buildings built before 1919, this was a welcome development (interview comment, Brighton & Hove City Council).

One Brighton was granted a planning permission on the condition that it will be built to the energy efficiency standard that had been volunteered by the developer (interview comment, Brighton & Hove City Council), i.e. the EcoHomes Excellent standard (BRE, 2006), with the aspiration of new zero carbon development and sustainable lifestyles strategies. Another prerequisite for the One Brighton planning application was that it would also house premises for local community and charity organisations (interview comment, occupant). As a result, the ground floor of one the One Brighton blocks was designed as a dedicated space for community organisations and became known as the 'Brighton Junction'.

CONSTRUCTION STAGE (2007–2010)

The role of Bioregional was central in the construction of One Brighton. After the planning stage, they were responsible for working with the local community, raising finance, securing

the joint-venture partners, leading on the sustainability design process and ensuring that it was implemented during construction. Bioregional did this by employing a Sustainability Integrator for the project, who worked closely with the contractor onsite and ensured that all sustainability attributes were implemented. This extended even to, for example, providing sustainable lunch options in the building site canteen and educating builders about sustainable construction and lifestyles. Bioregional also trained a caretaker to help with the everyday running of the building and support residents in sustainable living (Bioregional, 2014), and worked towards creating an energy service company, set up a process for post-occupancy evaluation and licensed the One Planet brand for the project (interview comment, Bioregional). In addition to the joint venture partners and the architects, the organisations involved in the construction stage also included the planning authority from Brighton & Hove City Council, the contractor Denne Construction, engineers, planning experts and landscaping consultants.

The One Planet Living approach was incorporated into the whole building process, from design and materials to construction and activities on the building site. The role of the Sustainability Integrator was pivotal, as he effectively acted as an extra project manager, ensuring that One Planet Living principles were followed throughout the whole process (interview comment, FCB Studios). Furthermore, Bioregional required that everyone involved in the project went through an 'induction to change' and over 1,300 staff in design, development and construction did so (Bioregional, 2014). It was seen as a two-way process, combining Bioregional's motives but also taking on board people's views on what sustainability meant for them: "It talked about what we wanted to do, but it also discussed with people what they thought about sustainability, and how they could apply it in their own lives" (interview comment, Bioregional). This approach worked well, helping to "create a different environment and culture there", with most of the people involved in the project embracing sustainability, while there were also "some real enthusiasts, and they brought the others on" (interview comment, Bioregional).

The sustainability consultant, who had been facilitating the community engagement of the development, also took on a role during the construction stage, especially focusing on the development of the community part of the building – the Brighton Junction – and identifying potential tenants for it, as well as helping to establish a One Planet café for the workers of the construction site, which served local, organic food and raised awareness of the importance of healthy living (interview comment, sustainability consultant). The café was popular amongst the contractors: "it was amazing how they embraced that more positive lifestyle" (interview comment, Crest Nicholson). The sustainability consultant also helped to promote the workers' café to the construction industry, and also aided with other smaller projects such as applying for funding for the biomass boiler from the Department of Energy and Climate Change (DECC).

The construction stage of One Brighton involved a lot of hard work, persistence and attention to detail, and the ability especially for Bioregional and their team to meet challenges along the way, such as ensuring that certain materials, like getting the right mix of concrete, were used. The Sustainability Integrator's role especially was key in ensuring that even during challenging times, sustainability was not compromised. FCB Studios had architects on the design team who had training in specific environmental design courses as well as in architecture, in order to have "the right level of expertise to meet their [the developer's] expectations and their requirements" (interview comment, FCB Studios). However, from Bioregional's point of view, it was more about having 'the right attitude' to development rather than having a certain skill set. This involved consulting closely with the local community and listening to them, helping shape the design, and working closely with the local council (interview comment, Bioregional).

The global financial crash hit the UK housing sector hard in 2008, with people unable to get mortgages and several building projects not materialising. For One Brighton fortunately both planning and funding had been secured before the crash (interview comment, sustainability consultant). However, it did mean that some flats took longer to sell than was initially expected. However, One Brighton returned a profit when most projects were losing money and was, for example, the best performing project in Crest Nicholson's portfolio at the time.

Sustainable energy in the form of renewables and high energy efficiency

Energy and energy efficiency were a part in meeting sustainability objectives for the site (see Table 1). This was key not only in terms of using renewable energy sources but ensuring that the development was energy efficient so that there would be a need to use less energy in the first place (interview comment, sustainability consultant). The building is heated by a biomass boiler, for which the developers secured funding from DECC's Low Carbon Buildings Programme (interview comment, Bioregional) and it also has solar panels installed on the roof. Initially the plans had included rooftop wind turbines but the development team sought the planning authority's permission to install solar PVs instead as that technology was better proven than rooftop wind turbines (interview comment, Brighton & Hove City Council).

As part of the development One Brighton Energy Services Company was set up, which operates as a wholly owned subsidiary of resident-owned One Brighton Management Company. The One Brighton Energy Services Company is responsible for sourcing all the energy that is used on site, billing and metering (interview comment, sustainability consultant). In addition to having a biomass boiler and solar panels on site, the company bulk purchases guaranteed renewable energy supply as part of a Zero Carbon strategy "which has been very cost-effective for our residents" (interview comment, Bioregional). In 2016, energy was supplied at about 30 % lower cost than for a typical equivalent UK home. Subsequent to starting operation, the company had problems with the biomass boiler. One of the reasons for this was seen to be the early stage of the young biomass industry in the UK: "the whole industry, from design through to supply of the boilers, through to maintenance of the boilers, through to fuel supply, was still in its infancy" (interview comment, Bioregional). A decision was made to replace the old boiler and a new, upgraded, version was installed in 2016.

POST-CONSTRUCTION: THE EXPERIENCE OF LOW CARBON LIVING

One Brighton was completed in 2010 (Table 1). Both the building fabric and the car-free aspects of the site have worked well and the project generated very good profits as the apartments sold well (interview comment, Bioregional). The residents' energy bills have been lower than initially predicted, due to lower consumption of energy than originally foreseen (Bioregional, 2014). However, while all the residential properties were either sold or rented out in One Brighton, the financial crash and following austerity measures by the UK government affected the shape of the community space at Brighton Junction, as many community organisations that had planned to move into the building had their funding cut in 2010 and ceased to exist (interview comment, Sustainability Consultant). This meant that Brighton Junction opened with very few people in it. By 2016 the development was completely filled. One Brighton succeeded also eventually in having a café on site.

One local community organisation that had been attracted to One Brighton from the early days was Friends Centre. It became one of the largest tenants in One Brighton and also bought three business units at the building. It is an adult education centre providing courses for approximately 1,200 learners each year, ranging from art and craft, IT, mental health awareness and counselling skills to adult literacy and numeracy, as well as English for Speakers of Other Languages (ESOL). The overall 'community experience' has been less for Friends Centre than what they expected, i.e. with less community-orientated organisations occupying the building than they initially thought. Furthermore, while they have experienced the building to be very warm, dry and clean, some technical aspects have not worked well, particularly the mechanical ventilation system and the biomass boiler. The air tightness of the building had also caused some workers to feel ill. However, most of the problems with technology have been addressed and the changes to the ventilation system and change of windows have meant that Brighton Junction is now a better place to work in. Despite the initial teething problems, users of the building have generally been happy and "a lot of people that hire rooms absolutely love it here and really like the atmosphere in the café" (interview comment, Friends Centre).

One individual resident, a photographer and her family, moved to One Brighton when it was built, renting their apartment through Moat Housing, a housing association operating in the South East of England. The family were especially attracted to the central location of One Brighton and the fact that the property had three bedrooms, though sustainability of the building was quite important too: "We feel privileged that we have been given the opportunity to live here and reduce our carbon footprint" (interview comment, One Brighton resident). Before moving in the family expected everything to be perfect, given that their new home was in a brand new building. They were given a basic introduction to the building and "a welcome pack that explained everything about the building and how it was at the time the forerunner in ecobuild in England" (interview comment, One Brighton resident). The family has been reasonably satisfied with their home so far and have particularly enjoyed the roof allotment and triple glazing that has dramatically reduced noise and heat loss (interview comment, One Brighton resident). However, some of their initial expectations of living in a perfect, new building were somewhat dampened by the fact that they experienced years of heating system problems and damp problems in one bedroom – since

Table 1. One Brighton features (Source: Bioregional 2014).

Accommodation mix	Design standard: EcoHomes (superseded by Code for Sustainable Homes)	Technical features	Energy consumption
Total of 172 flats (from 30,5 m^2 to 77 m^2): 19 private eco-studios 39 private 1-bedroom 15 shared equity 1-bedroom 14 social rent 1-bedroom 60 private 2-bedroom 10 shared equity 2-bedroom 11 social rent 2-bedroom 4 social rent 3-bedroom 925 m^2 community space 1,134 m^2 commercial space	EcoHomes 79,7 % of credits at design stage (highest achieved by an apartment building at the time) Post-construction evaluation score of 79,9 (the highest achieved for an apartment building under EcoHomes)	A-rated appliances Biomass heating and hot water Breathable clay block walls Car-free Concrete mix developed specifically for the project (47 % recyclable content) Energy efficient light fittings Photovoltaic panels 9,6 kWp Rain-water harvesting Roof top allotments Sustainably sourced timber Super insulated walls achieving air tightness of less than 5 $m^3/m^2/hr$ @ 50 Pa U levels of 0,21, 0,19, and 1,4 W/m^2K for walls, roof and ground floors, and windows respectively Ventilation system with heat recovery Water efficient taps, fittings and appliances	Predicted use for 2-bedroom apartment in 2010 (kWh/year): Heat: 4,398 Electricity: 3,419 Actual use in 2013: Heat: 1,984 Electricity: 2,821

rectified. Furthermore, as One Brighton is a car-free development, lack of parking has been an issue and the family has had to find parking elsewhere (interview comment, One Brighton resident). Overall, the experience of living in One Brighton has been a positive one, with the resident noting that "it is good to know that we are starting to make a difference, starting from the home".

Controlling ventilation, having potential overheating in the summer especially and the lack of car parking were also reported concerns in a post-occupancy survey conducted in winter 2011 (62 respondents) and summer 2012 (51 respondents) (Good Homes Alliance, 2014). However, 80 % of residents responding to the post occupancy survey indicated that the building had met their needs (Good Homes Alliance, 2014).

LEARNING FROM AND OUTCOMES OF ONE BRIGHTON

In developing One Brighton, Bioregional's key aim was to develop cost-effective and profitable apartments in an urban site based on One Planet Living principles. Bioregional wanted especially to build on the learning from BedZED (interview comment, Bioregional). While BedZED had been a success in several ways, not least by acting as an example of low energy housing, it had also faced several problems, including the biomass CHP plant that did not work properly (Chance, 2009). In BedZED, there were many aspects that could be built on, including the sustainable lifestyle approach and a completely car-free development. These were replicated in One Brighton, the latter possible due to the site's central location and good access to public transport. Furthermore, Bioregional had learnt from BedZED that simple things worked best and, hence, simplified their technological approach at One Brighton. This included focusing on good building fabric, setting up an energy services company to manage onsite renewable energy and bulk purchase the green electricity.

Post-occupancy evaluation

From the beginning, a key objective of the project was to include post-occupancy evaluation to assess how the building performs (see Good Homes Alliance, 2014). Bioregional wanted to set up their own estates management but given that they did not build more projects at the time, they outsourced the estates management to Stiles Harold Williams (interview comment, Bioregional). However, Bioregional collected post-occupancy energy data and completed an evaluation of the building performance, including in-depth monitoring for five one-bedroom apartments (including building fabric, energy consumption, thermal comfort, ventilation and interviews with residents), as well as daily heat and electricity data for all 172 apartments, non-domestic properties and communal areas (for details on collected data see evaluation by Good Homes Alliance, 2014). Bioregional also conducted two post-occupancy surveys, distributed and promoted by the caretaker, in winter 2011 (62 surveys completed by 60 apartments) and summer 2012 (51 surveys were completed from 50 apartments) (Good Homes Alliance, 2014). Again in this respect, Bioregional has been different to many other mainstream building developers who often build a project and leave the site once residents move in, (interview comment, sustainability consultant), providing the developer valuable learning for future projects on building performance and occupant experience.

Delivering low energy building design

From a design point of view, a key learning for the architects has been the need to focus on thermal comfort, overheating and ventilation at a very early stage in designing a low energy and very efficient building (interview comment, FCB Studios). In addition, the architects learned that while a knowledgeable design team is key to any building project, projects like One Brighton need "a strong client with strong ambitions and brief, who's willing to put the time and effort into seeing those through to fruition", which Bioregional certainly did (interview comment, FCB Studios).

For Crest Nicholson, One Brighton provided an opportunity to learn about delivering low energy buildings, especially in relation to issues such as the importance of heating sources and cooling (interview comment, Crest Nicholson). Crest Nicholson has also taken on board technologies such as combined heat and power and have installed those on sites in Bath and Southampton for example. This learning has been beneficial for the company in acquiring future sites for the business, and which they have been since delivering.

Sustainability throughout and beyond the building process

A key learning for many partners from the project has been the importance of a whole lifestyle approach, i.e. focusing on all aspects of sustainability and not only on energy consumption; including transport, waste, and food production as key aspects of sustainable building designs (interview comments, FCB Studios; Crest Nicholson). Furthermore, while the technology and knowledge exist to produce low-energy buildings, "the challenge is to make them good places to live in and enjoyable spaces that people want to live in. So, I think that's been part of the big learning for us from the project" (interview comment, FCB Studios). Yet, not all residents have taken on board the One Planet Living concept, partly due to the fact that as a city centre development, One Brighton has had a relatively transient population and many apartments have been let by overseas students who have come to attend the nearby language school (interview comment, Bioregional).

With the concept of One Planet Living being at the centre of the plans for One Brighton, there has been an opportunity to highlight these types of developments on a wider scale. One Brighton has acted as a showcase of a sustainable building design, and there have been many visits and tours around the building. Through the One Planet Communities Network, One Brighton has acted as an example to other projects in the US, Canada, France and Australia (interview comment, Bioregional).

For Brighton and Hove City Council, One Brighton development has acted not only as a learning point but an opportunity to highlight their sustainability credentials, helping to create the city as "a sustainability hotspot for construction" and encourage other developers (interview comment, Brighton & Hove City Council). Crest Nicholson and Bioregional both praised the supportive role that Brighton and Hove City Council had in the project. The working relationship between Bioregional and the Council was exceptionally good (interview comment, Bioregional). For Bioregional, it was especially important to get the Council's support, given that Bioregional were pushing boundaries with the car-free aspects of the development (interview comment, Bioregional). Furthermore, "the Council

and the developer have jointly won an award together, for what was achieved on that site" (interview comment, Brighton & Hove City Council). Overall, One Brighton development fitted well within the wider context of Brighton as a city that attracts people who have green, environmental values (interview comment, Brighton & Hove City Council).

According to Bioregional, One Brighton showed that it is possible to achieve a 90 % carbon saving through the choice of construction materials, use of highly energy efficient design, on-site renewable energy generation with purchase of additional renewable energy and a car free development, and also do it profitably (interview comment, Bioregional). Following One Brighton, Bioregional wanted to develop more projects, but with the financial crisis, development stopped and the company is only now starting to look at other sites again (interview comment, Bioregional). However, the financial crisis has affected the building industry as a whole and as the government has removed some of the regulatory framework such as the requirement for new zero carbon homes, "there has been a reversion back to compliance, away from excellence in sustainability" (interview comment, Bioregional), despite the fact that many of the actual technologies for low energy housing are now available and there are customers who value them.

Discussion and conclusions

The overall design of One Brighton project was a vision of Bioregional, a *cosmopolitan niche intermediary* (an actor intermediating within a wider community of multiple local projects across the UK) and a *project intermediary* (an actor facilitating and intermediating a specific building project) taking on a whole lifestyles approach to buildings. By working together with a large national developer Crest Nicholson, engaging widely with the local community and working closely with the Brighton and Hove City Council, Bioregional was able to develop a low energy building project that met both sustainability and profitability objectives. One Brighton, thus, extended from BedZED into being a more commercial experiment. Bioregional has addressed challenges throughout the project, from design to construction and post-occupancy experience, one by one and has not shied away when problems, such as a poorly working biomass boiler, have risen.

The One Brighton case shows how a low energy building experiment can build on early learning from a past experiment – coordinated by a *cosmopolitan intermediary* as an active developer. It also shows how a 'replication' of such an experiment need to be adapted to the needs and requirements posed by (1) local context specific factors, (2) changing market and policy conditions, and (3) the group of actors involved throughout the process that jointly created the 'market application' of the low energy building concept. Interestingly, biomass was used as an energy source on site, even with experience of problems with it in BedZED, resulting also in further problems in One Brighton despite considerable technical advancement in biomass boilers since the BedZED installation. At the same time, Bioregional, through learning from BedZED, paid close attention to post construction management in One Brighton, including periodical post-occupancy evaluation and setting up an energy service company to deal with energy production on site, to purchase of additional renewable energy supply, and to handle possible problems with the chosen energy options. In terms of the broader context, market potential and policy demand for low energy buildings were high at the time of construction of One Brighton, enabling and driving the involvement of housing developer Crest Nicholson in the project.

In addition to being a developer of One Brighton, Bioregional has also been one of the key intermediary actors advancing systemic innovation in low energy housing in the UK. By having a broader change agenda for advancing sustainable living and lifestyles, it has acted as a *cosmopolitan intermediary* in niche building transferring concepts, learning and ideas from the earlier BedZED project to One Brighton and advancing new technology, building process practices and networking. Bioregional operates in several countries and has developed initiatives such as One Planet Living Communities in Australia, France, Luxemburg, Tanzania, UK and the US. At the same time, in One Brighton, Bioregional acted as a *project intermediary*, after becoming a core part of project implementation. As such, it took on a range of innovation intermediary roles, including networking and partnership creation, sourcing and securing finance, liaising with the local authority and the community, and creating and integrating a sustainability vision for the project. This kind of dual role as a cosmopolitan niche intermediary and a project intermediary does not appear very common in recent low energy housing projects (Kivimaa and Martiskainen, 2016; Martiskainen and Kivimaa, 2016), whereas it has been recognised in some of the pioneers of sustainable housing concepts and renewable energy technologies, such as the Centre on Alternative Technology.

While the intermediary role of Bioregional was crucial for One Brighton, it was not the only necessary intermediary. The role of the Brighton-based sustainability consultant was central in initiating the development of One Brighton – he brought together community organisations, the local authority and key developer Bioregional in the first place. He effectively worked as a *project intermediary*, enabling changed perceptions by the Council regarding the brownfield site. Interestingly, his role changed as the project progressed, and he took on various positions and responsibilities, first stimulating a partnership at early phases of planning, being responsible for community engagement during planning and construction, and later taking on a position as a director of One Brighton Energy Services Company.

Other *project intermediaries* included the Sustainability Integrator, hired by Bioregional for the project to ensure that sustainability criteria set for the project were met at all stages of construction, and possibly also the energy services company set up for post-construction management for the energy issues.

These project intermediaries, together with *local niche intermediaries,* the local community group Budd and city council planners, formed an ecology of intermediaries that advanced energy efficiency and sustainability during different phases of the building project. When looking at the case in detail, each of these actors had a specific role and contribution in achieving the end result. In addition, Crest Nicholson, was there to show the commercial viability of low carbon buildings and provide financial backing.

In conclusion, the two actors, cosmopolitan niche and project intermediary Bioregional and CEO of Crest Nicholson were crucial in making a commercially-viable low energy building project that built on the initial BedZED experiment. However, several locally placed intermediaries were necessary to adapt this project to the local context, create a supportive local network of actors, and implement the project during construction and post-construction. Thus, our study demonstrates the importance of intermediaries in multiple scales to carry out larger experimental and innovative low energy building projects.

The experience from both BedZED and One Brighton show that policies addressing the sustainability of housing and those striving to create market demand for low energy buildings need to recognise how complex building projects are. While the actors involved perceive large opportunities in low energy housing, the key question for the sector still is to what extent and how can low energy buildings scale up from experiments to mainstream, become the norm and begin requiring less involvement from niche intermediaries. In the meantime, particularly at the absence of strong government policy, both national and local policy should set up, support, and nurture the emergence of cosmopolitan and local niche intermediaries that have the capabilities and resources to (1) actively engage in and develop new low energy housing projects, (2) stimulate and advice others to take on such projects, (3) remove policy and institutional barriers (e.g. in permitting, insurance, mortgaging) for low energy housing. In addition, policy makers should be made aware of how policy changes may curtail the space of already operating intermediaries.

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