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Title

Innovation in low-energy home renovation in the UK and France

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Abstract

In both France and the UK, low-energy renovation of housing is an important part of wider climate change mitigation strategy. Policy directed at householders and building professionals aims to increase the number and ambition of low-energy renovations. However, persistent problems exist for delivering genuine energy reductions at scale, including the design-performance, which can be understood as a problem for industry related to three factors: knowledge and skills; uncertainty over who has responsibility; and poor communication. This paper reports two case studies, focusing on the practices of innovative construction firms – one in the UK and one in France. The UK case concerns a social housing organisation which developed innovative ways of working and delivered high quality results at lower than expected costs. The French case study profiles a new start-up company with a co-operative governance structure offering guaranteed performance contracts to clients for its renovation services. Key common themes for these innovative firms are: new configurations of traditional roles and responsibilities on-site; new ways of responding to the needs and behaviours of building occupants; and the integration of different feedback mechanisms to provide learning.

Keywords chosen from ICE Publishing list: Energy conservation; Rehabilitation, reclamation and renovation

1 Introduction

The built environment must undergo dramatic changes to meet climate change targets (IPCC 2014). The World Business Council for Sustainable Development (2009) calls for a worldwide building sector energy reduction of 77% below projected 2050 levels. In both Britain and France, the residential sector is a major consumer of energy and a principal emitter of CO₂. Both countries have identified the improvement of existing housing stocks through renovation as an important part of a wider climate change mitigation strategy (H M Government 2008, French government 2009, 2010).

Delivering large numbers of high quality household renovations is a complex challenge. Oreszczyn and Lowe (2010) argue that the effort required to achieve genuinely improved energy performance of building stocks is unprecedented, requiring a new strategic collaboration between industry, research and policy. It is not simply a problem of missing technology: advanced low-energy renovations can be achieved using existing technology (Bell and Lowe 2000, Roberts 2008).

A recent review of the literature on design-performance gaps identified three recurrent themes requiring improvement throughout the design and building process – knowledge and skills, responsibility and communication (Zero Carbon Hub 2014). Similarly, there are multiple reasons for the current low householder demand for low-energy renovations, with lack of awareness, lack of motivation, tenure and affordability cited as barriers (EST 2010a, Consumer Focus 2012). Thus businesses hoping to deliver high quality low-energy renovations not only have to overcome the design-performance gap, they also have to create an offer which is attractive to potential customers.

This paper focuses on the organisations doing renovation as an important agent for change (see, eg, Janda and Killip 2013). The overall aim is to explore how two innovative organisations have created a practical response to the persistent problem of how to achieve genuine performance improvement. The two case studies presented are necessarily briefly described, and do not include full technical details, but have been chosen for the multiple dimensions of innovation they illustrate. These case studies are one element of a wider study which collected data from a variety of sources: 30 professional interviewees (20 in UK; 10 in France); numerous site visits, discussions and meetings in both countries to help understanding of innovative industry initiatives; literature and policy reviews; interviews and questionnaire research with householders living in renovated homes (see Fawcett et al 2013; Killip et al 2013; Fawcett & Killip 2014).

The detailed research aims are:

1. To explore the challenges and opportunities for low-energy renovation in the residential sector in both countries
2. To describe the policy environment for renovation in the UK and France, and show how it influences organisations undertaking renovation

3. To present a case study from each country illustrating innovation in practices and processes
4. To draw lessons from these examples useful to the wider industry.

While there are interesting differences between the UK and France, which are explored, the aim is to identify the common challenges of low-energy renovation and responses by organisations, not to provide a full cross-cultural comparison.

2 Challenges and opportunities for low-energy renovation

The challenges to delivering high numbers of high quality low-energy renovations in the residential sectors are numerous, with social, economic, organisational and technical dimensions. This market is characterised by non-expert clients and small and medium-sized enterprises, mainly micro-businesses, providing repair, maintenance and improvement (RMI) services. RMI is intrinsically a more labour-intensive process than new construction, and the reality of unforeseeable problems at the outset means that renovation is also heavily reliant on on-the-job problem-solving and negotiation. In the domestic renovation market projects often have neither design standards, nor professional consultants, nor formal procurement processes – making experience in their sector very different from that in the commercial building sector.

Nevertheless, there may be opportunities for this sector to learn from best practices in commercial renovations and new build – particularly in terms of strategies to bridge the design-performance gap. One initiative to eliminate this gap is the ‘Soft Landings’ approach to building handover. The approach means designers and constructors / renovators stay involved with buildings beyond practical completion. They assist the client during the first months of operation and beyond, to help fine-tune systems, and ensure occupiers understand how to control and best use their buildings (BSRIA 2014). The soft landings framework is designed for much more complex buildings and systems than those seen in the residential sector (UBT and BSRIA, 2014), but nonetheless, the core idea of delivering better performing buildings by extending the responsibilities of the designers and builders or renovators, also has resonance in the residential sector, and is picked up in our French case study.

Domestic renovation projects with formal energy standards and rigorous monitoring and evaluation are few and far between. The Retrofit for the Future (RFF) programme is the one notable exception in recent years, where a variety of approaches to ambitious carbon and energy saving were tested in 86 projects (Technology Strategy Board 2013). RFF monitoring results showed that ambitious standards can be achieved in practice, but that there is very little margin for error in doing so - the quality and integration of design and installation has to be exceptionally good. This programme demonstrated the need for close and careful working between different building trades, a theme which is explored in our UK case study.

Experiences in the RFF homes, though very useful, differ from most low-energy renovations. They had generous government funding (up to £150,000 per home), had high involvement from multiple building sector professionals, had a goal of 80% carbon savings and extensive monitoring and evaluation. Research into owner-occupied houses in the voluntary Superhomes network showed much lower typical expenditure, with many renovations happening in stages over years, a frequent lack of formal numerical goals (although all homes are judged to have made at least 60% carbon savings), a component of DIY as well as professional work, and a linking of renovation work to ‘trigger points’, such as home extensions (Fawcett and Killip, 2014). Extending the low-energy renovation market is highly likely to involve taking advantage of trigger points (EST 2010b) and adding low energy components to regular RMI work. Killip (2011) estimated that as much as 45% of the existing RMI market represents an opportunity to carry out low-energy works on the back of other works being planned.

3 National contexts

The key features of policy affecting low-energy renovation in France and the UK are briefly described (fuller descriptions are available elsewhere, e.g. Killip et al, 2013, Fawcett et al, 2013), followed with a discussion of the effects on renovation professionals and the markets for renovation.

The long-term strategic policy framework for France is provided by the ‘environment roundtable’ (Grenelle de l’Environnement), which calls for a fourfold reduction in energy consumption by 2050 across the entire economy. This has led to specific targets for housing, which include a target of 38%

reduction of energy use (compared with 1990) by 2020, and a renovation target of 400,000 homes per year, starting in 2013. The UK government's key target is expressed in terms of carbon rather than energy. The Climate Change Act requires a reduction in carbon emissions by 80% by 2050, compared with 1990 levels. There is no separate target for the residential sector, nor a target for the number of renovations to be achieved per year. Thus, the long-term national targets are similar, but specific targets for housing renovation have not been developed in the UK.

Both countries have a diverse housing stock in terms of ownership, age and built form. In France, 62% of properties are in owner occupation, compared with 70% in the UK (Eurostat, 2012). The countries vary in terms of built form (Table 1), with France having a much higher proportion of flats and detached homes than the UK, where semi-detached and terraced houses dominate.

Table 1: Percentage of housing in different built forms

	France	UK
Flats	33.9	14
Detached house	43.5	25.6
Semi-detached or terraced house	22.4	60.3
Other	0.2	0.2

Source: Eurostat, 2012

There is also more diversity of heating fuels and climates in France than the UK (Fawcett et al, 2013).

3.1 Policies for householders

Government policy is important in shaping the market for energy efficiency measures and low-energy renovation. In both countries, most policy focuses on either reducing renovation costs to building owners, or giving them additional access to finance.

In France, there are several kinds of financial incentive for installing energy efficiency measures / undertaking elements of low-energy renovation, which can be aggregated. These include:

- VAT reduction on renovation work
- Sustainable development tax credit (crédit d'impôt développement durable, CIDD)
- Zero interest eco-loan (l'éco-prêt à taux zéro, PTZ)

The rules of these schemes, and how they interact, have changed over the years, with an increasing emphasis on rewarding more ambitious renovation plans. The introduction of the PTZ in 2009 was largely a response to the limited improvements being made to the thermal envelopes of buildings through the CIDD. In the early years of the CIDD the eligibility criteria for supported measures did not change in response to the different speed of change in different markets, which meant that nearly half of credits went towards window replacements in 2007 (85% of windows on the market being eligible).

The PTZ was designed to place the emphasis on thermal fabric, using either a design standard or bundles of individual measures. The design standard is 80 or 150 kWh/m².year, depending on the modelled consumption of the building before renovation. Alternatively, two or more work packages must be undertaken from a prescribed list:

- High-performance roof insulation
- High-performance wall insulation
- High-performance windows and doors
- Installation or replacement of a system for space heating or hot water
- Installation of thermal renewable energy technologies for space heating
- Installation of thermal renewable energy technologies for water heating

These subsidies for individual efficiency measures have some similarities to what was offered under the UK's previous energy company obligation scheme (CERT, 2008-2012), although the UK scheme focussed more on insulation measures (Rosenow, 2012).

In the UK, the key policies for financially supporting energy efficiency measures are:

- Energy Company Obligation (ECO) which focuses on supporting high cost measures and lower-income households and those in fuel poverty
- The Green Deal – (unsubsidised) loans attached to the property of up to £10,000 per household for single measures or packages of measures.

Early take-up of Green Deal, introduced in 2013, has been extremely low (DECC 2014) and there has been criticism of the design of this scheme and its potential for delivering significant savings (Guertler et al 2013, Rosenow and Eyre, 2013). Presently, most savings are being delivered by ECO, with 500,000 measures installed in 2013 (DECC, 2014).

In the UK, ‘feed-in tariff’ payments for micro-generation technologies, such as solar photovoltaics, have been re-structured so that householders whose homes have an Energy Performance Certificate of D or above get higher payments (DECC 2012). Given the popularity of feed-in-tariffs, this could be a driver to encourage low-energy renovation.

In most circumstances, France offers more generous financial help per householder to fund low-energy renovation, and will fund larger and more ambitious packages of work. Based on interviews with French firms, the 0% interest rate itself is seen by innovative organisations as a tool for ‘up-selling’, whereby a request for work from a customer is a ‘foot in the door’ to offering additional, low-energy measures. There is no equivalent to this in the UK at present. Green Deal has not created a (largely unsubsidised) market for low-energy renovation in the UK, or encouraged new entrants and sparked innovation, which was the intention.

3.2 Policy effects on renovation professionals

In both countries, policy largely impacts professionals and tradespeople indirectly by affecting the market for their services. As the funding rules change, businesses are expected to offer different efficiency and renovation packages to clients, in order to take advantage of these.

France has pioneered the QualiBAT voluntary training programme for building-related trades, and programmes for microgeneration and low-carbon conversion technologies. There are also two accreditation schemes for skilled low-energy practitioners: the ‘éco-artisan’ scheme and the ‘pros de la performance énergétique’ scheme. The award of financial incentives is conditional on installers being trained on one or other of these schemes. Similarly, in the UK, grants and payments for micro-generation are linked to accreditation schemes (including training and quality standards for installers), as are Green Deal loans.

However, the link between financial incentives and training is far from being an industry-wide training programme. The majority of firms make a living without reference to these schemes.

4 Case studies

The case studies below are based on a series of semi-structured, recorded and transcribed interviews with individuals involved in each organisation (14 interviews in the UK case, 5 in France), as well as two unrecorded business meetings in France. Documentary evidence from organisations’ publications and websites has also been used.

4.1 France: a new low-energy renovation co-operative

This case is a new company with a co-operative governance structure offering guaranteed performance contracts to clients for its renovation services. This model is still being developed at the time of writing and the plan is to start with 15 renovations in the first year and 35 in the second year, so as to allow time for learning and making any necessary changes to the systems before extending the client base. The research involved site visits, observation of several business meetings, and interviews with five members of the co-operative: the CEO of the co-operative itself, and senior staff from four member firms.

A central technical function uses bespoke modelling software to model performance based on the design standard of the renovation works and a detailed list of energy-using behaviours (occupancy, internal temperatures, washing and cooking habits, etc). These parameters – both technical and behavioural – are used to create a detailed prediction of energy consumption, which underpins the contract between the client (resident) and the co-operative (renovation service provider). Then, should energy consumption fail to meet expectations, a review of contractual obligations on both sides is carried out. If the contracted behaviours are being honoured by the occupants, the contracting firms are deemed to be at fault and take responsibility for rectifying the renovation work or reimbursing the client. If, on the other hand, the contracted behaviours are not being honoured by the occupant (for example, if an extra person starts living in the home since the contract was drawn up; or if the household's showers are longer than first estimated), then the new occupancy/behaviour pattern is modelled, and a new contract is drawn up. Ongoing monitoring systems (temperature, humidity and CO₂ sensors) allow the co-operative to notice atypical energy use patterns or other signs that might require remedial action. Messages are sent quickly to alert clients of anomalous readings, with the aim of preventing problems before they get out of hand.

The contractors doing the renovation works are all members of the co-operative, as are the clients. This structure is designed to maintain a balance of voices in the ongoing development of the organisation – both operationally and strategically. For contractors, co-operative membership is conditional on key personnel being trained under the Eco-Artisan programme. The contractors themselves operate a form of quality control through regular review meetings, in which any concerns about the quality of a member firm can be discussed and action taken. Ultimately, the co-operative has the right to throw out any member who consistently fails to meet the commitments of the contractors' charter, although the preferred course of action is to raise the quality of such members' work through encouragement and training.

4.2 UK: low-energy renovation of a social housing estate

This case features a project by Radian Housing, a social landlord with 16,000 properties, involving a series of 36 low-carbon renovations of near-identical houses in southern England (pre-fabricated reinforced concrete REEMA construction), supported financially by the European Regional Development Fund. There were three design packages covering all energy end-uses (space and water heating, cooking, lights and appliances): a show home (23.1 kg CO₂/m².year); package A (24.7 kg CO₂/m².year); and package B (30.9 kg CO₂/m².year). Gas and electricity consumption were monitored before and after the renovation works for 4 of the 36 properties, but data was not available for a full 12-month period, so interpretation of results needs to be cautious. Monitored gas consumption reduced by 50-60% in the 4 monitored homes, while electricity consumption was unchanged or only showed small reductions. A fifth house, which had been heavily reliant on electric oil-filled radiators for space heating before the renovation, recorded more than 80% reductions in winter electricity demand after the renovation (Radian 2011).

The research focused on the process of renovation, exploring how the work had been carried out to achieve these performance figures. The landlord has an in-house repair and maintenance team, many of whom have been with the organisation for many years. Fourteen of the team members involved in this work were interviewed, in order to build up a picture of how the project evolved and was managed.

The work became faster and more efficient as the team grew in experience. This learning process was facilitated by an early decision to renovate an initial four properties completely before starting any others. The reason for this decision was that it would be easier to manage the temporary re-housing of tenants from other properties if homes were completed in small batches.

After initial site management problems, a temporary office was set up on-site so that problems could be reported and resolved quickly. A site management team was formed, with three people feeding into the management of the project on three key issues: supervision of the team of tradespeople; advocacy of the needs of the landlord client; and engagement with tenants to ensure good communication between residents and the on-site team.

A system of financial incentives was introduced by the site supervisor to promote efficient working, based on a bonus scheme, which was to be shared by all operatives on a pro rata (hours worked) basis. Thus, wherever a task was unfinished, all members of the team were expected to help out, because bonus

payments were triggered by completion of the whole project, not by completion of individual tasks. Thus, carpenters might find themselves doing work for plasterers, or vice versa. In fact, the task of external wall insulation was the one where this system of teamwork was most noticed, both because of the quantity of work involved and because of the hard physical nature of rendering outside walls in cold weather. This practice of 'multi-skilling' was remarked on by many in the team as being unusual and innovative, and many commented that it was only workable in this case because the individuals had a long history of working together, which meant that they knew one another well, and trusted each other's skills.

The process of learning over the course of doing work on 36 houses led to significant improvements in labour productivity. After the first two renovations had been completed, the whole project was running over-budget: but by the end, significant budget savings were being made, leading to a healthy level of bonuses for the team.

Other problems emerged too, which required on-the-job solutions. For example, where residents had satellite television dishes on the outside of their home, a means had to be found to re-attach the dish through a 150mm thickness of insulation without compromising the weather-proof properties of the render and with minimal loss in performance through thermal bridging. This type of on-the-job challenge resulted in frequent on-the-job meetings where the workforce all downed tools in order to talk through how best to resolve issues as they arose.

5 Discussion

First there is a discussion of the unique features of each case study, followed by an integrated discussion of themes that are common to both.

French case study

The approach being made to offer guarantees to householders in the French case study is innovative, and the authors are unaware of any parallel innovations in the UK. It has some elements in common with the 'domestic energy saving company (ESCo)' concept, whereby heat, light and power is provided for the home through a financing arrangement linked to the ongoing reduction of fuel bills, delivered through investment in energy efficiency and other measures. This has usually been thought to be very difficult to operationalise (e.g. UKERC 2005). Even in the much more sophisticated commercial market, guaranteed or energy performance contracts can be problematic (Fawkes 2013). The French business model is still under development, and may ultimately not prove successful. However, it represents a new approach, taking advantage of modern monitoring, modelling and communication systems. It is designed to engage the household in managing their own energy use, and to make guarantees for performance possible without exposing the renovation firms to unacceptable risk.

Another innovation is the organisation of 'back office' services to provide administrative and technical support services. The need for such services is partly brought about by the requirements of policy initiatives (eg for training and accreditation, and for securing financial incentives), but it also ensures the more expensive technical expertise is not on site all the time, but is available as needed.

UK case study

In the UK case, a multi-skilled team based on shared tasks, shared risks, and shared problem-solving was created. The on-site management team of three colleagues working closely together was key to negotiating issues between the client, the project team, and the tenants. The unfamiliar nature of the work (especially the labour-intensity of rendering on the external wall insulation) could have caused delays or other problems, but the innovation of a shared bonus scheme for all workers proved effective in motivating shared responsibility and shared problem-solving. The workers' long history of working together helped make the multi-skilling approach work: in a less tightly-knit group of workers, it seems reasonable to think that there would be greater risks (real or perceived) of relying on other trades to carry out tasks beyond their normal skill-set. The fact that Radian has a direct labour organisation for such works, rather than relying solely on outside contractors, cannot be assumed to be a determinant of the project's success, but it does seem to have helped.

One other outcome of this project was a recognition that there are significant cost savings to be made by creating opportunities for learning and increasing labour productivity. This emerged almost as an

unintended consequence of the shared bonus scheme: the shared bonus worked well as an incentive for collaborative working and creative problem-solving, but it also led to significant unit cost savings over the life of the 36-home project.

The UK case study in the social housing sector was not specifically supported by UK policy, and it demonstrates that innovation can take place even where policy support is relatively weak. It did, however, receive funding from the European Regional Development Fund.

6 Conclusions

Three common themes emerge as important from the comparison of these two case studies.

Roles and responsibilities: In the UK case, a multi-skilled team based on shared tasks, shared risks, and shared problem-solving was created. In the French case new forms of organising work and assigning responsibilities, including the customer's responsibilities, have been developed using a co-operative model. Both these models represent a shift away from the standard contractual and sometimes confrontational relationships typical in construction / renovation.

Client engagement: The traditional client role is extended in a striking way in the French case, where energy-consuming behaviours are contractualised as part of the renovation performance guarantee. In the UK case, the community liaison officer represented tenants' views and was an equal partner in the site management team, together with the site supervisor (who managed the labour force) and the site surveyor (who inspected and signed off the works). Both cases demonstrate a strong commitment to building occupants as integral parts of a building's operational life. They are socially competent as well as technically competent.

Learning and feedback mechanisms: The novelty of the French case lies in a business model constructed on a strong foundation of real-time monitoring and energy modelling. The performance guarantee is designed to give confidence to the client, but it also means that the co-operative's technical skills and tools need to be honed. A constant supply of monitoring data is the source of the learning, which hones the technical competence, which in turn underpins the performance guarantee. In the UK case, the decision to renovate four homes completely before moving on to a second set of four was driven by the desire to reduce the cost and disruption of decanting tenants, but it had the happy effect of facilitating an intense learning exercise, which led to unit cost savings over the life of the entire project. Feedback is iterative, with information loops running from one house to the next in the UK case, and from one moment to the next in the French case.

7 Practical relevance and potential applications

Definitions of conventional roles on construction projects (architect, engineer, builder, electrician, etc) are called into question by the findings of this research. If low-energy renovation is to move beyond its current niche, then the trades and professions need to offer a better integrated service. In the housing sector, in particular, this raises the question of whether engineers, say, should play a more active role in smaller projects (where they have typically not played a role)? Or, alternatively should the builders and other craft-based trades who dominate the RMI market be assigned some of the tasks which might currently be expected to be the preserve of engineering (or architecture)? To what extent might technical 'back office' functions replace or support the role of professions in the future? These issues are central to our understanding of what constitutes a successful low-energy renovation market, just as the veracity of technical monitoring data is key to evaluating each individual project.

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