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Social housing retrofit strategies in England and France: A parametric and behavioural analysis

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ABSTRACT

IFORE (Innovation for Renewal) is an EU Interreg funded partnership including two large housing associations, one in England, one in France, and a university from each country. The project is an exemplar large-scale retrofit, 100 houses have been retrofitted at Rushenden, on the Isle of Sheppey (Kent, England), and a similar number at Outreau, a suburb of Boulogne (Pas-de-Calais, France). This paper offers an overview of the methods used by the project team to find common solutions and to identify similarities between retrofit measures and occupant's behaviour in both countries. The cross-border nature of IFORE makes the project also original in relation to other similar national retrofit projects that have been developed prior to it. Dynamic thermal simulation was used to evaluate the thermal behaviour of the buildings refurbished. It is a valuable decision-making tool when assessing alternative retrofit measures. Initial surveys were carried out to make a classification of the housing stock which formed the context for the computer simulations. Some results from the simulations, carried out with ESP-r in England and Pleiade + Comfie in France, are presented in this paper. The comparison of the results from the two simulation tools shows great similarity between the two methods, which gave confidence for their use in evaluating alternative specifications for the works that have now been adopted for retrofit. At the same time sociological studies have characterised the populations in order to bring the most advantageous results from the retrofit works in reducing carbon emissions but also reducing fuel poverty whilst improving comfort standards.

1. Introduction

The European Union (EU) established the carbon reduction goals for all its member states to cut 20% of its carbon emissions by 2020, 40% by 2030 and 80–95% by 2050, below 1990 level [1]. In agreement with EU policy The Climate Change Act (2008) sets the legally binding target to reduce by at least 80% the UK carbon emissions by 2050 below 1990 baseline year level, through action at home and abroad [2]. In France, *Le Grenelle de l'Environnement* is composed of two environmental laws voted in parliament in 2009 and 2010 [3]. *Le Grenelle 2* (2010 – loi n° 2010-788 du 12 juillet 2010:) establishes the target to retrofit 400,000 dwellings each year starting from 2013 and 800,000 of the most energy inefficient social housing by 2020 (Le Grenelle de l'Environment, 2010). Towards this goal the RT 2012 (Reglementation Thermique 2012) sets up the minimum values for the thermal global resistance of each building after the retrofit [4].

"Buildings constructed today will be there for the next 50–100 years. For example, 92% of the building stock from 2005 will still be there in 2020 and 75% in 2050. This is due to the very low demolition rates (about 0.5% p.a.) and new build construction rates (about 1.0% p.a.)" [5]. In both England and France retrofit of the existing housing stock is being given a high priority since improvement of the existing built environment can make such a significant contribution to reducing national energy consumption [1]. "The measures in the buildings sector have the lowest abatement cost for greenhouse gas reduction which in many cases are at low, and even negative levels, due to the energy use cost reductions" [5]. According to the IPCC (Intergovernmental Panel on Climate Change) forth assessment report, "by 2030, about 30% of the projected greenhouse gas emissions worldwide in the buildings sector can be avoided with net economic benefit" [6]. The

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Intelligent Energy Europe Programme financed several projects that explored the retrofit of social housing in Europe. In particular the FRESH (Financing energy REfurbishment for Social Housing) programme "aimed to produce a cost model to reduce the green house gas emissions from social housing by a factor of 4 by 2050" [7]. It involved 4 European countries including France and the UK.

In the UK, recent retrofit initiatives include the "Retrofit for the Future" competition [8]. Launched in 2009 and organised by Innovate UK it involved the retrofit of eighty-six social houses. The Merton Parity Projects venture was commissioned by the London Borough of Merton in 2010 with the aim of analysing the potential for retrofitting the total housing stock in the borough [9]. The Bristol retrofit project by Arup [10] looks at the potential for retrofitting the private housing stock in the Bristol area. A number of housing associations, Affinity Sutton, Gentoo and Worthing Homes have championed the retrofit of their building stock. The latter has developed the Relish project [11] in partnership with the University of Brighton. It involves the low-cost retrofit (£6500 per house) of social housing and it focuses on the importance of energy advice and the occupants' education programme. The DEMScot project [12] studied the potential for retrofitting the Scottish housing stock and looked at the future of the houses up to 2050.

IFORE is a project funded by the EU Interreg programme with the aim to retrofit 100 social houses in Rushenden on the Isle of Sheppey in Kent (UK) and 100 social houses in Outreau near Boulogne-sur-Mer, in the region of Pas-de Calais (France) [13]. IFORE aimed to increment the carbon reduction achieved by the use of technical solutions with a change in the behaviour of the occupants in an effort to make them more responsible towards energy. The houses are well suited to a cross-border study since the geographic distance between them is relatively short and both share a maritime climate. The buildings however have different forms, typologies, using different materials and structures because of the different building traditions in the two countries. They represent both the similarities and differences between the wider housing stocks of both regions. Consequently the results from IFORE have demonstrated the advantages of cross-border cooperation whilst assessing the feasibility of implementing widely applicable technical and community-engagement solutions for retrofit.

The project draws upon expertise within the social housing sector in each country for comparison of the monitored data, and to promulgate the results for future retrofit schemes. This paper presents the preliminary analysis of the energy consumption of the houses in both countries and the results of the dynamic thermal modelling carried out to assess the reduction in heating demand after the retrofit measures were installed. Moreover, the paper discusses the approach used that was based on the engagement of the residents of two local communities and the exchange of technical expertise.

IFORE achieved cost effective low-energy improvements and encouraged the participants to take on board energy saving initiatives. In this sense IFORE encourages other similar public and private initiatives to adopt a community based approach which is characteristic of social housing projects. To arrive at common technical approaches, research into local housing standards entailed on-site surveys, simulation models were then constructed to judge the relative efficacy of alternative specifications that were adopted for retrofit at the two sites. Because IFORE has been as much interested in human aspects as the performance of technology a variety of methods have been used to monitor and analyse the project's results. This paper offers an overview of the methods used by the project team to find common solutions and to identify similarities between retrofit measures and occupant's behaviour in both countries. The cross-border nature of IFORE makes the combination of methods presented herein original in relation to other similar national retrofit projects that have been developed prior to it.

Table 1
English and French national housing stocks compared.

English National Housing Stock	French National Housing Stock
23.1 million homes (2012)	33.2 million homes (2012)
4.0 million social sector (17.3%)	4.7 million social sector (14.2%)

2. Material and methods: identification and selection of properties for refurbishment

The housing types have been chosen to best represent the overall housing portfolio of the two participating housing associations, maximising the future potential of the project's outcomes for immediate replication, but also to be representative of social housing within the cross-channel maritime region.

At a national level, as shown in Table 1, although the population of the two countries is similar at around 63.7 million in the UK and 63.4 million in France, in England which constitutes around 84% of the UK population, the housing stock is considerably smaller in provision per capita, in 2012 (the most recent for direct comparison) there were 23.1 million homes in England. Whereas, pro rata in France [14] the stock was approximately 15% larger. Although in England [15] the proportion that is within the social sector is greater than in France, there were (in 2012) 700,000 more social units in France because of the overall larger size of the housing stock. The latest English House Survey (2012–2013) shows the number of social housing units in England falling over the previous 6 years such that the private sector now has more tenants than the social rented sector.

These differences have historic roots in the patterns of housing provision and tenure within the two countries. At Outreau the 100 houses are distributed across four adjacent but distinct sites each with its own housing type. Rushenden is a typical English housing estate that has a larger number of plan types, three single storey and four two-storey, but within a basic form of brick cavity construction that can be found across the south of the country. The 100 houses which are 'stock transfer' (built by the local authority but subsequently transferred to the ownership of AmicusHorizon Housing Association) are within a single area, but the houses for study are interspersed with owner-occupied houses that were sold off as a result of the 1980s 'right to buy' policy. Whereas, at Outreau all the units are social housing within the ownership of Pas-de-Calais habitat though some can be sold to their occupants in the future.

The housing stock in England is both older than that in France and also performs less well in terms of energy and carbon emissions. In 2006, the annual average consumption of the 'main' homes in France was equivalent to a class D on the energy consumption scale used by the DPE (energy efficiency diagnosis). Whereas in England in 2006 the energy efficiency (SAP) rating average was 49, equivalent to a class E on the equivalent EPC (UK Energy Performance Certificate) scale. In France 59% of 'main' homes were built before 1975, in England 60% of the housing stock was built before 1965 [16].

The houses chosen for retrofit in Rushenden, by comparison with those in Outreau, are representative of these national characteristics. The houses in Rushenden are significantly older than those in Outreau and of worse energy performance. The primary energy use of the houses in Outreau is between 207 and 286 $kWh/m^2 \cdot yr$ and in Rushenden between 273 and 359 $kWh/m^2 \cdot yr$ (Tables 2 and 3). Slightly different calculation methods are used in the UK and France. The EPC in France (CEP – Consommation en Énergie Primaire – conventional primary energy consumption) includes only heating and hot water, while in England it also includes lighting. The English houses were constructed between 1945 and 1964 whereas the French sample dates from between 1979 and 1983, the latter consequently benefitted from