IFORE
Innovation for Renewal

Project Report

IFORE was selected under the European Cross-border Cooperation Programme INTERREG IV A France (Channel)–England, co-funded by the ERDF.

www.ifore.eu

Introduction

IFORE has been finding best ways of retrofitting social housing in order to cut fuel poverty by increasing energy efficiency, it has been financed by the European Regional Development Fund's Interreg programme and coordinated by the University of Brighton.

The partnership also includes two large housing associations, AmicusHorizon from the UK and Pas-de-Calais habitat in France, and building scientists from the Université d'Artois. The project's communications have been managed by GlazB/Coopetic based in Paris.

IFORE has been searching for the most efficient low-carbon methods by trialling different systems in 100 homes at Rushenden on the Isle of Sheppey, and in houses at Outreau near Boulogne on the northern coast of France. The houses have been retrofitted and then monitored to measure their relative energy consumption before and after the interventions.

The study has investigated householders' interaction with the technologies and involvement with the process. The importance of engaging with these behavioural aspects has been a major outcome of the project.

This large-scale study has paved the way for the introduction, and industrialisation, of low carbon solutions, it is guiding the future retrofit of 10,000 dwellings, out of a total of 66,000 homes for both housing associations at the project's completion.

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A way of thinking about retrofit

Setting the scene. In 2009 AmicusHorizon and Pas-de-Calais habitat were approached to join a European project entitled 'Innovation for Renewal' (IFORE). At that time thermal retrofit of both nation's housing stock was rising to the top of the agenda. The only completed examples were individual houses such as those used for the UK Retrofit for the Future competition. Retrofit at scale presents a range of problems and opportunities so we were keen to be involved and benefit from the scope of IFORE.

The partners. IFORE has been funded by the ERDF Interreg programme that supports the exchange of ideas and expertise across the Channel. So the team consists of one housing association and one university from each country: our UK partners at the University of Brighton who have coordinated the project and in France the Université d'Artois and Pas-de-Calais habitat.

While the application was being written we discovered a wonderful synergy between the background and aspirations of the partners. Pas-de-Calais habitat is a large organisation; its housing stock is similar in size to ours. They have an innovation department employing engineers and social scientists who have great expertise particularly in technical solutions. Housing projects in France that incorporate new methods are rewarded by a more generous government funding regime.

AmicusHorizon provides help and support to the communities within which we work, to help provide employment and community cohesion. We've developed methods of engagement with local communities and individual households and have staff dedicated to developing these aspects. The governance of AmicusHorizon includes representation from area panels and elected representatives. In France this kind of 'hands-on' approach was unfamiliar and our experience has contributed to the people-centred outcomes of IFORE.

At Rushenden and Outreau (on the outskirts of Boulogne) our task was to retrofit 100 houses with the intention of comparing and contrasting the results. The housing at Outreau is largely made of concrete with a limited number of different house types. In Rushenden we have more house types differentiated by size and accommodation layout but all are of brick cavity construction. AmicusHorizon's homes, unlike those in France, are of mixed tenure as a result of the 1980s 'right to buy'.

The academic partners worked together to build computer simulation models that would predict the energy benefits of the retrofits, as well as understanding the different standards and building regulations requirements. Different packages of measures were evaluated and eventually external render-finished insulation was chosen for Rushenden and a factory-made over-cladding system has been developed from prototypes in France.

Local residents in both countries have been involved in a wide variety of activities, raising awareness of the issues underlying the importance of better

The IFORE Project Timeline

March 2010
Start of the project

2010

June

Selection of house types.

July

Brainstorming for the IFORE logo at a Steering Committee meeting.

September

Appointment of Green Doctor for the Rushenden IFORE community.

October

Measuring thermal performance of selected house sample in Rushenden and Outreau.

November

Designs of possible retrofit solutions for Manor Close.

performing dwellings. Inevitably a major motivation has been the reduction of energy bills. Through working with local schools we have encouraged children to get involved, for example as Energy Detectives investigating where energy is used and wasted.

A mixed approach. This has been a learning experience for AmicusHorizon. Ventilation by 'supply air' windows was of particular interest. The usual energy-saving measures added to insulation and improved air-tightness present a challenge to good indoor air quality with implications for comfort and health. The 'supply air' windows developed in France are being monitored in Rushenden along with other renewable technologies, photovoltaic and solar thermal panels on roofs, and both air-source and ground-source heat pumps. These will continue to be monitored beyond the end of the project with a view to our implementing them in future retrofit projects.

There's been a mix of physical and community development. To understand the importance of behavioural factors in the outcome of retrofit projects, sociologists and psychologists have been involved along with surveyors and engineers. In France, it has been important to understand the changes that might result in optimal outcomes for future energy costs and household comfort. In England, the level of technology employed has to be user-friendly and appropriate to the available budget. This mixed approach has reinforced the importance of the Green Doctor's involvement, which offers a route to carbon reductions that are difficult and expensive to achieve using technical means.

A test-bed for larger projects. This report shows the technologies and the involvement of the communities, the insights we have achieved by working together and the difficulties encountered along the way. The knowledge gained has proved a test-bed for the roll-out of larger scale plans. In both countries the resources required to upgrade the stock of social housing will be considerable. The knowledge base isn't complete however IFORE has provided a stepping stone. We hope our experience will enable others to proceed with greater confidence.

Paul Hackett, Chief Executive, AmicusHorizon Housing Association

Innovating for lasting results

Energy is becoming increasingly expensive and in today's economic climate this poses particular problems for our tenants. Difficult as they are, these are realities for Pas-de-Calais habitat, which are nonetheless exciting challenges that we have to face together.

Innovation means new solutions. Throughout the European IFORE program, we have found answers that are economically viable for housing associations, but also acceptable to tenants.

Today, we know how to make both new and old buildings highly performing. One just needs to pay the price. But that is not innovation. Instead, to find new solutions that are easy to industrialise, and which are based on tenants' being in control of their energy consumption, and not to consider tenants simply as users or worse 'consumers', but indeed as players, that is undoubtedly a true combination of technical and social innovation.

Pre-assembled thermal envelopes, dynamic 'Paziaud' windows for ventilation, the use of heat sensors, monitoring consumption using touch pads, and other developments too numerous to mention… one can measure the positive impact of the joint work with our English partners, our university colleagues, local companies, whether industries or social integration charities, not to mention all that has been done with and for the residents on both sides of the Channel by the on-site community teams – which I congratulate for their involvement that never flagged.

I would like to emphasize this key point and I mean the involvement of the residents. We could probably just have focused on the technical aspects and on pure performance. We would definitely have obtained immediate results. But what we all wanted were lasting results. That is why we wanted from the start, on the English side as well as on the French side, to work with the residents and to promote cultural exchange. A great deal of effort, time and resources have been invested to facilitate the knowledge of others, the realization that residents can act independently and that ultimately it is they who hold the keys to the success of IFORE.

This human investment was one of the keys to success of the project, and the creation of the OUTRIFORE resident association brings us the guarantee that the links, activities and therefore the results, will continue beyond IFORE. This is the real sense of satisfaction we can take from the project.

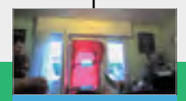
With IFORE, thanks to Europe, we have all learned from our differences and worked together with one same spirit to help the residents and promote a more harmonious neighbourhood. Again, we can be proud of that.

Fabrice Crepin, Deputy Managing Director,
Pas-de-Calais habitat Housing Association

Project timeline

2010

December



Blower-door test in Outreau.

2011

January

IFORE Community team starts working from the Rushenden Community House.

February

First issue of Innovation Action, a newsletter for Pas-de-Calais habitat staff.

March

First issue of an Eco Newsletter for the Rushenden residents.

May 2011

A SMIM group meeting, to prepare for the retrofitting works.

June

Appointment of Energy Ambassador for the Outreau IFORE community.

July

First steering committee in Cantervury.

First cross-border exchange : tenants from Rushenden come to Outreau.

August

Second cross-border exchange: 15 Outreau tenants meet IFORE tenants in Rushenden.

Researching, to improve the lives of people

The team at LGCgE University of Artois, Faculty of Applied Sciences at Bethune has for many years conducted research into the performance of materials and components for building envelopes (insulation, vapour barriers, solar walls ..). Our aim is to improve the energy performance of buildings and the comfort of their occupants. These issues are topical in a world undergoing profound changes at a time when protection of the environment and transformation of our relationship with energy are necessary; complex problems within a difficult economic context.

Our university's commitment is through research to develop new knowledge and disseminate it by teaching, student training and written and oral communication of results thereby hoping to contribute to the progress of society as a whole.

IFORE is a project... but above all an adventure in which we have all been engaged, partners from different backgrounds but with our eyes turned towards a common goal. We have worked together, through times of difficulty, to provide answers to challenges. Cross-border exchanges, experiencing our different cultures and practices, have suggested many new opportunities and discoveries.

Understanding the fundamental nature of innovative components such as windows has been recognised as an opportunity to develop scientific work but always bearing in mind their practical implementation within housing. Simulation modelling, laboratory experiments and field trials have been carried out. Visiting homes and meeting with the residents, each with their own histories to tell, have been fruitful encounters giving focus to the practical uses of research.

Tenants have visited the university and our laboratories. They gave their time helping install sensors and other monitoring equipment, shared moments that conveyed how the IFORE project has a common resonance.

The availability of funds enabled the occupants to work with us to improve their quality of life. New methods have been developed and disseminated, jobs created in industry and in participating businesses, the end users being engaged and empowered through the project to fully participate as co-innovators.

We are all very proud to have been able to make a modest contribution to this process which leaves a rich legacy for the future.

Stéphane Lassue, Professor, Laboratory of Civil Engineering and Geo-Environment, Université d'Artois

Learning from one another

IFORE has been something of a pathfinder, bridging the gap between the one-off retrofits of a few years ago and the hoped-for transformation of Europe's stock of housing.

What is apparent from IFORE is that changing the behaviour of the residents is very important and is the key to being able to achieve the 80% carbon reduction which is our joint commitment. Getting residents involved and committed to a 'green' ethos saves a great deal of money for a social housing provider. Working with AmicusHorizon has given us all a new perspective on engagement with local communities.

I think for many of us watching the films produced throughout the project that the participation of children is a key element in community engagement because their enthusiasm and curiosity is a huge influence on their parents and grandparents.

Not only can their children make families aware of the technologies that are out there to help save energy, but also the young can help the elderly make the adjustment. So the benefits are many - not only reducing bills but also improving conditions with better outcomes for health and social welfare – a general increase in the quality of life.

A crucial aspect has been the interaction between both countries; the Channel is a wide cultural divide which makes the idea of Interreg very valuable. Learning from one another, whilst circumventing the inevitable differences of outlook, has been a fruitful experience and helped put received wisdom about retrofit into perspective.

Whilst at both Rushenden and Outreau the Green Doctor approach has yielded many benefits, and the retrofits have clearly achieved major savings for heating budgets, there are other pressures that are difficult to address. The number of household electrical devices that need charging-up is increasing as are screen-based gadgets.

There is a growing understanding of the prime role to be played by the Green Doctor. In England, AmicusHorizon have already run Green Doctor activities and demonstrated that residents' satisfaction increases when they see their energy bills fall, enabling them to more easily afford their rent.

Pas-de-Calais habitat and their neighbouring housing associations are already progressing beyond IFORE. In the UK there is a huge difference between the standard of housing maintained by the social sector and private landlords. Hopefully, when social housing is visibly showing the way the rest of the market will catch on. Pas-de-Calais habitat and AmicusHorizon have thousands of dwellings awaiting retrofit so they are in an ideal position to get the ball rolling.

Mike McEvoy, Chef de Projet, Professor at the University of Brighton

Project timeline

2011

October

Installation of the community "hut" in Outreau.

November

AmicusHorizon organizes an Energy event to launch the project in Rushenden.

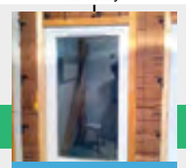
December

Launch of the focus group in France.

Installation of sensors in prototype houses.

2012

January



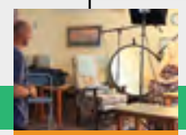
Installation of a laboratory test window which is to provide data for computer simulations.

March

Cross-border renewable energy training for staff and residents.

Innovation Award for "Most Innovative Refurbishment Project" won with Swale Heating.

May



Making of IFORE film in Rushenden.

Works start in Outreau for the first prototype house.

Combining technical innovation with community engagement

Four years ago, at the start of the IFORE project the context was one of growing energy insecurity and the necessity to reduce energy demand to avoid the worst repercussions of the changing climate. These drivers have only grown stronger in the intervening period. Dwellings are such large users of energy that retrofitting them to reduce demand offsets the number of new power stations required in future. For social housing there are yet further benefits, increased comfort means better health for residents, the economic activity associated with retrofit generates employment, and better insulation means lower fuel costs and reduced fuel poverty.

RESIDENTS: Participation of residents in the retrofitting process has been a key element to reach the objectives of energy/carbon reduction.

For housing associations there is a need to get the best returns for a limited budget. On the one hand there are purely technical approaches such as the enerPHit standard, a slightly reduced indicator compared with the Passivhaus standard for new buildings. In England, prior to IFORE, only one-off retrofits had been completed, notably as a result of the 'Retrofit for the Future' competition, which tested advanced and very expensive technologies. The IFORE approach has been different. Being one of the first large-scale retrofits in either country, the chance was taken to actively engage the community and to achieve optimal results through behaviour change. Many commentators have estimated the extent of energy use that is due to different patterns of behaviour and the interaction of households with technology. A wide variety of estimates have been made but that this is an important determinant of the success, or otherwise, of retrofit projects seems without doubt.

Both Pas-de-Calais habitat and AmicusHorizon established on-site teams within the areas to be retrofitted. AmicusHorizon have long experience of engaging with their communities and responding to their needs, this expertise was their contribution to this part of the project. A large number of activities and projects have taken place at the level of community, with individual household members, and with local children through the involvement of schools and youth groups.

A key team member is the 'Green Doctor' or in France 'Energy Ambassador' who is the person to make contact with individual households, offer energy advice, deliver free gadgets such as low-energy light bulbs, and engage the residents with the energy ethos. A principal lesson of IFORE is that employment of a Green Doctor is crucial for the success of retrofit projects. In Outreau the Energy Ambassador administered the use of tablet PCs so the residents could oversee their own energy consumption. At Rushenden the Green Doctor managed completion of questionnaires that were updated to track changing attitudes throughout progress of the retrofit. The results showed that a key success of IFORE has been in the perceived ability of residents to reduce their utility bills. At completion of the project 64% considered that they had been able to reduce their energy consumption in comparison with the previous 12 months; and of those two-thirds felt that this reduction was greater than 5%, achieved for example by reducing the temperature setting of thermostats.

The aim of the project was to see improvements in household fuel bills, and the reduction of fuel poverty throughout the community not just at the level of individual households. Social activities, reaching otherwise 'hard to reach' households has formed an important part of this strategy so residents have attended trade fairs, and a variety of information meetings and environmental workshops, entailing trips across the Channel.

These initiatives have had implications for the housing associations; the roles of local staff such as caretakers in France have been realigned as a result. Exchange meetings between the housing associations have encouraged this cultural exchange.

RESEARCH: The housing associations worked with academics to find innovative solutions.

IFORE is a collaborative venture between the housing associations and two universities, building science researchers at the Université d'Artois, architects and social scientists at the University of Brighton. Their collaboration has enabled a variety of data to be investigated.

At the outset of the project the use of different computer simulation tools, and the different regulations governing the process of retrofit in the two countries, were researched. The computer simulations were used in the first instance to evaluate different specifications for the building works and their relative merits in terms of payback periods. Alternative monitoring methods have been implemented to measure energy consumption before and after retrofit, and the levels of comfort that have been achieved, as compared with those predicted by the simulations.

A particular shared interest of the academic teams was the important issue of ventilation. Making houses more air-tight to cut down on draughts and wasted energy is a conventional approach for retrofit projects. Too often however this results in poor indoor air quality with implications for condensation, mould growth and the health of occupants. The technology of 'supply air' windows has been researched by both universities and is an example of the innovative approaches that have emerged from IFORE. Also, the Université d'Artois has long experience in the design and analysis of 'trombe walls' - a passive solar technology that provides free heat to homes. As a result a trombe wall has been built and is currently under test at Manor Close in Rushenden.

In both countries sociologists have been at work analyzing the questionnaires that have been completed by each household within the project. In France, a system has been developed that will enable better understanding of the energy needs and circumstances of particular types of occupancy. In England, changing habits

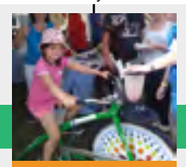
Project timeline

2012

June

Children from Outreau and St-Omer in Hastings for the Ecofab contest.

July



IFORE smoothie bike at the Kent County Show.

August

External insulation & colour rendering works start. On 17th, Gordon Henderson, MP, visits the site.

October

Children's cultural Halloween exchange: understanding energy saving in Victorian England.

November 2012

Taking delivery of dynamic windows, with their inventor, Jacques Paziaud.

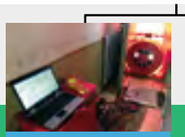
December

Window refurbishment in Rushenden.

Christmas exchange: residents view renovated homes in Rushenden.

2013

January



Post-retrofit measures: thermography & air-tightness test.

IFORE gets an award at the National Housing Maintenance Forum Award Ceremony.

in relation to energy use have been identified particularly in relation to the use of appliances, for example, lowering the temperature of washing machines, and not putting televisions on stand-by. Although technologies requiring little user interaction such as solar panels on roofs were quickly accepted, others that needed more engagement such as the AlertMe and Wattbox heating controls were more difficult to embrace.

WORKS: Working with local partners has had a positive impact on the local economy.

At both Outreau and Rushenden retrofitting the housing stock has been an opportunity for a boost to the local economy and through the involvement of local enterprises to generate employment. Both areas are ones of deprivation, economic opportunities have been limited by the lack of locally available work. For example, at Rushenden the decision was made to renovate existing windows, that better performance could be achieved by replacing double-glazing and improving their air-tightness, this was carried out using a local contractor.

The project has had ambitious targets for creation of employment in this way, as one method of social inclusion. In France, the innovative over-cladding system was prototyped on the rue du Biez where the single-storey housing for older persons was an ideal test-bed. As a pre-requisite for the full-scale roll-out of the system, across the remaining sample of houses at Outreau, its performance needed first to be verified by monitoring before the factory assembly-line, employing local labour, could be built. The insulation encapsulated within the over-cladding units is made from recycled clothing collected at charity shops, in this way a local and sustainable supply chain is being established.

Other Interreg projects involved with eco-construction have provided the means for IFORE to build a network of manufacturers, contractors and suppliers across the borders of the two countries. The 'supply air' windows being made at La Rochelle for the retrofits at Outreau have been adapted for use in England (where windows usually open outwards unlike those on the Continent) and are now installed and under test for further applications in the UK.

EXCHANGES: Cross-border dialogue has helped stimulate innovation and reinforce European togetherness.

IFORE has been funded through the European Regional Development Fund's IFORE programme which is dedicated to the exchange of information, expertise and cultural understanding across borders. IFORE has been ideally suited to this aim because of the importance of technological and community aspects to all the partners and the complementary knowledge that each has brought to the project.

As a result the benefit of these cross-border exchanges has been felt in every aspect. In terms of organization, from the outset the project's tasks have been divided between groups, each with representatives from each partner organization, which have alternated meetings between England and France.

The Green Doctor at Rushenden and the Ambassadeur de l'énergie at Outreau have been an example of collaborative working. As a result the questionnaires to households used in both locations have been shared where possible, but as importantly, the differences in their approaches to energy-saving are now understood.

The two communities have enthusiastically met to enjoy language instruction, and to share initiatives - the establishment of a cross-border residents' association and the planned twinning of the two districts.

The Anglo-French dimension has been important in making the project special for the residents, and thereby increasing its impact in the long-term. As one from Rushenden who made an exchange trip to France observed 'I think both communities have a lot to learn from each other. The shared experiences have been fantastic for French/English relationships. The exchange of ideas and working toward one goal of saving energy has been a very positive experience'.

COMMUNITY LEGACY: Influencing housing policies and community cohesion.

The behavioural and community aspects of IFORE's work are inherently less able to be quantified than are the savings achieved through technology. This masks the number of substantial contingent benefits that are a side-effect of a people-centred approach to retrofit. This is a principal lesson the IFORE project has for future projects that will be carried out as retrofit-at-scale becomes the norm. Many commentators believe that behaviour-change takes too long, that only technological solutions can achieve the rapid demand reductions needed to meet energy targets. However, there is evidence to suggest the contrary such as the rapid acceptance of smoking bans across Europe as an accepted norm. The example of IFORE is that a well-planned focus on social engagement can reap a variety of rewards.

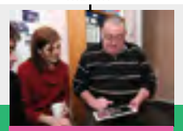
The eradication of fuel poverty has been helped, if not fully achieved. Tools have been developed in France to better understand its identification with a view to assistance, training and advice been made available, thereby limiting its effects. The project has encouraged better contact and conversation between elected representatives and local residents. The outcome has been better community cohesion, a feeling of belonging to the local area, which can now be seen in environmental improvements, for example a new interest in the care of gardens.

Our sociologists' analysis of changing attitudes within the communities bears out this conclusion. 25% of those questioned felt more positive about living in Rushenden compared to three years ago, before the project started. Also, a sense of empowerment, that nearly 50% of respondents stated that they felt able to share and pass on the information they had gained through the IFORE project. 21% regarded themselves as acting in a more environmentally friendly way, and that other members of their households were engaged with methods of saving energy.

Project timeline

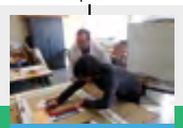
2013

March



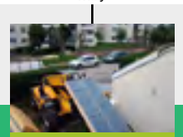
Presentation of tablet PCs and tools to English residents by French residents.

April



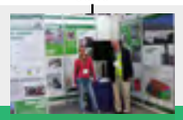
Instrumentation of a window at the LGCgE at Béthune Faculty by a "IFORE" student.

May



Prefabricated modules for second prototype house arrive on site.

June



Two academic presentations of IFORE project at CLIMA conference in Prague. IFORE stand at CIH Exhibition in Manchester.

August

Barbecue and Best Neighbours' Awards Day in Rushenden.

The Green Doctor reaches her goal of 400 visits to tenants made since the beginning of the project. Here with the 400th tenant, Mandy Laker.

September

Residents staff the IFORE stand at National Congress of Housing Exhibition in Lille.

October

A training session for caretakers in Outreau as part of the IFORE legacy.

December

Link with the EU Greenov cluster to build the IFORE legacy.

Continued on p. 50

The Green Doctor with children in Rushenden (October 2012).

Participation of residents in the retrofitting process:
a key element to reach the objectives of carbon reduction

The IFORE programme has demonstrated delivery of wider community renewal from large-scale retrofit and the introduction of energy efficiency / carbon reduction measures to homes.

AmicusHorizon's expertise in community engagement has been one of their main contributions to the project. This is their commentary, firstly outlining the key learning points:

- How behaviour change and the role of residents is essential to making the most of retrofit investment.
- How to maximise the community development impact from retrofit refurbishment activity.

Throughout the four year programme, we set out to explore and harness the community benefits we could achieve alongside a works programme. We were very successful in combining energy measure works programmes with wider community energy learning and benefits.

Behaviour and energy

Because we have 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. At each site a Green Doctor/Energy Ambassador has been based in the community, going door-to-door with energy advice and managing completion of questionnaires that were used to analyse how attitudes have changed throughout the project. In Outreau the Energy Ambassador administered the use of tablet PCs so the residents could oversee their own energy consumption. The simulation models, built by the academic partners, have been used to predict energy consumption post-retrofit, and to help evaluate different specifications for the works.

Benefits of a people-centered approach

The behavioural and community aspects of IFORE's work are inherently less able to be quantified than are the savings achieved through technology. This masks the number of substantial contingent benefits that are a side-effect of a people-centred approach to retrofit.

This is a principal lesson the IFORE project has for future projects that will be carried out as retrofit-at-scale becomes the norm. Many commentators believe that behaviour-change takes too long, that only technological solutions can achieve the rapid demand reductions needed to meet energy targets. The example of IFORE is that a well-planned focus on social engagement can reap a variety of rewards.

In our opinion, well planned and managed retrofit programmes provide a host of wider community opportunities. By going the extra mile to secure community impact, we helped residents and the community develop confidence, skills, energy, budget savings and jobs.

Most important of all, combining retrofit and community activity has created pride and value for the communities.

Preparatory work

Successfully combining works and community programmes requires good preparation. It's important the project team have a clear shared vision, goals and targets across both works programme and community activities.

The objectives and targets have to be fully owned by staff and residents in the team. For example, a community activity target is as important for a technical staff member on the works team as it is for the community worker on that particular activity. A 'one team' approach has the best chance of delivering added community results.

Sourcing adequate baseline information and knowledge about community energy use is important. It's good to have strong starting point information. It forms a starting point for developing community energy use, activities or community programmes. It also serves as a baseline against which to track progress.

Harnessing existing community networks or forum is important. It proved easier to develop the energy awareness activities, skills and knowledge on the back of existing community capacity. To get people to become early project champions, it was best, in Rushenden, to encourage the afterschool club and cooking club to refocus as the "young energy detective club" or the "energy cooking club". We were able to develop an initial set of local resident champions who would drive the project.

Tester work and early examples were vital in the preparation stage. Getting some residents set up as energy savers and completing a demonstration home as a first step helped raise understanding and aspirations across the neighbourhoods.

Project team

At Rushenden, we based a project team / community team in the neighbourhoods next to the homes set for refurbishment. This meant the team became familiar and trusted neighbours. The community team, activities and aspirations were very visible to residents and everyone on the works programme (contractors and suppliers, etc).

We had well defined roles and responsibilities for the small community team and a clear team plan. We shared this with all project staff and supporting roles, such as housing officers, local Neighbourhood Managers, etc.

Gaining local resident trust and respect is vital. Initial work involved helping residents sort an array of current issues. Clearing these was important to enable resident buy–in and engagement in other behaviour change or energy saving activity. Examples include sorting repairs, debt management and neighbourhood disputes. It was important to develop capacity in the community, such as offering

initial personal development programme options. Initial preparation for retrofit works meant an increased demand for repairs, previously unreported.

Resident engagement

Resident engagement is absolutely key to getting the best community impact alongside a works programme. In Rushenden, we worked hard to gain trust and develop an initial group of community champions for the programme and activities. The initial group helped recruit others. We then gathered momentum in the community activities via peer group support.

We identified residents' interests and based energy awareness and knowledge-share on themes, such as cooking or travel and transport. Handcrafts also proved popular.

To get maximum community involvement and ownership, we focused on involving all age ranges within households. We later found out how important is a whole household's committment to an energy saving or budgeting approach. So, we definitely benefitted by focusing on intergenerational work.

We enlisted an active resident group and quickly embedded them as a sounding board. They helped identify local community needs and priorities and set the activity plan.

Once we had an activity plan with resident ownership, we could approach local businesses and partnerships to crack-on with delivery.

Involving young people

Delivering best household energy impact requires input from everyone in the household. Young people can successfully advocate and promote new ideas, change or behaviour patterns at home. We recognise they're also the next generation of energy customers in the homes.

Young people are active community representatives and champions – they help set the tone and perceptions for a locality.

We planned young person's activities to maximise the champion's role and provide opportunities. Ideas at Rushenden included:

- Young Energy Champion programme and certificate
- Young Energy Detective Club
- Junior Green Doctor programme
- Exploration travel and trips

The aim was to harness and engage large numbers of young resident supporting the community activity and re-informing household behaviours – as energy awareness managers.

Skills and learning

To develop energy awareness and management skills, we devised activities based on resident's interests, such as cooking, travel, employment support, household budget management, IT devices, childcare and parenting... Training courses such as food hygiene and first aid training were a prelude to more formal energy awareness training.

'Green Doctor' or in France 'Energy Ambassador'

IFORE has been a mix of hard and soft knowledge. To understand the importance of behavioural factors in the outcome of retrofit projects not only surveyors and engineers have been involved, but also sociologists and psychologists. In France, it has been important to understand the organisational changes that might result in optimal outcomes for future energy costs and household comfort. In England, the level of technology employed has to be appropriate not only to the available budget but also to be comprehensible and acceptable to householders. One of the results from this mix of approaches has been to reinforce the importance of the Green Doctor's involvement, which offers a route to carbon reductions that are both difficult and very expensive to achieve using purely technical means.

There is a growing understanding of the prime role to be played by the Green Doctor. AmicusHorizon have already run Green Doctor activities for other social housing providers and demonstrated that residents' satisfaction increases when they see their energy bills fall, enabling them to more easily afford their rent. At Rushenden we've seen how the Green Doctor can become an integral part of the family but it's a particular skill requiring a very particular personality.

Promotion and visibility

To maximise community impact and energy behaviour, it's all about promotion, visibility and getting a neighbourhood-wide awareness and conversation going. We built on this throughout the programme:

- Website
- Facebook
- Shows / exhibitions
- Exchange visits
- Newsletters
- Notice boards

Demonstrating the tablet PC to the residents (Arras, 2012).

We seemed to get better results developing energy efficiency awareness and behaviour change when we first worked with a group of household members run some initial lifestyle or upskilling activity. Then, later, we worked through the detail of energy awareness and energy use.

By running a series of community learning activities we managed to promote a community discussion on energy awareness and energy use. At the same time, homes were being retrofitted. We were encouraging them to understand how choices and behaviours influence energy use and the performance of their newly retrofitted homes.

The behavioural and community aspects of IFORE's work are inherently less able to be quantified than are the savings achieved through technology. This masks the number of substantial contingent benefits that are a side-effect of a people-centred approach to retrofit. This is a principal lesson the IFORE project has for future projects that will be carried out as retrofit-at-scale becomes the norm. Many commentators believe that behaviour-change takes too long, that only technological solutions can achieve the rapid demand reductions needed to meet energy targets. This despite evidence to the contrary, for example the rate of acceptance, as a social norm, of smoking bans across Europe. The example of IFORE is that a well-planned focus on social engagement can reap a variety of rewards.

Feedback on energy consumption has been recognised as one way to increase and reinforce awareness. Research since the 1970's has shown that providing consumption information through feedback can reduce energy consumption by up to 15%. Direct feedback such as energy monitors has been found more effective (leading to a reduction of 5-15%). The tablets in use at Outreau have been enthusiastically welcomed by the residents who are using them to track their energy consumption over time. However, research has also shown that the impact of feedback through energy monitors can be greater at first but that the novelty can wear off. For example, one study found that initial reductions in electricity consumption of 7-8% were not sustained over the longer term.

Behaviour and energy – the French perspective

A sociological survey was initiated by Pas-de-Calais habitat and AmicusHorizon to identify the consumption patterns of residents in their homes and their attitudes to energy management. We wanted to find a typology of energy use, characterize the living conditions of the tenants in terms of comfort and their attitudes to energy-saving technology. These surveys have helped guide the re-casting of roles within our organisations so proximity staff can best help tenants throughout the building works, and then to achieve the best levels of comfort and economy in their newly rehabilitated homes. Having introduced the job of Ambassador Energy, a new route to engagement with tenants has been opened up, an innovation for France that offers better access to outreach services, tailored to the particular needs of individual households.

These surveys enabled us to understand the ways energy is used in the different types of dwellings, but they have also updated the variety of consumer habits, more or less in favour of energy management. On the one hand, Outreau has an aging population accustomed to simple comfort and very frugal in their use of energy but averse to new technologies. On the other, younger households (often families with children) have a different pattern of consumption because they favour their comfort rather than energy saving, and are accustomed to using a multiplicity of domestic appliances, with some risks for their household budget. This diversity of situations required responses that were varied and adapted to different energy and household cultures.

Beyond this prototype procedure, tested at Outreau and an outcome of the IFORE programme, Pas-de-Calais habitat is planning the next stages for this method of community rehabilitation - a set of procedures to guide new patterns of consumption throughout future retrofit projects. This approach combines technology with social science to achieve:

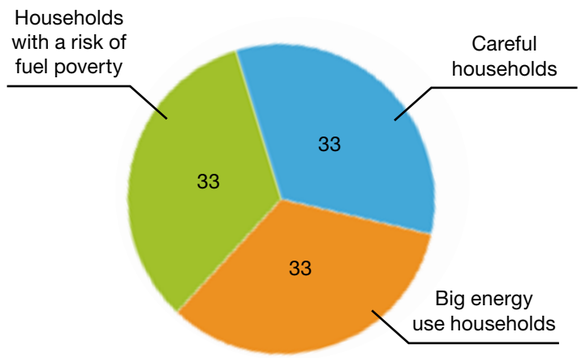
- Individual assistance to households with a concern for their lifestyles and technical capabilities;

Sociologists in the home of an Outreau tenant.

A reduction in energy bills

At Rushenden the results showed that a key success of IFORE has been in the perceived ability of residents to reduce their utility bills. At completion of the project 64% considered that they had been able to reduce their energy consumption in comparison with the previous 12 months; and of those two-thirds felt that this reduction was greater than 5%, achieved for example by reducing the temperature setting of thermostats. This was borne out by the temperature measurements made before after the retrofit works at Rushenden. Every house type showed an average fall in room temperatures with a substantial fall in bedroom temperatures being recorded. Median figures, which reflect asymmetry in the data caused by outliers painted a more complex picture. The averages are influenced by very low temperatures in a minority of houses.

Diagram 1: Mapping of uses



- Collective enjoyment of workshops for the exchange of experience and mutual learning;
- A technical tool (a tablet computer) to monitor and control their energy consumption, almost in real time.

A global approach

The socio-technical approach taken by Pas-de-Calais habitat was to take into account from the outset, user behaviour and the type of professional support that would help improve residents' attitudes to energy use.

The idea was therefore to develop an energy management strategy that concentrates on the household devices that were most likely to provide economic savings. At the same time it was necessary to focus on support for users who were learning new ways of managing their consumption.

In this respect, questionnaires and responses from different participants led to an understanding of how crucial it was to adapt the relationships between staff and customers to massive energy management, as the organization employs 900 professionals with approximately 100,000 residents.

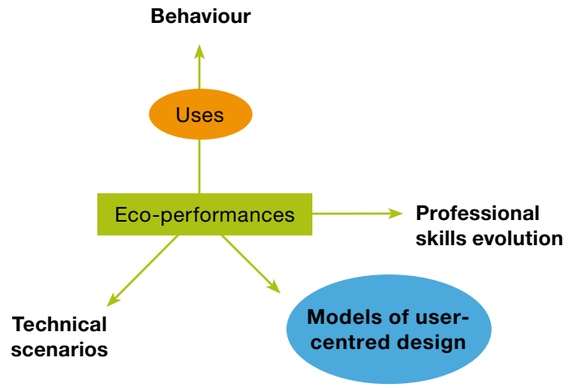
Strategy

The sociological study carried out by BESCB identified patterns of energy use and identified different types of consumers. Through this mapping exercise we gained an understanding of how energy was being consumed and which methods should be prioritized for each category of resident.

The typology was first divided into three categories by isolating from among an array of indicators those which were most influential for the resident population: family composition, income level, and behaviour towards the introduction of new technologies into homes.

The idea was to ask the same residents these questions again at the end of the project and thereby gauge how their behaviour had changed depending on the quality of the support and advice they had been given.

Diagram 2: Vectors of behavioural evolution



By supporting the three categories of consumers, we found that people had different attitudes to energy consumption and towards the technologies that were being implemented. The 'energy-precarious' households are those that spend more than 10% of their budget on energy. Accordingly, different levels of support were required from the customer-relationship staff.

Similarly, in order to understand what helps or inhibits the use of digital equipment - the energy consumption monitors - a survey confirmed that they were thought easy to use by 2/3 of the residents.

Surveys showed a good aptitude in everyday use of the PC tablets equipped with the 'EnergyCoach' monitoring system.

Measuring, monitoring and evaluating

We learned lessons. It's important a project team has in-built capacity to collect and analyse a lot of data. We gathered and analysed a lot of data. We installed Smart Meters. While meters worked well in many households, there's still a disconnect between residents and smart metering interactive energy control systems. Taking time to provide guidance and instructions is important.

Having team members on site to provide face-to-face advice and guidance worked well. When problems with metering or controls occurred, residents wanted face to face advice. The issues seemed too complex to discuss via a phone or call centre approach.

There were many examples of people who were suspicious or not maximising the potential of smart meters / controls, etc. There is room for improvement in use and advice on Smart Meters. New tenants' welcome packs can provide better instructions and guidelines on energy consumption and awareness.

Community achievement and impact

Our retrofit programme improved 100 homes. We were determined to maximise the wider community benefits and impact. Our targets and achievements at Rushenden are listed in Table 1. The headlines reflect life changing impacts for many of our participants*.

Table 1: Community targets and achievements in Rushenden

Target Progress	Achievements
Engage 620 residents	1034
400 involved in Green Doctor advice	465
Equip 300 households with tools to reduce environmental impact	263 (works)
Involve 3000 children as 'Energy Champions'	2936
Establish 10 sustained Community Groups/projects	11
200 people on green construction/installation activity	61
50 people into learning vocational training	78
25 people employed associated with project	20

The programme gave much added social value impact (community wellbeing values). We're analysing this using the Value Insight assessment tool (HACT). What it shows is for every £1 invested, in Rushenden, we achieved significant added social value impact.

Perhaps the most heartening impact made by our combined retrofit and community programme is the change of perception within the community and neighbourhood.

There is a sense of change. People have a new pride in where they live. It's an area into which people are moving to purchase new shared ownership housing, a scheme that has proved popular. Void rates are now low in these neighbourhoods. ■

**A set of detailed case studies are available from tina.miles@amicushorizon.org.uk.*

Case Study

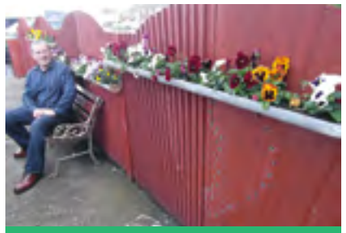
An account from a resident of Manor Road, Rushenden

"I was chosen as one of the properties to have the major retrofitting works done. As I ask lots of questions, the IFORE team have been great in listening and working through various problems with the new technology.

I think the IFORE project is about saving energy. More than this, it brings the community together to discuss that saving energy is the right thing to do. This is important when the HA put new technology into our homes. Having the Community Team on the estate means that if we have any problems we can go straight to them. They organise coffee mornings, events etc, so we can share our experiences with other residents.

The Green Doctor certainly made me more aware of saving energy. Having a large family, there are lots of cups of coffee. I decided to buy an urn rather than keep boiling the kettle, this has saved us both money and energy. I now also look at what can be recycled. When they took down the guttering, I made it into a flower trough, brightening the front of the house using waste material.

I went to France for Europe Day on 10th May 2012 to meet people from other projects. We also visited a War Memorial. It was good to see how the different Housing Associations provide housing. The converted hospital offered a good range of services under one roof. There appears to be a huge difference in how the two companies work. In the UK, AmicusHorizon works with many different suppliers to provide varied services whereas it looks as if in France,



Malcom Dalton in his garden.

Pas-de-Calais habitat have to do it all themselves. The communal garden and mixed tenure was all integrated and everyone got on well. In the UK, we tend to put older people and people with disabilities in separate areas. The French residents also looked after the gardens themselves.

I know, from various discussions that the French have more shared utilities. They also have to pay for improvements through their rent. In the UK, there is a direct relationship between us saving energy and saving money. Our actions benefit our pocket! In France, it appears that if one person saves energy they could be paying for someone who is not. Also, the saving must be worth the increase in rent.

French people are really friendly, we had a great time and the hospitality was excellent. One big difference is that the UK team seem to work with many more people and the whole community whereas the French seen to be concentrating on more training with fewer residents.

I think both communities have a lot to learn from each other. The shared experiences have been fantastic for French/English relationships. The exchange of ideas and working toward one goal of saving energy has been a very positive experience. ■

An IFORE team meeting between Université d'Artois and Pas-de-Calais habitat (Béthune, 2010).

The housing associations worked with academics to find innovative solutions

IFORE is in many ways a forerunner of the larger scale retrofit projects that are following on from individual demonstrations such as the UK's Retrofit for the Future competition.

100 houses were chosen as the sites for study in both Outreau near Boulogne-sur-Mer in the region of Pas-de-Calais and Rushenden on the Isle of Sheppey in Kent. They are well suited to a cross-border study since the geographic distance between them is relatively short and both share a maritime climate. They represent both the similarities and differences between the wider housing stocks of both regions.

At the same time sociological studies have characterised the population of the two communities 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.

At Outreau the 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 but within a basic form of brick cavity construction that can be found across the south of the country.

Results from Monitoring at Rushenden and Outreau

At Rushenden the changing performance of the houses has been monitored using a number of different methods. Pre-retrofit, Tinytag loggers were installed to measure humidity and temperature. Into a number, representing each of the seven Rushenden house types, Wattbox was used to record a larger number of variables. For some of the houses data has been received from the Institute of Sustainability post-retrofit, and for last winter Tinytags measuring temperature only were re-installed.

At Outreau fourteen dwellings representative of the four types have been intensively monitored, residents have used their tablets, with Intent Technologies software, to record their energy use. A profile for each house has been made by Pas-de-Calais habitat by working with energy suppliers data for consumption over previous years. This programme is ongoing so included here is post-retrofit data for the two house types that have been completed to allow evaluation of winter and annual performance.

The houses owned by AmicusHorizon at Rushenden are interspersed with owner-occupied houses, whereas, at Outreau all the units are social housing within the ownership of Pas-de-Calais habitat.

At Rushenden homes have been fitted with different renewable energy solutions, such as solar thermal and photovoltaic panels, ground and air source heat pumps. Innovative technologies, a whole-house ventilation system using 'supply air' windows as heat exchangers, and an English design of Trombe Wall is being prototyped at Rushenden.

Initial surveys

Surveys of the seven house types in the UK and four in Outreau, using thermography and pressure testing, gave figures for their current energy consumption and carbon emissions so they could be classified within Energy Performance Certificate bands.

Table 2: Pre-retrofit consumption per house type

UK house types						
Type 1	Type 2	Type 3	Type 4	Type 5	Type 6	Type 7
359	343	330	273	289	294	320
E	E	E	E	E	E	E

French house types			
Biez	Braque	Chaudière	République
230	286	218	207
C	D	C	D

Primary energy (kWh/m² per year) for space heating and hot water, and energy performance certificate bands, determined using SAP in the UK and ThCEx in France.

The English houses were constructed between 1945 and 1964 whereas the French sample dates from between 1979 and 1983, the latter consequently benefitted from energy saving legislation that followed from the 1970s oil crisis.

A comparison of standards between the two countries and Europe-wide to define targets was made to find a common basis amongst legislative requirements both in England and France, and in relation to the Europe-wide standard being introduced as 'Enerphit'. This has been successfully achieved using 'primary energy' as the basis of comparison.

Thermography before and after, elimination of cold bridges, leakiest houses re-clad

What we have done at Rushenden and Outreau is look at a variety of different dwelling types, and a large enough sample to begin to understand the way in which the houses are being used.

From measured surveys simulation models were built to determine the base-case energy consumption of the different types. The models were then used to assess, in terms of payback periods, alternative specifications for the works.

At both Outreau and Rushenden external insulation systems were used although of different types, a dry-assembly system for which an assembly line has been built for factory production in France, and a site-applied wet-finished system in Rushenden. Both have the advantage that most of the work takes place outside the homes to minimise disruption.

The largest houses at Rushenden performed badly under pressure testing. All the houses at Outreau were more air-tight by comparison, although some of the two-storey houses were relatively complex in section and less air-tight as a result.

Pressure testing, air leakage before and after

The previously part timber-clad houses at Rushenden were externally insulated and rendered so they are now of similar appearance to the rest of the retrofitted properties. In addition the windows throughout were renovated and re-fitted which has greatly improved both their energy performance and standard of comfort.

One of the interesting aspects was that many of the Rushenden houses were already relatively well-sealed, because of their form - they are basically rectangular boxes with brick cavity walls that were built wet-plastered. AmicusHorizon have succeeded in making them a little more air-tight in the majority of cases, some of the single storey houses are now below the 5m³/m².hr level of infiltration where indoor air quality and ventilation become a real issue.

Consequently this is a question we have been anxious to investigate within IFORE because there are relatively few options for the ventilation of retrofitted houses. Mechanical ventilation heat reclaim (MVHR) which is becoming the default system for new-build is extremely difficult to accommodate within existing dwellings, other than when single storey.

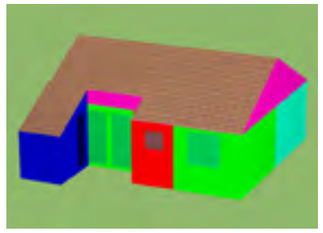
MVHR (heat recovery ventilation) is being tested within Manor Close at Rushenden (which are single storey so the ducting can be run within lofts) but a major innovation within IFORE has been research into the ventilation technology of 'supply air' windows, which is discussed later.

Dynamic thermal simulation is a valuable decision-making tool when assessing alternative retrofit measures, but different industry standards required that the same software could not be used in each country. Initial surveys were carried out to characterise the housing stock which formed the context for the computer simulations.

Parametric modelling has defined the benefits of standard retrofit technology solutions: each of the 'standard' solutions – insulation, air-tightening, upgrade of windows and boilers – have been modelled, at increasing levels of intervention, to arrive at optimum solutions that informed the final specifications for construction.

A modelling methodology was agreed for translation of the UK research program ESP-r's output into a format that could be compared with results from France. The method used was to adapt the widely-used French program Pleiade et Comfie for parametric modelling of a property type comparable between Outreau and Rushenden.

An agreed sequence was followed beginning with construction of models of similar houses at the two sites that were refined to achieve characteristics corresponding with published data, then the building



Computer simulations

Computer simulations were used in the first instance to evaluate different specifications for the building works and their relative merits in terms of payback periods. Although different monitoring methods were used to measure energy consumption before and after retrofit, and the levels of comfort that have been achieved, some of the data analysed from the houses at Rushenden proved unreliable. Computer simulations have the advantage of filling in the gaps to arrive at firm benchmarks for anticipated energy consumption pre- and post-retrofit. For example, to some extent in relation to space heating the variation in residents' behaviour from house to house can be gauged by running the simulations at actual room temperatures post-retrofit rather than comfort temperature since, whether by choice or due to fuel poverty, they reflect a lifestyle.

Monitoring systems

The physical outcomes have been recorded by individual data loggers. In Rushenden, Wattbox was utilised in a representative number of homes covering each property type. WattBox is primarily an 'intelligent' heating controller that also continuously records a variety of energy data sources for its operation. The collected data provided the 'numbers' for comparison with the computer simulation models. A number of logging systems were investigated but Wattbox, despite having been used by many Retrofit for the Future contestants, proved less than reliable. A readily available robust alternative monitoring method at the time was the use of individual data loggers ('Tinytags'). These basic loggers did not record energy use and required time consuming manual deployment and collection. Consequently, full energy statistics across all 100 homes suffered from inevitable gaps in recorded data. At Outreau the prototype houses have been monitored using a bespoke array of sensors, designed and installed by University d'Artois, a solution practical for only a limited number of properties.

A Blower-door test in Outreau (January 2013).

of individual models of each house type that could be used for comparative analysis.

Simulation models enabled the optimum specifications to be determined. Greater thickness of insulation eventually starts to have diminishing benefit. The thickness of insulation that proved affordable and practical in England is 60mm of external wall insulation (phenolic foam), which was the best available combination of economy and performance. In France the over-cladding panels encapsulate insulation which is made from re-cycled clothing that has been shredded and re-constituted as fleece. The raw material is sourced by arrangement with charities.

Payback periods for the specification packages have been agreed for Outreau and Rushenden: simple payback methods have been used, in relation to an agreed priority of measures, and current energy prices within the two communities, to arrive at a comparison of cost and benefits.

Post-retrofit, behavioural variable

One of the problems when a large proportion of the population is in fuel poverty is that they won't have been very comfortable pre-retrofit. The increased comfort post-retrofit may be enjoyed without any saving in energy. This rebound effect is one that has been widely reported and which could cause the carbon savings to rapidly disappear since room heating is the largest proportion of household fuel consumption.

The results from Rushenden are understandably mixed. The residents have lower energy bills and yet in most cases have absorbed the Green Doctor's advice and are actually lowering thermostat temperatures. The improved insulation resulting in more stable internal

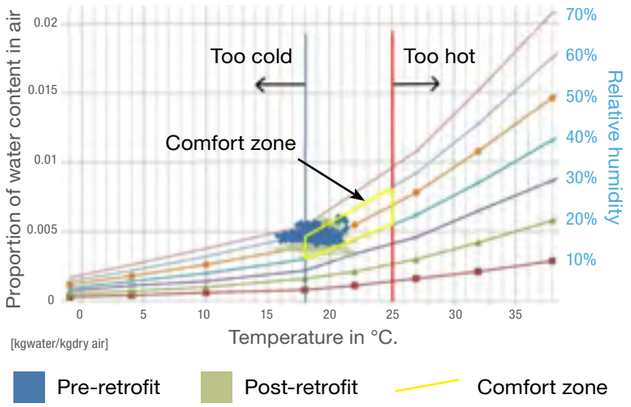
conditions have helped make this possible. There remain however some houses that are at a temperature below comfort level, which make the average figures less reliable.

Methodology: Outreau prototype, mass measurements at Rushenden

The improving performance of the houses has been monitored using a number of different methods. Pre-retrofit, 'Tinytag' loggers were installed to measure humidity and temperature within rooms and external temperature at a number of locations around the Rushenden estate. Into a number we then installed Wattbox which records a larger number of variables.

One of the facets that recommended Wattbox from amongst the several systems that were investigated for use in Rushenden was its inbuilt software that enabled the heating controls to be automated for most efficient operation. Wattbox incorporates a house heating-controller which can also monitor energy use within dwellings, thereby dispensing with the need for timers and thermostats which residents find difficult to set for maximum energy efficiency.

Diagram 3: Comfort conditions at an address in Manor Close, Rushenden (February 2011/February 2013)



By recording household occupancy data (with the ability to learn the patterns and habits of energy usage, especially relating to central heating and hot water usage) it appeared to remove the need for residents to set time-clocks, although settings could be overridden by users pressing a button for 'more heat' or 'less heat'. Its optimisation routines were designed to control and achieve the most efficient operation of heating systems (including solar thermal, condensing boilers and air source heat pumps).

Wattbox by partially automating the control of energy-use was to help achieve the 20% reduction in carbon emissions which is IFORE's target for positive interaction of the project and residents. The inbuilt learning algorithm was designed to gauge the occupants' requirements for heat and hot water and respond accordingly.

Green Doctor questionnaire.

Energy performance: gas and electricity

Whilst at both Rushenden and Outreau the Green Doctor approach has yielded many benefits and the retrofits have clearly achieved major savings for heating budgets other pressures are difficult to address. The number of household electrical devices that need charging-up is increasing as are screen-based gadgets. IFORE's statistics suggest that the worst offending households in terms of electricity consumption may be harder to influence, electricity consumption is difficult to monitor and model but is responsible for a lot of carbon. At Rushenden however changing habits in relation to energy use have been identified from questionnaires particularly in relation to the use of appliances, for example, lowering the temperature of washing machines and not putting televisions on stand-by. The Rushenden residents were asked before and after retrofit about the amount they spent on electricity. In most cases there was little change in the median figure for most house types, which represents a fall in real terms given rising energy prices. But the averages were distorted by some homes where electricity use had sharply increased.

In operation this didn't work satisfactorily, it proved very unpopular with the residents and had to be disabled. This created some challenges with interpretation of the winter data since some was from when the residents were in charge of thermostats, after control was wrested from Wattbox requiring that we once again had to install Tinytags post-retrofit.

In France throughout the project, data loggers have been located in 15 houses - a large sample of dwellings for intensive data acquisition and determination of levels of thermal comfort and air quality in rooms. Some prototype retrofitted houses have also been equipped with monitoring devices to plot the thermal behaviour of the 'supply air' windows and efficiency of ventilation.

An 'intelligent' controls system has been designed by a French consultant to the project. All the tenants at Outreau have been issued with a tablet computer that has software installed to record their energy use and to display the data graphically. Individual households can, using the tablet, track their energy performance and alter on/off settings for heating and hot water.

Temperature and humidity, comfort

At Outreau this intensive monitoring has included measuring the comfort of the inhabitants, their consumption of hot water and the amount of energy used for space heating. The 'supply air' windows were monitored in situ using the same instrumentation as in the laboratory at the University d'Artois.

Comfort conditions were recorded on a psychrometric chart which assesses comfort in terms of heat and humidity. In addition, levels of carbon dioxide, a usual proxy for indoor air quality, have been measured. Some of these same metrics are being used for description of the monitored data from Rushenden.

Rushenden gas and electric bills. Outreau weekly records

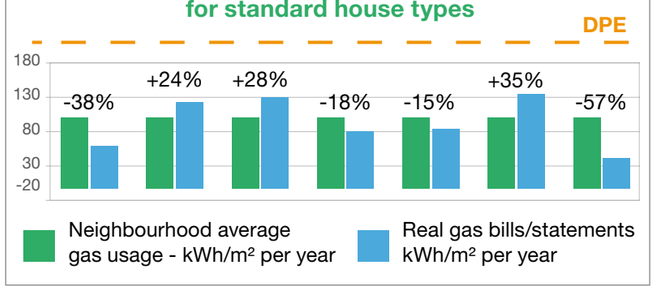
Sociologists from both countries have been working with the Green Doctor to build a series of questionnaires and to assess the range of behavioural variables between residents that affected the baseline level of energy usage prior to the building works taking place. The sociologists in both countries have been researching together to understand the energy consumption patterns within the two countries to anticipate measures to reduce future consumption as a result of individual behaviour change and community actions.

The questionnaires have enabled an in-depth analysis of changing behaviour patterns in relation to the energy and carbon savings being made by the improved fabric of the houses. The simulation models were then related to the temperatures of the houses, reflecting how they are being used post-retrofit to isolate the impact of tenant energy engagement. By running the models using a consistent weather file with pre- and post-retrofit room temperatures the total saving due to the retrofit works and resident behaviour was identified. Using pre-retrofit temperatures for simulations with pre- and post-retrofit building specifications found the percentage reduction due only to the building works.

Utility bills information: ErDF, GrDF

Utility bills made available by French energy providers ErDF and GrDF for Outreau have been used for comparison with the performance certificate bands in France (DPE). The DPE has been shown by this analysis to have a limited resemblance to reality; conversations with the residents have provided the key to understanding the real situation.

Diagram 4: Predicted gas consumption for standard house types



An example comparing actual gas consumption for several addresses at Outreau with neighbourhood averages and the DPE (Diagnostic de Performance Énergétique) standard.

Pre- and post-retrofit consumption patterns, support for tenants

At Outreau, contrary to expectations, there were particularly large disparities in gas consumption. The extent of use appears entirely due to different modes of behaviour so the key to more economic consumption is through support to households.

This requires an understanding of the different ways in which gas is used – for heating, hot water and cooking. Encouragingly, the

Wattbox explained to residents (Feb. 2011).

Measured performance in houses

Inevitably the monitored data is rather variable, sensors fail, devices go missing, so we have used the simulation models to form a complete picture. The models were first validated against one another and related to the energy costs being recorded by the residents, and the room temperatures pre-retrofit.

The models were then used to evaluate different building specifications, forecast the reductions in space heating, to investigate room temperatures post-retrofit and reports from the building users, as to the amounts of gas and electricity they are now using.

Validation

The prototype houses on the rue du Biez and rue Braque at Outreau have been intensively monitored for indoor humidity, temperature, and carbon dioxide concentrations. Subsequently all remaining houses on the rue du Biez have been completed and good energy and comfort performance have been recorded.

The software developed by Intent Technologies has been installed on 100 tablets that have been issued to, and are being enthusiastically used by the residents, who have been to England to demonstrate their use to the residents at Rushenden.

Extent of outliers, profile of residents and energy costs

From the reported utility costs being paid by residents the amounts for winter gas and summer electricity showed the largest number of outliers although in each case the median range was quite tight. Unfortunately in most cases the houses with the highest bills were not those where room temperature measurements had been taken, but in all cases it was families with small children who were incurring the highest bills for both gas and electricity.

The extent of these outliers has however been reduced. The highest reported winter gas bill was recorded as £70. This respondent, with two children aged between 5 and 19, now pays £20. The same family had summer electricity bills of £35 now reduced to £10. These outliers may reflect emotional responses rather than actual costs but for individuals there have been real benefits.

prototype innovative retrofit at rue du Biez is showing, to date, a 59% space heat load reduction.

For comparison of the results, and for wider comparison with other retrofit projects, the data from IFORE has been entered into the UK Energy Saving Trust database called EMBED. This was set up to contain the results from the UK Retrofit for the Future Competition that have recently become available.

The database has wide functionality, enabling individual parameters to be compared between different sites; in addition the database is being progressively enlarged to incorporate the outcomes of other retrofit schemes from around the UK and EU.

Pre- and post-retrofit simulation comparisons

Having been calculated using the same weather file and with room temperatures recorded before and after the retrofit, and having therefore eliminated variations in the climate, the results from computer simulations represent the actual reductions being achieved, including any behavioural changes made by the residents.

Table 3: Pre- and post-retrofit comparison of consumption at Outreau*

Type of energy (kWh/m²/year)	Site	Pre-retrofit	Post-retrofit	% reduction due to the retrofit works
Gas consumption	Rue du Biez	125	78	37.60%
	Rue Braque	91	61	32.97%
Hot water	Rue du Biez	41	33	19.51%
	Rue Braque	20	21	-5.00%
Annual space heating requirement	Rue du Biez	84	45	46.43%
	Rue Braque	71	40	43.66%
Space heating climate corrected by degree-days	Rue du Biez	114	56	50.88%
	Rue Braque	78	38	51.40%
Electricity consumption	Rue du Biez	40	41	-2.50%
	Rue Braque	23	22	4.35%

** 2013-2014 period and including any behavioural changes made by the residents.*

The differences reflect the relatively poor initial performance of the housing stock at Rushenden and the greater thickness of insulation that could be accommodated within the cladding panels at Outreau.

Table 4: Evolution pre and post-retrofit of annual space heating requirements and degree days in Rushenden

House type	Average kWh/degree day for February (1)		Annual space heating requirement kwh/m².yr	
	Kwh/degree day for retrofitted houses (2)	% reduction in heating load due to the retrofit works only	Pre-retrofit (3)	Post-retrofit (4)
Type 1	1.9	45%	318	175
Type 2	4.08	35%	308	200
Type 3	2.41	38%	297	184
Type 4	2.05	44%	247	138
Type 5	1.85	38%	265	164
Type 6	3.16	33%	309	207
Type 7	3.05	48%	295	153
Average		40%		

(1) Using S.E.England weather file averaged over the last 20 years in relation to Rushenden data.
(2) Using hourly set point temperature pre-retrofit from loggers installed in 2012.
(3) kWh using 2012 room temperatures.
(4) kWh using 2012 room temperatures from computer simulations.

Data for electricity consumption was limited in England due to the difficulty of accessing and analysing bills from the multiplicity of energy companies with different tariffs and billing dates.

At Rushenden, because the focus of our work there has been on community aspects (the manufacturing technology of their over-cladding system having been the pre-occupation in France) we needed to isolate the variations in behaviour that impacted on actual performance post-retrofit.

Assessment of the impact of household behaviour on consumption at Rushenden

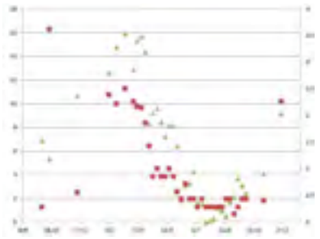
Questionnaire responses from card and key-paying residents reporting their utility costs might seem fraught with problems given the different tariffs being paid, but those who pay by card and key have an accurate idea of how much they pay, and there is a clear correlation between the size of house types and their reported payments. The sample at Rushenden was large enough to average out differences in price per unit between energy providers.

By taking the amount paid for summer gas (assumed to be for hot water and cooking only) from the amount for winter gas, an idea can be formed as to the cost of space heating only. Summer gas costs increased at Manor Close (the older residents' single storey houses) but has fallen markedly – 30% - across the rest of Rushenden, which reflects a positive change initiated by the Green Doctor.

Theory of degree days

A 'degree day' is a way of describing energy use related to actual room temperatures and climate. The number of degree days is the difference between the external temperature and internal set point temperature over the time period. So kWh/degree day are comparable pre- and post-retrofit no matter whether the winter was harsh or mild.

Diagram 6: Gas demand and degree days



Plot of degree days and gas demand at Outreau to establish pre-retrofit consumption.
Left axis: degree days averaged between two surveys (°C).
Right axis: gas demand by day averaged betweeen two surveys (m³/day).

On reflection

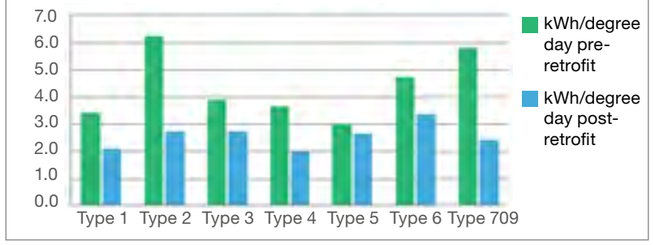
IFORE has tackled one of the difficult issues of our time – how to improve social housing stock, making it more energy resilient, so that energy demand will reduce - as will the necessity for new power stations. It has been a well-focussed investigation particularly since the English housing stock is amongst Europe's worst in energy performance.

In France the situation is different – the form of buildings, their age and construction, but also in terms of culture and the administration of public housing. So in many ways IFORE has been sufficiently expansive in its aims as to be a good representation of a wide range of European dwellings.

In the course of the project 100 houses have been retrofitted in England and a number of prototypes in France. By monitoring the performance of this relatively large number it has been possible to arrive at a holistic view of the issues that will be involved in country-wide retrofit.

Rather than opting for a readily-quantified purely technical solution IFORE has involved the two communities in achieving the best outcomes not just for energy saving and the reduction of fuel poverty but also to improve comfort and living conditions, provide employment, and increase the cohesion of communities.

Diagram 5: Pre and post-retrofit comparison of space heating kWh/degree day*



** Including any behavioural changes made by the residents.*

Whilst the card and key paying residents reported a reduction in their gas bills there appears to have been an average increase in electricity costs. This might be due to the sharp rise in utility prices over the time period of the project or increased use of appliances and computers.

The room temperatures recorded by the tinytag loggers at Rushenden pre- and post-retrofit suggest that in general more stable internal temperature conditions have resulted from the project. This might make the houses easier to live in at a cooler temperature, with the aid of a pullover, draughts and swings in temperature having been eliminated.

Indeed, average temperatures show each house type at Rushenden to have been operating post-retrofit at a lower internal temperature. A similar conclusion was reached by the sociologists' analysis of questionnaire responses. The reduction is approximately 0.5°C (the average living room temperature across Rushenden was 19.6°C in 2012 and 19.0 in 2014). It is generally considered that a 1°C reduction in temperature is equivalent to a 10% reduction in energy use so these room temperatures represent a 5% reduction being achieved by the residents when averaged across the whole of Rushenden. A marked difference between the average and median temperatures is due to the influence of outliers, whether due to the Green Doctor or remaining fuel poverty, enough houses are being kept at low enough temperatures as to reduce the overall average. ■

AmicusHorizon staff in Rushenden with ground-source heat pump contractor (December 2012).

Working with local partners has had a positive impact on the local economy

The project has had ambitious targets for creation of employment as one method of social inclusion. In France, the innovative over-cladding system was prototyped on the rue du Biez where the single-storey housing for older persons was an ideal test-bed. As a pre-requisite for the full-scale rollout of the system, across the remaining sample of houses at Outreau, its performance needed first to be verified by monitoring before the factory assembly-line, employing local labour, could be built. The dry-assembly cladding system has insulation encapsulated within the panels that is made from recycled clothing collected from charity outlets. The system is designed for rapid application to limit the disruption to neighbourhoods. The results have been favourably received by the residents.

An external insulation system was used in Rushenden: a phenolic insulation with polymer-bonded render more familiar than was the case in Outreau. AmicusHorizon specified the use of rigid phenolic insulation as it offers very good thermal insulating properties due to the very low thermal conductivity of phenolic foam, compared with rigid polyurethane or extruded polystyrene. Its low thermal conductivity allows specified thermal performance targets to be achieved with minimal thickness of insulation. This is particularly significant as space saving was important.

The 60mm thickness enabled external pipework, window and door reveals to be accommodated without any major design implications. Only a small number of roofs had to be extended to ensure the soffits were deep enough to cover the cladding.

Even so, and despite the weather at the time of year when the work was carried out being less than clement (a function of the funding timetable) the level of disruption appears to have been tolerable. For social housing where it is difficult to decant residents, external insulation remains an entirely viable solution to achieve the desired insulation levels and air-tightness.

At neither Rushenden nor Outreau was it possible to insulate ground floors. Because of the level of cost, disruption and associated works involved it seems unlikely that housing associations in general will be able to insulate ground floors. This limits the overall percentage energy reduction the retrofit works can achieve and creates a thermal bridge, as the base of the external insulation is at the level of the damp proof course. Extension of the insulation below ground level would have had negative repercussions for cost, disruption and construction time. These limitations on the carbon reductions achievable by social housing retrofit increase the necessity to make the best possible energy savings by engaging with households and the community.

Resident engagement during the works

This was recognised as key to successful integration of new technology with the residents. Different techniques were employed:

- Locally hosted information days
- Practical guidance during commissioning
- Bespoke user guides
- Training sessions for residents & staff
- Resident visits to manufacturers' demonstration sites.

Vocational training and jobs

AmicusHorizon used the retrofit programme to develop a number of valuable employment support opportunities:

- Volunteering (a gateway activity for job seekers, great addition to a CV).
- Trainee energy advisor/Green Doctor roles.
- Employment support linked to useful energy related knowledge (for example, thermography).
- Developing a network with energy related contractors and suppliers (e.g. Swale Heating).

Active residents on the IFORE community programme therefore could:

- Develop awareness and understanding of energy use.
- Improve household budgets.
- Secure energy knowledge to enhance employment prospects and opportunities.

The team saw 20 people in Rushenden become much more competitive job candidates. They won new sets of skills and knowledge, added to their activity experience, broadened their horizons and built higher aspirations for themselves.

In tandem, four major changes have been made by Pas-de-Calais habitat, to update front-line roles at Outreau:

- **The technical support** and equipment maintenance service has been adapted to meet the challenge of tracking household consumption, as relayed by the real time digital monitoring EnergyCoach tablets distributed to households. Pas-de-Calais

An Outreau prototype house during the works (May 2012).

habitat's "Multiservice" maintenance team who look after heating equipment, have been reorganised. As well as inspections and maintenance of electrical appliances they now carry out energy diagnosis and help families limit their consumption. A new public tender call has been launched to modernize the technical maintenance service. These new interactions with customers are ongoing and staff are getting used to new challenges.

- **An expert course** in "Energy expenditure mastering" has been undertaken by our building caretakers, to enable them to monitor and advise residents about their various uses of energy. This new "Nearby Energy Advisor" role will be gradually developed over two years with the caretakers who are in contact on a daily basis, have a close relationship with the locals, and enjoy a high level of trust. Pas-de-Calais habitat already employs around 400 outreach workers who provide support and carry out building maintenance.
- **This energy saving approach** has been integrated into Pas-de-Calais habitat's global communication policy wherever retrofit programmes are being planned. A retrofit programme, because it transforms the socio-technical context of housing and patterns of consumption, is a unique opportunity to join with households to present and explain manuals for best operation of new equipment and their improved homes, including lifestyle recommendations for energy conservation. Different media, events and energy-use guides are promoting this strategy, best practice examples are being fed into a bank of resources made available to all residents.
- **The involvement of residents:** joint sessions with housing association staff established new ways for the traditional services of the housing association to relate to households and for promotion of residents to become Green Ambassadors.

So far results are encouraging; residents are satisfied with the works and more comfortable. Their home has been upgraded, they need less heat and have gained a lot in terms of sound insulation. The support system has allowed them to better manage their energy consumption, change their habits and improve their comfort. In fact, 80% now track their energy consumption, which previously was only

Air-tightness

Making houses more air-tight to cut down on draughts and waste less energy is a conventional approach for retrofit projects. Too often however this results in poor indoor air quality with implications for condensation, mould growth and the health of occupants. To counter these problems MVHR (mechanical ventilation heat recovery) has been installed into the more air-tight houses at Manor Close in Rushenden. Monitoring has identified some persisting problems of air quality; also dry air which is often encountered with these systems. The houses at Outreau that are newer than at Rushenden and already had some insulation were more air-tight still. Supply-air windows have been installed in all the retrofitted houses at Outreau.

Renewables

The approach taken at Rushenden has been 'active house' – insulation has been the priority particularly In lofts where an additional thickness of insulation was a viable option, but given the UK's commitment to reduce carbon the photovoltaic panels installed on roofs are also making a welcomed contribution to the reduction of residents' electricity bills. In fact they have been an outstanding success contributing at least 50% of electricity demand in the 2 years since they were first installed. The PV panels have made a major contribution to carbon reduction at Rushenden. In France the feed-in tariffs don't favour this approach so at Outreau a 'fabric first' only solution has been adopted.

true for 42% of households before the tablets were put to use, and only 10% were taking an interest in the amount of energy being used. The support from staff has strengthened relationships with proximity staff, and Pas-de-Calais habitat have won strong support for the project. It is always difficult to estimate financial gains - IFORE's timespan is too short to adequately take into account climate variations and ongoing changes in occupancy (such as the death of a spouse or people moving away).

For their part, caretakers and local staff who engaged in the socio-technical support of the tenants are happy with this new approach. Despite initial reluctance and as a result of the help they received from the Energy Ambassadors and managers at Pas-de-Calais habitat, they are now enthusiastic and can see advantages:

- They are forming new and better relationships with residents: no longer just responding to problems but also to other aspects of their lives.
- It marks a significant enhancement of their status and the acquisition of new skills.

Partnerships

Establishing a successful community project requires excellent partnerships, the most important partners being residents and the community. At Rushenden, IFORE's success grew as a result of:

- A strong partnership in addition to EU pump-priming.
- Good strategic understanding by, and promotion for, Swale BC and Kent CC.
- Contractors and suppliers with significant community activity.
- Effective advocates and champions.
- Good communication and visibility.

Retrofit programmes provide future opportunities to secure wider social value in conjunction with procurement. We also see opportunities to develop a culture of the community giving back through establishment of supply chain businesses. For example, Swale Heating whilst engaged in the installation of solar panels have provided roles for trainees.

Air-tightness

At Rushenden the exceptions were larger houses, particularly those with timber cladding rather than cavity walls. As well as the usual leakage points, around pipes passing through the external wall under kitchen cupboards, and around window frames, the single skin blockwork behind the cladding was a source of air leaks. Although post-retrofit they are still the leakiest of the Rushenden houses, the external insulation, replacing the previously uninsulated cladding, has made an enormous difference to the thermal performance of this house type.

Rushenden is providing a home for a range of other technologies; the benefits of heat pumps, solar thermal panels on roofs, and a Trombe wall (a device to capture the sun's energy and provide free heating) are being monitored. The Université d'Artois has a long experience in the design and analysis of 'Trombe walls'. A Trombe wall has been built and is currently under test at Manor Close in Rushenden.

The Trombe wall design has been developed so that it can be easily incorporated into traditional British building construction. The questionnaires at Rushenden showed that technologies requiring little user interaction such as solar panels on roofs were readily accepted by householders.

Innovative technologies

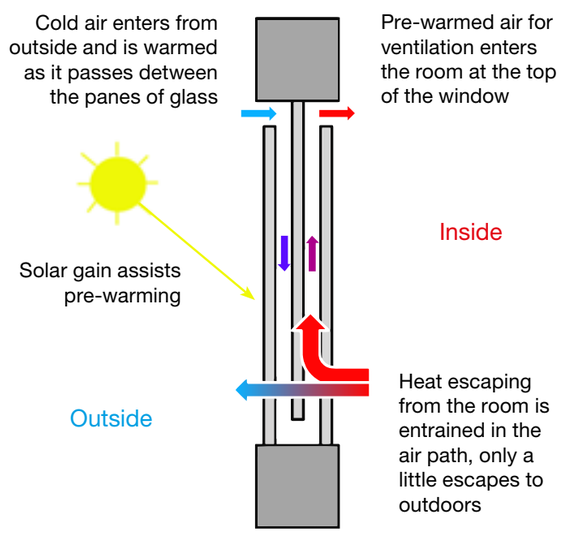
The innovative measures being employed required an extended period of development, laboratory testing and simulation. The university partners to the project have previous research experience demonstrating the energy benefits of Trombe walls and ventilated window systems. These are now at the beta stage of development and being refined for mass production.

Although the homes at Outreau have better air-tightness, because of the simplicity of construction at Rushenden (the houses have solid concrete floors and plastered walls) the single storey houses at Manor Close, in particular, were already relatively air-tight. This is a pre-requisite for the viability of advanced ventilation technologies whether MVHR or 'supply air' windows.

Low energy construction implies air-sealing the building so an engineered system of ventilation is required for reasons of both health and energy- saving, an important consideration since condensation and mould have been persistent problems in houses on both sides of the Channel.

The windows are different from conventional ones with double glazing in that they do not use sealed units, instead air from outdoors is circulated between the panes of glass so heat that would otherwise

Diagram 7: Principle of the "supply-air" window



Windows

At Rushenden the decision was made to renovate existing windows, that better performance could be achieved by replacing double-glazing and improving their air-tightness, this was carried out using a local contractor. At both sites a novel solution to the ventilation problem that has beset condensation-ridden public housing is being trialled. 'Supply-air' windows that use air circulation between the panes of glass, rather than sealed units, provide pre-heated draught-free air to rooms and a method of whole-house ventilation. The windows have been tested and their performance analysed, in the laboratory of the French academic partner Université d'Artois, before fabrication by a leading French manufacturer and installation throughout Outreau. The 'supply air' windows being made at La Rochelle for the retrofits at Outreau have been adapted for use in England (where windows usually open outwards unlike those on the Continent) and are now installed and under investigation for further applications in the UK.

Refurbishing rather than replacing

In Rushenden the existing 20 years old PVCu windows were sustainably renovated as they still had a life expectancy of more than 40 years. The profile of each window was re-built using new rubber gaskets and weather seals and replacement components such as handles and air vents. The process was optimized so that all the windows of each house were completed within one day to avoid any discomfort for the resident.

A 'Mono-Dec' safety platform was used to enable access and upgrade of the first floor windows with minimal disruption whilst satisfying health and safety requirements without losing speed on the project to meet the imposed project timescales.

Benefits:

- substantial retention of any financial investment and embedded energy contained within the existing installation
- improved SAP rating by reduction of energy in use through performance enhancements and improvements
- compliance with current Building Regulations
- tenant satisfaction targets
- unnecessary waste prevention.

This is borne out by the calculated saving at Rushenden equivalent to 56 tonnes of CO_2 cost savings when compared to second generation replacement windows.

Detail of a dynamic window.

escape from the room is entrained in the air path and used to pre-heat the incoming ventilation air i.e. the 'supply air' window acts as a heat exchanger. This is a whole-house system that pulls air in at the perimeter and extracts it from the kitchen and bathroom. In the prototype humid air from these 'wet' rooms is extracted mechanically so that air flow through the rooms is created with enough pressure-drop to pull air through the 'supply air' windows.

The innovative extract system was invented in France. A small hose is connected at the base of a passive stack and is used to blow high velocity air into the duct through a small nozzle. The accelerated jet of air induces higher speed air flow within the passive stack by Bernoulli effect. A single fan can be used to induce a higher flow of air into the passive stacks to maintain negative pressure within the house so the extract system functions no matter what the wind strength or direction. This is being installed into the two-storey houses at Outreau, the single storey terraces on rue du Biez have too little stack height to make the system practicable and so individual constant mechanical extract (CME) was installed instead.

Simulated performance

At the University d'Artois steady state models have been constructed based on fundamental algebraic functions and using computational fluid dynamics. Using these simulations predictions can be made of the internal temperatures within the window and at the room face of the window, under wintertime conditions, and the insulative capabilities of the window at usual building flow rates. In addition a network model was built to describe the temperature change as the air flows through the window.

Laboratory tests

This analysis was a precursor to the construction of a laboratory test rig within a test cell, the window being cooled on one side and heated on the other to replicate the situation within a real building.

The temperatures within the window and on the external surfaces of the window were measured at different rates of flow using an array of thermocouples.

Satisfactory resolution was reached between the theoretical model and the experimental setup confirming that the 'equivalent' U-value, which takes into consideration the heated air delivered into the room as well as conductive heat flow through the window itself, is between approximately 0.1 and 0.2W/m²K compared with the comparable figure for a conventional triple glazed window of 0.7W/m²K.

Table 5: Insulation value of the supply-air window

Flow rate (m^3/hour)	Ueq (equivalent U-value includes heat reclaim due to air flow)	% of ventilation heat load compensated by heat reclaim within the window
13.5 (at 2pa pressure difference)	0.18 W/m²K	39.4
20.8 (at 4pa pressure difference)	0.09 W/m²K	30.2

Subsequent tests within the prototype house at rue du Biez in Outreau have confirmed that an annual reduction in space heating load of between 1000 kWh and 1800 kWh can be anticipated, the system is suitable for either natural and mechanical ventilation, and there has been no record of summer overheating.

The Rushenden Trombe wall fits into traditional building design.

Summary of measures in Rushenden

AmicusHorizon maximised the installation of the identified energy efficiency measures by combining existing planned programmes with available government funded schemes to provide the following improvements for the project:

- A' rated boiler upgrades – 54
- Solar PV - 41
- Solar thermal Systems - 27
- Loft and cavity insulation – 100
- Door replacement - 160
- Window refurbishment - 100
- External wall insulation - 100
- Ventilation (MVHR) – 29
- Draught proofing – 100
- Air source/ ground source heating - 6

External insulation and house aspect

In England, owner occupiers interspersed with social housing within the length of a terrace, resulted in cold bridging at the junction of the insulated external walls with their unimproved neighbours, a problem not encountered in France. The choice of paint colours by the residents has highlighted the contrast with the owner occupiers who all chose not to have the work done, despite the assistance offered by the housing association, while the contractors were on site. This 'pepper-potting' seems likely to be universal in England once large scale retrofit gets underway country-wide. External insulation is however the best technical solution. It avoids cold-bridging whilst coupling the thermal mass of the structure to the internal environment of the house, providing a more stable thermal environment. The individual identity that has been given to each household has helped the re-branding of the estate and a general uplift in community spirit.

A novel method of window cleaning has obviated the need for the panes of glass to be hinged which makes the windows very cost-competitive - de-ionised water is injected under pressure through holes at the top of the window frames and leaves through drain holes at the lower edge.

Industrialization

The level of performance achieved by the first retrofitted houses in Outreau, using prefabricated external insulation panels, convinced Pas-de-Calais habitat to roll-out this system (including 'supply-air' windows) for all their stock. Since the end of 2013, six sites and nearly 150 homes – representing the full range of the housing association's dwellings - have been included in this process.

Work will start before summer 2015 to check the compatibility of the insulation panels with the different types of houses before large-scale deployment across all of the stock that is in need of better insulation.

Trombe wall installation

Trombe walls have been demonstrated, since the 1970s, as having potential as a low-cost passive solar component for housing but they depend on reliable and simple controls for optimal operation. Within a composite Trombe wall the temperature increases in the air space behind the glazing and in front of the heat store proportional to the extent of solar radiation.

This ventilated type of Trombe wall is one of the innovative solutions being incorporated into south-facing walls of retrofitted homes at both Outreau and Rushenden. Vents at the lower and upper parts of the insulated wall allow the circulation of warmed air into the room in winter at the top of the Trombe wall. A very simple system has been installed to avoid inverse air circulation when the wall is cold.

A shutter behind the outer glass pane is closed in summer to avoid overheating. In this way approximately 30 to 40% of incident solar energy can be utilized in winter, and at periods of intermediate temperature - spring and autumn - as a contribution to the space heating load of the rooms served by the device. ■

Cross-border visit of tenants from Outreau and Rushenden (December 2013).

Cross-border dialogue has helped stimulate innovation and European togetherness

The housing association partners' strategy for community engagement included the cross-Channel exchanges for understanding and learning:

- Compare learning and ways of working with different communities/ countries. This gives organisations the development opportunities to provide better services to their clients.
- Cultural exchange to increase understanding between the two countries. Breaking down cultural barriers.
- Resident exchanges to share learning experiences. Building capacity to create better neighbourhoods.
- Differing business approaches by staff shadowing and meetings. Sharing best practice.
- Work in partnership and with other businesses to develop further opportunities for development.

During frequent resident engagement and exchange visits, we established a core group with a membership of 60 French and English members. The members were drawn from the Rushenden Community House project and a new Outrifore community group established by the project in Outreau. Effectively residents associations, both groups felt that it would increase local participation to have different names for their associations.

The established groups will provide the catalyst for longer term working in building the twinning relationship. They have already planned and worked together to deliver activities:

- Community legacy projects are now run by the residents themselves.
- Energy awareness activities and conversations continue.
- We're building on links with agencies, businesses, schools and the community.
- Rushenden and Outreau residents are proud of their achievements.
- Housing associations are taking forward ideas and lessons about business planning and work programmes.
- We can use retrofit refurbishment as a catalyst for community activity.
- Work with residents on energy awareness and behaviour is valuable and helps maximise the impact of retrofit investment.
- Effective retrofit refurbishment partnerships can create community opportunities beyond just work programme improvements.

As part of the IFORE project legacy programme, a work plan and continued facilitation of the group is set for the next two years. The groups have set up Facebook accounts to share new ideas/plans. So far Outrifore has 37 followers and Rushenden Community House has 538. Other methods of communication have been tested, such as Skype and IMO. This meant that both groups were able to participate in activities, even if they were not physically there.

We've held introductory visits and exchanges for the Town Mayors and local councillors. We've involved local politicians within exchange visits and learning sessions. It was important to get local council/municipality input into the community presentations. These were effective events promoting the IFORE collaborative approach and its findings.

These project events have helped establish good relationships between France and UK residents, communities, young people and seniors. We've got a combined community group ready to take legacy action forward.

Twinning the communities

We've drafted twinning documents. These are available as a basis to the local Town Council / Municipality to develop formal twinning activity.

Common projects have already been identified. So a legacy programme over the next two years is to develop a plan for formal twinning between Outreau and Queenborough Town Councils. This is dependent on political and election positions post May 2015.

Learning points:

- It's essential to have a good platform for community access to Facebook and Skype.

The European dimension

A crucial aspect has been the interaction between European neighbours. Learning from one another, whilst circumventing the inevitable differences of outlook and organisational structures of housing associations, has been a valuable experience and helped put received wisdom about retrofit into perspective.

The two communities have enthusiastically met to enjoy language instruction, and to share initiatives - the establishment of a cross-border residents' association and the planned twinning of the two districts. The Anglo-French dimension has been important in making the project special for the residents, and thereby increasing its impact in the long-term. As one from Rushenden who made an exchange trip to France observed 'I think both communities have a lot to learn from each other. The shared experiences have been fantastic for French/English relationships. The exchange of ideas and working toward one goal of saving energy has been a very positive experience'.

- The UK housing association recognises this and is going to improve IT / Skype access to better facilitate cross-boundary communications. The aim is to establish better Skype access at Rushenden Community House.
- Facebook works well, especially the translation capacity. This has been a good tool for cross-boundary resident links. It can be proactively managed by participants.

Exchanges between housing partners

Embedded within the project, there have been regular learning exchanges. Quarterly meetings with the specialist community development, proximity and technical teams from both countries have developed a high level of learning. There have also been several exchanges with staff from different departments during 2014. 40 people were involved - exchanging ideas, skills and learning points across the two companies.

- Learning points from these visits relate to management differences on several aspects:
- Allocations – seem to be made based on a panel who may be managing. People 'apply' to live in the homes. This may be why they seem to take more care of the area outside their front door.
- Intergenerational projects – lots of fantastic work involving disabled and older people.
- Flats and children – no children over 7/8yrs in flats – must move to a house.
- Challenging behaviours and disabilities – incorporating specific schemes for Alzheimer's, severe mental health, downs syndrome, and autism with general needs housing.
- Mayor support – the need to ensure political "buy-in" is essential in France.
- Extra Care – the idea of en-suite bedsits with communal cooking facilities and support.
- Innovation – There is a greater emphasis on trying new methods of working.
- Social impact – working closely with universities to research and evaluate impact of projects is an area of potential development. The French involve academics in innovative/pilot projects to track and assess the benefits.

Staff shadowing also led to interesting assessments, such as differences in responsibilities. Housing staff in France have more of a caretaker role whereas in the UK contractors are outsourced for general maintenance etc.

As a result of the learning exchanges, we've developed new business networks and understanding. This includes legacy meetings to secure new business development and joint projects, and meetings to look at both community and physical opportunities.

Student Exchanges

Student exchanges and cross-border visits have continued throughout IFORE, involving school age students; graduate students from the academic partners to the project – the University of Brighton and the University d'Artois; the two PhD students who have been attached to the project as researchers; and members of the local communities who have been learning for example about the use of PC tablets for energy monitoring. ■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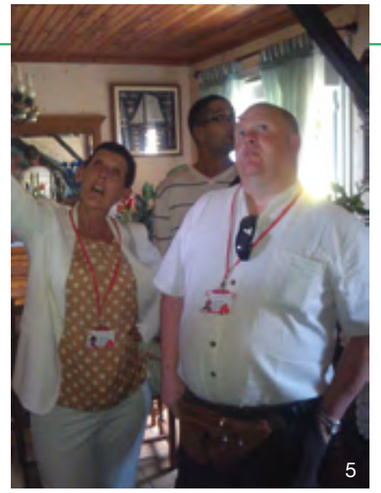
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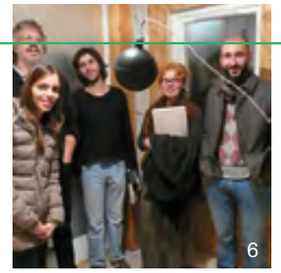
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7


8

Different types of exchanges were organized during the project: for children (1 & 2); for residents (4 & 5); for the team (3 & 8); for academics (6); for professionals (7).

A meeting of the Outrifore resident association in Outreau (April 2014).

Influencing housing policies and community cohesion

Whilst the retrofit works were underway our sociologists, in both countries, were analysing responses to questionnaires and the literature of energy psychology. Behaviour change in energy conservation can be achieved through altruistic and egoistic rather than financial influences. If people are motivated only by cost, this may change as circumstances change. In addition, without a change of awareness about environmental issues, money saved may be reinvested into other carbon intensive ways. When designing projects to reduce domestic energy use, it is important to reflect on these broader considerations if energy savings are to be maximised. This is a point that IFORE has embraced.

For Pas-de-Calais habitat, an essential aspect of this socio-technical approach was to actively involve end users, in the hope that by supporting them, individually and collectively, we would generate more enthusiasm and promote energy-efficiency. One of the

Community benefit

Both Pas-de-Calais habitat and AmicusHorizon established on-site teams within the areas to be retrofitted. AmicusHorizon have long experience of engaging with their communities and responding to their needs, this expertise was their contribution to this part of the project. A large number of activities and projects have taken place at the level of community, with individual household members, and with local children through the involvement of schools and youth groups.

What is apparent from IFORE is that changing the behaviour of the residents is very important and is the key to the UK and Europe being able to achieve the 80% carbon reduction which is our joint commitment. Getting residents involved and committed to a 'green' ethos saves a great deal of money, to achieve the 80% reduction without the involvement of the community costs much more than would conceivably be feasible for a social housing provider.

outcomes is a qualitative indicator of behavioural contributions to performance. It reinforces the importance of designing retrofit projects with occupancy in mind.

As part of a major retrofit programme, the social benefits of this engagement with residents and the consequent improvement in their quality of life were highlighted. These are not confined solely to technical performance, but also a new commitment of households after their interest has been raised, and their homes' energy performance has become a matter of curiosity. The result has been a marked improvement in comfort, and the promotion of closer relationships with our proximity staff and the housing association itself.

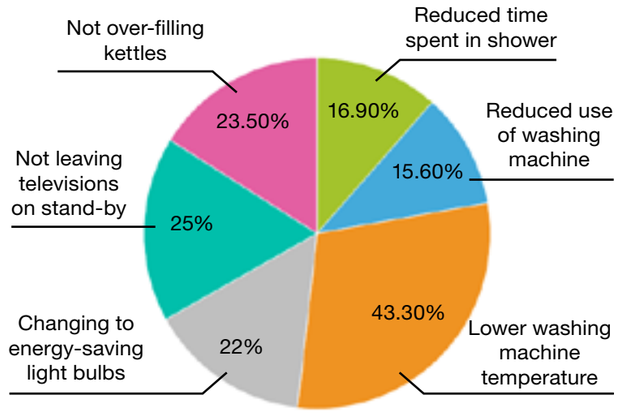
Exploring data from the post-retrofit survey in Rushenden a key success of the IFORE project can be found in the attitudes of the residents, their new found ability to reduce their consumption.

IFORE has made individuals feel more capable of reducing household energy use, 64% of individuals stating that they have been able to reduce household energy consumption compared to the previous 12 months. In addition, 69% of them felt this reduction was greater than 5% highlighting a perception that this reduction was of a significant amount.

As shown in diagram 8, there are a range of different ways in which IFORE's Rushenden residents feel they have managed to shift their everyday practices, habits and behaviours. By far the most common way for individuals to actively save energy was the reduction of the temperature they set their washing machine, 43% of respondents felt this to be one way they had been able to reduce their household energy consumption.

Using the TV power-down rather than leaving the TV on standby was something that a quarter of respondents felt they had started doing as a result of the IFORE project. Using energy saving light

Diagram 8: Shift of their everyday practices according to Rushenden 'IFORE' residents



bulbs (22%) and avoiding overfilling the kettle (24%) also featured strongly in the perceptions of respondents with regards to the ways in which they have managed to shift their everyday habits.

Finally, reducing the time taken showering (17%) and reducing washing machine use (16%) were also ways in which individuals felt that they had managed to change their everyday behaviours.

One of the aims of the IFORE project was to work with the local community to bring benefits that didn't only look at a reduction in household energy consumption but also worked to install a greater sense of community empowerment and cohesion.

Diagram 9 reports the ways in which IFORE residents felt that the project has had a positive effect on their local community, and has empowered them as individuals to pass on some of what they have learnt from the project to other residents and family members.

The 'Active' bubble highlights the finding that 21% of IFORE respondents stated they have become more involved in AmicusHorizon community activities over the past 3 years (i.e. pre-IFORE). In addition, 25% of respondents stated they felt more positive about living in Rushenden compared to three years ago. These findings show the positive effect the IFORE project has had on community cohesion and engagement.

In addition, residents also expressed feelings of empowerment with regards to the work of the IFORE project. For example, the large 'practices' bubble highlights the finding that 65% of respondents now felt capable of passing on the information they have learnt through the project about energy-saving practices. Also, 47% of respondents stated that they felt capable of sharing and passing on the information they had learnt through the IFORE project with regards to new and energy saving technologies.

Finally, 21% now felt that now performed in a more environmentally friendly way but also that other members of their household were now more likely to adopt energy saving practices as a direct result of their involvement with IFORE.

Another potentially motivating factor, particularly in deprived neighbourhoods, is lower bills achieved by reducing consumption. Messages around this have been a particular focus for government, the voluntary sector and housing association energy reduction initiatives, and projects with the aim of incentivising residents to take measures to reduce consumption.

However, cautionary messages relating to the emphasis on financial savings have also been expressed by some observers, in terms of the wider picture of energy conservation. It is argued for example that the idea that people are motivated through monetary rewards is over ambitious and generally only creates short term behavioural change.

The results of one study of residential energy behaviour suggested that motivational factors are more complex than is sometimes thought, with monetary rewards not necessarily being the most prominent. Most residents, for example, turned down heating at night because of reasons of comfort rather than in order to save money.

The value of working with the community as a whole emphasises the importance of peer group pressure in achieving a community-wide energy ethos.

Tools derived from the project

The partners to the project identified areas in which new tools were required for analysis of the project's results, and ways in which IFORE could contribute to the ongoing debate about retrofit in both countries.

Role of the contractors

The necessity to get every benefit from retrofit extends to economic benefit, making the construction work generate jobs, and apprenticeships, so local youngsters can stay a part of the community and maintain the legacy initiated by the Green Doctor and the rest of the on-site team.

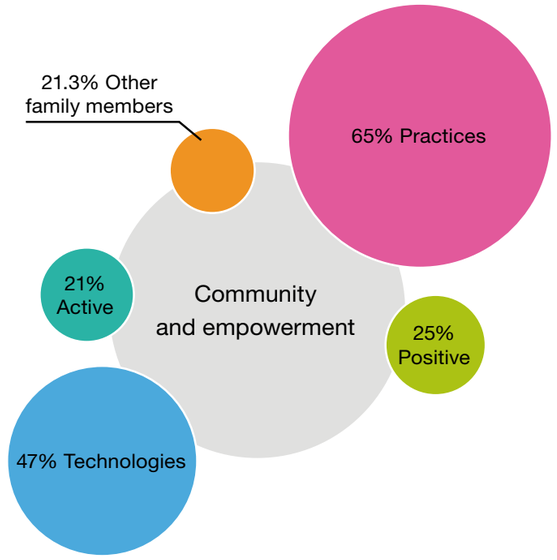
Working against the 'rebound effect'

The real test for IFORE is to make the retrofit have a lasting benefit. The problem is what has been termed 'rebound effect' – people enjoy their new houses and increased comfort so they don't turn thermostats down and energy savings aren't realized. Given the usual rate of turnover all the current tenants will have gone within 10 years so the question is how can the ethos of an energy community be made to continue?

Encouraging a new ethos

The project has encouraged better contact and conversation between elected representatives and local residents. The outcome has been better community cohesion, a feeling of belonging to the local area, which can now be seen in environmental improvements, for example a new interest in the care of gardens. Within housing associations this ethos needs to be firmly embedded so the proximity staff can make use of the short period after residents move in when they can successfully be encouraged and so they get the message immediately.

Diagram 9: Ways the project has had a positive effect according to Rushenden 'IFORE' residents



A Rushenden resident at an IFORE stand (August 2013).

Predictive device to detect the onset of fuel poverty

In France a predictive method has been developed from historic figures provided by utility companies for water, electricity and gas consumption, which have been analysed over the last six years' records. Individual households can, by reference to their usage per day, be located within the range which is typical of the community as a whole. Individual households can be compared with their neighbours to show whether or not they fall into a band of consumption representing the normal minimum to maximum levels of consumption.

In this way residents can be characterised as falling within one of the groups suggested by sociological research, ranging from careful consumers to those homes using more than would seem necessary. In this way help or advice can be offered to offset costs and to identify those who are in danger of falling into fuel poverty.

Table 6: A tool for fuel poverty prevention

Foresting fuel poverty		Rue du Biez, Outreau	
		Use	
Water	Code standard: 100 010 litres/year 274 litres/day	Consumption of around 150 litres/day	
		137.07 **-50%** /code standard	
		142.87 **-4%** /profile	
		173.07 **0%** /reference	
		Concern	
Electricity	Code standard: 2920 kWh/year 6 kWh/day	Consumption of around 6 kWh/day	
		5.76 **-4%** /code standard	
		5.18 **11%** /profile	
		5.76 **0%** /reference	
		Danger	
Gas	Code standard: 3780 kWh/year 10.35 kWh/day	Consumption of around 10 kWh/day	
		20.88°C	12.74 **23%** /code standard
		19.77°C	29.84 **-57%** /profile
			12.74 **0%** /reference

French method of using statistics to identify consumption of households performing well, needing advice, or in jeopardy of falling into fuel poverty.

The system is not just concerned with quantitative issues such as the costs of retrofit and energy but also qualitative ones such as levels of comfort, and sensitivity to issues with families and individual relationships within the community. The analysis can suggest different levels of engagement, on the one hand through use of the PC tablets given to residents to make a record of their energy and water consumption.

Fuel poverty

The aim of the project was to see improvements in household fuel bills, and the reduction of fuel poverty throughout the community not just at the level of individual households. Social activities, reaching otherwise 'hard to reach' households has formed an important part of this strategy so residents have attended trade fairs, and a variety of information meetings and environmental workshops, entailing trips across the Channel. These initiatives have had implications for the housing associations; the roles of local staff such as caretakers in France have been realigned as a result. Exchange meetings between the housing associations have encouraged this cultural exchange.

In France, a system has been developed that will enable better understanding of the energy needs and circumstances of particular types of occupancy. Also, tools have been developed for early identification of households at risk of fuel poverty with a view to assistance, training and advice being made available, thereby limiting its effects. The eradication of fuel poverty has been helped, if not fully achieved.

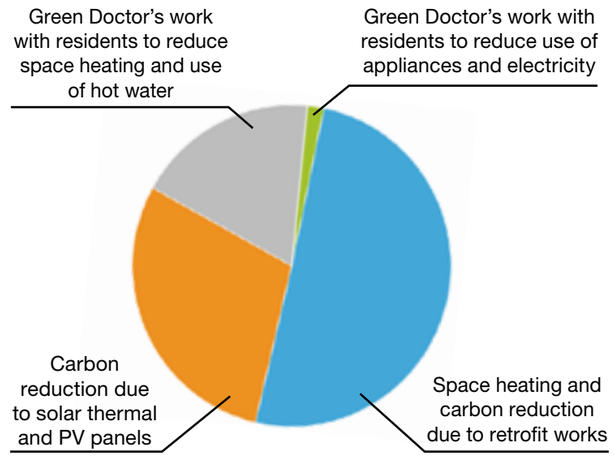
So for social housing retrofit offers a multitude of benefits, increased comfort means better health for residents, the economic activity associated with retrofit generates employment, and better insulation means lower fuel costs and reduced fuel poverty.

Focusing on residents to achieve 80% carbon reduction target

The UK Climate Change Act commits the country to an 80% reduction in carbon emissions. In relation to housing it is usually thought that about 60% can be achieved by conventional building works – insulation, air tightening, and better boilers. The remaining 20% is increasingly difficult to achieve just using technology. Panels on roofs – PV or solar thermal – can make a contribution particularly in the case of PV since electricity is so carbon intensive. But the big contributor, and the aspect that is little understood, is the relationship of people to their houses. The way in which people live makes a huge difference to the way in which houses perform.

The UK government sponsored the Retrofit for the Future Competition, the results for which showed that using a variety of advanced technologies, out of the 80 or so houses that were retrofitted (at 10 times the amount of available funding per house that was available for Rushenden) only 3 managed an 80% reduction.

Diagram 10: Relative reduction in carbon due to technologies and work of the Green Doctor



Prediction based on the outcome of the models

We started by following the Retrofit for the Future guidelines and plotted the retrofit through SAP and using the Passivhaus software PHPP which gives carbon figures in relation to both gas and electricity. This is based on an indoor temperature of 21°C, not surprisingly the larger, leakier houses were operating at lower temperatures.

2012 Wattbox data gave room temperatures below the 21°C initially assumed so the models were re-run at 18.5°C.

A simple spreadsheet program was made to predict the overall savings due not only to the retrofit works but also the addition of renewables, and as a result of residents' behaviour change due to the impact of the Green Doctor.

To some extent this has been based on notional figures i.e. the manufacturers' perhaps optimistic predicted performance of solar thermal panels.

The ESP-r models have shown a heating load reduction being achieved due to the retrofit works of approximately 40% (48% in the case of house type 7), a function of the restricted budget at Rushenden, it wasn't possible to insulate ground floors for example.

The sociological survey for residents' behaviour, reducing heating and hot water consumption (turning down temperatures using showers, not baths etc) and electricity, for example not leaving TVs on standby reinforce these conclusions:

With the exception of Manor Close there has been a marked reduction in summertime use of gas for hot water and cooking, a median figure for house types 4 to 7 of -30% (or greater if inflation was taken into account).

IFORE's educational aspects explained to trainee-caretakers.

Electricity use is problematic so whereas for house types 4 to 7 there has been little change in median electricity consumption winter and summer, the averages have risen which would indicate an overall increase in carbon emissions across the community.

The average KWh being produced by the PV panels at Rushenden would seem to meet at least 50% of demand which is the usual industry assumption. The industry norm for solar thermal panels is that a well-designed system should cater for 30 -40% of hot water requirements.

Carbon reduction

Taking the most favourable case a type 7 house assumed with both solar thermal and PV panel:

A total carbon reduction of around 58% with about 0.8 of the reduction being due to the retrofit and 0.20 due to the Green Doctor (lower temperatures and less summer gas).

As a result of the retrofit, and then the work of the Green Doctor, overall carbon drops and the total reduction increases. For type 7 the carbon reduction achieved is as good as that managed by 50% of the Retrofit for the Future contestants at 10% of the budget, which implies, for social housing at least, that the participation of a Green Doctor is worthwhile.

For the least favourable case a type 2 house would only achieve the 35% heating reduction due to the retrofit without solar or PV panels and the poor hot water and electricity consumption figures achieved at Manor Close.

Quantifying the utility of the Green Doctor

The aim of Pas-de-Calais habitat was to change the job description of caretakers and provide them with training in energy-management.

Legacy building

The acid test is yet to come, the residents need to take ownership - community leaders need carry the message, understand it and then keep the momentum going. Equally the methods AmicusHorizon have developed for engaging with new residents coming into the community, so they are on board as soon after they arrive as possible, need to be maintained. A major achievement is the evolution of a long term and lasting relationship between residents in France and the UK.

The new function of 'Caretaker-Ambassador' had the advantage of being on-the-spot, personalized and affordable in terms of human resources. It has become a primary goal for skills development and resource planning within the housing association.

Previously individual help for residents learning to manage their use of energy was limited since there were only two 'ambassadors' but this has been scaled up by appointment of the 'Caretaker-Ambassadors'.

At the end of the programme, 78% (BESCB 2014) of residents expressed their satisfaction at receiving individual support from their site's caretaker.

This adapted role for 'Caretaker-Ambassadors', as well as tenants-ambassadors, is likely to appeal to the very large population living in social housing across the Channel (10.2 million in France, but significantly less in England, according to 2010 figures). Thanks to these initiatives, Pas-de-Calais habitat's internal organization has become better suited to a personalized approach (for 'energy-coaching').

The sociologists' inclusive analysis is encouraging our consideration of other ways forward and is evolving into a pro-forma that can be broken down into gradual steps, including tools for education and implementation.

This work is being approached in a collegial and multidisciplinary way so as to best meet the interests of a variety of groups concerned with the eco-retrofitting of social housing. ■

Successful eco-retrofit is the result of resident engagement

Four years after the start of IFORE, the project's outcomes were presented at two events, one in Outreau (Pas-de-Calais, France) and again in Rushenden (Kent) on 3rd & 10th June 2014. The team explained the benefits of an inclusive approach, embracing both technical and social aspects.

In Outreau about 80 participants attended a conference. The day included visits to the retrofitted houses, guided by the tenants themselves and IFORE representatives, and to the IFORE bilingual exhibition.

The messages from the project are many and varied:

The 4.5-year €6.3m scheme to help tackle climate change has resulted in 100 homes being fitted with energy-saving systems in England and in France.

Monitoring the performance of these homes has led to an holistic view of issues that will be involved in country-wide retrofit projects.

Rather than opting for a readily-quantified purely technical solution IFORE has involved the two communities in achieving the best outcomes, not just for energy saving and the reduction of fuel poverty but also to improve comfort and living conditions, to provide employment and to increase the cohesion of communities.

The setting up of a local team, informed and trained about energy issues, has been crucial in creating the link to transmit information to the community, both adults and children.

IFORE's housing association partners, AmicusHorizon in England and Pas-de-Calais habitat in France, relied on a balance between technology and engagement with the local residents to implement their retrofits.

To achieve the European target of a 80 per cent reduction by 2050. technology alone is not the answer. The way people live is a major determinant of the actual savings achieved. These aspects are a lot more difficult to measure but with the assistance of the social scientists attached to the project this difficult question is one that IFORE has addressed.

The fight against fuel poverty is supported by the IFORE approach which saw the development of fuel poverty prevention tools;

Fuel poverty, the rising price of energy, and indoor comfort are shared concerns in both the UK and France. Pas-de-Calais habitat have prototyped a dry-assembly factory-made cladding system with insulation. The system is designed for rapid application to limit the disruption to neighbourhoods, the completed works have been favourably received by the local community.

The strategy for engaging residents during this large-scale experiment in participatory retrofitting has now borne fruit in the two communities: awareness about energy and environmental issues has improved which will help the savings as a result of the retrofitting to continue.

The retrofit programme at Rushenden has transformed what had been considered a run-down neighbourhood. AmicusHorizon housing association installed a team throughout the project engaging with individual households to reduce their energy profile, and with nearby schools and students to raise awareness.

A Green Doctor or the French equivalent, the Energy Ambassador, is essential to the success of these teams. IFORE has taken the first steps to understanding the relative cost efficiency of a method that directs residents towards the goals of eco-retrofit, and positively engages with the way they use their houses. This is important given the restricted budgets of social housing providers.

The need for every retrofit project to include a Green Doctor has been established by IFORE's huge success in transforming not only the physical appearance of these estates but the recorded increase in satisfaction of its residents who engaged enthusiastically with the project's goals.

Working with academics has created new opportunities for the housing associations:

- a wider choice of technical solutions facilitated by the modeling and computer simulation of housing performance;
- the study of technical innovations, such as dynamic (or "supply-air") windows, has been shown to make substantial savings in energy. Together with the exterior insulation panels, the saving was about 60% over two heating seasons for the prototype houses in Outreau.

This novel solution to the ventilation problem that has beset condensation-ridden public housing is being trialled. The windows have been tested and their performance analysed in the laboratory of the French academic partner Université d'Artois, before fabrication by a leading French manufacturer and installation throughout Outreau.

Civic momentum has been created. Emblematic of this success has been the creation of a tenants' association in France - its mission - to continue the spirit of "IFORE". Denis François, the association's president provided the concluding address to the conference in Outreau.

IFORE has paved the way for major retrofit projects through the UK and France, with support from residents who now have a warmer feeling of belonging to their community, feel more confident about job search, and community cohesion has been fostered.

Also, the European aspect of the project has helped the partners to broaden their horizons for the benefit of each organisation: the housing associations inspired one another (exchanging concepts such as the "Green Doctor", and "supply-air" windows); academic capabilities complemented one another. But the European dimension provided the impetus towards making the project interesting and "special" and productively contribute to common goals. Links between the two communities – including the twinning of the tenants' associations – will help to make the outcomes of the project a lasting commitment.

Project timeline

Continued from p. 11

2013

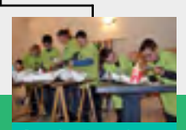
December

Student exchange: visit of Béthune Faculty Laboratory.

2014

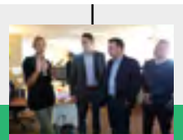
February

Installation of Trombe wall in Rushenden.



Preparing a tree and a work of art for the IFORE exhibition.

March



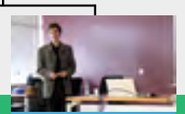
Second exchange visit by managers: to the Pas-de-Calais habitat's Call Center in Lens.

March 2014

Premiere of the film "The Energy Chase", made by Energy Champions.

April

Creation of the French resident association, Outrifore.



François Gloriant, University of Artois, successfully completes his PhD thesis on IFORE's supply-air windows

June

IFORE end of project Conference in Outreau.

IFORE end of project Event in Rushenden.

Official end of the project, 31st August 2014

www.ifore.eu

AmicusHorizon

Pas-de-Calais habitat

University of Brighton

UNIVERSITÉ D'ARTOIS

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