Carbon Co-op

PEOPLE POWERED NOT FOSSIL FUELLED

Powering Down Together
Community Green Deal Case Study Summary

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SECTION 1: EXECUTIVE SUMMARY

Community Green Deal was a home retrofit project run by Carbon Co-op working in partnership with design consultancy URBED. This report on Community Green Deal shows that:

- Whole-house fabric retrofit plus installation of renewables can cut energy use by around 50% - and carbon emissions by around 60% - at an affordable level of capital spending.
- Given the right support, owner occupiers are willing to largely self-fund this level of retrofit, and would recommend it to others.
- With careful design and installation of measures, whole house retrofit can improve comfort and living conditions while reducing carbon emissions and energy bills – a win-win outcome.

ABOUT THE PROJECT

Carbon Co-op is a community benefit society, based in Manchester, established to assist its members in making large scale reductions in their domestic energy consumption. URBED is a sustainable building and neighbourhood design consultancy, run as a worker co-operative.

Community Green Deal began in 2013, and was completed in 2015. The project was part of a larger programme under the umbrella of AGMA (Association of Greater Manchester Authorities), which received funding from DECC (Department of Energy and Climate Change) for the 'ECO Go Early' programme to pilot approaches to home energy retrofit, in advance of the Green Deal and ECO (Energy Company Obligation)[1] programmes.

With Community Green Deal, Carbon Co-op and URBED set out to explore whether, by offering 0% loan finance alongside mutual support and expert technical input, owner-occupiers could successfully self-finance a more ambitious level of energy retrofit than is typical of government programmes.

ACHIEVEMENTS

The project demonstrated that by retrofitting the fabric of homes and installing low-carbon generation, in many cases with the occupants in-situ throughout, cuts of 40-60% or more can be made in domestic energy consumption and emissions.

Gas use was very nearly halved, and for the majority of participants, PV panels generate approximately as much electricity as the household uses. The project came very close to achieving the ambitious target of cutting emissions to 17kgCO_2/m^2.a – representing the ~80% emissions cut from 1990 levels needed to reach the nation's 2050 emissions targets.[2]

'HARD TO TREAT' HOMES

Of the 12 retrofits completed under this programme, nine were consolidated into a single contract, with Carbon Co-op as the client, managing the project on behalf of householder members. In the joint contract, householders spent between £20,000 and £60,000 each (average around £40,000) on the retrofit, PV panels

[1] ECO (Energy Company Obligation) is grant funding made available from energy companies to top up the costs of domestic retrofit, and in its early stages there was a focus on solid wall insulation

[2] The Climate Change Act established a TARGET for the UK to REDUCE its EMISSIONS by at least 80% from 1990 levels by 2050

and associated fees - depending on the size of the house and the number of basic energy efficiency measures already in place.

Most of the houses in the project were older, traditionally-built properties with solid walls, so had not been able to take advantage of previous subsidised cavity wall insulation programmes. By looking at the whole dwelling and developing an integrated specification, the designers took care to ensure measures were not working against each other, or introducing problems elsewhere in the building. For example, purpose-provided ventilation was specified for all dwellings that did not already have it, to ensure that even after airtightness improvements, there would be a good supply of fresh air.

Varying combinations of around 15-20 measures were specified depending on the individual requirements of each house and the priorities of the householders, the following were widely installed:

- External wall insulation as appropriate; mostly woodfibre (for vapour permeability and all round sustainability)
- Internal wall insulation (as appropriate, often on front elevation), also vapour open
- Triple-glazed timber replacement windows
- New insulated doors
- Humidity controlled passive stack ventilation systems
- Loft insulation top up
- Floor insulation
- Air tightness works
- High-efficiency solar photovoltaic panels
- Low flow hot water fittings

New efficient boilers were installed in the three homes that did not already have them.

PROJECT IMPACT

The project succeeded in its main aims. There was an average of 47% reduction in gas use and for the majority of the houses, the PV panels generate approximately as much electricity as the household uses.

Before retrofit, households had energy bills ranging from around £500 to £2,000 a year. After retrofit, these fell decisively, with households saving from £200 (off an already small bill) up to £650 per year. Adding in the income from the Feed-in Tariff from solar generation, savings effectively rose to between £800 and £1,100 per year for these homes.

Many of the householders reported an improvement in comfort and indoor conditions post retrofit, including:

• Homes are warmer, including first thing in the morning.
• They feel less damp and the air feels fresher.
• Homes are less draughty.
• Homes are cooler in summer when it's hot

HOUSEHOLDER PRIORITIES

Householders planning to retrofit their homes are looking for:

- Accessible and affordable finance
- Competent trusted contractors
- Technical information and design advice for example on selection and sequencing of measures

The 0% finance offer in the Community Green Deal was particularly successful in drawing people to participate. Householders were as keen to improve the comfort of their homes as they were to reduce energy

bills, and were prepared to invest in comfort and a healthy living environment even if this entailed a net outlay for a number of years into the future.

Householders were also drawn to the project because of the level of technical expertise and contract management offered. Each household benefited from individual calculations and specifications for each home, offering:

- More realistic energy saving predictions than typical under rdSAP
- Retrofit strategies that guarded against thermal bridging, moisture problems and loss of traditional character of older homes.

On-site training for site crews and regular site visits by the design team supported a high quality of installation – and job satisfaction for the tradespeople.

The distinctive features described above are believed to have contributed to the overall success of the project. The project team also recommends a number of additions or modifications to future project design.

CONTRACTUAL ARRANGEMENTS

Although amalgamating nine of the retrofits into a single contract gave the project access to price discounts of 25 to 50%, there were a number of hidden costs:

- The decision to run one large contract constrained the choice of contractors, ruling out some smaller firms that might have had more relevant experience.
- Central administration of the contract left Carbon Co-op as the conduit for all communication between contractor and householders - which slowed communications, imposed a very large workload on the co-operative, and frustrated all concerned.
- Running the builds as one project caused delays mid-build for some individual households.

In line with what most householders say they would prefer, Carbon Co-op recommends most owner-occupier retrofits be run as individual contracts – though some householders would still like a full third-party management service for this.

A majority of participants also said they would prefer to have been able to move out during the most disruptive parts of the work (and some indeed did so) but only a minority would recommend being absent for the entire duration.

EXPERIENCE OF ECO

ECO funding (funding that the government obliged energy companies to make available for home energy efficiency) imposed a disproportionate burden on the project in a number of ways:

- The application process was complex and time consuming.
- Poor administration of the ECO scheme and associated training programmes led to false starts and delays.
- The funding came with highly restrictive criteria, limiting both the choice of contractor, and of materials that could be used in the project.

In retrospect, Carbon Co-op and URBED believe the project would have run better without the ECO funding element, including in financial terms, and take the view that ECO funding is ‘not fit for purpose’.

LESSONS FOR FUTURE RETROFITS

All construction projects involve an element of uncertainty, and some mess is also inevitable. However, whole house retrofit would probably be easier for participants in future programmes (particularly vulnerable householders eg elderly, disabled or on low incomes) if the following were put in place:

- Better advance information about what is going to happen when, and what will be involved, enabling householders to prepare better.
- Offer of physical help with preparation (eg clearing lofts, moving heavy or built-in furniture)
- A daytime 'refuge' or in some instances, alternative accommodation, for the most disruptive parts of the build: the majority of householders said they would have preferred to have been able to move out for at least a short period during the build.

Carbon Co-op is now offering householders training and 'buddying' opportunities, and chances to network with contractors. This support has contributed to up to 50 more retrofits being independently procured by members. The co-operative feels it is now building up a network of trusted contractors, another aim of the project.

CONCLUSIONS

A workable strategy to deliver deep cuts in household energy use and carbon emissions is urgently needed. In November 2016, the UK ratified its commitment to the Paris Agreement on Climate Change. Retrofitting the UK's homes to reduce home energy demand will be an essential part of our progress towards meeting this commitment.

Every £1 invested in energy efficiency is estimated to return £3.20 to the economy.[3] Cold homes lead to or exacerbate a range of health problems, including cardiovascular and respiratory problems. Whole house retrofit like those in Community Green Deal should enable people to keep warmer and healthier while saving money on bills.

But despite all these arguments in favour of home retrofit, and especially whole house retrofit, progress is still drastically short of what is needed.

Community Green Deal indicated that the UK construction workforce is readily able to develop and deploy the specialist skills required to carry out this type of high-performance retrofit. However, the funding and administration of current government support for retrofit stands in the way of scaling this kind of intervention.

A rethink is needed of support for retrofit, for both the able-to-pay and more vulnerable occupants, in order to make this kind of retrofit feasible at scale. The obstacles are political and administrative, not technical, nor necessarily financial. If support were to be redesigned it would be a great deal easier to cut domestic energy use – and without widespread domestic retrofit at this level, the UK's wider decarbonisation goals will remain out of reach.

Community Green Deal offers a scalable model for achieving cuts in household emissions and energy use compatible with our 2050 climate goals. Elsewhere in the world funding models similar to that used in

[3] Building the Future: The economic and fiscal impacts of making homes energy efficient. Verco & Cambridge Econometrics, 2014

Community Green Deal have been used with success. They are viewed as an infrastructure investment, and deliver net benefits to the national economies, as well as cutting emissions. Community Green Deal shows the model could be a great success in the UK, too.

SECTION 2: THE COMMUNITY GREEN DEAL - INTRODUCTION & CONTEXT

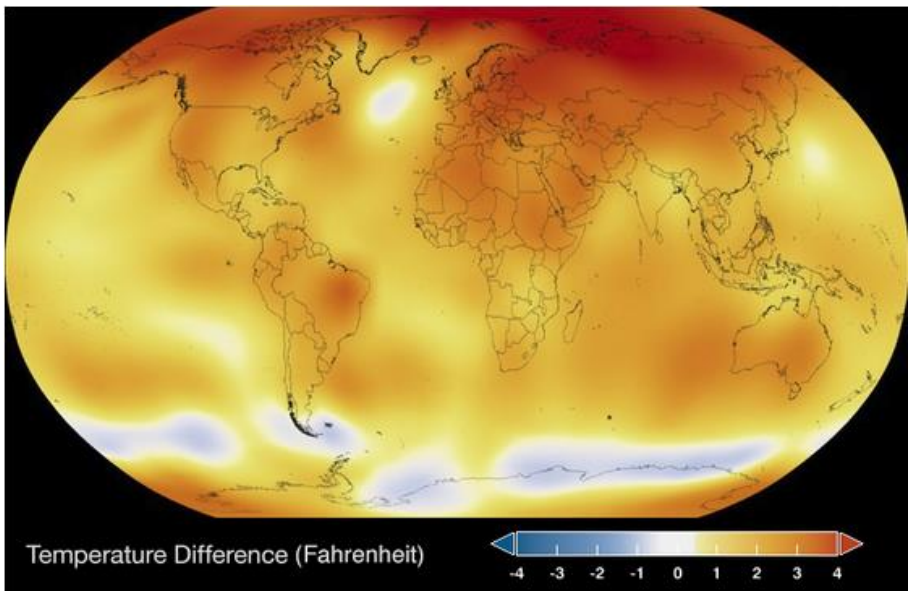
"In the UK we need to upgrade about one dwelling every minute of the day over the next 35 years" ….**Dr Sofie Pelsmakers , Sheffield School of Architecture**

"Across Great Britain, millions of properties are without adequate insulation … We're serious about increasing our efficiency. Our Paris obligations represent an enormous challenge, they are also an opportunity in which energy efficiency can play a very significant role."[4] … **UK Energy Minister Baroness Neville-Rolfe Speaking to the International Energy Agency (IEA)**

WHY HOME ENERGY RETROFIT IS SO URGENTLY NEEDED

CLIMATE CHANGE

A workable strategy to deliver deep cuts in household energy use and carbon emissions is urgently needed. 2015 was globally the warmest year seen over the 130 years that records have been made, and 2016 then broke this record, at a significant 0.2 degrees higher[5] - the continuation of a clear trend.



[4] http://www.energylivenews.com/2016/10/18/energy-minister-uk-must-do-more-on-energy-efficiency/
[5] https://climate.copernicus.eu/news-and-media/press-room/press-releases/earth-edge-record-breaking-2016-was-close-15%C2%B0c-warming

GLOBAL TEMPERATURES – AMOUNT ABOVE OR BELOW AVERAGE IN 2015. DARK BLUE INDICATES AREAS COOLER THAN AVERAGE. DARK RED INDICATES AREAS WARMER THAN AVERAGE.[6]

In November 2016, the UK ratified its commitment to the Paris Agreement on Climate Change, committing the nation to pursuing policies compatible with limiting climate warming to 1.5 degrees.

This is an extremely challenging goal and requires vigorous action both to reduce energy demand, and to de-carbonise what energy we do use.

Heat forms a major part of the UK's energy use, with a high proportion used to heat our leaky, old housing stock.[7] Retrofitting these homes to keep the heat in and reduce home heating demand will be an essential part of our progress towards the Paris goals.

As well as cutting UK emissions, retrofitting homes makes them warmer and more comfortable to live in, can improve the health of occupants, relieve fuel poverty – and also creates a lot of local jobs.

ECONOMIC OPPORTUNITY

Researchers have estimated that a national programme of investment in energy efficiency in buildings could deliver net economic and social benefits of around £8.7 billion over 10 years. Every £1 invested in energy efficiency returns an estimated £3.20 to the economy.[8]

At the same time, energy efficiency cuts the national cost of decarbonisation. Calculations by the Association for the Conservation of Energy showed that high levels of energy efficiency enable carbon targets to be met at lower cost than in scenarios relying on more investment in energy supply.[9]

There have been numerous calls for building energy efficiency to be included within the government's National Infrastructure Plan[10]. The tremendous economic advantage of energy efficiency work is that it is labour-intensive, creating jobs which are distributed throughout the country. And rather than the work going to big engineering multinationals as is often the case with civil engineering projects, the majority of retrofit works could be delivered by a supply chain of local firms, with the investment returned straight into the local economy.[11]

TACKLING POOR HEALTH AND FUEL POVERTY

[6] http://climate.nasa.gov/vital-signs/global-temperature
[7] See https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/244735/4_estimates_of_heat_use_in_the_uk_2012.pdf for more detail
[8] See for example Frontier Economics, Energy Efficiency: An Infrastructure Priority, 2015.
[9] Association for the Conservation of Energy National Infrastructure Assessment Consultation Response 2016
[10] A housing stock fit for the future: Making home energy efficiency a national infrastructure priority, UKGBC (2015); An end to cold homes.
[11] Installer Power: The key to unlocking low carbon retrofit in private housing Maby, C and Owen, A (2015), University of Leeds

Fuel poverty is caused by low incomes, high energy prices and energy inefficient housing. In 2014 the Department of Energy and Climate Change (DECC) estimated that fuel poverty affected 2.39 million households in England, as calculated with their new 'Low Income High Costs' definition. But people who fall outside this definition also under-heat their homes –often because they can't afford to heat them properly, and sometimes because the home is so badly insulated it is simply impossible to keep it warm.

Cold homes lead to or exacerbate a range of health problems, the most serious probably being cardiovascular and respiratory problems. According to the charity National Energy Action: "Low temperatures also diminish resistance to infection and encourage damp and mould growth in the home. Cold indoor conditions have also been linked to poor mental health resulting from anxiety and stress. Social isolation can be exacerbated where the home does not present a welcoming environment and there is evidence that cold homes can reduce educational attainment."[12]

FUNDING FOR RETROFIT – THE PIECEMEAL GOVERNMENT APPROACH

Retrofit is widely accepted to be a central weapon to tackle both climate change and fuel poverty, but progress in the UK is still drastically short of what is needed.

Statutory schemes promoting energy efficiency in homes have tended only to support a limited range of measures, often with only one or two installed per dwelling. Schemes have included CERT and CESP, both funded by energy companies, and Warm Front, which was funded directly by government.

CERT and Warm Front delivered mostly loft and cavity wall insulation and new boilers/heating systems. CESP saw some more ambitious measures, with quite a bit of external wall insulation installed, but did not reach the 'whole house' ideal that CESP's designers set out to achieve.

These schemes were all closed at the end of 2012. In 2011, the then Department for Energy and Climate Change, DECC, announced the replacement - billed as a major programme for energy retrofit of the UK housing stock - the Green Deal and the ECO.

DECC's idea was that under this programme, retrofit would be funded mainly by occupants themselves – owner occupiers or tenants - out of predicted cost savings on energy bills. A commercial loan (the 'Green Deal') would be advanced to fund the work, and repayments would be made by home occupants, via their energy bills, over subsequent years.

Where measures were too expensive to be financed entirely out of energy savings, or occupants were at high risk of fuel poverty, additional grant funding, known as the 'Energy Company Obligation' or ECO would sometimes be available, subject to a number of qualifying conditions.

WHERE HAS THE UK GOT TO WITH DOMESTIC RETROFIT?

While a lot of single efficiency measures such as cavity and loft insulation have been carried out under past programmes, millions of homes still remain to be tackled. Despite the renewed focus on solid-wall insulation, only a tiny proportion of solid-walled homes in the UK so far have wall insulation, and whole-house retrofit remains vanishingly rare.

Alarmingly, as the umbrella campaign group Energy Bill Revolution has pointed out, the rate of retrofit seems if anything to be falling: "In 2013, as the ECO was introduced there was a crash in the number of installations of

[12] http://www.nea.org.uk/the-challenge/

energy efficiency measures. Cavity wall insulation measures reduced by 74%, solid wall insulation measures reduced by 68% and loft insulation measures crashed by 90%."[13]

The government stopped actively funding the Green Deal in July 2015, after far fewer loans were taken out than expected. According to the National Audit Office's report into the Green Deal, its design and implementation "did not persuade householders that energy efficiency measures are worth paying for."[14] Although the ECO is continuing, installation rates are low, and the focus is shifting away from supporting solid wall insulation towards simpler measures such as cavity wall insulation, with funding directed mainly to fuel poor households.

At the start of 2017, there is now no national scheme promoting whole house retrofit, and no incentives to encourage able-to-pay households to retrofit their homes to save energy and carbon.[15]

Call after call has gone out to the government to increase the rate of domestic retrofit.[16] The Community Green Deal points to an approach which improves living conditions and achieves significant cuts in emissions and heating bills, and can also mobilise private funding to do so.

[13] http://www.energybillrevolution.org/faqs/

[14] https://www.nao.org.uk/report/green-deal-and-energy-company-obligation/ "Demand for Green Deal finance has fallen well below the government's expectations, with households only funding 1% of the measures installed through the schemes with a Green Deal loan. The schemes have not improved as many solid-walled homes, a key type of 'harder-to-treat' homes, as the Department initially planned."

[15] There is a Scottish government scheme (HEEPS) offering interest-free loans for home retrofit (plus grants to households in fuel poverty). The loan scheme has been taken up by a little over 1,000 households per year, with many installing solid wall insulation – however, this tends only to be tackled as an isolated measure. http://www.energysavingtrust.org.uk/sites/default/files/HEEPS%2014-15%20report.pdf

[16] For example, in the run-up to the 2015 General Election, the UK Green Building Council collaborated with 19 other charities, environmental groups and trade associations and released a statement calling on all political parties to: Make home energy efficiency a top infrastructure priority; Support investment with a long-term revenue stream; Achieve 1 million deep retrofits each year by 2020

SECTION 3: ESTABLISHMENT OF THE COMMUNITY GREEN DEAL

INTRODUCTION TO CARBON CO-OP AND URBED

Carbon Co-op is a community benefit society, based in Manchester, established to assist its members in making large scale reductions in their domestic energy consumption. It was set up in 2007 as a collaboration between 'early adopter' advocates for home retrofit. Design and sustainability consultancy URBED, a sustainable building and urban design worker co-operative, helped the group to establish.

As a co-operative, Carbon Co-op is owned and controlled by its members. Its objective is to promote household energy efficiency in a programme driven by members for members. This is in contrast to top-down programmes that tend to be geared towards the needs of the big corporate bodies.

The co-op's home energy efficiency enthusiasts support each other and also share their experience more widely, through open homes events and networking. In this way, the co-op engages the wider community, assisting them to cut energy consumption and improve their homes.

Carbon Co-op's early activities included street-based Community Champion workshops and bus tours of eco-homes – to begin spreading ideas of what was possible, and at the same time learn from participants about the barriers that were preventing them taking action on their own.

Many community energy initiatives have focused either on generation, or on small scale energy efficiency and simple measures such as loft insulation. However, informed by close links with Manchester's Tyndall Centre for Climate Change Research,[17] Carbon Co-op has had a more ambitious agenda from the outset: to enable people to achieve reductions in carbon emissions compatible with the UK's 2050 carbon reduction obligations via whole house retrofit.[18]

The Community Green Deal was a home retrofit project run by Carbon Co-op, working in partnership with URBED, which has experience in retrofit at both the neighbourhood and individual building scale.

URBED have investigated domestic retrofit from a technical angle, authoring reports for the Sustainable Housing Action Partnership (SHAP) on developing an ambitious standard for retrofit for social housing towards an 80% cut in emissions on 1990 levels, and 'A Community Green Deal' (2011), an exploration of an area-based, bottom up programme of retrofit that would support the development of a trusted network of professionals.

URBED also worked as designers on two of the Technology Strategy Board's 'Retrofit for the Future' projects, piloting approaches to whole house retrofit. URBED's projects were carried out at considerably lower cost than most of the other retrofits in the programme – they used the same amount of funding to retrofit 10 houses that was used in other projects to retrofit two to four.[19]

OBSTACLES TO RETROFIT

[17] http://www.tyndall.ac.uk/about/objectives

[18] The Climate Change Act established a TARGET for the UK to REDUCE its EMISSIONS by at least 80% from 1990 levels by 2050. IN MANCHESTER, THIS WAS REFLECTED GM LOW CARBON HOUSING RETROFIT STRATEGY - DISCUSSION DRAFT (2013)

[19] http://urbed.coop/projects/tsb-retrofit-future

Early outreach work by Carbon Co-op uncovered key requirements without which owner-occupiers are held back from undertaking whole house retrofit:

- Accessible and affordable finance,
- Competent trusted contractors,
- Technical information and reassurance, for example on selection and sequencing of measures.

People want objective advice, yet Carbon Co-op was finding that often people's only sources of information were potential contractors or installers, making it hard for householders to know who to trust, partly because of potential vested interests, but also, because, particularly in the 'green' building sector, different installers tend to have strong beliefs about the 'right' approach -- which may contradict each other.

The co-op felt that this was one reason many schemes never got beyond the initial inquiries stage: householders were left feeling poorly equipped to make the right decisions. This suggested a role for a community energy organisation in 'hand-holding' and householder advocacy.

But of course, the other big obstacle is finance.

THE COMMUNITY GREEN DEAL

In 2012, before the Green Deal itself was launched, DECC funded a series of pilot projects designed to test some of the key elements of the Green Deal and ECO programme. 'Eco Go Early' was one of these, established to look at the way ECO could support the Green Deal. The Association of Greater Manchester Authorities (AGMA) obtained £3.5m under this scheme for home energy retrofit.

The financing structure of the Green Deal restricted retrofit measures to those that could (theoretically) 'pay back' in just five or 10 years (and cover commercial interest charges as well), with ECO only payable for specific measures over and above this.

The co-op believed this would lead to piecemeal and incomplete retrofit. Informed by URBED's previous work on 'Retrofit for the Future' they believed a different approach was needed to realise the kind of energy and carbon savings needed to reach our climate goals. Carbon Co-op wanted to explore ways to mobilise people's own resources to improve the performance of their homes more radically.

The co-op received nearly £500,000 of the Manchester 'Eco Go Early' funding for their 'Community Green Deal'. The aim was to enable members to carry out whole house retrofit in their homes via an affordable, community-led version of the 'pay-as-you-save' model for financing retrofit.

The project would seek to overcome other key barriers to self-funded retrofit: householders' need to find competent, trusted contractors, and to access reliable technical information and advice that worked for their needs, their budget, and their individual property.

Project funding would be advanced to householders as 0% loans to be paid back over 20 years. As the money was repaid, it would be disbursed again, this time as grant funding to fund retrofit for households in fuel poverty. A small sum was also used for project set-up and management, and professional fees.

WHY THE 'WHOLE HOUSE' APPROACH?

In order to achieve the kind of savings required for the UK to meet its emissions reductions commitments by 2050, the majority of older homes in the country will require most elements of the building - and building services - to be made more efficient.

Although in theory a house can be retrofitted step by step, to ultimately arrive at the desired reduction in energy demand, Carbon Co-op believed there were important reasons to tackle as much of the fabric as possible in one go:

- To maximise the overall energy savings, the building must be considered as a whole. A plan must be drawn up that ensures all the proposed measures are compatible, and that installing one measure will not hinder or prevent additional necessary works from being installed later - a 'whole house plan'.
- A whole house plan takes into account issues such as dampness and ventilation, as well as simply energy use, guarding against unintended consequences of retrofit (see 'Experience and Learning') and promoting improvements in occupant comfort and health, rather than endangering these.
- Carrying out the plan in one hit minimises the number of household upheavals and reduces peripheral costs such as scaffolding and redecoration.
- 'Biting the bullet' also reduces the risk of parts of the plan being 'lost' or forgotten, for example if the property changes hands.
- And the sooner any emissions reduction is made, the more it contributes to the cumulative emissions reductions that are needed in order to meet our climate goals.

Partial retrofit may not save energy at all!

Research by the University of Salford's Jenny Love, modeling a range of retrofit options and of 'energy use behaviours', indicated that if occupants change their energy use behaviour after a 'moderate' energy efficient retrofit, there is a significant risk that energy use will increase - for example as it becomes more worthwhile to heat more of the house or heat it for longer. However, if 'significant improvements in heat loss and system efficiency are undertaken, 'space heating energy use will 'reduce irrespective of occupant behaviour,' the calculations showed.[20]

WHY A CO-OPERATIVE APPROACH?

There were various potential advantages to basing the programme in a co-op, and running the retrofits as one single contract.

By being a community organisation, it was felt that a co-op would command higher levels of trust from members than towards purely commercial bodies, overcoming one of the key barriers to retrofit. Once the programme was up and running, belonging to a co-op would offer householders opportunities for information sharing and support, both during the construction process, and with the day-to-day occupation of a low energy home. There is also a core group of home energy and environmental monitoring enthusiasts in the co-op, that members would be able to benefit from on a long-term basis.

Working collectively could also give the individual members more power as a group, including purchasing power that could realise economies of scale ('bulk discounts').

[20] http://www.salford.ac.uk/__data/assets/pdf_file/0005/142385/023-Love.pdf

SECTION 4: HOUSEHOLDER RECRUITMENT – WHAT DREW PEOPLE IN?

Householders were recruited to the Community Green Deal programme mainly by word of mouth: from among existing members, via green networks in the city and their contacts. Many people joined the co-op specifically for a chance to participate in the scheme.

All the households who joined were ready to carry out work on their homes: some were moving into a 'wreck'; some had undertaken limited energy saving measures but were ready to make deeper improvements. Most were family homes where the occupants were expecting to remain long term.

Participants were motivated to retrofit their homes for quite a wide range of reasons. The top three motivations for whole house retrofit among participants were:

1. To save household carbon emissions
2. To improve the comfort of their home
3. To save money on their fuel bills

The availability of low cost finance undoubtedly drew people in and the project was oversubscribed several times over.

Householders had self-selected to be involved with quite a pioneering programme, and as such were not necessarily typical of owner-occupiers more generally. Most would be characterised as 'early adopters', and environmental motivations featured highly. Carbon Co-op's customer research received responses such as: "It's something that really needs to happen nationally," and "The important thing to me is to reduce my carbon footprint."

Participants also felt that by playing a pioneering role they could make the path easier for others to follow:

"Cutting our fuel bills was only part of it really, fuel is still relatively cheap. There were other reasons for doing it – in a way it was for the 'greater good'. There is a need to push the industry and supply chain forward, it's so terrible at the moment. But also, we wanted to make our house nicer to live in."

People were also seeking a whole house retrofit to improve comfort of their homes – participants cited issues with damp, cold and mould:

"I was fed up of wearing a hat, scarf and gloves with heating on in my own home."

"Comfort was partly about air quality – the house was musty and damp."

"The house was too cold!"

"We were approaching retirement and wanted the house to be ready for our old age: after we retire we'll be at home indoors more, and we wanted to keep the bills down and be more comfortable."

People were drawn to the Carbon Co-op scheme for a number of reasons, these included:

- The availability of a zero-interest loan: *"Wouldn't have done it without the interest free loan."*
- Participants said the fact that the price was fixed at the outset was attractive to them
- Participants valued the chance to work with a community intermediary who was potentially more trustworthy than a purely commercial body: *"If it was a corporate [thing], I probably wouldn't have had it done. I trusted them."*

- This couple had had bad experiences with commercial salespeople: *"We were looking for reliable advice from someone trustworthy. The co-op had an architect working with them, and we liked the sound of that."*

The fact that the programme was geared around whole house retrofit, based on detailed technical advice, was also valued:

"It appeared to be the only place we could get a whole bunch of things done at the same time, holistically...a one-stop solution to a number of problems. We feared getting things done separately, (that we) would spend more than necessary, and also felt they had the expertise...We'll look at your whole house."

"We had done some piecemeal improvements like a bit of glazing: this was an opportunity to get it all done together, which I thought was really the best way of doing it."

SECTION 5: PROCESS AND ACHIEVEMENTS

ACHIEVING ENERGY AND CARBON REDUCTION TARGETS

Carbon Co-op had sufficient funding for around 10 – 15 whole house retrofits – there were far more applicants than this. The team drew up a shortlist of 40 potentially suitable households, all of whom received a whole house assessment.

A final list of 12 recipients was chosen on the basis of the fabric of their houses being in suitable condition to receive retrofit immediately (without the need for extensive remedial work); the willingness of the householders to carry out whole house retrofit towards the ambitious carbon saving targets for the project; and the type of dwelling - homes were chosen to provide a variety of house-types and locations.

The participants' houses were generally older - early 20th century or Victorian, and of the hard, red engineering brick found throughout Manchester. Much of the older, more energy inefficient housing stock in the UK is of solid wall construction and these homes were no exception, so had not been able to benefit from subsidised cavity wall insulation programmes, for example under CERT. However, some energy saving measures were present in most, for example varying amounts of loft insulation, and some double-glazed replacement windows.

The Community Green Deal set out to deliver packages of improvements that would take the performance of the homes as close as possible to Carbon Co-op's proposed 2050 carbon reduction target[21] of 17 kgCO2/m2.a.[22] The target fabric space heat demand was to be no more than 60kWh/m^2.a (similar to that required in new buildings), or less where possible, aiming for 40kWh/m^2.a (AECB Silver Standard) as the ideal.

To reduce energy use this far requires a whole house retrofit. And a whole house retrofit requires whole house plan, as we saw above.

HOME ASSESSMENTS

The first step was to assess the buildings, talk to the occupants, and scope out the options for energy saving and improvements. URBED developed a bespoke whole house assessment tool, later named My Home Energy Planner, much more detailed than those used for Green Deal assessments (see box).

The team was keen that the assessment and design process should be flexible, to take into account both the individual features of the building, and the preferences of the householders. Considerations were technical, but also related to the aesthetics and heritage aspects of the buildings and their location.

The assessment reports proposed a range of suitable energy saving options for each dwelling, alongside estimated carbon and bill savings, enabling the householders to understand more about what their savings were likely to be in practice in order to draw up a plan based on their preferences and available budget.

[21] 'Whole House Retrofit Assessment Method' report, URBED/Carbon Co-op, July 2012, see also the draft Greater Manchester Housing Retrofit Strategy (2011) http://urbed.coop/projects/gm-housing-retrofit-strategy

[22] Expressing the emissions target for the homes in terms of annual emissions per square metre of floor space in the home enables homes of different sizes to be compared on a like for like basis. A fixed target rather than a percentage cut was chosen as it seemed reasonable to take into account energy improvements that had already been made - the idea was to take everyone as close as possible to the same final goal.

The Whole House Assessment began with a detailed inspection of the house structure, heating systems and appliances, as well as any pre-existing energy efficiency measures; consideration of existing energy bills and discussion about how the house was lived in (for example, normal indoor temperatures and heating schedules). This was used to estimate current household energy use, and how it would be likely to change under the influence of various efficiency measures.

As well as the quantitative data needed to assess the building fabric, the assessment also collected qualitative data from occupants including:

- Perceptions of comfort
- Retrofit priorities and motivations
- Concerns about damp, condensation and mould

The assessment report offered a range of measures that together could deliver performance as close as possible to the scheme targets, for each individual home. The assessment report showed the householder both the 'standard' energy saving predictions calculated directly by the SAP software, and the savings adjusted for their real-world energy use of the household.

The assessments presented householders with estimated costs for a set of energy efficiency options, with estimated energy, carbon and bill savings. The assessments also contained information about the wider possible benefits of retrofit, plus advice on combining measures, and on ensuring good ventilation and safe installation, as below:

- A detailed model of energy use (full SAP rather than the reduced information version rdSAP).
- Cooking and appliance use included, as well as heating, lighting and hot water, for a full picture.
- An absolute target for the proposed measures, in line with the 2050 80% reduction target.
- A description of the proposed measures and costs specific to each home.
- Factors such as comfort, ventilation and indoor air quality, and the level of disruption involved in installing measures.
- Embodied environmental impact of the materials and systems considered, proposing lower impact materials where possible.
- Availability from local suppliers and support to the local economy where practicable.

Avoiding the performance gap

Real-world energy use information was taken into account because URBED were aware that the standard method to calculate bill savings, through rdSAP, is liable to give over-optimistic estimates.

One reason for this is that in SAP, the calculated savings are based on the heating assumptions built in to the model, with living areas heated to 21 degrees, and bedrooms to 18, for a set number of hours per day. In URBED's experience, these assumptions rarely reflect reality, especially among the energy conscious population within the Carbon Co-op membership. If less energy than predicted is being used before retrofit, there is less available to save afterwards. It was important therefore that the report gave participants as realistic a prediction as possible.

As an additional precaution against over-estimating the savings available from solid wall insulation, URBED used realistic estimates of the thermal performance of solid walls. Informed by recent research,[23] rather than the 2.1 W/m2.K for an uninsulated solid wall (as suggested in SAP/rdSAP 2012), the team used a more realistic figure of 1.8. The BRE have proposed the figures for solid wall U-values are updated to approximately these levels in the forthcoming version of SAP/rdSAP.

While not a huge difference, the overall effect of insulating a slightly less conductive wall is a slightly lower proportional reduction in heat loss from the same insulation, so predictions should be more accurate with the values used by URBED.

Real world energy savings can also fall short of predictions through faulty design and installation preventing energy saving technologies from working fully as intended – for example, via allowing air leaks, or gaps in insulation cover. The steps taken to avoid these are discussed below ('The Design Process').

PREPARING BESPOKE SPECIFICATIONS - UNDERSTANDING POTENTIAL UNINTENDED CONSEQUENCES

Once the participants had been selected, the team talked householders through the pros and cons of the options offered in the assessments, to help them make an informed decision on which measures to go for. Based on these choices, detailed retrofit specifications for each house were drawn up by URBED.

In order to reach the ambitious fabric performance targets, walls, roofs and where possible, floors would have to be insulated; leaky doors and windows replaced with high-performance versions, and close attention paid to minimizing air infiltration and thermal bridging – both of which lead to unwanted heat loss if not tackled.

Thermal bridging occurs where there is an uninsulated 'route' between insulated areas that allows heat to leak through the structure, reducing the effectiveness of the insulation, and potentially causing a cold surface and problems with condensation and mould. Air infiltration is simply draughts – bringing cold air in and driving warm air out, with occupants having no control over the air movement.

As most of the dwellings were of older construction, they had solid external walls in at least part of the property that would need insulating. Carbon Co-op and URBED were aware that if done badly, solid wall insulation (SWI) can present risks to both energy performance and fabric safety. Thermal bridging is one of the major sources of potential SWI problems, so this was a double reason to pay close attention to the issue.

Some thermal bridges are inevitable in retrofit, as some parts of the building cannot be altered (the way it sits on the ground, for example), but the important thing is to make sure that thermal bridges are minimised overall, to control heat loss, and then to examine the most potentially serious ones more closely, to check they won't lead to localised problems. To keep track of potential thermal bridges, key junctions were modelled in Therm, a specialist software.

[23] For example, that carried out by Dr Caroline Rye for SPAB (Society for the Protection of Ancient Buildings)

Where internal wall insulation (IWI) is used, the insulation separates the masonry from the warm interior of the house, so the masonry itself becomes colder. If any of this cold masonry comes into contact with warm, moist indoor air, then there is a risk of condensation.

Therm modelling was undertaken to check the internal surface temperatures where cold masonry might be exposed inside (both in the insulated houses and neighbouring ones) to check for condensation risk.

Window and door reveals were insulated; where the insulation was internal and the risk of cold spots therefore highest, a thin section of high performance insulation or insulated plasterboard was specified, including below the cill. The specification also called for the IWI installation to be carefully made airtight, to prevent warm and relatively moist indoor air from getting behind the insulation. High quality tapes were specified for airtightness details.

If the masonry behind internal wall insulation becomes very cold, the masonry may also suffer moisture or frost damage from outside. The thickness of the IWI was therefore restricted in all the retrofits, in order to permit a little heat to pass through.

In external wall insulation (EWI) installations, the potential thermal bridge between wall and roof insulation was insulated, and insulation was also carried down below floor level - in contrast to 'standard' EWI systems, where the foot of the wall is frequently left uninsulated.

Wood fibre insulation, rather than the more common synthetic foams, was selected for the EWI. It is a relatively robust and 'forgiving' material - soft enough to fit snugly to uneven brickwork, reducing the risk of thermal bypass (leaks of cold air between insulation and wall that can 'wash away' the heat). Its vapour open and hygroscopic qualities allow any moisture in the masonry to dry out. Wood fibre was also attractive to many co-op members on grounds of lower environmental impact.

Although it was not possible to specify wood fibre for the internal wall insulation as no eligible system was available (see below under 'Bureaucratic Obstacles'), an alternative vapour-open insulant was used to help protect the masonry.

Replacement windows were installed within the plane of the insulation where possible, to further reduce thermal bridging.

Care was taken during the design process to minimise other known risks with retrofit. Further inspections of the fabric were carried out to ensure as far as possible that there were no 'hidden' issues - including using a boroscope to investigate under floors and within wall cavities.

Installation of solid wall insulation and new doors and windows can reduce the random movement of air in and out of the building (draughts), and there was a specific intention with the Community Green Deal to improve airtightness to enhance energy performance.

This made it especially important to ensure sufficient fresh air was delivered to the building (many homes had previously had inadequate or even no purpose-provided ventilation), so the need for ventilation was routinely addressed.

Achieving the emissions target of 17 $kgCO_2/m^2.a$ generally also required the addition of some renewable generation, with PVs being the usual choice.

INTERVENTIONS CHOSEN

Around 15-20 energy saving and renewable generation measures were used for each dwelling to produce the integrated retrofit, including for example:

- External wall insulation (as appropriate, often at side and rear of property only, to preserve the traditional appearance of the street frontage); mostly woodfibre (for vapour permeability and all round sustainability and robustness)
- Internal wall insulation (as appropriate, often on front elevation), mostly vapour open mineral fibre between battens, sealed with intelligent vapour-check membrane
- Triple-glazed timber replacement windows
- New insulated timber external doors.
- Humidity controlled passive stack ventilation systems to improve and stabilise internal air quality while minimising energy use
- Loft insulation top up to 400mm
- Floor insulation: 200mm wood fibre insulation between joists
- Air tightness works
- High efficiency solar photovoltaic panels
- Low flow hot water fittings

New efficient boilers were installed in the three homes that did not already have them.

FINANCING THE WORK

As set out above, the financial basis of the programme was for householders to self-fund their retrofits. The Community Green Deal project succeeded in devising whole house retrofit packages that were within financial reach of owner occupiers.

Within the joint contract, the average net construction cost was £30,000 for the whole house fabric works, around £3,000-£5,000 to cover the cost of PV panels, then some extra for VAT and statutory fees; totals ranged from £20,000-£60,000. All the homes (and households) were different, and spend related to numerous factors, for example the size of the house and the number of basic energy efficiency measures already in place.

Occupants paid for the lion's share of the work themselves, yet achieved much more comprehensive retrofits than those carried out under the Green Deal/ECO as a whole.

The householders did not pay the full price however: they received subsidies as follows:

- Subsidised borrowing – a 0% interest loan over 20 years.
  In 2013 interest rates available commercially for individual borrowers ranged from around 4-6 % for a loan secured on a house, up to 7 or 8% for a Green Deal loan secured on an electricity account.
- Subsidised development costs meaning survey and design fees were reduced or eliminated
- A grant from ECO (average around £4,000 per house).

The bulk of the occupier finance came via the 0% loans, but some householders also contributed from personal savings (from a few hundred to more than ten thousand pounds).

Many householders agreed to a retrofit that was expected to cost more in loan repayments than they would recoup in energy savings for many years, but they proceeded on the basis that bill savings would offset some of the outlay, and they were anticipating additional benefits (discussed above in 'What Drew People In').

PROCUREMENT

A distinctive feature of the Community Green Deal was for the co-op to procure work collectively, amalgamating nine of the 12 individual jobs into a single contract. Carbon Co-op was the single client, acting on behalf of the householders and as the intermediary between householders and contractor. URBED's role would be to specify measures and administer the contract on site.

The co-op wanted to use a local contractor for practical reasons, and to support the local supply chain. Choice

was restricted however, due to a combination of factors: lack of expertise in the sector locally; restrictions on eligible contractors imposed by ECO funding; and the capacity to deliver on a number of projects within the short deadlines imposed by external funders - which most small firms often lack.

The project encountered a number of delays. In one or two cases there was a need to secure planning consents, but the main delay was caused by extensive difficulties in securing ECO funding, (see below – 'Bureaucratic Obstacles') so the first retrofit finally went on site in January 2014 with 'practical completion' on the fabric works being achieved by the end of July in most cases. PV panels were fitted to the houses in late 2014 and early 2015.

TRAINING AND CONSTRUCTION

The firm employed had more experience of simpler and more homogenous social housing projects than with the wider ranging and varied work involved in the Community Green Deal contract.

However, many suppliers offer site training in the installation of their products and systems. For example, the site staff plus URBED staff members undertook a half-day training on air-tightness with the airtightness tape manufacturer, to learn about how to use the tapes and the methods needed for sealing windows. A second session was provided by the wood fibre insulation supplier: required for the manufacturer's warranty, but also informative on some of the key concepts such as thermal bridging.

Contractor staff were enthusiastic about the training but nonetheless, the first few retrofits in particular took longer than expected, as new techniques and approaches needed to be perfected. This caused further delays to the programme and problems for householders, contractor and the co-op. The implications of this are discussed further below.

While construction was under way, Carbon Co-op brought the householders together regularly in order to raise issues and concerns, ask questions and share their experiences – positive and negative. Some householders opened up their homes during building works, providing insight into the programme for professionals and householders.

MONITORING

As celebrated physicist Amory Lovins has said, 'systems without feedback are stupid'. Without monitoring and feedback, no-one can learn what works best, and nothing will improve. Yet monitoring and feedback is still not a routine element in mass retrofit programmes.

By contrast, an important aspect of the Community Green Deal was to monitor the performance of the buildings before and after retrofit, to gauge the level of success of the interventions and take the learning forward.

Performance monitoring was commissioned to accompany the AGMA 'ECO Go Early' programme, and delivered by University of Salford.

To provide householders with direct access to information about their energy use and the performance of their individual retrofits, the co-op has also been working with OpenEnergyMonitor (OEM), an open-source project that has developed hardware and software tools to collect, store and present energy data to householders.

Electricity use, humidity and temperature are recorded by the OEM equipment and co-op members can use this data to understand their own individual energy use. This data is being analysed to evaluate the success of the project and to give tailored advice to householders. This is a much higher level of engagement with the performance of retrofit than occurs under any of the large-scale schemes.

POST-WORKS EVALUATION – TECHNICAL PERFORMANCE

ENERGY USE

Of the nine houses included in the joint contract, eight underwent a full whole house retrofit, and sufficient data is available for five of these to gauge the success of the retrofits.

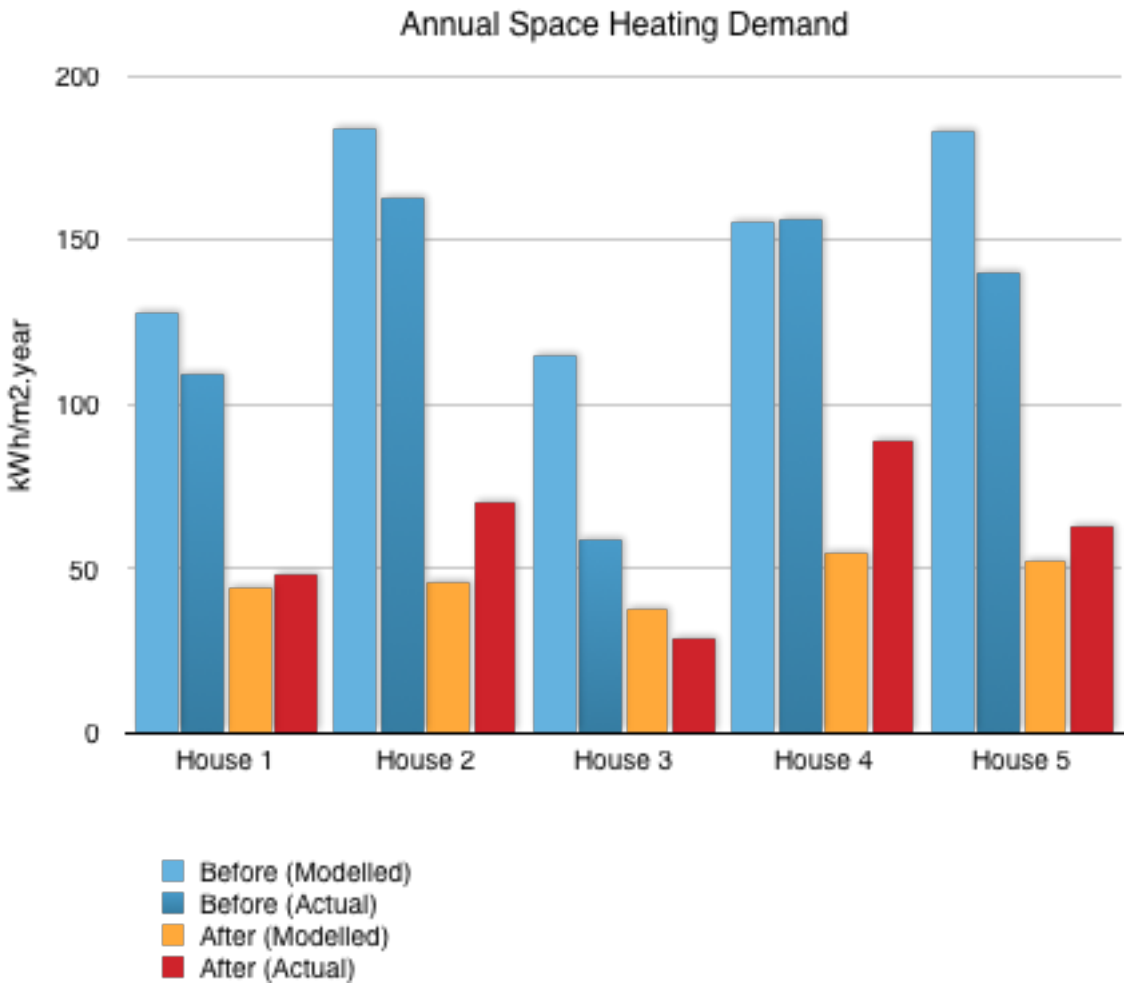
Co-op member Dominic McCann collated householder energy monitoring and billing data in collaboration with fellow householders, collecting information on gas and electricity use and PV generation. All the households had data for at least 18 months across the period of the retrofit – most for over 5 years.

Before retrofit, households had energy bills ranging from around £500 to £2,000 a year. After retrofit, bills fell decisively, with households saving from £200 (off an already small bill) up to £650 per year. Adding in the income from the Feed-in Tariff from solar generation, savings effectively rose to between £800 and £1,100 per year for these homes. One household now has bills of £-70 (minus!) per year, in effect generating income from their home.

The main aim of the retrofit works was to reduce carbon emissions through reducing space heating demand. On a simple analysis, this has been achieved, with an overall reduction in gas use of 47% on average, and an estimated space heating demand reduction of 52%.

After retrofit, the dwellings with data were mainly using at or below half the UK average amount of gas; some used less than one quarter of the national average.

The average estimated space heating demand is now estimated at just below the target of 60 kWh/m2/year. (see graphics below).



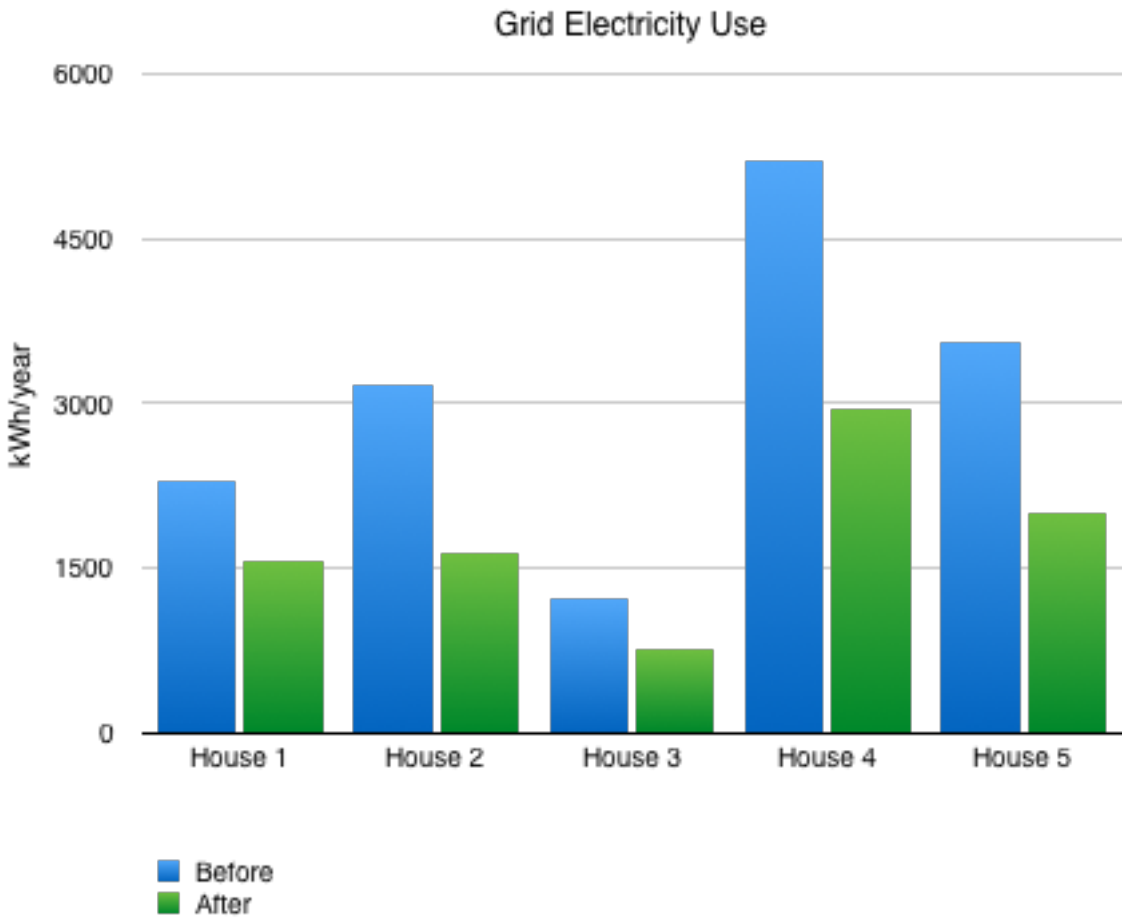
Credit: Dominic McCann/Marianne Heaslip

The solid bars show the space heat demand based on metered gas use data. Gas use for cooking and hot water was estimated and subtracted from this total, to arrive at a figure for space heat demand.

These are early results – a more sophisticated analysis of just three of the houses, taking into account slightly warmer winter temperatures in the first year post-retrofit suggests that, per 'degree day' of heating requirement, the overall reduction in space heat demand may have been slightly lower. A longer period of monitoring of more houses will be needed to understand this more fully.

Electricity use reductions were a secondary consideration of the whole house retrofit. This is because these are both more dependent on the individual purchasing choices and actions and use patterns than the building fabric, and across the homes in the programme, electricity use was already lower than predicted by standard models, and lower than the national average. Despite this, electricity use still seems to have reduced.

Anecdotally, the coop believes this is due to the reduction in electricity use by some 'parasitic' electrical loads, such as central heating pumps, and to changes in user behaviour. Even among this committed and engaged group of householders, many report that they are now more conscious of their energy use, and have made changes to their home to reduce their electricity use – such as buying more efficient appliances. In addition, many householders report they have adapted their daily habits to make best use of the electricity generated by their PV panels, further reducing the demand for electricity from the grid.



Credit: Dominic McCann/Marianne Heaslip

PERFORMANCE GAP

Post-retrofit monitoring suggests that the retrofit performance did fall slightly short of the target reductions. Falls in heat demand appear to be around 10-15% less than predicted. There are several reasons why this might have been.

The aim was to increase airtightness to a level of 5.0 ach@50Pa[24] in all the homes. The houses were mainly very leaky at the outset, with air permeabilities as high as 15 or 20 in some. Many did show big reductions in air permeability, but nonetheless, final figures were mainly closer to 10ach@50Pa (the maximum leakiness allowable for a UK new build). Calculations suggest the airtightness shortfall was probably responsible for a proportion of the small energy performance gap that was seen. This demonstrates the importance of air-tightness for energy performance, though it does not give the whole answer.

Possible reasons for the shortfall in airtightness are discussed in implications of this are discussed in 'Experience and Learning' below.

All the households use gas for cooking and hot water as well as for heating; both these uses vary significantly, both between households and within households over time (for example when occupancy changes). Analysis

[24] ach@50PA stands for air changes per hour at 50 Pascals, a measure of the amount of air leakage though the fabric of the building at a set pressure difference between inside and outside. A low figure equates to low permeability, ie high airtightness

of the data suggested that these differences also contributed somewhat to the difference between predicted and actual gas use.

Households also have widely variable heating patterns. Some may have taken advantage of cheaper heat post-retrofit to make their houses more comfortable than before – for example, increasing living temperatures (known as 'comfort taking'). This latter effect would also show up as a small 'performance gap' in terms of gas use – though this is clearly an improvement in 'comfort performance'.

AWARENESS & BEHAVIOUR CHANGE

The project worked in a number of ways to help the householders reduce their energy use through the way they used their homes and appliances.

Around one quarter of the potential energy savings from home retrofit depends on household behaviour; carbon emissions reduction for existing housing 'is unlikely to achieve its aims without the positive engagement of the people who live in [the] buildings.'[25] Both information, and the support from, for example, community energy groups, have been highlighted as key mechanisms to enable this.

Monitoring of energy use thus had two purposes – to measure the impact of the retrofit (see above), but also to enable householders to understand and therefore, modify their energy use behaviour. Monitoring was also useful in highlighting energy inefficient appliances, as the energy use shown on the display changed in real time when appliances switched on and off.

Several householders reported that the project made them more aware of their energy use, and they modified energy use behaviour. One household for example observed that two of their lamps were particularly energy-inefficient: the one that was used for several hours daily they replaced with ultra-low-energy LEDs, the one that was only switched on occasionally for short periods, they retained.

Some households also changed their routines to take advantage of PV generation, for example to wash clothes during the day, thus reducing the amount of electricity they would need to buy from the grid and reducing the emissions directly attributable to their energy use.

CARBON EMISSIONS

As mains electricity is currently still a relatively carbon intensive energy source, householders' electricity use has a significant impact on the ability to meet the carbon emissions target for the project. A combination of lower than expected electricity use (partly attributable to behaviour change, see above) and better than expected performance in the PV systems (which therefore substituted more of the remaining use with low carbon electricity than expected) in part compensated for worse than hoped for space heating demand.

The resulting average carbon emissions rate achieved is 22kgCO_2/m^2.a excluding PV generation, and 18kgCO_2/m^2 .a including PV generation - just one kilogram per square meter short of the original design target. Houses are on average 60% below current UK household emissions excluding the contribution of PVs, and 67% below current UK average household emissions including them – despite being if anything bigger than the average UK house and with more occupants.

INDOOR CONDITIONS – COMFORT AND HEALTH

[25] 'The Missing Quarter: Integrating Behaviour Change in Low Carbon Housing Retrofit, Low Carbon Housing Retrofit Greater Manchester, published by the University of Salford

Before the retrofits, although none of the homes suffered severe mould, some reportedly felt damp and/or had some slight surface mould; several had condensation, especially on the windows.

Many of the householders reported an improvement in comfort and indoor conditions post retrofit, including:

- Homes are warmer, including first thing in the morning.
- They feel less damp and the air feels fresher.
- Homes are less draughty.
- Homes are slower to cool down and faster to warm up.
- Improved occupancy of rooms that weren't frequently used before.
- Homes are cooler in summer when it's hot

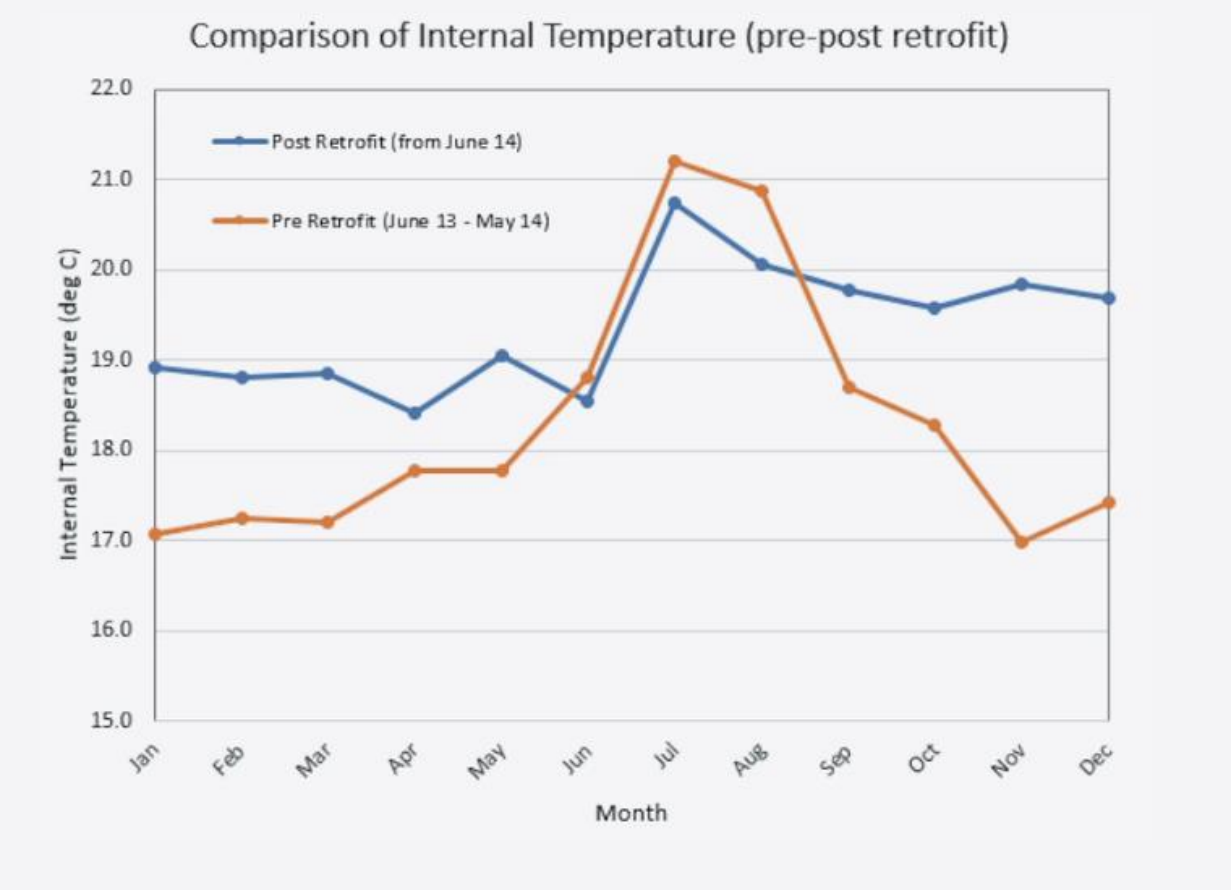
"The house is warmer in winter and no warmer or slightly cooler in summer. It doesn't cool down so much when the heating goes off at night. We have seen a big reduction in how much gas and electricity we use, and on top of that energy is being generated. The best thing is having more comfortable house with a more stable temperature – you don't find yourself grabbing a sweater as often, and knowing what you're saving energy and saving money is a pleasant feeling."

"The house maintains its heat - I can quite easily walk around in a t-shirt in winter and the heating's on really, really low. We've got a wood-burner but we don't use it very often, as realistically we don't actually need it."

"The house was very draughty, you couldn't stand in the hall to talk on the phone without getting frozen; the hall and staircase were acting like a chimney. Now it's a lot warmer."

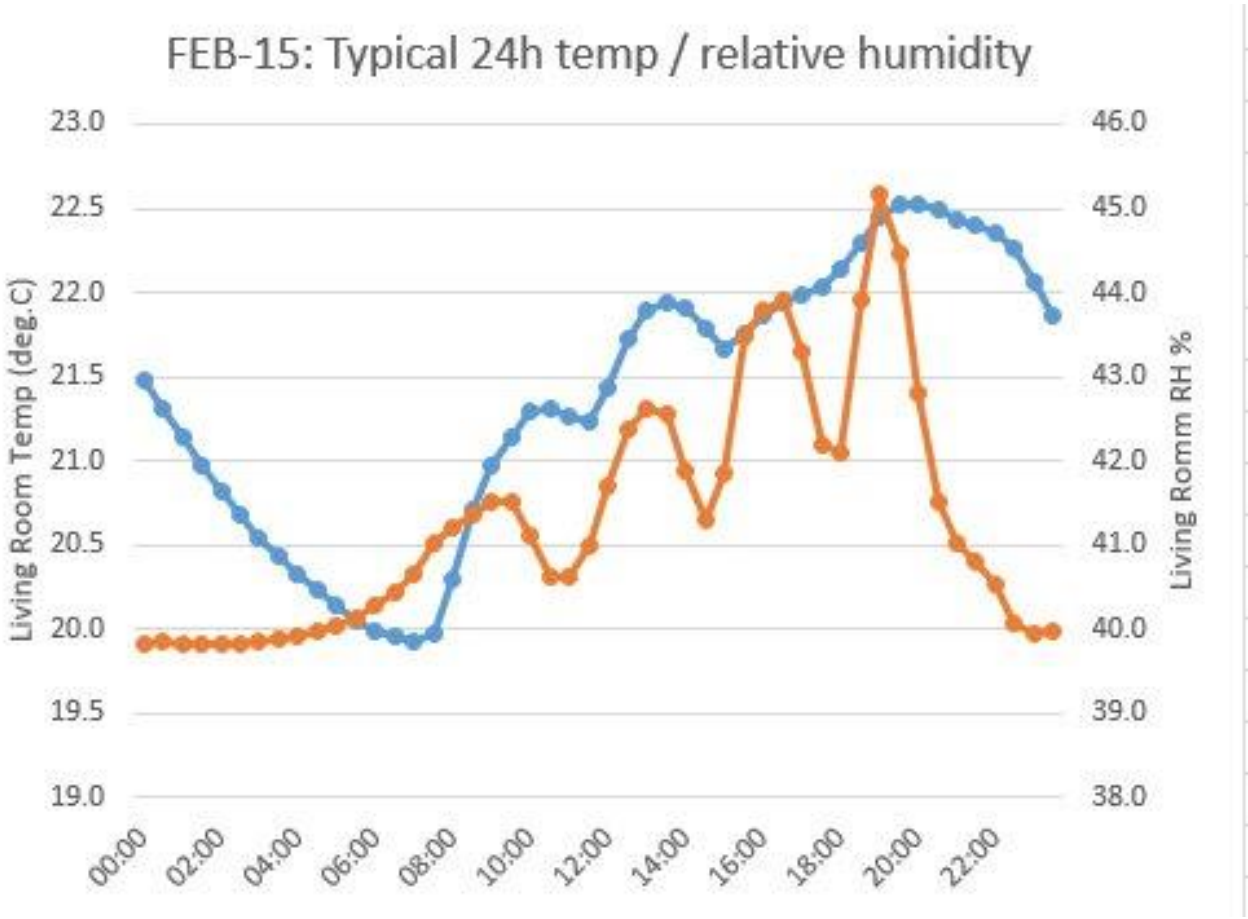
"My father suffers breathing problems and he noticed the improvement in air quality."
"The house stays warm longer, and there is less condensation - and none at all on the new windows."

Robust temperature and humidity data both pre- and post-retrofit is only available so far for one of the houses so far (though more data will soon be available for the others). On this house, the data indicates that retrofit has had a distinct effect on the internal environment, smoothing out internal temperature variations and increasing winter temperatures. There appears to be no significant difference in relative humidity values, which were already good, with the home maintaining an acceptable level of between 40 and 60% RH.



Credit: Dominic McCann

WARMER IN WINTER AND COOLER IN SUMMER – TEMPERATURES PRE- AND POST- RETROFIT IN ONE PARTICIPANT HOME



Credit: Dominic McCann

THE INDOOR CONDITIONS IN THIS RETROFITTED HOUSE APPEAR COMFORTABLE ON THIS FEBRUARY DAY, WITH TEMPERATURES (BLUE) AROUND 22 IN THE EVENING, AND FALLING ONLY TO 20 OVERNIGHT WHEN THE HEATING GOES OFF. THE VENTILATION ALSO APPEARS TO WORK WELL IN THIS DWELLING: THE SPIKES IN HUMIDITY (ORANGE) CLEAR QUICKLY, AND OVERALL THE RELATIVE HUMIDITY RANGES BETWEEN 40 AND 45%. FEBRUARY IS ONE OF THE COLDEST MONTHS THIS IS LIKELY TO BE CLOSE TO THE ANNUAL LOW FOR INDOOR HUMIDITY. THE IDEAL RANGE IS BELIEVED TO BE BETWEEN 40 AND 60%.

HOUSEHOLDER RATING OF THE RETROFITS

Carbon Co-op surveyed the members after the retrofits were complete. Nearly three quarters of participants would recommend whole house retrofit to a friend or neighbour, the remaining respondents answered 'maybe', with no one responding with an outright 'no'.

Participants were asked which, if any, of the measures they would recommend to others. The replies were as follows:

1. External Wall Insulation (*"The least disruptive."*)

2. Solar PV panels (*"A good [energy] conservation starter."*)

3. Triple Glazed Windows (*"Because the difference they make is amazing."*)

4. Internal Wall Insulation (*"If prepared for some disruption IWI isn't that expensive."*)

5. Under floor insulation

6. A new boiler

Householders offered plenty of recommendations that might improve future programmes – these and the recommendations of Carbon Co-op and URBED are discussed in the next section.

EXPERIENCE & LEARNING

RETROFIT SHOULD BE SOLD NOT JUST ON BILLS, BUT ON A RANGE OF ADVANTAGES – BECAUSE THAT'S WHAT PEOPLE WANT TO BUY

As discussed above, householders opted to carry out comprehensive retrofits under the community green deal for a number of reasons, but the most common ones were:

- To save household carbon emissions
- To improve the comfort of their home
- To save money on their fuel bills

"For us it wasn't really about the bill savings. I calculated that it would probably take about 90 years for the improvements to pay off, but that wasn't the point. We have improved our house, it's warmer and nicer to live in - we no longer have condensation on the bedroom windows for instance. It looks smarter and it is also fresher feeling. We chose to spend money on this and not on a flash kitchen or bathroom. And after all, it's easy to spend the same on a conservatory that is doing the opposite -making your home colder and increasing bills."

Post retrofit monitoring has shown that bills have fallen, which householders welcome. However, a lot of the post-retrofit feedback focuses on improvements in comfort and 'niceness' of the home. For example, the benefits from triple glazed windows were mentioned often. While in terms of energy saving to capital expenditure, triple glazed windows are perhaps marginal in their benefit (compared to good double glazing), they appear to add a great deal to the 'experienced' value of the retrofits due to comfort and aesthetic improvements.

Witnesses to the House of Commons select committee enquiry into home energy efficiency and demand reduction[26] also highlighted the importance of non-financial incentives for retrofit: "We were repeatedly told that improved comfort was one of the key drivers of energy efficiency improvement," the committee reported.

The evidence from Age UK was typical of many: "Age UK explained that the marketing focus on the financial aspects of the Green Deal meant that other important messages were missed: 'The Green Deal was marketed as a financial proposition... This approach did not reflect the multiple factors that motivate people, such as health and comfort."

IT WAS RIGHT TO PUT TIME AND EFFORT INTO ASSESSMENT & DESIGN

ENERGY USE

As discussed above, many participating households had been under-heating their homes, sometimes for ethical reasons – although nationally, more people probably under-heat due to fuel poverty (and, sometimes,

[26] House of Commons Energy and Climate Change Committee 2015-2106 Session: Enquiry into home energy efficiency and demand reduction

because the fabric of the dwelling is so poor that the heating system simply cannot get the space up to temperature).

Because of under-heating, predictions from the rdSAP calculations (used in, for example, the Green Deal) of energy use and possible savings, routinely over-estimate the savings available from low energy retrofit.

URBED's use of the actual energy use data collected in the Whole House Assessment enabled them to give householders more realistic predictions. There was nonetheless a small performance gap (see above). The inevitable inaccuracy of any energy use predictions is another reason not to make predicted savings the whole story when promoting retrofit to householders.

HOME RETROFIT IS STILL A DEVELOPING INDUSTRY AND CAREFUL DESIGN IS CRITICAL

An important aspect of the Community Green Deal was the individualised construction specifications drawn up by URBED. These specifications addressed householders' preferences and budget, optimisation of energy and carbon savings. Importantly, they also considered the potential for changes in the behaviour of air and moisture in a building when the fabric temperatures and airtightness are changed by retrofit.

As touched on earlier, these considerations are liable to be overlooked when there is neither detailed inspection of the property, nor a bespoke design. Sometimes the consequences are serious. In 2015, the then Department of Energy and Climate Change commissioned BRE to report to them on two technologies in particular: internal and external solid wall insulation.[27] Design and installation were found to be inadequate in a number of instances (see box).

POOR DESIGN AND POOR SUPERVISION - WHAT CAN GO WRONG

In research carried out by Colin King of the BRE for DECC[28] (and by architect Nick Heath for English Heritage),[29] a number of solid wall insulation installations carried out under large scale retrofit programmes were studied. Most were of external wall insulation.

Problems uncovered included:

Extensive thermal bridging – many installations stopped short of both the ground, and sometimes the eaves as well, for ease of installation. Reveals were also generally left uninsulated. Calculations suggest that thermal bridges like these may account for around a third of the heat loss from the entire building. With good detailing, these losses can be cut by around a half.[30]

Damp and mould problems - King reports that he has seen condensation, mould and decay post-retrofit. These problems are thought to arise from factors such as:

- Reduced air infiltration as cracks and air bricks in the building are covered by insulation, in a building with inadequate purpose provided ventilation. In programmes that do not address ventilation as part of the retrofit – or do not fund it – this may result in a dwelling with inadequate fresh air supply.

[27] Solid wall heat losses and the potential for energy saving BRE 2016
[28] BRE as above
[29] EXTERNAL WALL INSULATION IN TRADITIONAL BUILDINGS: Case studies of three large-scale projects in the North of England by NDM Heath Ltd published by English Heritage
[30] Reducing thermal bridging at junctions when designing and installing solid wall insulation, BRE

- Vapour-impermeable insulation installed on fabric that is already wet, or is prone to damp penetration e.g. from rising damp, and cannot now dry out.
- Building disrepair that is not remediated, or poor detailing and/or sloppy installation, allowing rainwater to penetrate behind impermeable insulation, saturating the fabric which cannot now dry out.

The designers from URBED have witnessed some of these issues first hand in energy company-funded schemes in the north-west, such as uninsulated reveals, and lack of attention to thermal bridging. Poor air-tightness was another weakness, with risks to both performance and the building structure.

Nick Heath believes that the system of competing purely on price, as happens with the energy company funded installations, lies behind the very poor standard of some of the work he encountered:

"The way the jobs are funded and procured makes it almost impossible to do EWI properly; the many fine words of guidance may as well not be there. There is no time to deal with the fancy bits on the building, so you see massive thermal bridging – the sole measure of its success is numbers completed by the deadline. And there is never enough money for ventilation."[31]

The Community Green Deal team's approach was designed to guard against these risks as far as possible. If there had been obvious signs of damp, or a problem was discovered once work had started, work would have stopped while discussions took place with the householder to agree how to proceed. The specification required the builder to report any issues immediately, and URBED also checked each site regularly.

Luckily only a couple of minor issues were discovered, and these were dealt with as above.

Care was taken with specification regarding moisture, for example specifying vapour open insulation, insulating reveals as far as possible, requiring high levels of airtightness to guard against interstitial condensation, and ensuring variable membranes were used rather than impermeable polythene.

The use of a traditional contract, with URBED acting as contract administrator, gave the team control over the detail of the installations, and what got signed off. When compromises had to be made, URBED knew what was important in terms of building risks and prioritised these items, even if it was then necessary for some more cosmetic elements to lose out. It is likely that under a design and build contract, it would have been harder for URBED to maintain this level of control.

While the energy company schemes have not generally offered bespoke designs such as were used in the Community Green Deal, following Dr King's report, and increasing concern in both the government and the insulation industry itself, there is increasing pressure for this to change, and for retrofit to be carried out in a way that more closely resembles the Carbon Co-op model. A revision of PAS 2030, which sets out the requirements for the installers of the low-carbon technologies funded under the government's energy company carbon schemes, is due, and many in the industry are hoping that it will require much increased rigour in order to improve the quality of installations. (However, the scheme should be easier not harder for smaller contractors to join, suggesting a rethink of the scheme structure is needed: see 'The Importance of Small Builders, below)

[31] Risks of retrofit, Green Building Magazine, Summer 2015

Colin King of BRE is concerned that fabric safety should be combined with the retention of traditional character, calling for the creation of good detailing to allow a hybrid system to be used (internal insulation to front elevations, external to the remainder of the property). This concern was shared by URBED (and by the householders), so hybrid systems like this were used in the Community Green Deal, carefully detailed to avoid a cold bridge in the corner where it changed over. Where properties were already rendered, EWI on the front of properties was also an option, and some householders welcomed the opportunity to give their homes a 'facelift'.

VENTILATION

Most of the houses had humidity controlled passive stack ventilation (PSV) installed – some had previously had no purpose provided ventilation, others some basic intermittent extract fans and trickle vents. The idea of passive stack ventilation is that it acts like a chimney, drawing air up from the bottom of the stack to be vented from the top at roof level, with fresh air being drawn in to the house via purpose-provided inlets in the walls. Humidity-sensitive controls open the vents when more fresh air is needed, and reduce the openings when humidity falls to save energy.

In general, the householders report improved air quality after the retrofit, but the passive stack ventilation does not always seem to work completely consistently.

There is not yet sufficient indoor air quality monitoring data available to draw firm conclusions, but the impression gained by the team so far is that on the whole humidity levels are good, indicating the ventilation is performing adequately. There is a preliminary suggestion (not currently backed by data) that it may perform best downstairs and in taller houses, where there is more height to create a 'draw'.

In subsequent retrofits, some members have opted to install mechanical ventilation, which may perform more consistently.

It is worth noting that in the ventilation world as a whole, monitored performance data is frustratingly hard to obtain, so the monitoring of member homes will contribute useful information.

AIRTIGHTNESS

As discussed above, the final energy performance of the retrofitted homes, while a great improvement on the previous energy use fell short of the target reductions, on average and missed airtightness targets were thought to have been a significant factor in this.

The failure to achieve the airtightness target was probably attributable to the areas of the homes that were not worked on in the retrofit contracts. A radical improvement in airtightness generally requires extensive work in the roof, for example, as well as replacement of all doors and windows.

Although these retrofits did look at the whole house, budgets were limited and pragmatically, elements that had reasonable performance already and were not in disrepair, were not replaced. Some elements were also preserved because of their historic or decorative character (such as stained glass). Achieving the highest levels of airtightness is generally only possible if the building is being gutted – and is therefore unoccupied.

These practical considerations limited the impact it was possible to make on airtightness – and thus on energy performance. (Note that when airtightness levels below 5ach@50Pa are achieved, it is usually recommended that whole-house mechanical ventilation is fitted if not already present.)

TRIGGER POINTS

The difficulties in increasing airtightness highlight a tension between carrying out an area-wide retrofit programme and responding to the 'trigger points' in the lives of both buildings and households.

In an area-wide approach, there are potentially economies of scale with design and installation (particularly if dwellings conform to the same general archetype), and a single source of grant funding may be directed towards a whole area at once. However, it will almost certainly not be possible to retrofit to the highest standard that is theoretically possible because households will not necessarily be ready for that level f intervention.

To carry out more comprehensive retrofits even than were achieved in the Community Green Deal (for example, the Passivhaus EnerPHit standard[32]), the dwelling must generally be at a 'trigger point'. These relate to both the building fabric and household circumstances. The deepest retrofits are highly disruptive, often needing the building to be unoccupied at least for a few weeks.

For them to be economic, retrofits as deep as this normally need to piggy-back onto refurbishment and remediation that is already necessary – re-roofing or damp treatment, for example. Good moments for comprehensive retrofit from a household's point of view include immediately after purchase, especially if the dwelling does not have to be occupied immediately, and when an extension is being constructed, as this is already disruptive.

GRANT FUNDING AND BUREAUCRATIC OBSTACLES

The householders in the programme were eligible for grant funding on top of their loans, through the ECO.

However, the decision to seek additional grant funding via the ECO imposed a disproportionate bureaucratic burden. ECO funding took many months to find, negotiate and secure: extra tasks included finalising a deal with an ECO provider, and finding a contractor qualified to carry out the Green Deal Assessments that were required by the ECO process (there was a regional shortage, but investing resources to train an URBED staff member to become a qualified assessor proved fruitless as there were problems with the course certification).

ECO funding brought with it constraints that severely limited the team's choices. ECO rules require contractors carrying out funded work to have PAS 2030 accreditation – a fairly bureaucratic requirement that is generally only sought by larger contractors expecting to deliver multiple ECO-funded installations.[33] Only one of the contractors tendering for the Community Green Deal collective contract held PAS 2030 accreditation, so the co-op had little choice about whom to employ.

Energy saving components or systems funded under the ECO are also required to be either British Board of Agreement (BBA) or ETAG certified – again, a relatively slow, bureaucratic and expensive step unattractive to smaller manufacturers who do not expect their product to have wide take-up under mass installation schemes. A woodfibre external wall insulation was available with ETAG certification, but no certified woodfibre internal insulation was available, so an alternative system had to be specified.[34]

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[32] EnerPHit retrofit achieves a demanding specific space heat demand of just 25kWh/m2.a, partly by requiring very high levels of airtightness and, usually, the installation of heat recovery ventilation.

[33] Maby, C and Owen, A (2015) Installer Power: The key to unlocking low carbon retrofit in private housing. University of Leeds

[34] NB a woodfibre internal wall insulation system was certified by the BBA in late 2016, so there is currently one available

Finally, when government announced changes to the ECO in late 2013, the co-op's ECO provider imposed extremely challenging completion deadlines.

With the benefit of hindsight, the amount of extra work, disruption and stress the ECO imposed on both the project managers and the householders could be said to outweigh the benefit from the (relatively small) amount of extra funding it provided, and Carbon Co-op and URBED would not apply to ECO again under the current terms.

While being considerably less bureaucratic than the ECO, the DECC funding for the loan finance via Greater Manchester Council did impose timing constraints, with short deadlines by which money had to be spent and work completed. This meant the team had to rule out the use of one of the possible contractors, who did not have a large enough team to complete the contract within the narrow timeframe.

Carbon Co-op and URBED found that the tight deadlines caused by funding availability caused significant stress for all involved, placing undue pressure on households, contractors and the management team. This is likely to be an issue where any project is reliant on grant funding to subsidise or fully cover the cost of the work, unless funding programmes can be more intelligently devised.

Carbon Co-op's negative experience of ECO was not an isolated instance. The Centre for Sustainable Energy's evaluation of the first year of ECO concluded that "ECO's very precise eligibility criteria and onerous reporting requirements … increased delivery costs, slowed down activity and hindered customer take-up."

HOUSEHOLDERS' EXPERIENCE OF THE COMMUNITY GREEN DEAL

Market research shows that the most important features of 'an attractive value proposition' for retrofit are lower up-front cost, more reliable contractors, less disruption to domestic life and less 'hassle factor'[35].

This finding is echoed by the participants in the Community Green Deal. Many were drawn in by the low-cost finance and spread repayments, and the intention of Carbon Co-op and URBED to find a contractor and oversee the work, taking on much of the 'toing and froing'.

Although the householders in the Community Green Deal were generally very pleased with the finished results of their retrofits, many (though not all) found the process of retrofit very stressful. Uncertainty, communications and disruption were found to be the hardest aspects of the project.

Talking to the householders afterwards, the co-op found there were three related reasons behind the stress:

- Lack of information from the contractor and Carbon Co-op, especially not knowing what was going to happen when
- Not being able to communicate with and direct building crews on site
- The practical disruptions – both to lifestyle (eg having to take time off work) and the physical impact: mess, dust and noise

Some of these difficulties are an inescapable part of any building work, but some may have been caused or exacerbated by the particularities of this project.

[35] Wilson et al 'Understanding Homeowners' Renovation Decisions: Findings of the VERD project' UKERC 2013

LACK OF INFORMATION AND DELAYS

"Didn't fully appreciate the risk of significant delay."

"In general, our expectations very poorly managed, about timescales and so on."

One objective of the project was to help build skills and new links within supply chains and to develop new relationships with contractors. The undeveloped nature of the retrofit supply chain did cause issues such as unexpected arrivals or delays to materials getting to site threw work programmes off track and made planning difficult.

In addition, some of the materials and techniques used were new to the contractor and they were working outside their usual supply chains. A lot of learning took place on the first homes to be treated, although the process speeded up a great deal later on.

However, with hindsight, householders were not all fully aware of the undeveloped state of the supply chain and the associated risks.

Running all the jobs as one contract probably contributed to the delays for some householders:

"The timing and organisation was bad. I would not go in a [group contract] again because you had to keep waiting for other people's work to be in sync."

The way participants experienced the project depended in part on their expectations and prior understanding – and on how well they understood the Community Green Deal project (or how well it had been explained to them). Householders who had not previously experienced major building work may not have been expecting delays and therefore found them more stressful.

Participants who understood the pioneering nature of the initiative were generally more understanding of the difficulties encountered:

"I'm satisfied. A lot of room for improvement but this was a learning experience. I'm quite happy to contribute."

LACK OF CONTROL

"Hardest thing was (and none of us foresaw) that we couldn't question contractors."

"It was bizarre when [the contractors were] in your house and not supposed to say anything to them!"

One of the features of the collective contract was that as the client, Carbon Co-op had final financial responsibility for the contract, and acting on their behalf, URBED had final technical responsibility. This meant that any modifications to works had to be approved by Carbon Co-op and URBED.

A contractor was employed whose experience lay mainly with social housing, with staff not used to dealing directly with individual owner-occupier householders.

These factors led to a situation where 'midstream' changes to the specification – even quite minor -- could not be decided on then and there between householder and site staff. For a variety of reasons, not all of which could have been anticipated, householders instead had to communicate their wishes through Carbon Co-op, URBED, and then the contractor management who would instruct the site staff.

This convoluted process inevitably led to frustration and delays – as well as a lot of unfunded extra work for Carbon Co-op staff. It did mean though that changes to the specification were controlled, and unintended

consequences and potential impacts on quality and performance mitigated, through URBED's technical expertise and understanding.

Some householders also requested detailed technical information in order to inspect the work being carried out on their homes more closely. While an understandable wish, this conflicted with the structure of the project in which works were inspected and contractors instructed by URBED.

DAY-TO-DAY DISRUPTION AND MESS

Experiences were varied:

"If I'd known then what it was going to be like I would not have stayed in the house while the work was done. There was an awful lot of dust."

"It was easier for me because I work from home so am able to be bit flexible."

"I'm working from home so I got little work done for 4 months."

"We had very few issues with the contractors - they cleaned up after themselves at the end of each day, and were gone by time we got home."

Mess is of course inevitable with any building work – though different teams vary in the amount of warning and preparation they allow, and how well they clear up after themselves. While it would not have been possible to make the work inherently less messy, a number of factors affect the impact on the householder.

Some householders had experience of building works and a good understanding of the likely disruption, which helped them be prepared. But an issue acceptable to one householder might be unacceptable to another, given occupancy patterns (out all day versus working from home or retired), levels of health, age and general willingness to accept disturbance.

Although some of the Community Green Deal householders were happy to provide access to the contractors when they weren't there, others found this more difficult, either because of concerns about security and/or because it might invalidate their home insurance, and this too affected how disruptive the work was.

One or two householders did move out for a short period during the works, but with hindsight, several more said they would have preferred to do so had it been possible – one or two for the whole duration.

MATCHING THE CONTRACTOR TO THE CONTRACT

For a number of reasons, the Community Green Deal team was limited in the choice of contractors, which meant that it was not possible to employ a contractor with experience of retrofit to individual owner occupied homes, who was also eligible and could take on the work.

The contractor employed was a firm geared to working for social landlords: work that usually comprises relatively simple packages of measures applied to multiple similar houses. They were used to working up an efficient protocol for a particular task, then repeating it many times.

The Community Green Deal presented a different set of challenges, with unfamiliar materials and much more variety than the firm was used to addressing in a single contract. Nonetheless after the initial learning stage the contractor's site crews generally proved skilled, and grasped what was required. They enjoyed doing quality work and took a lot of care. Subcontractors also responded to the challenge of new techniques, but all were under pressure because of the extra time that was required as against a more standardised job.

The difficulties lay then not so much with staff skills or aptitude, so much as with the structure and systems used by the contractor, which were not a good fit with the requirements of the work.

In hindsight, the co-op suspects whole house retrofit may lend itself better to a firm that is more adaptable, has low staff turnover and a stable team of subcontractors – as may be more common in small, family run firms. The experience for householders could also be improved if the contractor is generally 'customer facing', i.e. used to dealing with individual homeowners.

While a smaller firm would not necessarily be able to carry out a larger contract so quickly, the payoff could be better communication and more adaptability.

Participating householders echo this view: their recommendation was to work with those recommended by friends, with energy efficiency experience.

IS A 'COLLECTIVE CONTRACT' THE WAY TO GO?

URBED and Carbon Co-op set out to explore the advantages of householders acting collectively to procure and deliver multiple home retrofits as a single contract. The potential advantages envisaged were:

- Economies of scale leading to bulk cost savings (on paper these savings were 25% - 50%).
- Streamlined design and management – less need to 're-invent the wheel'.
- Strength in numbers and mutual support.
- Risk moved away from individual households – an advantage to them.

However, in practice the collective approach also had disadvantages:

- Risk moved onto the co-op – a disadvantage for the organisation.
- Smaller and potentially more flexible or consumer-friendly contractors may have been excluded because of the size of the contract.
- The structure meant that as the single client, Carbon Co-op (assisted by URBED) was responsible for all liaison between contractor and householders. This inevitably slowed and sometimes prevented clear communication, leaving householders at times frustrated and Carbon Co-op staff overburdened with liaison.
- Timing of work was organised around delivering the contract as a whole, rather than each site individually.
- Lines of responsibility and the apportionment of risk were not always clear
- Although there were some benefits from mutual support, when there were problems early on in the contract, group meetings acted as something of an 'echo chamber', where concerns about the work multiplied.

Now that the contract has been completed, the feeling is that overall, the potential cost savings were not fully realised in practice.

A number of extra costs had to be paid for on top of the initial quote from the contractor, reducing cost savings closer to 5-10%. On top of this, the considerable 'hassle factor' and unpaid time contributions, and the demands on good will from participants, were in effect additional costs. The team conclude that the savings did not necessarily justify the additional costs or fully result in economies of scale, and that a co-operative advantage could in future be realised in different ways.

WHAT APPROACH WOULD CLIENTS RECOMMEND?

As we saw in the paragraphs above, despite mixed experiences the majority of householders would recommend whole house retrofit. However, while outcomes met and possibly exceeded expectations, for a variety of reasons as discussed above, the process in places fell short.

Some participants would recommend the Community Green Deal approach provided there was the same financial support available, and participants were primed and willing to experience disruption and mess. However most, given the understanding in advance, would have chosen a different procurement method; they highlighted the need for a model balancing more direct householder control with similar high levels of performance.

In particular, participants felt the following would help in future programmes:

- Offer more clarity on roles and more involvement from householders at an earlier stage,
- Improve communication,
- Offer more accurate costings; and/or
- Create options for householders to administer their own works using detailed designs drawn up by specialists

PUTTING THE LEARNING INTO ACTION

HELP FOR MEMBERS TO BECOME 'INFORMED CLIENTS' AND PROCURE THEIR OWN WORK.

Through the Community Green Deal, URBED and Carbon Co-op members and staff accrued a great deal of learning they aim to share. On the basis of these experiences and participant feedback, Carbon Coop have developed some new approaches to supporting domestic whole house retrofit.

The co-op's focus now is enabling householders to procure their own works, the approach the majority of members favour, as it gives them direct control as the client. (There is around another 15% who would still like the "full service" ie for a third party to take responsibility and manage the job, and URBED are investigating possible ways to offer some form of project management while minimising costs to the householder.)

The co-op is therefore undertaking a range of activities aimed at helping householders to become better informed clients, to help them procure the right job from the right contractor, and ease the process, enabling potential contractors to learn more about the kind of retrofit co-op members are seeking – and bringing the two together.

Under the title of 'Routes to Retrofit' Carbon Co-op is running householder training events to help overcome the lack of confidence people feel in procuring retrofit. The events are delivered by industry experts with the focus on equipping householders with the necessary knowledge and capacity to go through a procurement exercise, including choosing the correct contractual form, matching the size and scale of the job to an appropriately sized contractor and obtaining quotes and estimates. The idea is that if people know what they want, and have confidence to ask questions and make sense of the answers, contractor and client can work together more easily.

Peer-to-peer support is also available; a good proportion of the members who have gone through a retrofit are staying active in the co-op and sharing their experiences with others who are undertaking retrofits. Involvement in the coop means more to them than just their own retrofit.

The co-op has been piloting a match-making buddy system, pairing up people who have retrofitted their homes with new members, to help them navigate the process, for example by being available to talk to them when they have questions.

DEVELOPING THE SUPPLY CHAIN: CONTRACTOR RELATIONSHIPS

As the size of the membership grows and contractors begin to move from client to client via recommendations, Carbon Co-op believes it is starting to develop a local supply chain equipped to meet the demand of members.

The hope is that by supporting a consistent demand for quality from customers, the contractors will skill up and offer it. It is not an easy market for contractors because even when they have the necessary experience, pricing the work is complex and time consuming, meaning contactors are sometimes reluctant to pursue enquiries, unless they are already keen to take on a particular job and optimistic about securing it.

One way Carbon Co-op is trying to help is by running 'trades-meet-clients' information events, helping contractors to understand more about the market as well as being another way to help householders become better informed clients. (see box) The co-op can also step in as an independent broker, with the aim of facilitating and smoothing relationships between householders and contractors.

CARBON CO-OP INFO NIGHT: TRADES PERSPECTIVES

A chance to talk with trades people, find out what makes a good contractor and what makes a good client

Have you struggled to find a good trades person? Have you asked for quotes that have come back wildly different? Are you puzzled as to why your contractor seems to be taking a while to get back to you? This event aims to support a better understanding and communication between trades people and their clients.

Particularly for pioneering retrofitters, finding a trades person who will follow your plans is difficult. At the same time, trades people have met clients who are very knowledgeable on what works they want done, but less so on how to do them.

There exists a communication gap at times and having an openness and awareness on both sides to acknowledge limitations, and a willingness to learn and communicate well, we may be able support the whole process to be a little bit easier for everyone.

Since the Community Green Deal ended, around 50 co-op members have succeeded in appointing their own contractors for retrofit works. In some instances, these contractors could be seen as 'retrofit specialists' – for example members of the AECB (Association for Environment Conscious Building) or industry retrofit bodies, in others they are simply local contractors with an aptitude or interest in applying their skills in a retrofit context. A few are sub-contractors who worked on the Community Green Deal, and have maintained a relationship with the co-op through personal contacts.

DEVELOPING THE SUPPLY CHAIN: DESIGNERS

Carbon Coop and URBED also see a role for themselves in building confidence and understanding among architects/designers and building inspectors - skilling up the whole supply chain that currently delivers most domestic scale refurbishment and extension work.

For example, URBED have recently worked with one or two fellow architects employed by Carbon Co-op members, advising on matters of thermal bridging and moisture risk. They are exploring the possibility of formalising the process as a Retrofit Professionals Network in order to build local supply chain design knowledge.

POLICY IMPLICATIONS

LOCAL BODIES WITH LOCAL KNOWLEDGE HAVE AN IMPORTANT PART TO PLAY IN RETROFIT

There has recently been some recognition of the potential to drive national retrofit via area-based, rather than centrally-driven programmes, and some recognition of the role non-statutory bodies such as local energy agencies and co-ops could play.

In the government proposals for modifications to the ECO[36] in 2017,

local authorities will be able to determine eligible homes under the new 'flexible eligibility' mechanism, though this will only apply to a maximum of 10% of the spending.

Locally-based action on retrofit has been advocated by many in the sector. For example, witnesses to the House of Commons Energy and Climate Change Committee inquiry into Energy Efficiency suggested Government should draw lessons from the area-based approach of the Home Energy Efficiency Programme (HEEPS) in Scotland. [37]

"We were told that this scheme provided funding for local authorities to deliver in the most appropriate way for their housing stock. This helped to allow for a true area-based approach which fostered strong relationships between local authorities and communities, and delivered a more integrated policy than in

[36] ECO is being relabelled 'Help to Heat', as from April 2017 it will be geared very largely at helping those in fuel poverty

[37] http://www.eas.org.uk/en/home-energy-efficiency-programmes-for-scotland-heeps_50558/

England," the committee reported, adding that the consumer organisation Which? had told them that HEEPS addressed the lack of trust consumers have had for past schemes.[38]

COMMUNITY ORGANSATIONS HAVE A DISTINCT ROLE

The interest and expertise of local authorities is variable; sometimes, energy agencies may take the lead on local authorities' behalf, they may run programmes in partnership, or they may play a valuable complementary role.[39]

Not only do community organsiations have specialist expertise (they are often staffed by enthusiasts), they also have a different kind of relationship with potential retrofitters. They are perceived differently from local authorities, and particularly, from commercial bodies such as energy companies or the firms that 'piggyback' onto government-backed schemes, sometimes employing cold calling and high- pressure sales techniques.[40]

The House of Commons select committee heard evidence that engagement with consumers on home energy efficiency is better done by organisations who are close to the customer, and the people suited to carrying the message about energy efficiency are individuals or groups who have an "energy-related interest in how [people] are living [their] life" – a fair description of Carbon Co-op.

[38] House of Commons Energy and Climate Change Committee as above

[39] Another example is the collaboration between Gloucestershire-based Severn Wye Energy Agency and Stroud District council on the Target 2050 retrofit loan scheme.

[40] A complaint against at least one of these piggyback' firms, for mis-selling, has been upheld by the Financial Ombudsman, see for example http://www.bbc.co.uk/programmes/b083l8x1

THE COMMUNITY GREEN DEAL AND FUEL POVERTY

As the House of Commons select committee investigation into domestic energy efficiency [41] were told: "There are other important household benefits to improved energy efficiency [alongside lower bills and increased occupant comfort], including wider societal benefits like mental well-being, reduced contacts with the health service and reduced absence from school or work."[42]

For example, an elderly couple exchanging a cold, poorly insulated home for a good quality, insulated affordable home would be less at risk of suffering from excess cold. This has the potential to save the NHS an estimated £8,000 per patient per year. [43]

At present, fuel poor households are typically offered only a basic range of energy efficiency improvements. Yet as we saw above, to ensure increased comfort *and* substantial bill savings, substantial energy efficiency improvements are required.

The second round of the Community Green Deal, in which grants for retrofit will go to households in fuel poverty, is now being planned. With the assistance of the Chesshire Lehmann Trust, URBED and Carbon Co-op will be evaluating how the process might need to be adapted for fuel poor households.

Carbon Co-op and URBED are exploring area-based retrofit programmes, for example investigating a scheme to retrofit the homes of fuel poor owner occupiers in a regeneration area to the south of the city. The co-operative hope to replicate the technical approach of the Community Green Deal and realise similar occupant benefits, though a more geographically focused programme should make for easier management, they believe.

BE GENTLE WITH BENEFICIARIES

Carbon Co-op are mindful of the fact that an area based whole house retrofit programme should not lose sight of householders' needs to have personal control over what happens in their homes.

As described above, the householder experience of installing whole house retrofit was at times stressful for the relatively comfortably situated able-to-pay participants of the Community Green Deal. Households in fuel poverty often have other vulnerabilities and could find it harder unless great care is taken with delivery. Carbon Co-op warn about the following issues in particular:

- Existing respiratory conditions (including those caused by living in a cold and/or damp home) could be exacerbated by dust from construction.
- Mental health problems (anxiety, depression) could make occupants particularly vulnerable to additional stress and uncertainty.
- Where there are mobility issues caused by a disability, age or other medical conditions, households are likely to need much more assistance in preparing for building work: for example, moving belongings. In a whole house retrofit large items of furniture, carpets etc. often need to be moved.

[41] House of Commons Energy and Climate Change committee as above
[42] See also the early results from the Warm Homes Oldham programme, https://www.theguardian.com/society-professionals/2016/nov/30/guardian-public-service-awards-2016-sustainability-winner-warm-homes-oldham
[43] https://www.frontier-economics.com/documents/2014/09/rpt-affordable-housing-report-2.pdf

- It may be more difficult for lower income households to take time off or have flexible working hours, for example to admit contractors or supervise the movement of belongings.

SOCIAL LANDLORDS SHOULD ALSO BE LOOKING TO WHOLE HOUSE RETROFIT

Homeowners can be motivated to improve the energy efficiency of their homes for a number of reasons, including increasing comfort and reducing energy bills. When a landlord improves the energy efficiency of their stock they may not benefit directly from these effects, however research (below) now indicates they may nonetheless enjoy measureable benefits through reduced arrears and voids.

Tenants in extreme fuel poverty may be faced with the inability to afford both energy and rent, and sometimes it is extremely hard to prioritise rent, increasing the risk of rent arrears (see box).

Why fuel poverty is bad for landlords

A jobseeker in one of the universal credit pilot areas interviewed on BBC Radio 4 explained that he received £140 per week, half of which was for his rent which, under universal credit, he was responsible for paying (rather than under the previous system where housing benefit had been paid direct to the landlord).

"I would like to think I'm responsible, but still, it's difficult to manage on £70 a week," he said. "If you've got another £70 a week that's seemingly floating and you're stuck for electric or something like that, the temptation is so great, just to buy some more electric."

Tenants enjoying improved health in a warmer healthier home may also have increased earning power too – again, helping landlords as well as occupants.

Research was carried out by the charity Sustainable Homes into the relative financial performance of social housing units in relation to their energy efficiency rating.[44] The findings clearly indicated that the most energy efficient properties suffered far fewer rent arrears and lower void rates, than did the inefficient properties.

[44] 'Touching the Voids' http://www.sustainablehomes.co.uk/research-project/rent-arrears/

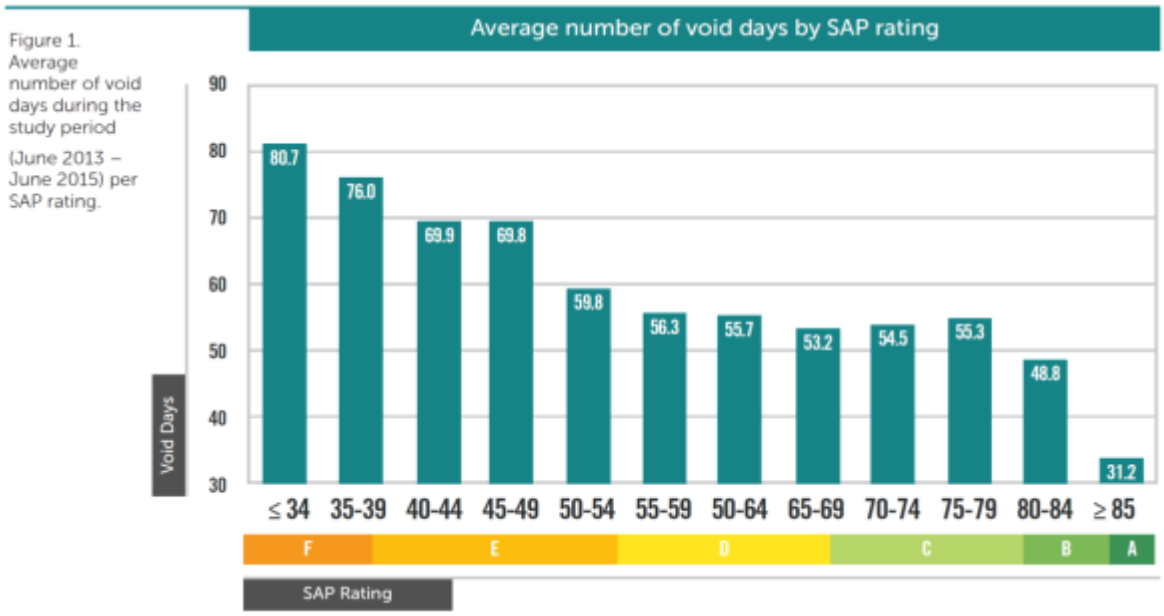

Figure 1. Average number of void days during the study period (June 2013 – June 2015) per SAP rating.

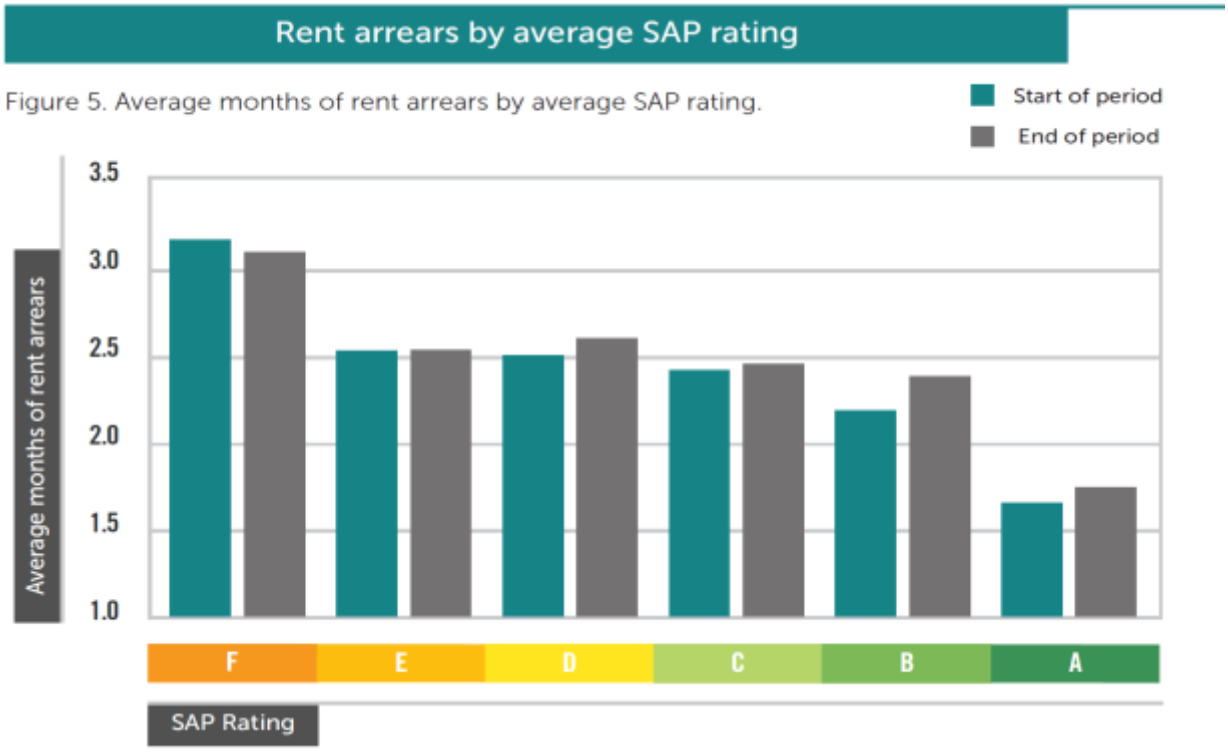

Figure 5. Average months of rent arrears by average SAP rating.

At the lowest end of the spectrum, properties in the E and F bands were empty for an average of up to 70 and 80 days respectively over the two years of the study – more than one day in 10. This is in contrast to those at the other end of the scale: energy efficient properties, such as those with a SAP rating over 80, were void for only around 50 days - 40% less – meaning proportionally less rental income was lost.

A worked example in the report suggests that investing in improved energy performance could be expected to cover the landlord's cost within a reasonable period of time (perhaps as little as 10 or 15 years) – though the charity is also calling for a provision to allow landlords to recoup a small fraction of the tenants' bill savings in increased rents, to roll forward into further investment.

Deep retrofit of properties where the occupants are in fuel poverty is increasingly being seen by landlords as a way to improve the lives of their tenants and at the same time, secure their own financial investment in the property. A good local example is the deep retrofit of the flats at Erneley Close in Longsight, Greater Manchester, which were fully externally insulated and fitted with balanced heat recovery ventilation, to bring about a dramatic reduction in energy demand and equally dramatic improvement in comfort.[45]

As pointed out above, great care must be taken when carrying out extensive retrofit to the homes of vulnerable occupants. Many social landlords engaging in deep retrofit opt to decant tenants for a short time during retrofit (even if only during the day to, for example, a comfortable TV lounge)[46]. This is better for the occupants and also enables the contractors to complete works more rapidly.

RETROFIT AND THE SMART GRID - A NATURAL PARTNERSHIP

Demand reduction is central to decarbonising our energy supply – and demand reduction is what home retrofit delivers. However, one of the next biggest challenges in decarbonisation is that of storage – holding on to low carbon energy until it is needed. Energy demand is very variable ('peaky') and with increasing amounts of renewable generation, supply can be peaky too. The better demand can be matched to supply, the less 'backup' energy is needed (often fossil fuel powered) – and the cheaper and lower carbon the whole system will be. Home retrofit can therefore play a role.

In highly insulated dwellings, energy can be stored as heat. Heat does not necessarily need to be supplied at the peak times of demand: the better insulated a building is, the more slowly it will cool down, and, therefore the more flexible it can be about when it receives its heat – without impacting on the comfort of occupants.

Carbon Co-op has a twin interest in fabric retrofit and empowering customers to understand and control their energy use, including by monitoring and use of smart devices. Some of the households are already embracing the potential synergies between these complementary approaches to cutting carbon.

"We are less burden on the energy supply – the country needs to import less gas from Russia. And our house is Smart grid ready. We've got the warm box, our heat demand is less peaky, and we can store energy."

[45] http://r-gen.co.uk/projects/erneley-close/passivhaus-project-erneley-close/
[46] See for example the retrofit strategy at Cedar Court in Glasgow, by Collective Architecture

CONCLUSIONS

As we saw in the introduction, progress with domestic retrofit currently falls far short of that needed to meet our climate goals.[47]

In November 2016, the UK ratified its commitment to the Paris Agreement on Climate Change. Retrofitting the UK's homes to reduce home energy demand will be an essential part of our progress towards meeting this commitment. A workable strategy to deliver deep cuts in household energy use and carbon emissions is urgently needed.

Every £1 invested in energy efficiency returns an estimated £3.20 to the economy.[48] Cold homes lead to or exacerbate a range of health problems, the most serious probably being cardiovascular and respiratory problems. Whole house retrofits like those in Community Green Deal should enable people to keep warmer and healthier while saving money on bills.

But despite all these arguments in favour of home retrofit, and especially whole house retrofit, progress is still drastically short of what is needed.

Community Green Deal offers a scalable model for achieving cuts in household emissions and energy use compatible with our 2050 climate goals.

The model:

- Offers a combination of fabric retrofit and renewable generation that keeps the cost in the range of £20,000 - £60,000 for a typical house, depending on the size of the building and the number of energy efficiency measure already in place.
- Can be carried out with occupants in situ for the whole or nearly all of the duration of the work
- Is attractive and affordable enough to encourage self-financing by able-to-pay owner occupiers - via the availability of subsidised finance (a 0% loan)
- Delivers improvements in comfort as well as energy use

Important factors in the success of the Community Green Deal were:

- Information to prospective participants about comfort and carbon savings, as well as bill savings
- An intermediary or advisor with technical expertise, who was not part of the corporate sector
- Bespoke specifications for individual homes prepared by a construction professional – important for performance, and for householder reassurance
- Regular on-site supervision by a construction professional – as above
- Energy and indoor environmental monitoring before and after the project, with ongoing involvement to fine-tune the user/house interactions

The 0% finance was particularly successful in drawing people to participate. Householders were as keen to improve the comfort of their homes as they were to reduce energy bills, and were prepared to invest in

[47] Energy performance improvements in buildings "are currently running at 1% per annum, rather than the 2-3% required". Heat and Energy Efficiency: Making Effective Policy Advisory Group Report for the UK Committee on Climate Change, Professor Janette, Webb University of Edinburgh, 2016

[48] Building the Future: The economic and fiscal impacts of making homes energy efficient. Verco & Cambridge Econometrics, 2014

comfort and a healthy living environment even if this entailed a net outlay for a number of years into the future.

Community Green Deal demonstrated that the UK construction workforce is readily able to develop and deploy the specialised skills required to carry out this type of high-performance retrofit. However, the funding and administration of current government support for retrofit stands in the way of scaling this kind of intervention.

IMPLICATIONS FOR POLICY

Supporting SMEs and even micro companies to deliver, and ultimately to recommend, home energy retrofit is seen by many as the best way to mainstream retrofit into routine building work – and it after all is routine building work that creates many of the trigger points that make energy retrofit feasible.[49]

Mainstreaming home retrofit into the work of small local construction firms is an important step on the road to increasing the uptake of 'able to pay' home retrofit, as numerous experts have concluded,[50] but the way grant schemes are structured can militate against this. With the changes proposed to the ECO for 2017 and beyond, with a renewed focus on fuel poor households, even this not very helpful source of support for retrofit in the able-to-pay sector is being largely removed.

As the House of Commons Energy and Climate Change Committee has been told, "financing options must be re-introduced to help households make energy efficiency improvements."[51]

The offer of subsidised loan finance certainly drew 'able to pay' would-be retrofitters to the Community Green Deal. Elsewhere in the world, funding models similar to that used in Community Green Deal have been used with success, and delivered net benefits to the national economies as well as cutting emissions. Community Green Deal shows the model can be a success in the UK, too.

The 0% loan funding in the Community Green Deal however differed considerably from past and present UK government schemes to encourage energy retrofit, by being flexible in the way that it was spent, with a great deal of the detail to be determined between the co-op and the householders.

By contrast, the government schemes, when they exist at all, have been highly bureaucratic and extremely prescriptive, and in Carbon Co-op's experience, not fit for purpose. (The HEEPS (Home Energy Efficiency Programmes for Scotland) 'cash-back' scheme in Scotland operates under the same constraints as ECO, potentially excluding smaller 'ordinary' building firms – and has limited impact with mainly single measures being installed.)

A new policy is needed, and it should take account of the following:

- For able-to-pay households, flexible loan funding on subsided interest rates was shown to be an attractive financing option in the Community Green Deal, as it has elsewhere (as for example in the German KfW loan scheme). There is no reason to think this approach would not also be attractive to social and private landlords wanting to improve the energy efficiency of their properties. Evidence shows that investment in public subsidies of this kind is more than offset by the increase in tax

[49] See for example Maby & Owen, as above
[50] See for example evidence to House of Commons Energy and Climate Change Committee 2015-2106 Session : Enquiry into home energy efficiency and demand reduction by Catrin Maby , the Centre for Sustainable Energy (CSE), and others
[51] House of Commons Energy and Climate Change Committee as above

revenues and savings in welfare spending due to lower unemployment, so would bring no net cost to the taxpayer.[52]

- Frequent changes in the structure and availability of funding are counter-productive. Short term schemes are not conducive to long-term planning. Releasing and withdrawing funding from the market does little to provide confidence and certainty to the supply chain.
- Accreditation systems need to be responsive to the needs of a range of housing archetypes (including heritage buildings), as well as being accessible and affordable to innovative producers and smaller manufacturers.
- Support to householders needs to be designed in such a way as to assist, rather than exclude, the involvement of small, local construction and supply businesses. This will facilitate uptake by householders, and may also enable higher quality installations.

A rethink is needed of support for retrofit, for both the able-to-pay and more vulnerable occupants, in order to make whole house retrofit feasible at scale. The obstacles are political and administrative, they are not technical, nor necessarily financial. If support were to be redesigned it would be a great deal easier to cut domestic energy use – and without widespread domestic retrofit at this level, the UK's wider de-carbonisation goals will remain out of reach.

[52] https://www.raponline.org/energy-efficiency-the-sweet-spot-for-economic-stimulus-after-brexit/

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