

Scaling Up Retrofit 2050

Why a nationwide programme to upgrade the existing housing stock is the only way for the UK to achieve its carbon saving goals.



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FOREWORD

Domestic energy efficiency is one of the most under-appreciated opportunities in the UK's efforts to tackle climate change. The IEA (International Energy Agency) has said energy efficiency should be recognised as the 'first fuel', offering a win-win-win in terms of lower emissions, lower energy bills and improved energy security. Retrofitting homes offers one of the most cost-effective routes to reducing emissions and will be crucial to ensuring an affordable transition to a clean energy system.

At the same time, retrofit offers other wide-ranging benefits for residents and communities. It can offer a lasting solution to tackling fuel poverty and addressing rising energy bills. It can prevent vulnerable households from having to live in dangerously cold homes, reducing pressures on our overstretched health services. And it can create skilled local jobs in construction across the whole of the UK.

But home retrofit it is also a significant challenge. To meet the UK's climate change targets, we will need to improve nearly every home in the UK with energy efficiency measures at a rate of more than 1.5 homes every minute between now and 2050. And that is only if we visit every home once, with a single 'whole house' renovation rather than incremental improvements. Right now, we are falling far short in both the rates and depths of interventions.

The only way we can achieve this step-change in scale is through the sort of ambitious national programme outlined in this report. Stimulating demand, driving investment and building supply chains will take time but the report recommendations provide practical first steps for how we can get started. And we need to get started as soon as possible because the longer we wait, the bigger this challenge will become.

Richard Twinn

Senior Policy Advisor, UK Green Building Council (UKGBC)



1. EXECUTIVE SUMMARY

1.1. WHY RETROFIT?

Domestic energy consumption accounts for about 30% of the UK's total energy budget, and 20% of UK greenhouse gas emissions. Reduction in carbon emissions from domestic properties is essential to achieve the goals of the 2008 Climate Change Act.

Over three-quarters of household energy demand is for space and hot water heating. We must decarbonise or reduce heating demand. Since 80% of the homes we will be living in by 2050 have already been built, a nationwide programme of deep retrofits and refurbishment of the existing stock is the only way to deliver the required carbon savings.

Deep retrofitting to 2050 standards is complex and costly but early pioneers are attempting this transformation. There are a number of cases across Europe where retrofit development at scale has already been achieved or is being delivered, several of which are highlighted in section 4 of this report. This document focuses on how to scale up these attempts.

1.2. BARRIERS TO PROGRESS

Although large-scale retrofitting of the existing stock is required, it is not happening fast enough. A large number of barriers have been identified through a review of existing literature and interviews with experts and stakeholders for this report.

The commonly reported barriers can be grouped into:

- **Technical**
- **Financial/economic**
- **Social barriers among home occupiers**
- **Organisational issues within social housing providers**
- **Regulatory/legal**

The most important barriers are:

- **A lack of user demand. Retrofit for energy savings is not an attractive consumer proposition for owners or occupiers**
- **A lack of clear and consistent government policy and actions that demand delivery of the 2050 targets**
- **High costs and insufficient supply chain capability and capacity**
- **A lack of finance**

1.3. RECOMMENDATIONS

Establishing a long-term plan by creating clear, consistent policy objectives and a national programme for deep retrofit and climate resilience, with an initial focus on social housing. Cities and local authorities should also be asked to develop long-term plans for all properties while receiving additional support for innovative procurement processes that encourage innovation and shared risk-taking. Deep retrofit needs to become integrated with other strategies for the future of the city.

Reducing costs and building supply chain capacity by developing pilot projects and demonstrators as well as a plan to bring the cost per property to below 30-year repair, maintenance and refurbishment budgets. A national programme will also require a Centre of Excellence, along with support for innovation across the supply chain and utilising modern construction methods. It would need a standard menu of options for typical construction types. Collecting and sharing evidence of performance in use will be essential.

Engage with the consumers by identifying the best ways to discuss the benefits of deep retrofit with householders, and developing trusted intermediaries to be a single point of contact for owners and tenants.

Encourage investment by aggregating projects in large blocks to attract investors and reduce costs while introducing more flexible ways for local authorities to borrow and invest in retrofit programmes. There needs to be more revenue-neutral methods of incentivising deep retrofit, more assistance for registered social landlords (RSLs) to develop long-term financial plans and more learning from investment approaches used for other forms of national infrastructure.

1.4. THE WAY FORWARD

Many of the recommendations will take some time to develop. The immediate next steps should be to reduce costs and increase the evidence base for the value of deep and large-scale retrofit of domestic properties for energy efficiency.

Social housing is the natural place to focus. A critical mass of demand will be needed to drive down costs. The goal should be a roll-out plan that progressively reduces costs until they can be covered by the normal long-term investment plans of RSLs.

2. WHY RETROFIT?

The Climate Change Act of 2008 sets a legal target for the UK to reduce greenhouse gas emissions by at least 80% of the 1990 baseline by 2050. The pathway to 2050 is steered by a series of 5-year carbon budgets set with the advice of the independent Committee on Climate Change. All parts of the UK economy must contribute to reducing greenhouse gas emissions, including the built environment.

2.1. IMPACT ON UK ENERGY DEMAND AND GREENHOUSE GAS EMISSIONS

Domestic energy consumption accounts for about 30% of the UK total energy budget of 140Mt oil equivalent per year, and 20% of the UK greenhouse gas emissions of 466 Mt CO₂ equivalent per year.

Reduction in carbon emissions from domestic properties is essential to achieve the goals of the Climate Change Act.



FIGURE 1
UK Energy Consumption 2016

- 29% Domestic
- 40% Transport
- 17% Industry
- 14% Other

Source: <https://www.gov.uk/government/statistics/energy-consumption-in-the-uk>

2.2. NEED TO DECARBONISE HEAT

Over three-quarters of household energy demand is for space and hot water heating, therefore the only viable strategy is to decarbonise or reduce heating demand.

A number of analyses suggest that we must reserve some of the available future carbon budget for sectors of the economy that will be very difficult to decarbonise, and therefore we must plan to reduce the carbon emissions from heat demand in buildings to zero.

Currently the electricity supply system is being rapidly decarbonised with the elimination of coal-fired plants and an increase in renewable supply. However, there is a major imbalance between heat demand and electricity demand. Although the domestic demand for electricity varies through the day, it is relatively stable across the seasons. In contrast the heat demand is approximately the same as electricity demand in the height of summer, but peaks to six times the electricity demand in the depth of winter.

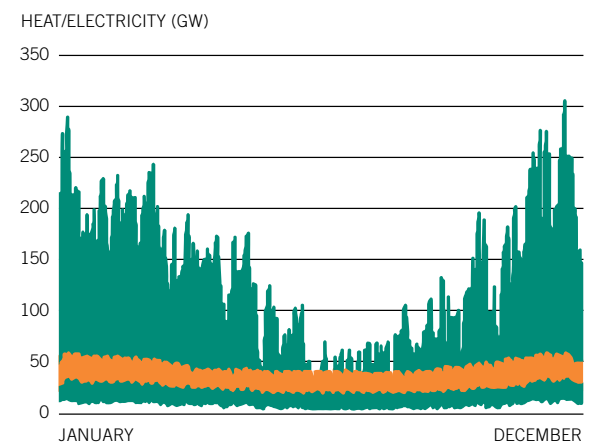


FIGURE 2
Variation in UK Demand for Heat and Electricity Across a Year

- Heat
- Electricity

Source: Smart Systems and Heat: Decarbonising Heat for UK Homes, Energy Technologies Institute 2015

2.3. DEEP RETROFIT IS ESSENTIAL TO REDUCE HEAT DEMAND

If the heat demand stays at the same level, we will not be able to switch to solely low-carbon electric heating at the required rate - particularly as increased deployment of electric vehicles will be demanding more electricity at the same time.

Heat demand must be reduced, and this is most effectively achieved by dramatically increasing the thermal efficiency of our housing stock.

Although new homes could be built with very high energy efficiency, current standards are not sufficient to achieve the 2050 objectives and the rate of house building in the UK is low. 80% of the homes we will be living in by 2050 have already been built. A nationwide programme of deep retrofits and refurbishment of the existing stock is the only way to deliver the required carbon savings.

Deep retrofit is an integrated and whole house approach to upgrading the energy efficiency of a dwelling that brings it to the standard required to meet 2050 targets in one step, rather than as a series of single and incremental interventions carried out over a long time.

The requirement for deep retrofit is clear but is not happening at the scale required to meet the challenge. What is happening is piecemeal and incremental, driven by short-term support programmes that favour a stepwise approach. New thinking is required to unlock the benefits.



Image courtesy of Welsh Government.

2.4. SOCIAL HOUSING IS THE BEST PLACE TO START

Social housing has a significant role to play in developing the market. Local authority and housing association homes account for 17% of the total housing stock. Social housing is an easier market to access than private rental or owner-occupied, as the owners have an explicit social goal, and can be encouraged to take a longer-term view of housing quality and performance than other sectors. 17% of the stock (~4.5m homes) is a sufficiently large market to develop and deploy scaleable retrofit solutions which can later spread to the rest of the stock.

Social housing is already in the lead in delivering thermally efficient homes. The figure shows that the SAP rating (Standard Assessment Protocol for evaluating the thermal efficiency of buildings) has been consistently much higher for social housing compared to both private rental and owner-occupied. In recent years the gap has narrowed, but it is still significant.

Social housing is the most appropriate starting point for a large-scale programme of deep retrofit.



FIGURE 3
Distribution of Tenancy Types in the UK

- 63% Owner-Occupied
- 20% Private Rental
- 10% Housing Associations
- 7% Local Authority

Source: <https://www.gov.uk/government/statistical-data-sets/live-tables-on-dwelling-stock-including-vacants>

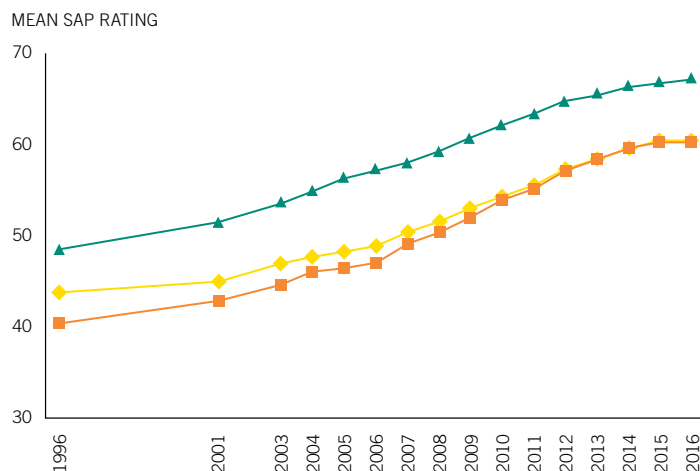
FIGURE 4
Mean SAP ratings by Tenure

- ▲ Social Sector

- ◆ Owner Occupied

- Private Rented

Source: <https://www.gov.uk/government/statistical-data-sets/live-tables-on-energy-performance-of-buildings-certificates>



2.5 ADDITIONAL BENEFITS OF DEEP RETROFIT

Deep retrofit of the existing housing stock will bring benefits beyond reducing carbon emissions and meeting the challenges of the Climate Change Act.

Calculations from Nottingham City Homes show that using the budget they would have spent on just maintaining stock over 30 years can bring additional benefits if this money is directed into deep retrofit. The most efficient way for the UK to achieve 2050 standards in social housing is for the providers to invest money that would have been spent over 30 years on repairs and maintenance on long-term refurbishment.

Poor-quality housing leads to poor health outcomes. It has been estimated that it costs the NHS £1.4 billion per annum in additional treatment costs for conditions arising from bad housing¹. At least £145 million of those costs arise directly from cold homes. Warmer housing could also prevent many of the 35,000 excess winter deaths recorded annually.

Modifying homes for an ageing population not only reduces stress on the NHS, it directly impacts care budgets. Adaptation and improvement of home quality reduces social care costs by between £1,700 and £4,500 per person per annum, and can cut GP visits by almost 50%².

Quality and availability of housing has a direct impact on productivity and economic growth³. Housing must be integrated into local infrastructure and be available at sufficient quality and cost to bring workers into the local economy. In the longer term, poor-quality housing has been shown to affect educational attainment, reducing the locally generated pool of talent¹.

Deep retrofit of housing should not be considered purely from an energy efficiency and carbon emissions standpoint but should be fully integrated into the plans for a thriving and resilient local economy that meets the current and future needs of citizens.

¹ “Good Housing – Better Health”
 The Academic – Practitioner Partnership, 2016
<https://www.birmingham.ac.uk/Documents/college-social-sciences/social-policy/SPSW/Housing/2016/goodhousing-better-health-2016.pdf>

² “Housing our Ageing Population”
 Local Government Association, 2017
https://www.local.gov.uk/sites/default/files/documents/5.17%20-%20Housing%20our%20ageing%20population_07_0.pdf

³ “Housing and Economic Development”
 Housing Corporation and Centre for Cities, 2008
<http://www.centreforcities.org/wp-content/uploads/2014/09/08-11-06-Housing-and-economicdevelopment.pdf>

3. BARRIERS TO PROGRESS

There are many reasons why progress on scaling up retrofit to domestic properties has been slow. These have been covered in a number of reports and publications and confirmed in interviews undertaken for this study.

The most commonly reported barriers can be grouped into:

- **Technical**
- **Financial/economic**
- **Social barriers among home occupiers**
- **Organisational issues within social housing providers**
- **Regulatory/legal**

A detailed breakdown of the nearly 40 commonly reported barriers can be found in Appendix 1.

The most important barriers identified are:

- **A lack of user demand. Retrofit for energy savings is not an attractive consumer proposition for owners or occupiers**
- **A lack of clear and consistent government policy and actions that demand delivery of the 2050 targets**
- **High costs and insufficient supply chain capability and capacity**
- **Lack of finance**

These barriers interact. Lack of clear government policy means there is no incentive to invest in innovative solutions and supply chain capability. Lack of user demand and government mandate means that the market is not large enough to drive down costs and investment. High current costs mean it is difficult to get the volume needed to drive those costs down in the absence of government policy and pressure.

Solutions will have to address all these key barriers.



4. EXAMPLES OF LARGE-SCALE RETROFIT INITIATIVES

There are relatively few cases where large-scale significant retrofit of housing is being delivered. Most of the examples highlighted in this section are still at the prototyping and demonstrating stage, and are not the integrated, whole-house, deep retrofits that will be required.

4.1. ARBED

Arbed was a strategic energy performance investment programme run by the Welsh Government. It focused on 'whole-house' thinking and tried to work on a community or street-by-street approach to provide social benefits and to drive down the unit cost. The programme was delivered in two phases.

Phase 1 focused on Registered Social Landlords in regeneration areas. Funding of £36 million was provided by the Welsh Government, and it was able to leverage in similar funding from registered social landlords (RSLs) and energy companies. Over 6000 homes were retrofitted, with the main interventions being solid wall insulation, PV, solar thermal, heat pumps and fuel switching. Phase 2 treated a further 6500 properties at a cost of £67m.

The Arbed scheme demonstrates the benefits of clear and consistent policy, public investment to encourage retrofitting, and the aggregation of properties at community level to reduce costs and provide social benefits.

Phase 1 was estimated to raise the EPC rating from F to C, and phase 2 from E to D (note the impact reports were prepared by different consultants using different methodologies). Although the substantial programmes did make a significant difference to the performance of the properties, they are incremental and do not demonstrate a pathway to 2050. Further interventions will be required and many of the solutions installed in this programme cannot meet 2050 targets and will have to be removed and replaced in the future. Deep retrofitting requires a whole-house strategy from the beginning.

The Welsh Government is now consulting on a plan to bring all homes to zero-carbon by 2050 with an initial focus on homes in fuel poverty.⁵

⁴ <https://gov.wales/topics/environmentcountryside/energy/efficiency/arbed/publications/?skip=1&lang=en>

⁵ <http://www.assembly.wales/en/newhome/pages/newsitem.aspx?itemid=1894>



Before and after pictures of an Arbed project in Aberystwyth.

4.2. KIRKLEES WARM ZONE

Kirklees is a Metropolitan Borough in West Yorkshire that incorporates Huddersfield and Dewsbury, along with a number of other towns.

The Kirklees Warm Zone programme ran from 2007 to 2010. The goal was to improve domestic housing energy efficiency to:

- Tackle fuel poverty
- Deliver a low-carbon Kirklees
- Improve the uptake of state benefits support by residents
- Create jobs

The main interventions were cavity wall and loft insulation. Heating systems were upgraded and replaced where necessary, co-funded through local, regional and central government support. Low energy light bulbs were provided together with a range of support and advice for everything from fire safety to water conservation.

The cost of the programme was £21 million - the bulk from the council and CERT funding from energy providers. A number of other funding sources also contributed.

The service was offered free to private residents. Social housing in the area was generally of good quality (EPC C).

The programme rolled through Kirklees district by district and street by street. This meant that the community was very aware of the programme, and there was no stigma attached to accepting help. Your neighbours were all being offered the same help.

- 133,746 energy assessments were carried out
- 111,394 homes were referred for a technical survey
- 51,155 households had energy saving measures installed
- 42,999 properties received free loft insulation and 21,473 had cavity wall insulation installed

Every home in Kirklees was approached. 80% of properties were surveyed and 50% had some work done - about one third of all properties in the target area. Including properties already improved, 60%-70% of properties were reached. The remainder had problems that the scheme could not deal with; for example, structural issues or otherwise hard to treat homes.

When presenting the project to users, they did not talk about costs and energy saving; they talked about warmer and more comfortable homes.

The Kirklees Warm Zone demonstrates the value of place-based retrofit programmes, aggregating properties to keep down costs, and of developing an attractive customer proposition – warmer more comfortable homes for free. However, it did not take a whole-house approach.

This was not an attempt at deep retrofit. The estimated improvement in SAP score was 5 – 6 points. This might be sufficient to raise the performance by one EPC letter; e.g. from E to D. It is not an effective route to the 2050 target.

⁶ <https://www.kirklees.gov.uk/beta/delivering-services/pdf/warmzone-economic-impact-assessment.pdf>



4.3. PICARDIE PASS RÉNOVATION

Picardie Pass Rénovation is a French initiative targeting homeowners. Using a loan from the European Investment Bank it offers a comprehensive one-stop shop. The programme provides a single point of contact, a complete thermal audit of the home, a plan of the works required to achieve energy savings, sources financing, finds supply companies and manages installation, and provides a five-year follow-up including monitoring the consumption and advice on usage.

The work is funded by a loan over 15 to 25 years at an interest rate of 2.5%. Risk on the debt is carried by the Picardie Region.

There is a second option in which Picardie Pass Rénovation provides technical advice only, but so far 70% have chosen the complete service.

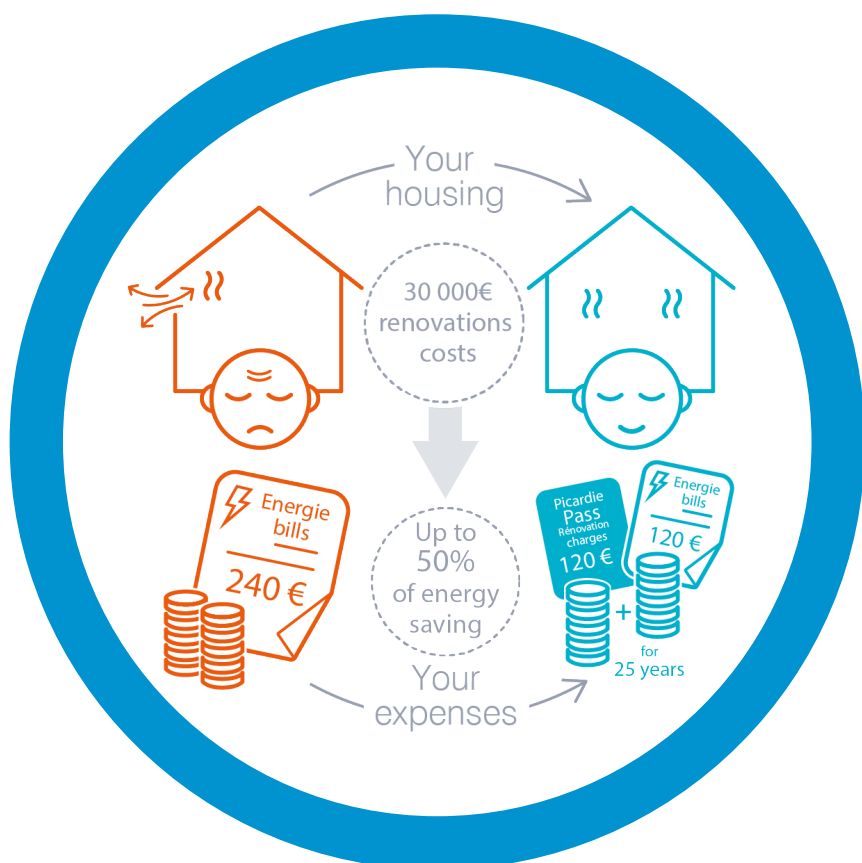
In order to make the project commercially viable the retrofits target a 50% – 75% energy saving. The intention is that loan repayments plus energy costs after retrofit will always be less than or equal to energy costs before retrofit. So far on average 70% of the monthly loan repayments are covered by energy savings.

The typical financial package consists of 13% subsidies, 17% self-financing by the homeowner, and 70% loan.

In three years, over 4000 households have approached the service, over 2000 thermal assessments have been carried out and 1400 homes have been or are being renovated. The goal is to complete 2000 retrofits by the end of 2018, and then to scale to 10,000 a year.

Picardie Pass Rénovation demonstrates the value of a good customer proposition combined with a one-stop shop that reduces the risk to the homeowner. Creating a trusted organisation that will deal with many of the complexities on behalf of the homeowner encourages homeowners to invest. Access to significant amounts of long-term and low-interest rate money makes the projects viable in economic terms alone to the homeowners.

⁷ <http://www.pass-renovation.picardie.fr/project-funded-by-europe/>



4.4. ENERGIESPRONG

Energiesprong is an innovative approach to deep retrofit pioneered in the Netherlands. It achieves a near net-zero energy property with a performance guarantee for 30 years. The performance guarantee allows the housing organisation to charge the occupier a fee, which creates an income and this, alongside the savings in maintenance and management costs, covers the cost of the work.

The Energiesprong model is based on procuring a performance outcome which includes measures such as space heating demand, and net-zero energy. The performance must be guaranteed, and performance is monitored. The model is solution-agnostic, although a requirement to complete in 10-15 days on site drives offsite manufacture of components. Through supply chain innovation, costs are reducing. In the Netherlands there is now a viable business model, and Energiesprong is self-financing.

Typical interventions include:

- **A new thermally efficient wall envelope created with prefabricated panels manufactured offsite**
- **PV built into a thermally-insulated roof cassette, also manufactured off-site**
- **Air source or ground source heating**
- **Removal of gas to create an electricity-only property**

The provider supplies a 30-year construction and energy performance warranty to reduce risk to the building owner. There is a whole-life finance model with the cost of the retrofit equal to the expected maintenance cost and energy savings over a 30-year period. Users commit to an Energy Service Plan. Income from the plan combined with reduced maintenance costs provide the funds for the initial investment.

The Energiesprong approach makes it possible to take a property in one jump to the required 2050 performance.

This approach is developing quickly in the Netherlands. Here, the programme that delivers Energiesprong retrofits is called Stroomversnelling ('rapids' or 'fast-track'). It is a network of contractors, component suppliers, housing providers, local governments, financiers, DSOs and other participants. It aims to reduce the cost of retrofitting to net-zero energy and increasing householders' acceptance of this kind of renovation.

So far 1300 net-zero energy retrofits have been carried out with 15,000 more in the pipeline. The Energiesprong concept is being extended to other countries with the UK, France, Germany, Italy, Luxembourg, British Columbia, Ontario, and New York State already signed up.

Energiesprong demonstrates the value of a whole-house approach, targeting net-zero energy performance, and a whole-life financing model that pays for the retrofit out of energy savings and reduced maintenance costs. Because the appearance of the home is radically improved at the same time as its energy efficiency, there is a good consumer proposition.

Through setting clear and consistent performance specifications, Energiesprong allows innovation and standardisation of interventions. Coupled with offsite manufacturing this can dramatically cut the cost of a retrofit.

The first Energiesprong retrofit outside the Netherlands has just been completed in Nottingham.

⁸ <http://energiesprong.eu>



4.4.1. NOTTINGHAM ENERGIESPRONG PROJECT

Nottingham City Homes (NCH) and Nottingham City Council (NCC) have recently completed an Energiesprong pilot of ten properties with Melius Homes to explore methods of making their homes 2050 ready (see videos ¹¹).

The drivers for this are Nottingham's ambition to take a lead in becoming a low-carbon city, dealing with fuel poverty, regeneration of the local economy, and a search for economically-efficient ways of improving the stock. As part of their Environmental Strategy

Nottingham City Homes set out the long-term ambition to have low and zero carbon homes by 2050, and they will pilot methods of achieving this in the most cost-effective way.

Energiesprong is seen by Nottingham as a way of using money that would have been spent anyway on elements such as the roof, or windows, in a way that will achieve far more.

NCC has a 30-year strategy for its Housing Revenue Account broken down into five to ten-year programmes totalling £1.4 billion.

Taking a long-term view it can be shown that although the upfront capital costs of innovative deep retrofit solutions may be higher than would normally be budgeted, the avoided costs later in the programme equal or in some cases exceed the total investment over the 30 years. Lower whole-life costs justify the higher initial investment, with a higher quality of property and associated benefits throughout the 30 years. The challenge is that the money is budgeted over 30 years, and not all available now. Innovative finance solutions are being explored which could make funds available now.

Nottingham City Council and NCH participated in European project REMOURBAN, led by Nottingham Trent University, which explores the integration of sustainability into the regeneration of towns and cities. The ten Energiesprong houses were part of this project. The procured capital cost of each pilot property was £65k. This was a fixed price, set by NCH at an early stage. However, the actual cost was nearer to £90k for houses and £80k for bungalows.

The pilot retrofits have been completed, and performance is being monitored. Initial evidence is that the homes are much more comfortable, feel larger because more of the space can be used, and look much better. So far, the tenants are happy. The value of the homes has also increased. Houses were valued at £80k before the retrofit and £100k after retrofitting, with bungalows showing the same 25% increase from a lower starting point.

Competitive dialogue¹² enabled performance-based procurement for this project, and the next planned step is to replicate at a larger scale, with NCC and NCH securing funding to do this. It is hoped that such a roll-out would reduce unit costs through more efficiencies of scale.

Other UK local authorities are interested in following this approach. Scaling up the number of pilot houses around the UK should bring costs to a level whereby the solutions become market ready and cost-effective.

⁹ http://energiesprong.eu/wp-content/uploads/2017/04/EnergieSprong_UK-Transition_Zero_document.pdf

¹⁰ <http://energiesprong.eu/nottingham-first-to-adopt-revolutionary-housing-approach/>

¹¹ https://www.youtube.com/watch?v=Es-7k4tl_3Q&t=9s and <https://vimeo.com/267967831/e5a6d34cfb>

¹² https://www.procurementportal.com/files/Uploads/Documents/public_contracts_regs_2015_guide.pdf



4.5. KfW

Kreditanstalt für Wiederaufbau (KfW) is a German state owned promotional bank, which operates a scheme for homeowners to invest in deep retrofits as well as in energy-efficient new build. For retrofits they provide both grants and loans. Grants range from 17.5% to bring an inefficient property up to the reference standard for that property type, to 30% to bring the property to the stage where it only uses 55% of the energy of the reference standard.

Customers apply for loans through their usual bank, and if accepted KfW refinances the loan at favourable interest rates. These are typically 25-year loans denominated in euros and charged at 0.75% interest.

Typical interventions are improving thermal insulation, renewal of windows and exterior doors, installation or renewal of ventilation systems, and renewal of the heating system.

KfW operate through a network of over 11,000 accredited local project managers and engineers. Their responsibilities are:

- To liaise with the homeowner to decide what works need to be carried out
- To co-sign the loan provided by the homeowners' bank or mortgage provider under the KfW scheme
- To organise contractors and installers and oversee the agreed works
- To certify that the work has been carried out properly

They are not paid until the final certification is completed.

This programme demonstrates the value of a trusted single point of contact who can deal with all of the complexities of deep retrofit. This dramatically reduces the risk to the homeowner.

Access to cheap finance through state-owned banks means that retrofitting can be added to an existing mortgage on very favourable terms. Although there is no direct connection between energy savings and the cost of retrofit in the scheme, reducing the cost of capital increases the number of projects that are economically viable for the homeowner.

However, this programme does not share the ambition of Energiesprung to retrofit properties to near-zero net energy. Its focus is on more modest improvements in energy efficiency.

¹³ <https://www.kfw.de/inlandsfoerderung/Private-customers/Existing-Properties/Original-Existing-Properties.html>

4.6. FACTORS LEADING TO SUCCESS

Each of the programmes described operates in a slightly different way and targets different customers. There are a number of features that contribute to the success of these programmes, although not all are found in every programme. They include:

- A clear policy lead
- Public sector subsidy, or access to low-cost finance
- Whole-house approach to retrofit
- Aggregation of properties into larger projects
- Single, trusted point of contact for owners and tenants that will stay with them throughout the retrofit process
- A good consumer proposition
- A long-term strategy

These factors address many of the barriers identified in Section 3 and Appendix 1. Any plan to scale up retrofit in the UK to meet 2050 targets should address these success factors.



Picture: KfW image archive/photothek.net

5. RECOMMENDATIONS

If we are to meet the 2050 objectives of the Climate Change Act, then all housing in the UK must have zero carbon emissions from space and water heating, and space cooling. They should also be near net-zero overall energy.

This objective will not be met by the market on its own. The costs are currently too high, and the risks perceived as too great. Investment cannot be justified by energy savings alone. Although this transition is of great value to society, there is little market pull.

Governments - both national and local - must take the lead in encouraging and supporting the necessary changes. Government interventions in the past have been slow and lacked continuity. Cities and local authorities have a key role in driving this transition.

This is not primarily a technological challenge. New developments will always assist in reducing costs and improving performance, but sufficient work has already been done in research and pilot studies to show that massively reducing the carbon emissions and energy requirements of housing is feasible. There is also considerable practical experience in financing deep retrofit projects, managing them, and engaging with the householders.

We need to build on that experience to create a national retrofit programme to deliver our 2050 goals. Developing such a programme needs four overlapping strands of activity.

First, we need to develop a long-term strategic plan. We need to agree as a society that achieving the 2050 goal for housing is important and justifies concerted action. Creating the conditions for concerted action requires a clear 30-year plan leading us to 2050, and a supportive policy environment.

Second, we need a drive to reduce costs and build the capacity of the supply chain in the UK. This is best delivered by a programme of further demonstrators and pilots which will increase the number of properties retrofitted, allowing innovation and scale to cut the costs per property. These will generate the evidence to support the business case.

Progressively we will build the capabilities to deliver the 26 million home retrofits that will be needed to hit the 2050 targets.

Third, we must engage with the end-users - the householders. There will be scepticism about the benefits to the individuals, and concerns about whether the planned improvement in performance will be delivered and whether providers can be trusted to look after the interests of householders. There needs to be a strong and easily understood consumer proposition that makes the benefits clear.

Finally, we need to encourage investment in deep retrofit. This requires innovation and flexibility in financing, public sector support in the cost reduction phase and developing scale-up projects for commercial investment.

Energiesprong has conducted a study on how many pilots are necessary to make Retrofit 2050 solutions market ready. These will be in the social sector. A phased approach is necessary with government subsidies on a sliding scale.

- **3500 pilot homes are needed in the next 2-3 years**
- **25,000 pilots need to be completed in a five-year period**

At this point the solutions will be market-ready and private owners and commercial landlords may start to participate in the transformations.

There is an opportunity to integrate energy efficiency improvements with other required housing improvements such as:

- **upgrading homes for modern lifestyles**
- **upgrading to lifetime homes for an ageing population**
- **fire resilience**

Combining these requirements will spread the cost of deep retrofit.

The following recommendations are grouped into the four strands, and address the key barriers identified in Section 3 using the success factors in Section 4.6.



Picture: Simmonds.Mills Architects.

RECOMMENDATIONS						BARRIERS
	CENTRAL GOV.	LOCAL GOV.	RSLs	SUPPLY CHAIN	KNOWLEDGE BASE	
ESTABLISH A LONG-TERM PLAN						
Create a clear policy objective and national programme for deep retrofit	✓	✓				Clear policy lead
Ensure policy consistency over time	✓					Clear policy lead
Focus initially on social housing	✓	✓	✓			Clear policy lead
Require RSLs to have a 30-year plan to deliver 2050 targets	✓		✓			Clear policy lead
Ensure Right to Buy does not impede a national retrofit programme	✓	✓	✓			Clear policy lead
Ask cities and local authorities to develop long-term plans for all properties, regardless of tenure		✓				Clear policy lead
Support innovative procurement processes for local authorities that encourage innovation and shared risk taking	✓					Clear policy lead
Ensure planning law, standards and practice are not a barrier	✓				✓	Clear policy lead
Integrate planning of deep retrofit with strategies for the future of the city	✓	✓			✓	Clear policy lead
REDUCE COSTS AND BUILD SUPPLY CHAIN CAPACITY						
Develop pilot projects and demonstrators to build capacity and reduce costs		✓	✓			High costs
Develop a roll-out plan to reduce cost per property below 30-year repair, maintenance and refurbishment budgets				✓	✓	High costs
Create a centre of excellence to support a national retrofit programme	✓			✓	✓	Supply chain capacity
Support innovation in the retrofit supply chain - modern methods of construction	✓			✓	✓	Supply chain capacity
Develop standard menu of options for typical construction types				✓	✓	High costs
Collect and share evidence of performance in use			✓	✓	✓	Lack of demand
ENGAGE WITH CONSUMERS						
Identify the best ways to communicate benefits of deep retrofit to householders			✓		✓	Lack of demand
Develop trusted intermediaries to be a single point of contact		✓	✓			Lack of demand
ENCOURAGE INVESTMENT						
Aggregate projects into large blocks to attract investment and reduce costs		✓	✓			Lack of finance
Increased flexibility for local authorities to borrow and invest in retrofit programmes	✓					Lack of finance
Develop revenue-neutral ways of incentivising deep retrofit	✓					Lack of demand
Assist RSLs to develop long-term financial plans	✓		✓		✓	Clear policy lead
Learn from investment approaches used for other forms of national infrastructure	✓				✓	Lack of finance

5.1. ESTABLISH A LONG-TERM PLAN

The UK Government and the Devolved Administrations have not given a clear and consistent policy lead on the importance of whole-house retrofit for energy efficiency. Although deep retrofits for the existing stock are critical if we are to meet the requirements of the 2008 Climate Change Act, governments at all levels have not required action.

The history of policy declarations followed later by policy changes has damaged industry confidence in the commitment to radical reduction and decarbonisation of domestic heat demand (c.f. Zero Carbon Homes and the Green Deal). The challenge is now to convince industry, owners and tenants that investment in developing and implementing low-carbon retrofit solutions will be repaid.

A clear statement of the importance of deep retrofit for energy efficiency, and creation of a national strategy to deliver it, is vital.

Recommendation: The UK Government working with the Devolved Administrations should promote a clear policy objective and a national programme of upgrading the UK housing stock to be zero-carbon for heating, near net-zero overall energy and resilient to future climate change by 2050. Policy should be developed with the involvement of all stakeholders and specify outcomes, not means.

Such a national programme will extend beyond the lifetime of a single administration. Therefore, cross-party commitment to the overall objective is essential.

Recommendation: The UK Government and the Devolved Administrations should seek cross-party support for the national retrofit programme to ensure policy consistency over time.

With 17% of the housing stock owned by local authorities and housing associations, and with the social rented sector showing consistently higher energy efficiency than other forms of tenure, social housing is the natural place to start a national retrofit programme.

Recommendation: The national retrofit programme should be initially focused on social housing.

The attention of Registered Social Landlords needs to be directed towards developing plans to deliver the 2050 targets.

Recommendation: The regulators of Registered Social Landlords in the UK should require that each RSL should have a 30-year plan showing how they will manage their stock to deliver the 2050 target. This plan should be regularly reviewed and updated.

Where it still exists, Right to Buy represents a significant barrier to delivering large-scale retrofit. Either by scattering non-participating dwellings through planned regeneration and retrofit areas, with a consequent loss in coverage and increase in complexity, or by loss of capital and future energy savings from completed retrofits.

Recommendation: In areas where Right to Buy still exists for social housing, governments must work with local authorities and RSLs to ensure that investment in deep retrofit is not lost to the public sector if Right to Buy is exercised.

Although social housing is the logical starting point for a national programme, cities and local authorities will need to develop plans for the whole of their administrative area. They will also need plans to encourage deep retrofit in owner-occupied and privately rented homes.

Recommendation: As a subset of the national retrofit programme, cities and local authorities should develop their own plan for meeting the 2050 targets for all the properties within their administrative boundary.

The Nottingham pilot project has demonstrated that alternative procurement processes, such as competitive dialogue, can be very helpful in supporting the outcome focused procurement required for deep retrofit. These methods are available, but not yet widely used.

Recommendation: The UK Government and Devolved Administrations should actively encourage and support the use of innovative procurement processes by local authorities that stimulate innovation and shared risk-taking.

Existing planning rules and practices have been regularly identified as a barrier to large-scale retrofit programmes. Particularly the large number of properties in conservation areas or with listed status.

Recommendation: Planning law, standards and practice should be reviewed to make sure that cost-effective deep retrofit of properties is permitted, whilst recognising the cultural importance of the UK's diverse housing types and ages.

Planning law and practice should start to integrate the various housing and infrastructure needs for future cities.

Recommendation: Government and devolved authorities should conduct pilots and R&D to explore how to better integrate the planning process with the city strategies.

5.2. REDUCE COSTS AND BUILD SUPPLY CHAIN CAPACITY

A barrier to large-scale retrofitting of the existing housing stock is high capital costs and relatively poor returns from savings. Because volumes are currently small and the housing stock diverse, we have not seen the same reductions that we saw with PV and wind turbines.

Because of erratic and low demand, the supply chain in the UK does not currently have the capacity to deliver the scale of deep retrofitting required to meet 2050 targets. There is a significant potential for new jobs and additional growth in tackling the retrofit challenge.

Increasing volumes through larger-scale demonstrators will improve the evidence base and help to increase volumes.

Recommendation: Cities and local authorities should collaborate in developing pilot projects and demonstrators to help to build capability and reduce costs.

Costs will inevitably fall as volume increases and supply chain capability grows. We will need to develop a plan that takes us to the point where deep retrofit is demonstrably economically viable.

Recommendation: Develop models for the reduction in costs as volume grows and for predicting the impact of different mixes of interventions on the energy efficiency of a home. This will identify the tapered financial support that will be required to reduce costs to ensure economical viability, and size the scale-up projects that will be needed.

Technical standards, advice on good practice and training will be required.

Recommendation: The UK Government and the Devolved Administrations should work together with industry to create a Centre of Excellence that can develop the technical standards and processes for the national retrofit programme. This could be a new group, based on the Zero Carbon Hub example, or built on one of the existing trade and expertise groups in the sector.

Although the challenge of large-scale retrofit is not primarily technological, innovation in the supply chain will still be required, particularly in reducing costs of delivery through the use of standardisation and modern methods of manufacturing and construction.

Recommendation: The Department for Business, Energy and Industrial Strategy should take the lead in encouraging and supporting innovation within the retrofit supply chain, specifically in modern methods of construction, such as off-site manufacturing and pre-fabrication of retrofit systems.

The diversity of the housing stock means that current projects deploy bespoke and unique solutions. This means that unlike PV and wind turbines, increasing volume is not driving down costs quickly enough. Standardisation of solutions will help to reduce costs.

Recommendation: Technical experts and the supply chain should work together to develop a standard menu of options for the typical construction types in the UK.

It is essential that the design performance of retrofits is delivered. Improvements in EPC rating cannot currently be reliably predicted for the highest ratings using existing methods. Collection and sharing of performance in use data is vital.

Recommendation: Collection and sharing of performance in use data should be a key requirement in all demonstrator and pilot projects, including real-time feedback to users.



5.3. ENGAGE WITH CONSUMERS

One of the dominant barriers to large-scale retrofit is the lack of awareness of the benefits of retrofitting and lack of trust that retrofits will deliver the expected benefits. This is both a problem of creating a compelling owner/user proposition and providing confidence in delivery.

Recommendation: research should be undertaken to identify the best ways to discuss the benefits of deep retrofit with householders, and what steps need to be taken in the design of the national retrofit programme to overcome their concerns.

The apparent complexity of whole-house retrofit, together with trust in the providers, is a major issue for both owners and tenants. Evidence from successful schemes show that some trusted form of ‘one-stop shop’ is essential.

Recommendation: cities and local authorities should develop trusted intermediaries to act as a single point of contact with owners and tenants within their administrative area. This can be either internally, or through partnership.



5.4. ENCOURAGE INVESTMENT

Inability to finance retrofit projects is reported as a major barrier, particularly for larger schemes. Large amounts of private finance are seeking reliable streams of future income, but current retrofit projects are too small to be attractive. Projects need to be aggregated and simplified with standard risk profiles and contract terms. There are also substantial practical barriers to the deployment of public finance, even for publicly owned housing stock.

Assembling planned projects into larger programmes will make them more attractive to the finance industry.

Recommendation: Cities and Local Authorities should collaborate to aggregate properties into large blocks of retrofit activity to attract investment and to reduce costs.

The payback for investment in retrofit is not currently attractive. We need new approaches that shift the economic balance in favour of investment whilst not requiring excessive public subsidy.

Recommendation: the UK Government and the Devolved Administrations should explore revenue-neutral ways of incentivising deep retrofit. For example, properties with significantly better performance than the stock average could be charged a substantially reduced stamp duty on sale, and properties with the performance below the average significantly more. This would help to progressively lift the stock average.

There is evidence that by combining the planned investment in the maintenance and refurbishment of their stock over 20 - 30 years with energy cost and other savings over the period, social landlords can make an economic case for investing in deep retrofit to jump the stock to 2050 standards now. However, social landlords are finding it difficult to develop such long-range financial plans.

Recommendation: Social landlords should be supported to develop whole life investment plans against their long-term budgets, reduction in projected costs and reduction in energy consumption. These should be used to develop long-term funding schemes with the financial institutions.

There is evidence that the payback to society from deep retrofit of the housing stock is at least as good as for other major infrastructure programmes. Yet funding for retrofit is treated differently to national infrastructure.

Recommendation: Low-cost and patient financing is essential to delivering a national retrofit programme. The UK Government should look at what can be learned from the experience of other major national infrastructure investments.

6. THE WAY FORWARD

Many of the recommendations will take time to deliver; particularly developing a clear and supportive policy lead. Work in this area should be initiated immediately through the UK Government and Devolved Administrations with the support of professional and trade groups.

Although a clear and supportive policy is vital to success, we can immediately focus on driving down costs and developing the evidence base.

A critical mass of demand is needed to encourage the development of innovative solutions and to draw suppliers into this sector.

Social housing should be the initial focus as:

- **Social landlords have a longer-term focus and a greater interest in the performance of their stock and the sustainability of future rental streams**
- **Social housing typically consists of larger numbers of identical or similar properties, and social landlords typically own a large number of properties**
- **Social housing accounts for 17% of the housing stock**
- **Social housing has traditionally been of superior energy efficiency compared to the rest of the stock**

The most effective way to create a critical mass of demand for retrofit in social housing is for cities, local authorities and social landlords to collaborate; pooling projects to increase the numbers of homes for retrofit.

Such a programme would:

- **Increase scale to reduce costs**
- **Bring new solutions and new suppliers to the market**
- **Enable the sector to build capacity**
- **Build the evidence base on the value of large-scale retrofit as a route to the 2050 targets**

This approach will require additional funding to bridge the current gap between economically viable retrofit and actual costs. This support would be tapered as volume grows. Current estimates are that no further support for retrofitting social housing will be needed once 25,000 properties have been treated.

An early task will be to get a more accurate estimate of the total support needed and over what period.

The technical and financial challenges are consistent and aligned with the targets in the Construction Sector Deal ¹⁴ under the UK Industrial Strategy with its ambition of:

- **Better-performing buildings that are built more quickly and at lower cost**
- **Lower energy use and cheaper bills for homes and workplaces**
- **Better jobs, including an increase to 25,000 apprenticeships a year by 2020**
- **Better value from the £600 billion infrastructure and construction pipeline**
- **A globally-competitive sector that exports more**

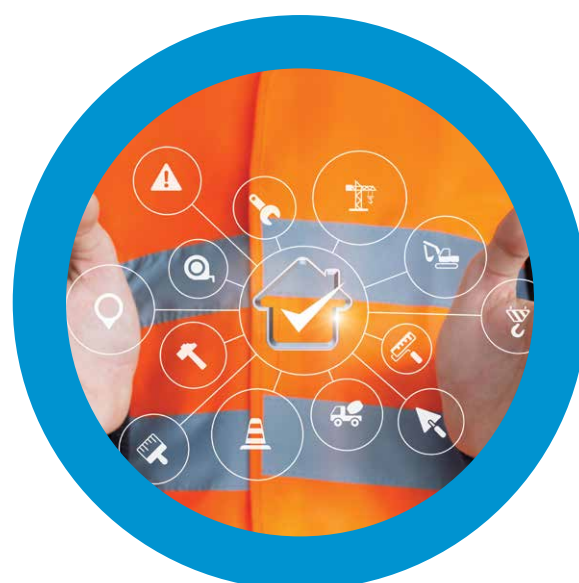
Delivered through a focus on:

- **Digital techniques throughout construction and operation**
- **Offsite manufacturing technologies**
- **Whole-life asset performance**

The technical approach is also consistent with the recommendations of the Hackett review of Building Regulations ¹⁵, including a clear model of risk ownership, outcomes-based regulation, recognising the central role of the householder, and improved procurement.

¹⁴ <https://www.gov.uk/government/publications/construction-sector-deal/construction-sector-deal>

¹⁵ https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/707798/Building_a_Safer_Future_-_print.pdf



7. APPENDIX 1

DETAILED BARRIERS TO RETROFIT

There are many reasons why progress on scaling up retrofit to domestic properties has been slow. The most commonly reported can be grouped into:

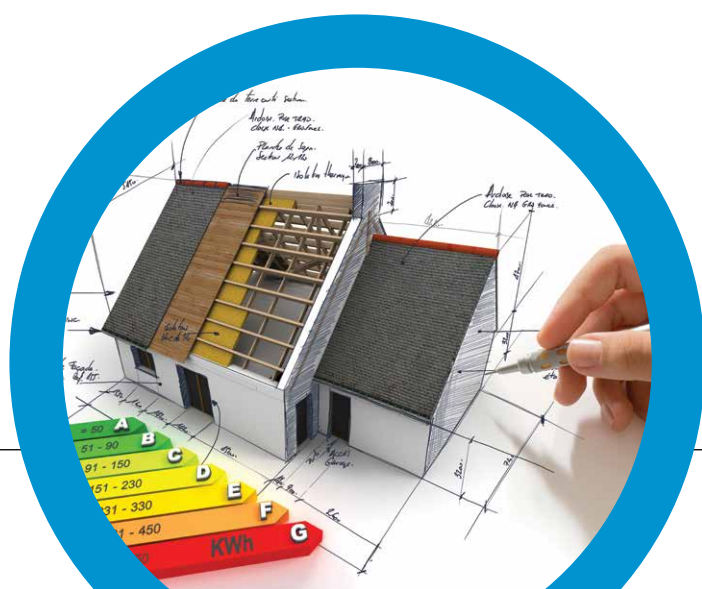
- **Technical**
- **Financial/Economic**
- **Social barriers among home occupiers**
- **Organisational issues within Social Housing providers**
- **Regulatory/Legal**

Details of barriers to retrofit identified in a review of key reports are given in the tables below together with report references. References are listed in Section 8.2.

These barriers have been confirmed and reinforced in interviews with experts and participants in the retrofit agenda.

7.1. TECHNICAL	REFERENCES
<p>The complexity and diversity of building types and conditions requires unique solutions, making it hard to bring down costs:</p> <ul style="list-style-type: none"> ■ The UK has the oldest and coldest housing stock in Europe ■ 70% of the housing stock does not reach EPC grade C ■ We have a wide range of construction types, many of which have been substantially extended and modified 	<p>1, 3, 4, 9, 11, 12</p>
<p>Supply chain capacity and organisation. Although there are good technical solutions for deep retrofits there is:</p> <ul style="list-style-type: none"> ■ A limited supply of people who understand and can design deep retrofits. ■ Not enough tradespeople with the right skills to deliver at scale. ■ A lack of integrators in the supply chain. ■ A limited range of technical solutions ■ A lack of manufacturing facilities for prefabrication 	<p>1, 2, 4, 9, 10, 11, 12</p>
<p>Confidence in performance in use– lack of evidence that retrofit will be successful and deliver projected benefits.</p>	<p>1, 2, 3, 10, 12</p>
<p>Existing methods for calculating expected energy consumption are not adequate for the challenge of designing solutions for a diverse housing mix. Lack of models for the interactions and influences of various elements of city infrastructure.</p>	<p>1, 7</p>
<p>Understanding interaction with the rest of city infrastructure</p>	<p>5, 7</p>
<p>High costs – due to lack of demand, costs for deep retrofits have not reduced in the same way as for wind and PV.</p>	<p>1, 2, 6, 10, 11</p>

7.2. FINANCIAL/ECONOMIC	REFERENCES
<p>Poor return on investment. Seen in purely economic terms, and using current models, the payback time for many interventions is too long. This is particularly an issue for owner occupiers who are looking for materially-reduced costs and increased property value. Economic studies have shown that deep retrofitting has a payback for the whole economy roughly equivalent to major infrastructure projects, but the return is spread over many areas and the costs fall on the owners.</p>	3, 4
<p>Unreliable return on investment. Because of rebound in energy use, installation and commissioning problems, and unreliability of new technologies, there is uncertainty about whether projected returns will be realised.</p>	1, 3, 4
<p>Access to finance. Because of weak theoretical returns on investment, and uncertainty about benefits in practice, finance can be difficult to obtain unless there are specific incentive schemes in operation. Retrofit projects are not packaged into large enough investments with standard terms to attract finance markets.</p>	2, 5, 7, 10
<p>Absence of project ‘developers’ who would package projects that were bankable and deliverable at sufficient scale to attract investors. Many trial schemes have failed because they did not have a sustainable business model.</p>	2, 10
<p>Costs are currently too high for available funding mechanisms. Front-loading of capital investment is needed to deliver deep retrofit. Even if funds are available over time the phasing may be wrong.</p>	5



7.3. SOCIAL	REFERENCES
<p>Lack of demand from housing users is driven by multiple factors:</p> <ul style="list-style-type: none"> ■ Lack of awareness of the benefits of retrofitting ■ Lack of information about options for retrofitting ■ Lack of interest in energy efficiency ■ Preference for investment elsewhere ■ Resistance to change in habits or lifestyle ■ Concerned that the property may be 'damaged'; for example, by reducing room sizes through interior insulation, or damp and fire hazard from external cladding (cf grenfell tower). 	<p>1, 3, 4, 6, 8, 9, 10, 11</p>
<p>Lack of financial incentives for owners – e.g. subsidies or reduced taxes.</p>	<p>1, 3, 6</p>
<p>Lack of trust – occupiers may be suspicious of the motives of those advising retrofit, unconvinced that the benefits will actually be delivered, and worried about 'cowboy' builders. The Grenfell Tower disaster has increased concerns about the safety of energy efficiency retrofit.</p>	<p>1, 3, 8, 9, 10</p>
<p>Hassle factor – retrofitting is seen as a major and intrusive intervention in the property. Users expect significant disruption and inconvenience for a benefit which may prove illusory.</p>	<p>1, 2, 3, 4, 8, 9</p>
<p>Ownership – in the rental market the landlords meet the cost and the tenants reap the benefit. This is a major barrier in the private rental sector.</p>	<p>1, 4, 7,9</p>



7.4. ORGANISATIONAL	REFERENCES
Local Authorities may have other priorities. For example, there is a current focus on new-build to address the ‘housing crisis’. High-quality, low-carbon housing is not a strategic priority.	2, 5
Procurement regulation and practice is perceived as a major barrier to retrofitting projects.	2, 5
Perceived risk – large-scale deployment of new and relatively untried approaches to retrofitting appears to make large-scale projects very risky.	2, 5
Low awareness of the financing options and lack of skills to access.	2, 5, 7, 10
Ownership – in the rental market the landlords meet the cost and the tenants reap the benefit. This is a major barrier in the private rental sector.	5
Siloed organisations – split responsibilities for various aspects of regeneration retrofitting across multiple departments makes it difficult to coordinate and integrate activity.	5, 11
Slow and complex decision-making – complex siloed organisations with multiple levels, together with lack of leadership, slows down decision-making.	5
Lack of top-level commitment – leadership commitment is essential to enable alignment of all the players within a city or local authority.	5
Lack of evidence and showcases – in order to gain commitment and belief people need to be able to see and touch exemplars.	6
Building partnerships for delivery – it is not only necessary to break down silos within an authority, a new set of external partners are required for effective delivery.	7, 10, 11
Lack of systems vision – because of the interaction of city systems, city leadership and management need a vision of how their city will operate in an integrated, sustainable and successful way.	7
Lack of long-term (30-year) strategies - short-term strategies encourage inappropriate interventions that will need to be replaced later.	



7.5. REGULATORY/LEGAL	REFERENCES
<p>Planning issues - conservation areas, listed buildings etc. Planning rules and policies may not be conducive to large-scale retrofit.</p>	<p>1,2, 4, 8, 12</p>
<p>Procurement standards need to be available and promoted that enable complex, shared, public and private schemes to be developed.</p>	<p>5</p>
<p>Current regulation/policy does not give a clear direction – central government has experimented with regulation to drive improvement in the housing stock, but has now pulled back.</p> <p>At present it is giving no clear direction on future requirements. Current policy encourages short-term interventions that will need to be replaced to achieve 2050 targets – e.g. condensing gas boilers are a step forward for many homes but cannot deliver 2050 targets.</p>	<p>6</p>
<p>Lack of reliable incentive schemes – money has been periodically made available to support retrofitting and housing improvement, but the intention, level and targets have been subject to regular change.</p>	<p>6</p>
<p>No stability in regulatory/policy environment – business has been unwilling to invest in developing supply chain and delivery capability because of the lack of policy continuity from central government.</p>	<p>6</p>
<p>FCA rules barrier to lending by cities for retrofit</p>	<p>10</p>



8. APPENDIX 2 METHODOLOGY, REFERENCES AND RESOURCES

8.1. METHODOLOGY

Background material for this whitepaper was obtained in two ways:

- A review of relevant reports on retrofitting for energy efficiency
- Interviews with experts, organisations and businesses involved in the housing and retrofit sector

Reports consulted are listed in Section 8.2 and organisations interviewed in Section 8.3.

8.2. REPORTS AND REFERENCES

1	"Breaking Barriers" report, National Energy Foundation & Energy Efficiency Partnership for Buildings, 2014
2	"Domestic Retrofit 2015", report, RE:NEW, NEF and University Salford, 2015
3	"Domestic UK Retrofit Challenge", Dowson, Poole, Harrison and Susman, Energy Policy, 2012, 50, 294-305
4	"Domestic UK Retrofit Challenge", presentation, Dowson and Poole, Buro Happold
5	"D1.13 Report on Non-Technical Barriers and Legal and Normative Issues", report, REMOURBAN, 2016
6	"Warmer and Greener", report, Policy Connect for Westminster Sustainable Business Forum, 2016
7	"Retrofit 2050: critical challenges for urban transitions", report, Cardiff University for EPSRC Retrofit 2050 programme, 2014
8	"Retrofitting in the private residential and commercial property sectors - survey findings", report, Britnell and Dixon, Retrofit 2050, 2011
9	"Breaking Down Barriers to Achieve UK Domestic Energy Efficient Retrofit at Scale; lessons to be learned from the German policy", Gooding and Gul, paper presented at "Beyond Globalisation: remaking housing policy in a complex world", Edinburgh, 2014
10	"Regeneration and Retrofit", report, UK Green Building Council, 2017
11	"Retrofit for the Future: a Guide to Making Retrofit Work", report, Innovate UK, 2014
12	"Retrofit Revealed", report, Innovate UK, 2014

8.2. REPORTS AND REFERENCES	
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14	“Experimental deployment of Picardie Pass Rénovation”, presentation, Alice Morcette, 2018
15	“Prospects for land, rent and housing in UK cities”, report, Michael Edwards, Foresight Future of Cities, 2015
16	“City Space Race: balancing the need for homes and offices in cities”, report, McDonald and Bessis, Centre for Cities, 2018
17	“Accelerating investment into energy efficiency”, presentation, Steven Fawkes, BRE Cities Convention, 2015
18	“Where is the money and how to make it flow?”, presentation, Steven Fawkes, Ecobuild, 2017
19	“Welsh Government Warm Homes Arbed EU, Final Report”, report, Ricardo, 2017
20	“Accelerating Green Finance”, report, UK Government Green Finance Taskforce, 2018
21	“Affordable Warmth, Clean Growth”, report, Frontier Economics, 2017
22	“The Clean Growth Strategy: leading the way to a low carbon future”, report, BEIS, 2017
23	“An Independent Assessment of the UK’s Clean Growth Strategy”, report, Committee on Climate Change, 2018
24	“Towards the Delivery of a National Residential Energy Efficiency Programme”, presentation, Chris Jofeh, ARUP, 2016
25	“Invest to Save: applying the concept to cities”, report, Richard Blyth, Foresight Future of Cities, 2014
26	“Smart Systems and Heat: consumer challenges for low-carbon heat”, report, Energy Technologies Institute, 2015
27	“State of the Nation Survey: low energy retrofit in social housing”, report, NEF, Capita & University of Salford, 2017
28	“Retrofit 2050: critical challenges for urban transitions”, report, Eames et al, EPSRC Retrofit 2050, 2014
29	“Delivering and Funding Housing Retrofit: a review of community models”, report, Arup & Institute for Sustainability, 2013
30	“Domestic Energy Services”, report, Energy Technologies Institute, 2018

8.2. REPORTS AND REFERENCES

31	“Energy efficiency in the British housing stock: Energy demand and the Homes Energy Efficiency Database”, Hamilton et al, Energy Policy, 2013, 60, 462-480
32	“Energy efficiency uptake and energy savings in English houses: A cohort study”, Hamilton et al, Energy and Buildings, 2016, 118, 259-276
33	“Good practice in energy efficiency”, report, European Commission, 2017
34	“Future of Cities: Foresight for Cities A resource for policy-makers”, report, Foresight Future Cities, 2016
35	“Housing Retrofits – a new start”, report, Energy Technologies Institute, 2016
36	“How Can People Get the Heat they Want at Home, Without the Carbon?”, report, Energy Technologies Institute, 2018
37	“Kirklees Warm Zone Scheme: End of Project Process Evaluation Report”, report, Kirklees Council, 2011
38	“Introduction to the Low Carbon Domestic Retrofit Guides”, report, Institute for Sustainability, 2011
39	“UK Scenarios for a Low Carbon Energy System Transition”, report, Energy Technologies Institute, 2015
40	“Optimising Thermal Efficiency of Existing Housing: Whole House Solutions Report”, report, Energy Zone Consortium, 2011
41	“Towards the delivery of a national residential energy efficiency programme”, report, Arup, 2016
42	“Responsible Retrofit: rethinking quality”, report, Sustainable Homes, 2018
43	“Regeneration and Retrofit”, report, UK Green Building Council, 2017
44	“We Can Make: civic innovation in housing”, report, Mean, White & Lasota, 2017
45	“Carbon Emissions in the UK Built Environment”, 2050 Low Carbon Construction Routemap, Arup, 2016
46	“Industrial Strategy – Construction Sector Deal”, report, HM Government, 2018
47	“Construction 2025”, report, BIS, 2013
48	“Delivering Low Carbon Infrastructure”, report, UK Green Building Council, 2017
49	“The Clean Growth Strategy”, report, HM Government, 2018
50	“Building a Safer Future Independent Review of Building Regulations and Fire Safety: Final Report”, report, HM Government, 2018

8.3. INTERVIEWS AND ACKNOWLEDGEMENTS

The IET would like to thank Richard Miller of Miller-Klein Associates and Marjan Sarshar of Nottingham Trent University for their efforts in authoring this white paper. We are also grateful to the following organisations for offering their time and expertise to develop the report.

ORGANISATION		WEBSITE
1	AREBS - Association de Redéploiement Economique du Bassin Sérésien	http://www.arebs.be/
2	Arup	https://www.arup.com/
3	Association of Environmentally Conscious Builders	https://www.aecb.net/
4	Building Performance Network	https://building-performance.network/
5	Centre for Cities	http://www.centreforcities.org/
6	Dept for Business Energy and Industrial Strategy	https://www.gov.uk/government/organisations/department-for-business-energy-and-industrial-strategy
7	Energiesprong UK	http://www.energiesprong.uk/
8	Energy Institute, University College London	https://www.ucl.ac.uk/bartlett/energy/
9	Energy Pro Ltd	https://www.energyproltd.com/
10	Energy Systems Catapult	https://es.catapult.org.uk/
11	Future Cities Catapult	http://futurecities.catapult.org.uk/
12	Innovate UK	https://www.gov.uk/government/organisations/innovate-uk
13	Investor Confidence Project	http://www.eepformance.org/
14	KTN	https://www.ktn-uk.co.uk/
15	Leeds City Council	https://www.leeds.gov.uk/
16	Melius Homes	https://www.meliushomes.co.uk/
17	National Energy Foundation	http://www.nef.org.uk/
18	Nottingham City Council	http://www.nottinghamcity.gov.uk/
19	Nottingham City Homes	http://www.nottinghamcityhomes.org.uk/
20	Oxford City Council	https://www.oxford.gov.uk/
21	UK Green Building Council	https://www.ukgbc.org/
22	White Design	https://www.white-design.com/

ADDITIONAL PARTNERS



Nottingham City Homes manages homes for Nottingham City Council, as well as its own homes and homes owned by other landlords. Around 27,500 homes are under NCH management, and a fifth of Nottingham households live in an NCH managed property.

Find out more at www.nottinghamcityhomes.org.uk



REMOURBAN is a five-year, European-funded project which involves many partners across Europe working together to achieve a sustainable urban regeneration model leveraging the convergence of energy, mobility and ICT to transform European cities into Smart Cities.

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Find out more at www.remourban.eu



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