

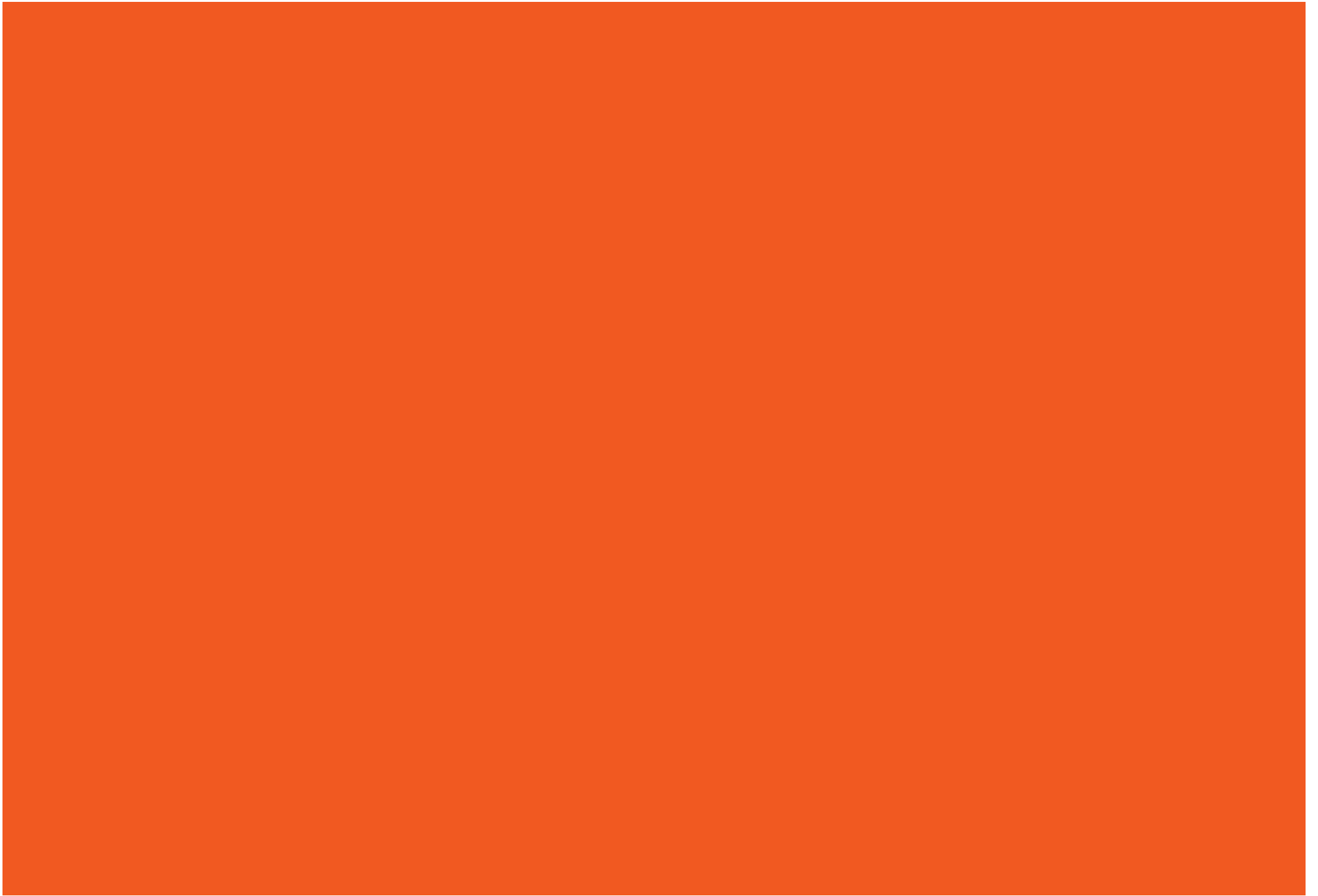
ARUP

Towards the delivery of a national residential energy efficiency programme

Creating the right conditions to halve the energy consumed in all UK homes within 25 years

May 2016





Contents

This report presents an overview of what needs to be done. More details and extensive references can be found in the appendix to this report, which can be downloaded from www.arup.com/residentialretrofit. A single page summary can also be downloaded from the same address.

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Foreword

In November 2014 I challenged Arup to lead the development of a plan to reduce the energy consumed in all our homes. I am now pleased to write this foreword to the Arup plan.



Lord Deben

The CCC, which I chair, believes that:

- Reducing emissions and adapting to the impacts of climate change provide the opportunity to drive innovation, support growth, contribute to improved health, develop effective and resilient infrastructure and minimise the disruptions caused by flooding, water scarcity and other climate change risks
- The most cost-effective approach to dealing with climate change requires steady progress over many years
- National government needs to develop plans and policies that deliver low-carbon heat and energy efficiency, whilst also addressing the increasing risks of heat stress and flooding, and that
- Current ambition and funding commitments are inadequate for meeting carbon budgets and further funding is likely to be needed to meet the proposed EPC targets

Some would have liked Arup to define in some detail what a national programme would look like. However, their research and analysis showed that the better way would be to set down a sensible set of affordable steps that can be taken to create the conditions across the UK in which:

- a) the relevant people and organizations (both public and private sector) do know what needs to be done,
- b) they are ready to do so in an organised way,
- c) industry has the confidence to invest and innovate, and
- d) home owners and landlords choose to improve the energy efficiency of their properties, and find it easy to do so.

This will only succeed when there is long-term cross-party support for policies to improve the energy efficiency of homes and reduce substantially residential energy demand.

This report makes the case strongly that residential energy efficiency should be designated as a national infrastructure priority. Scotland has already taken this step, the rest of the United Kingdom should follow.

I commend the Arup report to the UK's national and devolved governments, city governments and local authorities.

A handwritten signature in black ink, appearing to read 'Deben', with a horizontal line underneath.

Summary

This report contains our recommendations for a coordinated set of activities that will enable the UK to halve its residential energy consumption. An important component is a series of large-scale pilots to test ideas and to maintain retrofit activity while the future direction of the UK's energy efficiency policies is being determined.

Our recommendations are principally directed at national government, devolved administrations and the political parties. The report aims to:

- Make a case for modest investment in research and in preparing business cases for HM Treasury (HMT)
- Facilitate planning and budget-setting for the work needed to catalyse a national-scale residential retrofit programme
- Identify and cost key components of the programme and its enabling projects
- Provide the context for subsequent investments

The UK is well placed to improve the energy efficiency of all its homes, because:

- Excellent primary legislation is in place
- There is a huge amount of data that can be used to inform the planning and delivery of a national residential retrofit programme
- Lessons can be learned from work undertaken around the world over the past two decades

Addressing the challenge

Well over 80% of the UK's housing stock of about 28 million homes will still be standing in 2050.

According to the Department of Energy and Climate Change (DECC), the residential sector is responsible for just under one third of the UK's energy use and carbon emissions. So reducing the energy consumption of existing homes is important in meeting the UK's statutory 2050 decarbonisation target.

Almost 18 million of the UK's 28 million homes are owner-occupied and a further 5 million are owned by private landlords. The remaining five million are owned by social landlords.

A major challenge for any national programme will be the differing priorities and constraints facing social landlords, private landlords and owner-occupiers. A range of measures is needed to address this.

A national residential retrofit programme will intersect with policy and legislation, cut across departmental and devolved boundaries, and will involve influencing every household of every tenure. In the need to change behaviours it has some similarities to public health campaigns such as drink-driving or smoking; and it has similarities with the digital switch-over in ensuring a mass technology shift.

Compulsion may be needed in particular circumstances. This was recognised by the recent Minimum Energy Efficiency Standards for UK rented properties and the Scottish Energy Efficiency Standard for Social Housing.

Many large-scale residential retrofit schemes have been undertaken at home and abroad. We have studied these and consulted with contractors, campaigners, academics, funders, government departments, devolved administrations, local authorities and housing associations.

Substantially reducing the energy consumption of existing homes is a complex problem and further work is required to determine the best course of action.

- It may take as long as 25 years to halve the energy consumed in UK homes
- Consistent effort and direction from successive governments will be needed
- The public sector must initiate the programme, provide some of the early investment and create the right governance structure
- Funding models that leverage private investment, recycle government capital, and reduce the cost of financing must be created
- Businesses must develop the right products and services

Summary

For a homeowner or landlord, improving the energy efficiency of a home should not be any harder than choosing, installing and paying for a new kitchen. For the construction industry, there should be no energy-efficiency ‘performance gap’.

Retrofit

Measures applied to existing homes are often referred to as retrofit. In addition to schemes to deliver low-carbon district heat, work in individual homes will include some or all of:

- Improving insulation
- New glazing and draught-proofing
- Installing new energy-efficient appliances
- Installing smart energy controls
- Installing renewable energy technologies
- Providing storage and control of energy from renewable sources

In this report, retrofit refers to work that leads to a reduction in energy used for heating, cooling, ventilation, hot water, lighting, installed equipment and appliances of at least 50%. This target is achievable and consistent with the UK’s goal of an 80% reduction in GHG emissions by 2050.

Holistic thinking

The focus on homeowners and landlords who can afford to pay does not mean ignoring those who cannot, or the contribution that district energy schemes can make. Both of these are essential aspects of a national programme, and need to be considered together. Policies, standards and regulations for new build and retrofit need to be considered holistically. It makes no sense to allow new new homes to be built that will require substantial retrofitting in ten years’ time.

Scale

Creating and maintaining demand at scale will give investors confidence, spur innovation and reduce costs – making retrofits affordable.

The Welsh Arbed scheme and the work of Fusion21 point the way forward. They show that efficiencies gained from aggregating spending can create large-scale, effective and affordable retrofit programmes that can be delivered by local supply chains.

But how do you begin to create demand at a national scale? One promising solution is for the public sector to take the lead by subsidising and organising retrofitting of the four million or so energy-inefficient households that are in, or close to, fuel poverty.

This will require funding from multiple sources, including the Treasury. Maximising tax revenues for the Treasury will also be important, so that any investment of public funds is repaid with interest.

Technology

To maximise private investment in the deployment of technology, government must be clear on the long-term direction of policy.

Skills and supply chains

Demand at this scale would start to improve skills and supply chains, and lower costs. Once costs start to come down and those able to pay see that it works, then market development is more likely to be self-sustaining.

A meaningful commitment of work over a long period drives competitive pricing. It also improves credit terms. And it encourages recruitment and retention of a directly employed workforce, as well as investment in training and apprenticeships. The result is a sustainable workforce.

Creating the necessary conditions will take time, and there is a risk that government support for residential retrofit will dwindle during that time. If this happens, industry could lose the necessary skills. We recommend some early pilot projects around the UK to help address this.

Funding

For the homeowners and landlords who are able to pay, an unprecedented level of public-private collaboration will be required. Public funds and incentives should be blended with private sector investment to address the risks and achieve financing on the scale needed.

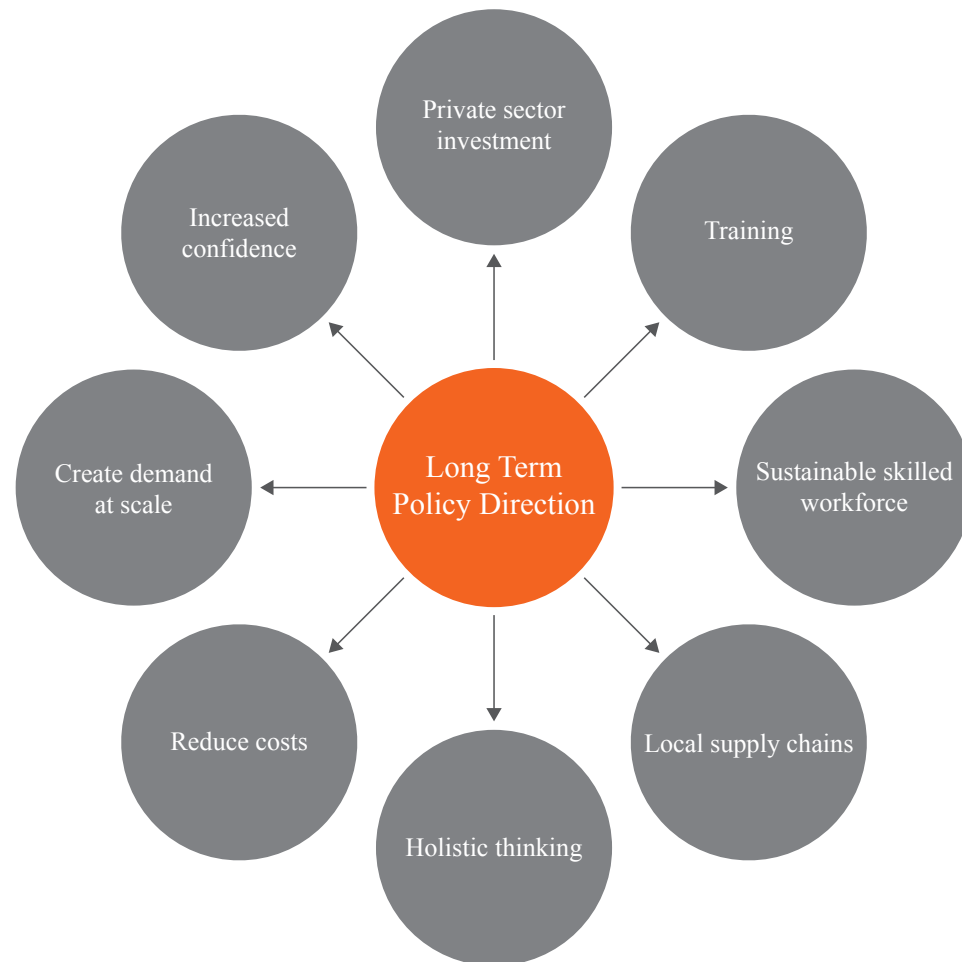
Summary

Investors

Aggregation is key – by pooling projects owned by the same client and by bundling projects owned by multiple clients. This will reduce transaction costs for due diligence processes and ensure projects are attractive to investors. Fusion21 in Liverpool has pioneered bundling of demand for products and services to create demand at scale and reduce costs.

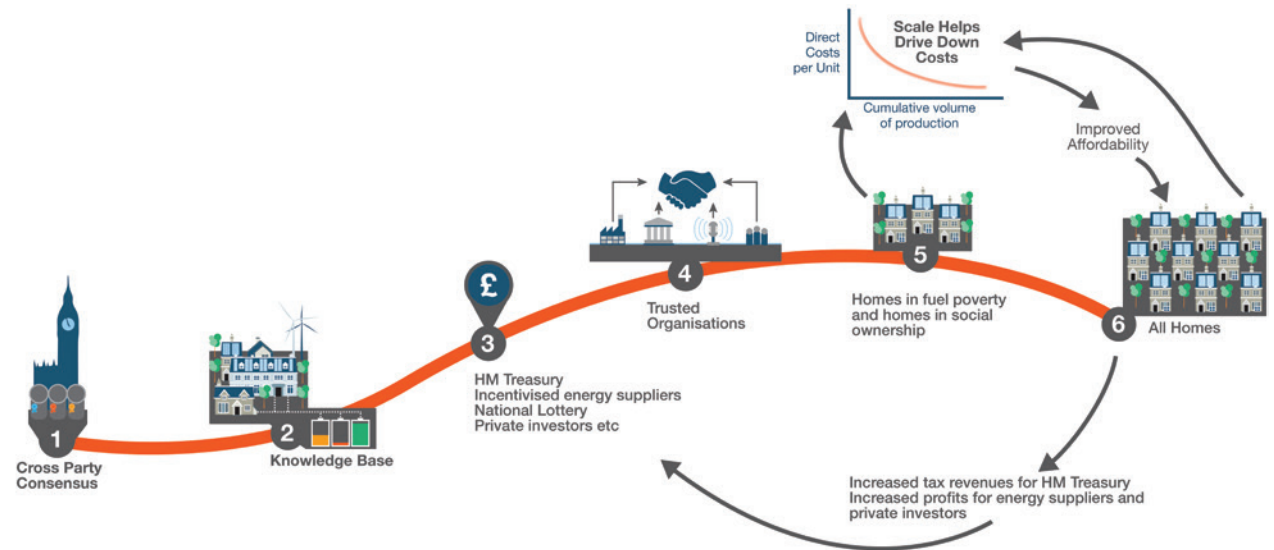
Work is underway in Europe and the USA to unlock access to financing for the building renovation market by standardising the way in which energy-efficiency projects are developed and measured. Streamlining transactions and making projected energy savings more reliable will help to build a marketplace for standardised energy-efficiency projects. Individual projects can then be aggregated and traded by institutional investors on secondary markets – just like mortgages or other asset-backed securities.

The largest utility company in the USA has just launched a new pilot scheme that aims to accelerate energy efficiency retrofits by the use of standardized protocols and certification designed to make the projects more attractive to investors and homeowners alike.



Summary

The goal of the energy-efficiency programme is to make 28 million homes warmer in winter and cheaper to run, halving their total energy demand and greenhouse gas emissions in 25 years. To achieve this, the programme needs the six main components detailed below.



The main components of a national residential energy efficiency programme

1. Cross-party consensus

To establish a long-term approach to the energy-efficiency challenge, a cross-party consensus on an integrated and enduring policy approach across the built environment is needed. An energy-efficiency programme would qualify as infrastructure development under the criteria set out by HM Treasury. Making energy-efficiency a national infrastructure priority is also supported by leading UK business associations and businesses, including the Confederation of British Industry. So it's encouraging that four of the main parties had this in their general election manifestos.

Successive business cases will be needed:

- To make the case for public sector investment
- To appraise the main options for service delivery
- To provide national and devolved governments with a roadmap for policy and regulation.

2. A robust knowledge base

The design of the programme must be based on knowledge of:

- How to create customer 'pull' from those able to pay
- Which retrofit measures are best for different property types and occupancies
- How to manage such a large-scale programme
- How to encourage innovation
- How best to fund energy-efficiency improvements for those unable to pay
- How to attract private funding and investment
- What skills gaps exist and where, so that a provider strategy can be developed

3. Aggregated funding

Spending on cold weather payments, the winter fuel allowance and the warm homes discount amounts to almost £3bn per year. But direct cash funding to help with bills is like giving people £10 notes to burn to keep warm.

Publicly funded improvements to around four million homes will cost at least £20bn over a decade. It will be necessary to aggregate funding from EU structural funds, the devolved administrations, local authorities, housing associations, energy companies, the National Lottery and HM Treasury.

The experience of Revenue Decoupling in the USA also has lessons for the UK. US regulators incentivise energy suppliers to help their customers save energy, rather than obliging them to do so.

4. Trusted organisations

Who should be the public face of the programme? Organisations that are experienced in dealing with the public and with retrofit at scale, that understand home improvements, and are local. Housing associations, local authorities and some social enterprises fit the bill.

Not all will want to become involved or be able to do so. Some will need help from the private sector because of the scale of the task, and those involved will change over time – partly in response to public feedback on their performance.

Summary

A national residential energy-efficiency programme requires excellent leadership and management. While there are similarities to other major projects such as London 2012 or the installation of smart meters in every home, the task is bigger, longer lasting and more complex.

5. Retrofit of homes in fuel poverty

The UK has about four million homes in or close to fuel poverty. The enormous demand created by improving these in ten years, combined with the confidence provided by cross-party consensus, will enable industry to invest, innovate and drive down costs.

6. Retrofit of all homes

By the time the initial four million homes have been tackled, millions of homeowners and private landlords will find it easy, affordable and desirable to improve the energy efficiency and comfort of their homes.

All homes are unique, but most share many characteristics with others of similar type built at the same time, in the same region of the country. We need to find common solutions that can be delivered with minimal waste by mass customization.

Over 25 years nearly all properties will undergo extensive refurbishment. Part of the challenge is to ensure that this includes measures to make them more energy-efficient.

No. of dwellings (mean useable m ²)	Pre-1850	1850-1899	1900-1918	1919-1944	1945-1964	1965-1980	1981-2002	2003-2010	All ages
Terraced	 185,000 (110)	 1,088,000 (89)	 1,150,000 (88)	 1,036,000 (79)	 920,000 (79)	 1,049,000 (80)	 691,000 (71)	 236,000 (93)	6,356,000 (83)
Semi-detached	 154,000 (149)	 327,000 (121)	 307,000 (120)	 1,731,000 (93)	 1,754,000 (89)	 922,000 (87)	 539,000 (76)	 126,000 (90)	5,860,000 (94)
Detached	 279,000 (208)	 176,000 (172)	 130,000 (190)	 449,000 (160)	 492,000 (147)	 804,000 (133)	 1,210,000 (134)	 256,000 (153)	3,796,000 (149)
Bungalow	 18,000 (*)	 30,000 (*)	 13,000 (*)	 195,000 (79)	 594,000 (75)	 698,000 (77)	 389,000 (91)	 60,000 (80)	1,996,000 (78)
Converted flat	 105,000 (83)	 450,000 (63)	 263,000 (62)	 101,000 (63)	 22,000 (*)	 5,000 (*)	 2,000 (*)	 * (*)	948,000 (65)
Purpose-built low-rise flat	 3000 (*)	 79,000 (71)	 96,000 (73)	 216,000 (57)	 541,000 (57)	 938,000 (56)	 797,000 (50)	 370,000 (58)	3,039,000 (56)
Purpose-built high-rise flat	 1,000 (*)	 3,000 (*)	 8,000 (*)	 21,000 (*)	 73,000 (52)	 187,000 (58)	 23,000 (*)	 74,000 (62)	391,000 (58)
All types	744,000 (150)	2,153,000 (94)	1,967,000 (95)	3,751,000 (93)	4,397,000 (87)	4,602,000 (84)	3,650,000 (89)	1,112,000 (92)	22,386,000 (92)

Residential typologies by BRE © IHS, reproduced with permission from BRE FB 71, The age and construction of English homes

1. Introduction

The UK has about 28 million homes, of which almost 18 million are owner-occupied. About 30% of all the energy consumed in the UK is consumed in homes – consumption that is responsible for around 30% of the country’s greenhouse gas emissions.

To meet the UK’s 2050 greenhouse gas emissions target, total energy consumption needs to be significantly reduced and the energy supply decarbonised. The two go hand in hand.

Halving the energy consumed in all homes is a major challenge, but it will bring tremendous economic, social and environmental opportunities. The UK is well placed to undertake this and reap the rewards, but success requires careful planning, based on hard evidence.

Pioneers of low-carbon renovation such as Innovate UK’s *Retrofit for the Future* project show that reductions in residential CO₂ emissions of as much as 80% are achievable, but only with very high standards of design and installation, and integration of energy system components. New technology can help, but other issues need addressing: a lack of technical knowledge; poor communication skills within project teams; and unclear boundaries between roles and responsibilities.

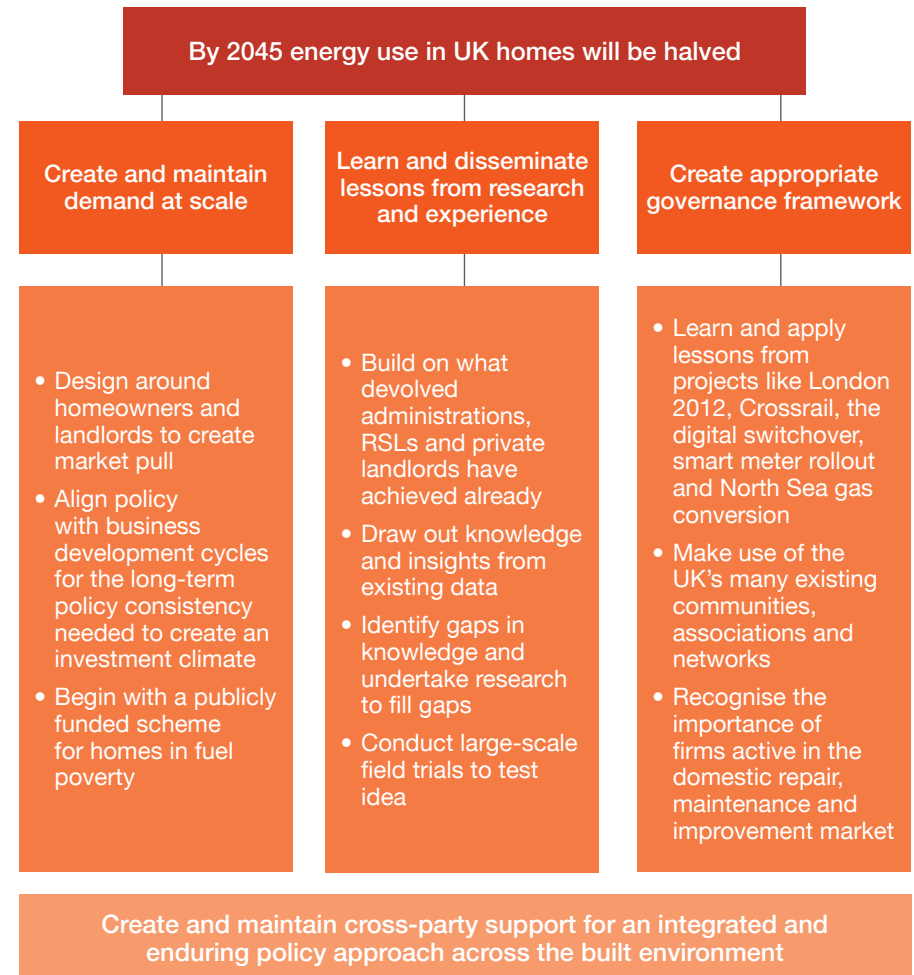
In this report we outline a plan for creating the conditions in which the energy consumed in all homes will be halved in 25 years. We begin with a description of the benefits this will bring.

Then we describe the actions needed to create the three building blocks of a national residential energy-efficiency programme:

1. Create and maintain demand at scale
2. Learn and disseminate the lessons from research and experience, especially from schemes that did not perform as intended
3. Create the right governance framework.

As shown in the figure opposite, each building block requires a series of underpinning actions.

In section five, we identify the first steps. These are the things that will start to make a difference and can begin immediately.



Strategic framework for national residential energy efficiency

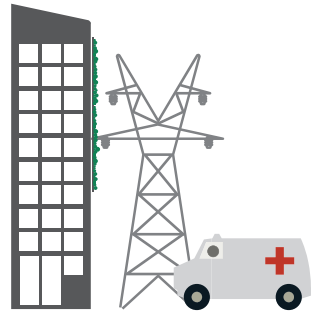
2. Benefits for the UK

A national residential energy-efficiency programme, properly designed and managed, can deliver enormous benefits to the whole of the UK.



Benefits for the UK

- Increased GDP
- Increased tax revenues
- Improved energy security, with a more resilient economy that relies less on fossil fuels and imported gas
- Improved UK balance of payments
- A better balance of responsibilities for economic development between central and local government, and between government and the private sector
- Substantial progress towards the UK's 2030 and 2050 targets for reducing greenhouse gas emissions
- Compliance with the statutory obligations to eradicate fuel poverty
- Enables the electrification of heat and transport



Benefits for the public sector

- Reduced demand on the NHS and social care
- Reduced benefit payments
- Less investment needed in generating capacity and future grid or network reinforcement
- Neighbourhood improvement
- Regeneration of public housing estates
- Lower social (and private) rent arrears



Benefits for families and businesses

- Higher employment and higher incomes
- Improved quality of life thanks to lower energy bills and improved environments
- Physical and mental health benefits with the elimination of fuel poverty (particularly for children, disabled and elderly people)
- Improved learning, because children learn better in warm homes
- Opportunity to future-proof homes against climate change
- Opportunity to improve home security
- A market for UK firms supplying the construction sector with innovative energy-efficiency products and services
- Enhanced skills base

3. Creating and maintaining demand at scale

The goal of the activities outlined in this report is to create the conditions in which millions of homeowners and landlords choose to improve their properties to reduce energy consumption, and find it easy to do so.

In recent years a fluctuating policy environment has made it difficult for the private sector to play a part in reducing energy demand. Policy measures have not been maintained long enough for behaviour to change or for services to adjust at the required scale. The frequent changes, or indications of changes, have damaged the confidence of investors.

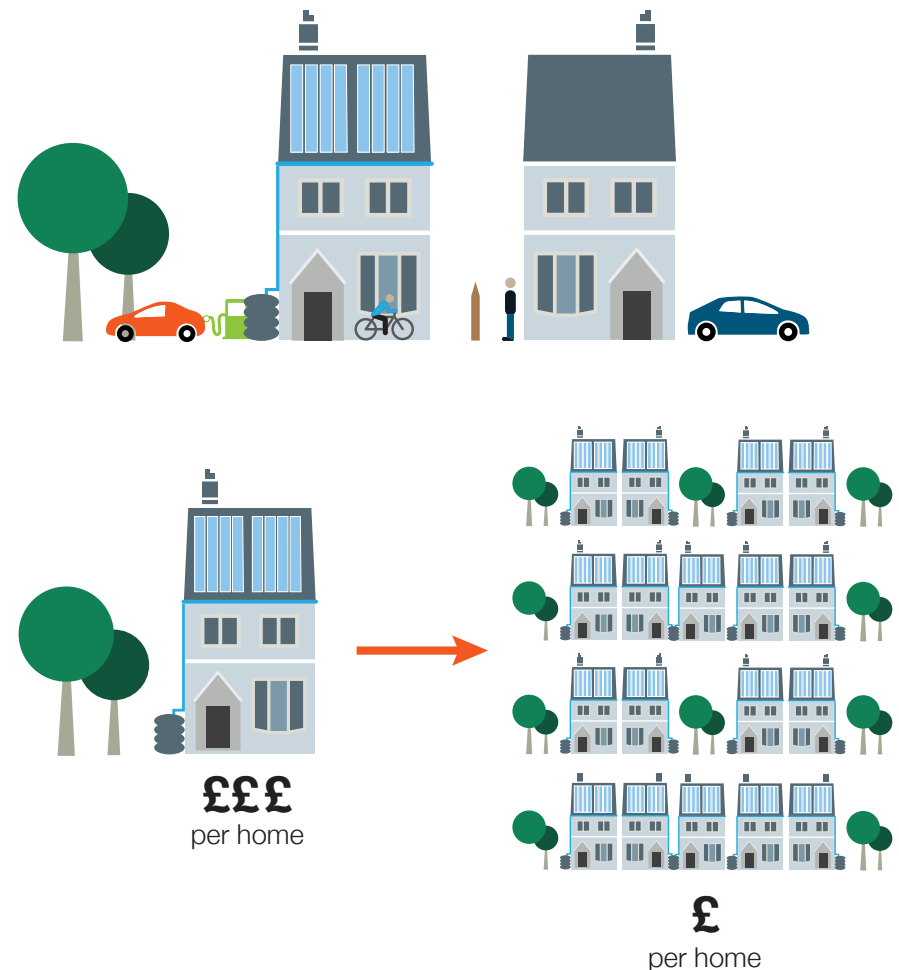
Local authorities and housing associations have been disillusioned and angered by the withdrawal of subsidies at relatively short notice. This has left them unable to implement contracts that they had drawn up at considerable cost. And supply chains have been similarly disrupted.

In contrast, real prospects for growth in a market drive innovation. A sustained and mature market then drives the reductions in costs needed to make whole-house retrofits affordable to millions of families.

Buying at scale has led to unit price reductions for both local authorities and housing associations. Scale also encourages a copycat effect; not falling behind one's neighbours can be a powerful spur to action.

Many attractive energy-efficiency investments will be small and distributed across large numbers of homes. So potential energy-efficiency investments need to be aggregated into large pools of conforming projects to create enough demand and spread risk at a portfolio level.

Work underway in Europe and the USA seeks to create a consistent and transparent process that promotes market development by increasing confidence in energy efficiency as a demand-side resource.



4. Creating the right conditions

Although the UK is well placed to undertake a national residential energy-efficiency programme, not all the foundations are in place.

Any programme will need to evolve over time so flexibility and adaptability must be built in from the start. A stable and credible policy framework within which a national programme can flourish is also essential.

With this in mind, the creation phase will:

- Build on what has been achieved already, and on what is underway
- Use existing data to create new insights and knowledge, and undertake research to fill any gaps
- Introduce a quality framework to drive up and enforce minimum standards (following the recommendations of the forthcoming Bonfield Review)
- Build on the many UK associations and networks that could play an important role in a national residential energy-efficiency programme
- Design around the customers to create market pull
- Design carefully targeted financial assistance for those in or close to fuel poverty
- Implement standards for the documentation of energy-efficiency investments to make it easier for the private sector to invest in large portfolios of residential energy-efficiency projects
- Encourage industry to apply the principles of lean manufacturing and mass customisation to retrofit
- Design feedback mechanisms that make the programme self-correcting and improving



4. Creating the right conditions

Build on what has been achieved already, and on what is underway

Use existing data to create new knowledge, and undertake research to fill any gaps

Data alone is of little value. But if data can be contextualised, information may be created, and insights derived. Knowledge can be generated, which informs strategy and policy.

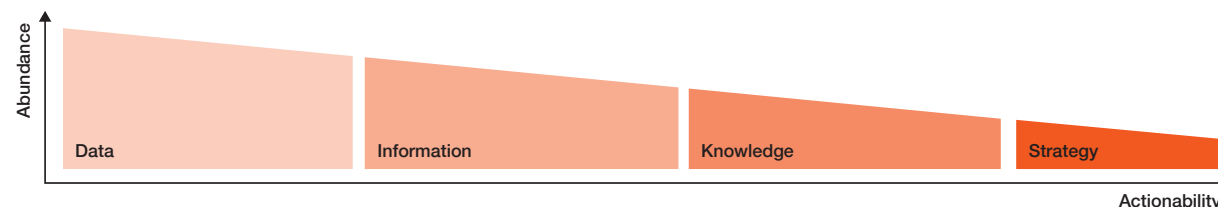


Diagram adopted from Nissen, M. E., ed., 2006. *Harnessing Knowledge Dynamics: Principled Organizational Knowing & Learning*. IRM Press

Around the country there are valuable examples of energy-efficiency retrofit activity at a significant scale. They are mostly undertaken by local authorities, social landlords and devolved administrations, but there are also some by landlords in the private rented sector. Some schemes have been designed to be expanded and adopted by neighbouring bodies.

Housing associations have published significant research. There are valuable lessons (both successes and failures) to apply to a national programme. The appendix contains a small selection of the many exemplary programmes that exist across the UK.

It is particularly important to understand why certain measures have not always worked as intended and how different measures interact. There are likely to be unavoidable trade-offs but a more integrated approach to decision-making could ensure these are dealt with explicitly, the co-benefits optimised, and the negative impacts reduced.

It will be essential that researchers have access to data from smart meters to provide the feedback necessary to understand what is working well and what needs improving.

The providers of pay for performance energy efficiency schemes will also need that data so that they can be paid according to the difference between metered usage and adjusted baselines, aggregated on a portfolio basis.

The UK has a huge amount of data relating to the energy efficiency of homes, including:

1. Homes Energy Efficiency Database (HEED)
2. National Energy Efficiency Data-framework (NEED)
3. ONS construction industry statistics gathered for BIS
4. DECC publishes national and official statistics covering energy, climate change, energy efficiency, fuel poverty and related areas. The National Household Model, built by CSE for DECC, is a domestic energy policy modelling and analytical tool covering the whole of Great Britain
5. The Energy Saving Trust's *Home Analytics* service
6. The energy suppliers' meter point gas and electricity data
7. English Housing Survey
8. Scottish House Condition Survey
9. Welsh House Condition Survey
10. Northern Ireland House Condition Survey
11. Valuation Office Agency Council Tax data
12. Census data about the UK population and its characteristics
13. Benefits data
14. Local authority housing stock models
15. Housing association asset databases
16. Private landlord asset databases
17. Ordnance Survey data
18. Calnea's residential transaction prices dataset
19. Landmark's Domestic Energy Performance Certificate Register
20. CSE's Open Data
21. Data on the outcomes of retrofit projects – such as *Embed*, which holds data from Innovate UK's *Retrofit for the Future* project
22. NHS data on illness caused by or made worse by living in cold damp homes
23. Residential thermal imaging data

4. Creating the right conditions

Build on existing networks

Many networks exist in the UK that could play an important role in the design and delivery of a national residential energy efficiency programme. We need to identify them and to understand their functions and build on what they do.

Harnessing them requires identifying them, understanding their functions and building on what they do. Then it will be possible to identify the roles that the different networks can play, and the help that they might need.

For example, researchers have identified a large and potentially highly influential group of actors who are currently neglected in the debates which influence policy development and effectiveness: advisers and installers (mostly sole traders, micro-enterprises or small or medium enterprises (SMEs)) involved in the repair, maintenance and improvement (RMI) of existing homes.

The size of the UK's RMI market is large (>£10bn pa) and if a significant fraction of this activity contributed to low carbon retrofit the impact would be considerable.

SMEs and builders' merchants are often a household's first port of call for energy efficiency advice. It is therefore important that policy and delivery go with the grain of the good practice that many are already undertaking, and build upon the knowledge and skills that exist at local level.

The function of networks

Their purpose

- What change they are trying to achieve

Their objectives

These may include:

- community building
- filtering information
- facilitating
- learning
- providing resources
- convening stakeholders

Their geographic area of activity

These may be

- community
- city
- regional
- national
- international



4. Creating the right conditions

Design around the customers to create market pull

Every aspect of the national programme needs to be designed with homeowners, landlords and tenants in mind, and it must be aspirational. A whole-house retrofit where the occupants' health, comfort and wellbeing improve speaks to people more than just a projected reduction in the energy bill.

Designers of the programme should draw on lessons from three workshops organised in 2013 and 2014 by the Royal Academy of Engineering, the Royal Institution of British Architects and Arup. These responded to the desire of the Department for Communities and Local Government (DCLG) to better understand behavioural issues when developing policy for the built environment.

A report on the workshops noted that policy-makers are designers; that policy-making is, at least in part, a creative process; and that the following design principles are relevant to policy-makers and policy-making:

1. View human behaviour in the built environment as a complex socio-technical system
2. Use collaborative methods and tools to involve all key stakeholders, especially end users, throughout the design process
3. Include behavioural issues from the very beginning of the design process, in particular making the behavioural assumptions explicit at the outset
4. During design, explicitly consider key characteristics of all users
5. Make it easy, fun and engaging to create and sustain good habits

6. Ensure the system gives users feedback at the right time and in the right format
7. Empower users to handle problems with the system as they occur
8. Learn and apply lessons from related domains

The lesson for a national residential energy-efficiency programme is very clear: the customer journey is paramount.

No matter how deep their understanding of consumer needs, the designers of a national programme will still not be able to predict with confidence how people will react to what is offered. They must engage with potential customers early and often to get feedback that will improve what is on offer.

This process is similar to iterative rapid prototyping of a manufactured item. It can be a very effective way to give confidence to funders and to the many companies, large and small, whose commitment will be needed to deliver the programme.

Recent experience of estate retrofit has shown the importance of careful management, planning, and clear and consistent communication with residents throughout the process.

Field trials to test the efficacy of different customer journeys for the uptake of energy-efficiency retrofits should be developed. This needs to be done in partnership with DECC, DCLG, the Department for Business, Innovation and Skills (BIS), devolved administrations, local authorities and businesses.

Networks such as Core Cities will have an important role to play in sharing and exploring ideas and best practice, and in driving improvements.

The scheme should not aim to work everywhere from the start. It is much better to begin in selected locations, on smaller projects where quality controls and design fees can be included to get it right. Once lessons have been learned, they can be applied to similar schemes elsewhere, and then to larger and more complex schemes.

4. Creating the right conditions

Make it easy to pay for and invest in energy efficiency

There is no one-size-fits-all solution for stimulating demand through funding models. There are a number of mechanisms for funding and financing energy-efficiency improvements, including market incentives, utility obligations or public-sector supported grant or loan schemes, and on bill financing, sometimes known as pay as you save. Some are more suitable for large-scale retrofit deployment than others. Simplicity and clarity are important.

There are schemes that have successfully funded large-scale energy-efficient retrofits, and schemes that have had lower take-up. These highlight the key principles that should be followed in devising future funding models for a national residential energy efficiency programme.

Any new funding approach, policy or programme should:

- For investors: deliver scale, reduce complexity and provide technical reassurance plus a clear line of sight to a long-term revenue stream
- Facilitate demand by creating value for the homeowner
- Maximise the return to government
- Facilitate demand by providing competitive and affordable finance
- Seek to blend public funds with private sector investment to address the risks and achieve the scale of financing needed
- Engage with mortgage lenders
- Minimise the cost to the consumer and to government

A key driver is sustained or improved asset values. Schemes that incorporate broader capital improvements and modernisation beyond energy-efficiency measures experience a higher take-up.

German development bank KfW (formerly Kreditanstalt für Wiederaufbau) is behind one of the most successful public-sector-supported housing retrofit schemes to date. Every year, it funds between 60,000 and 150,000 energy-efficiency projects. For each euro invested, between two and four euros in taxes levied on the ensuing economic activity go back to the public treasury.

In the Netherlands, among a raft of measures designed to reduce energy consumption, the National Revolving Fund for Energy Efficiency provides very low interest loans to landlords and housing associations for energy efficiency retrofits.

To date, little consideration has been given in the UK to aggregating residential energy-efficiency schemes to meet the needs of private-sector funding.

In late 2013, the European Commission and the United Nations Environment Programme Finance Initiative established the Energy Efficiency Financial Institutions Group (EEFIG). This specialist expert working group is determining how to overcome the challenges of obtaining long-term financing for energy efficiency. Its research shows that the most important factor for investors in energy efficiency across Europe is standardisation of each element in the investment process.

EEFIG's research also shows that: "Residential buildings ... often have economically attractive energy-efficiency investment returns, yet this market segment is highly fragmented and requires a successful and low-cost retail distribution strategy to engage at scale."

To achieve the potential of energy efficiency, we need to transition from the limitations of today's top-down programmes to a system that can animate markets, encourage innovation, and attract private capital.

An important part of the research phase will be to test and refine different funding schemes.

4. Creating the right conditions

Apply the principles of lean thinking and mass customisation to retrofit

Too often residential retrofit is characterised by partial measures undertaken unsystematically. This leads to inefficiency, waste, re-working, disruption and unnecessary expense.

While it may not always be possible or desirable to carry out a deep, whole-house retrofit in one go, a worthwhile goal is to provide and install measures designed and manufactured according to lean principles and mass customisation. The Dutch Energiesprong scheme has made significant progress in this direction.

Lean means creating more value for customers with fewer resources, not just in manufacturing but in every step of the retrofit process. Mass customisation enables manufacturers to create specific products for each customer based on their needs for a large number of customers at a competitive price.

Arranging a whole-house retrofit should be no harder than ordering a new kitchen; the installation should be no more disruptive. Detailing is vital as all homes are different. And this must not become a race to the bottom with price – quality and design are vital.

The Edge Commission report *Collaboration for Change* highlights the need to close the “scandalous” gap between predicted and actual energy performance of buildings. Confidence in the outcome of energy-efficiency retrofits is essential – not only for homeowners, landlords and investors, but also for a public sector that is asked to help fund work for those in fuel poverty.



5. Immediate next steps

There are six steps that will help to create the right conditions and that can be undertaken immediately, for minimal outlay. Underpinning these must be a clear focus on what will create the maximum value for homeowners and private landlords, thus generating the maximum customer ‘pull’.

1. Begin preparation of the business case.
2. Begin a systematic research and development programme that involves academia, industry and the Energy Systems and Digital Catapults, providing a clear pathway from research and knowledge to real action.
3. Identify existing networks and associations active in improving residential energy efficiency, and in combating climate change and fuel poverty.
4. Identify and share best practice.
5. Create a planning environment that de-risks and facilitates energy-efficiency retrofits.
6. Stimulate demand from homeowners and private landlords.

Co-creation is essential for the success of any scheme. Politicians and people from both within and outside the construction industry should work together to create a framework to deliver steps one to four.

Diversity of background, geographies, skills and experience is essential. The terms of reference for the steering group tasked with guiding steps one to six should be brief and signed off by the appropriate national and devolved ministers. The focus should be on using evidence to inform the design of the national programme.

The Energy Company Obligation (ECO) currently delivers subsidised energy-efficiency measures. The current phase will end in March 2017. The government is consulting on a plan for a successor. In order not to lose skills and supply chains, it is important that work continues as soon as possible, preferably before April 2017.

If possible, qualifying work carried out before 2017 should be allowed to be ‘banked’ against the second phase, to maintain some continuity of demand.

The successor scheme needs to be better targeted, and attract lower administrative costs, than the current phase.

Later in this report we suggest that it could take 25 years to improve the energy efficiency of most homes in the UK. It may be that a more ambitious programme is needed to help meet the UK’s climate targets. An early research task will therefore be to determine the optimum duration of a national residential retrofit programme.

The current retrofit industry is fast disappearing and needs to be supported through this transition. There is much practical retrofit that should be taking place in the next three or four years while the bigger programme is designed.

It is important to identify and support schemes where good design and supervision of quality are likely to be in place, such as tower blocks and schemes for housing associations and local authorities.

Phase 1 of the Arbed project, established in 2009, was the largest programme of its type in the UK. It provided energy-efficiency measures and other improvements to over 7,500 households in Wales.

A dozen similarly sized whole-house energy-efficiency projects should be delivered over the next three to four years to test process, product and funding innovation.

The intention is not to replace programmes such as Arbed and HEEPS but to build upon and complement them.

5. Immediate next steps

1. Begin preparation of the business case

In line with Treasury guidance, the most important next step is the preparation of the first part of the business case, known as the Strategic Outline Case (SOC). This will take around six months to produce and should be sponsored by DECC.

The SOC is the first of three five-part business cases required for public-sector funding of a major new programme, the others being the Outline Business Case and the Full Business Case.

The key purpose of the SOC is to:

- Establish the strategic context for the spending proposal
- By strategic context is meant the fit with wider policy objectives and relevant department plans, both national and devolved; and the interaction with or dependency on any other public sector programmes
- Evidence the case for change
- Establish the preferred way forward

The five parts of a business case

Strategic case - the programme must be supported by a compelling case for change that fits with other public sector goals

Economic case - the programme must represent best public value

Commercial case - the programme must be attractive to the market place, capable of being procured and commercially viable

Financial case - the proposed expenditure must be affordable

Management case - what is required from all parties must be achievable

2. Begin a systematic research and development programme, involving the Energy Systems and Digital Catapults

Potential funders of the research include:

- Research Councils UK (RCUK)
- The EU's Horizon 2020 programme
- Innovate UK's Small Business Research Initiative (SBRI)
- Suppliers and contractors

Expert workshops organised by RCUK identified the following priorities for UK energy demand research that are relevant to the residential sector:

- System-level and socio-technical perspectives on energy demand
- How large-scale and incremental technological innovations could reduce energy demand

Energy retrofits will not happen at scale simply by giving homeowners the 'right' information and motivating them, as technological and economic models assume. Homeowners are 'carriers' of social norms so the policy and practice of energy retrofit must evolve to include a much better understanding of its social aspects.

Research is also needed to explore the synergies between improving the energy efficiency of homes and supplying low-carbon energy through heat networks. DECC reported last year that approximately 14% of UK heat demand could be met by heat networks by 2030 and around 43% by 2050.

Innovation will be critical to delivering a successful national residential energy-efficiency programme. Lessons need to be transferred from projects such as Heathrow

Terminal 5 and Crossrail, both of which have taken a systematic approach to innovation.

Creating a shared research roadmap should be an early priority. It would provide a common reference framework for national residential research priorities that can be used for shaping calls for top-down research funding and for selecting bottom-up proposals.

Research will help to identify skills and training needs, and should be accompanied by substantial field trials. Innovation through R&D spending is essential, but has to be done in conjunction with learning through deployment.

Innovate UK Catapult centres are intended to accelerate and simplify the path from research to commercial products in a number of industries. We would encourage the Energy Systems Catapult to focus on demand management in the domestic sector because it offers the potential for very low-cost ways of reducing energy demand. Demand management also links into the work of the Digital Catapult.

At present, DECC has access to every household's energy consumption data. That will change with the advent of smart meters. It is essential that trusted researchers acting can continue to have access to monthly household consumption data.

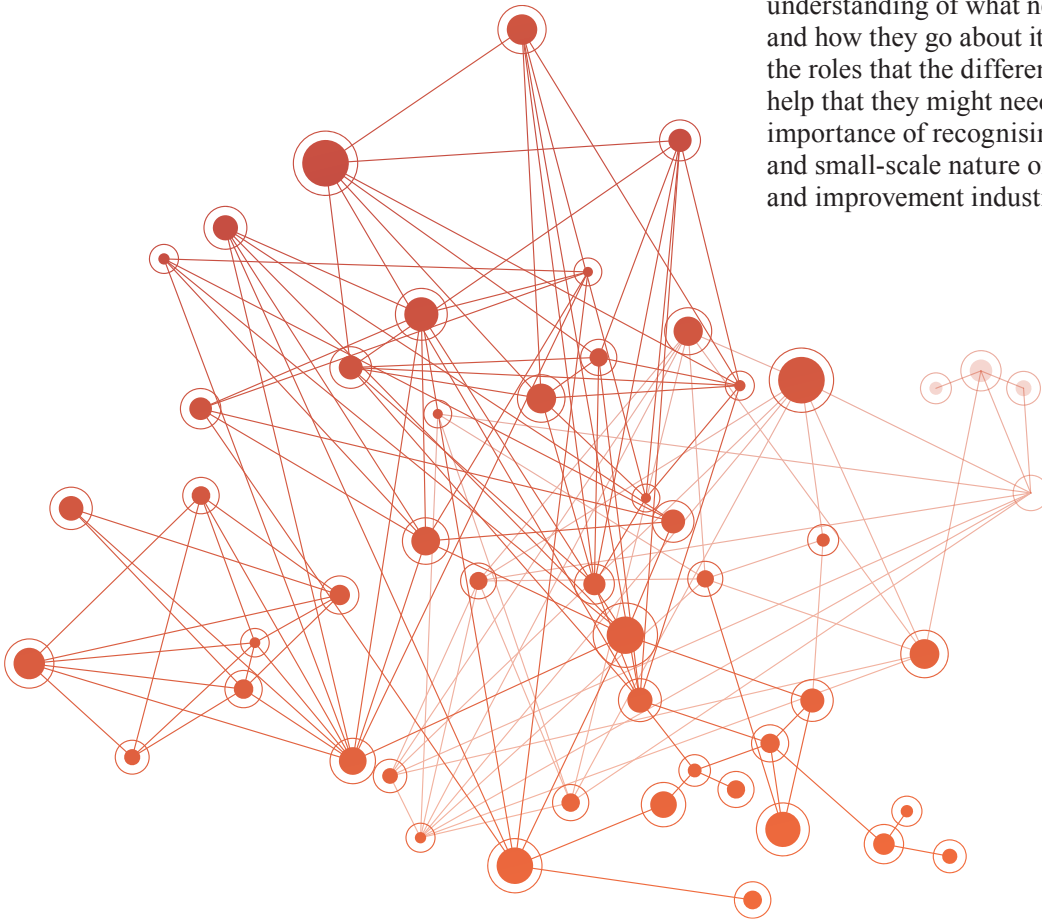
We would encourage urgent cross-Catapult work on how the data captured by smart meters can be used to help reduce residential energy consumption without compromising confidentiality.

The key is to make doing the right thing ordinary. To achieve this, research will be needed in the social, technical, economic, environmental and political aspects of retrofit. Some suggestions are given in the appendix

5. Immediate next steps

3. Identify existing networks and associations

These are organisations already active in improving residential energy efficiency, and in combating climate change and fuel poverty. Some work has already been undertaken to identify them. With a comprehensive understanding of what networks exist, what they do and how they go about it, it will be possible to identify the roles that the different networks can play, and the help that they might need. Research has identified the importance of recognising and understanding the local and small-scale nature of the home repair, maintenance and improvement industry.



4. Identify and share best practice

A number of organisations have recommended creating a national hub for sharing best practice in retrofit – something that would be of immense benefit.

But is a national hub the most efficient and effective way of sharing best practice? And what other functions are required to support a national residential retrofit programme?

The UK has many networks actively engaged in this and related areas. It may well be that many of the existing networks, such as the KTN, can play a significant role in sharing best practice. So one role of a new national hub may be simply to coordinate the activities of the networks.

Sharing of best practice should not be limited to practitioners. It is important that the Building Regulations Advisory Committee receives feedback to help it define new regulations and standards for repair, upgrade and renewal.

5. Immediate next steps



5. Create a planning environment that de-risks and facilitates energy-efficiency retrofits

If the planning process were easier, more energy-efficiency works could be carried out, delivering an economic boost and greater local employment.

English Heritage has provided guidance on suitable retrofit measures for historic and traditionally built buildings. Pre-approved locally appropriate solutions are needed for external wall insulation, windows and roof-mounted photovoltaic panels in conservation areas and other 'ordinary' areas.

First, planning officers and councillors must be familiar with measures such as external wall insulation and double-glazing, the options for, and pros and cons of, ensuring a 'similar appearance'. This should include an understanding of the public benefits of such measures and could be achieved through training and site visits.

As part of the research phase, the Association of Local Energy Officers should survey how implementation of planning policy on visible energy-efficiency and microgeneration measures varies across the UK.

This research may identify a need for new legislation or regulation.

6. Stimulate demand from homeowners and private landlords

Among the very first research activities in step one should be area-based trials of ideas to stimulate demand. These should be informed by analysis of previous attempts to stimulate demand, to identify:

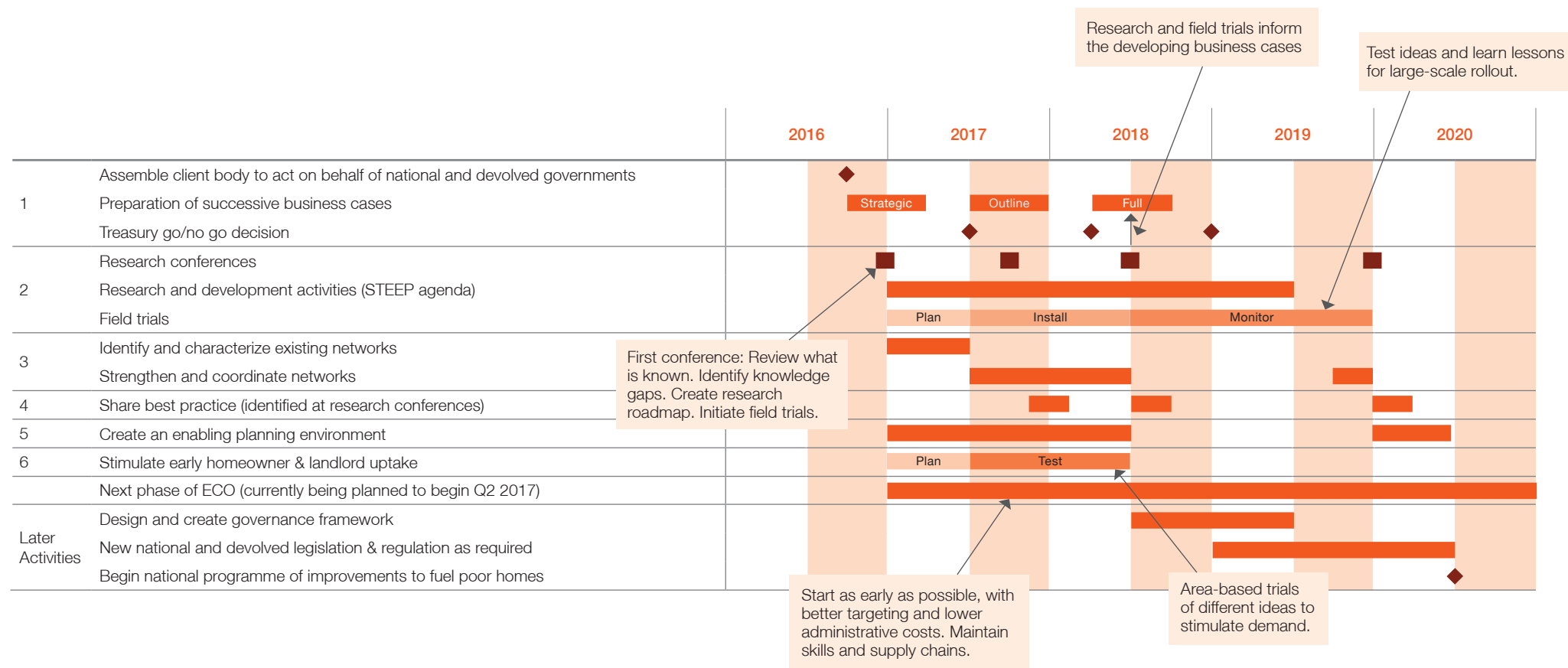
- What worked for which types of household in what locations, and what needs were met?
- What did not work, and why?

Ideas to be trialled should include:

- Tax ideas, such as nudging Stamp Duty Land Tax (in Scotland, Land and Buildings Transaction Tax)
- Funding ideas such as a Home Energy Revolving Loan, UKGBC's Help to Renovate and linking mortgage offers to a property's EPC
- Insurance-backed energy performance guarantees similar to those offered under the Dutch Energiesprong programme
- Obliging landlords to tell prospective tenants of both the rent and the likely cost of heating
- Extending the Enhanced Capital Allowance tax scheme for businesses to cover measures commonly used in the retrofit of tenanted residential properties
- Using local networks of micro-enterprises and SMEs to influence homeowners

6. Outline timetable of next steps

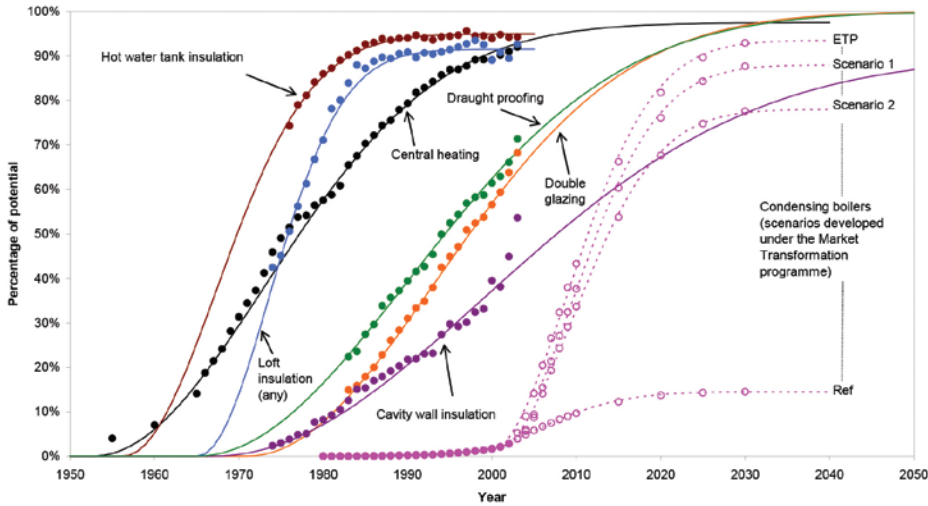
The timetable below illustrates early activities that will help to create conditions for halving the energy consumption of the UK's homes in 25 years. It is offered as a starting point for the development of a comprehensive national programme. See the appendix for further information.



7. Indicative uptake of retrofit

The charts indicate the approximate rate at which the energy efficiency of the UK's homes would be expected to improve as a result of the national programme outlined in this report.

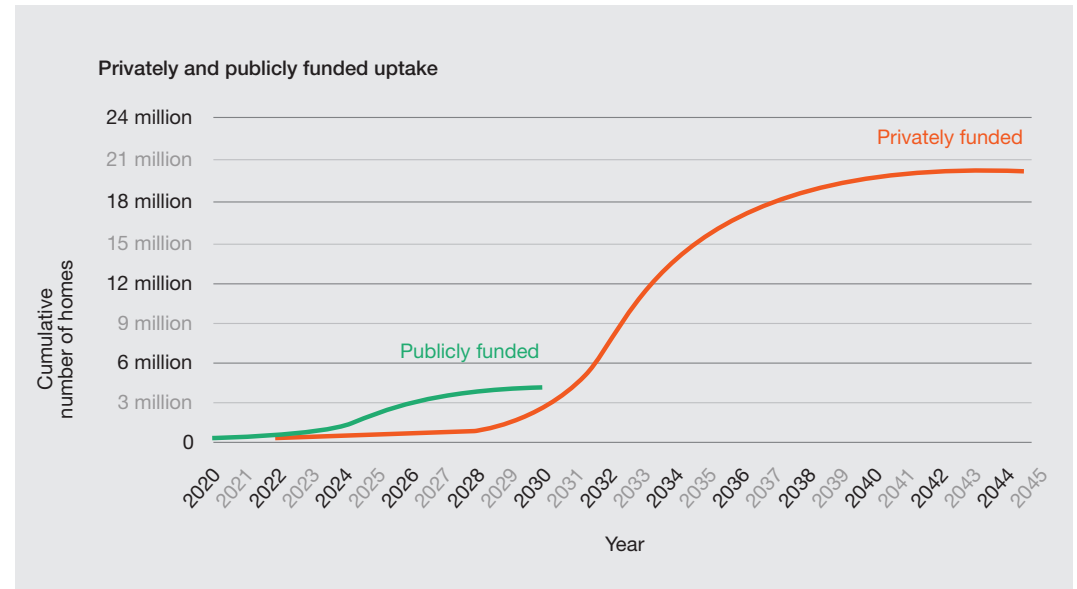
The graph below shows the rate of uptake of a range of energy-efficiency measures over the past sixty years. In every case the uptake follows an S-shaped curve. First innovators, then early adopters, then the majority and finally the laggards all install the measures in their homes.



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We have assumed that around four million homes out of the UK's 28 million will not be upgraded, either because their owners choose not to, or because it is sufficient to connect them to low-carbon district energy schemes. The comfort and energy efficiency of over 20 million homes would be improved by 2035.

The uptake curves below assume that large-scale retrofits will also follow a similar S-shaped curve. They also assume that uptake begins with work on homes in or close to fuel poverty. After two years the able-to-pay homeowners start to join in, slowly at first and then in increasing numbers. At the peak of the programme, in the mid 2030s, almost three million homes per year are being upgraded.



8. Acknowledgements

On 12 November 2014, Arup hosted the event What's Next after the Green Deal? In his concluding remarks that day, Lord Deben, chair of the UK Committee on Climate Change, challenged Arup to lead the development of an all-party supported national programme to halve the UK's residential energy consumption in 25 years. We are grateful to Lord Deben for that challenge and for his continued support and encouragement.

During the preparation of this report we consulted with many people, from many organisations. All generously shared their experiences and their thinking, and this report has benefited immeasurably from that. The report's recommendations and any errors are, of course, our responsibility.

We are grateful to Grosvenor for its generous sponsorship of this report.

Jeremy Kape	Affinity Sutton
Aled Jones	Anglia Ruskin University
Joanne Wade	Association for the Conservation of Energy
John Beckford	Beckford Consulting
Elizabeth Costa	Behavioural Insights Team
Liz Peace	Birmingham Curzon Urban Regeneration Company
Marion Kerfoot	BRE
Andy Sutton	BRE
Sarah Sims	Bristol City Council
Patrick Carey	Cabinet Office
Phil Summerton	Cambridge Econometrics
Malcolm Eames	Cardiff University
Phil Jones	Cardiff University
Nick Pidgeon	Cardiff University
Chris Tweed	Cardiff University
Annie Crawford	CBI
Simon Roberts	Centre for Sustainable Energy
David Pierpoint	Centre of Refurbishment Excellence
Paul Helyar	Charter Housing
Chris Murray	Core Cities
James Davey	DECC

Matthew Webb	DECC
Matt Golden	Efficiency.org
Steven Fawkes	EnergyPro
Duncan McCombie	Energy Saving Trust
Jeff Douglas	Energy Technologies Institute
Ed Matthew	E3G
Dave Neilson	Fusion 21
Sally Hancox	Gentoo
Nicky Gavron	GLA
Hugh Goulbourne	Global Action Plan
Michael O'Doherty	Greater Manchester Combined Authority
Will Andrews-Tipper	Green Alliance
Kate Brown	Grosvenor
Victoria Herring	Grosvenor
Paul Jowitt	Heriot-Watt University
Alison Mathias	Homes and Communities Agency
Jessica Strömbäck	Joule Assets
Panama Bartholomy	Investor Confidence Project Europe
Nigel Banks	Keepmoat
Tom Knowland	Leeds City Council
Paul Wong	Lee Wakemans

Jane Forshaw	Local Partnerships LLP
Peter Quinn	Lovell Construction
Anne Power	LSE
Francine Bennett	Mastodon C
Mark Gardner	Melin Homes
Peter Smith	National Energy Action
Yodit Stanton	OpenSensors.io
Russell Smith	Parity Projects
Nick Martin	Poplar Harca
Richard Sagar	ResPublica
Angus MacLeod	Scottish Government
Liz Warren	SE2
Catrin Mabey	Severn Wye Energy Agency
Dan Suyeyasu	Slate Policy & Design
Jade Lewis	Saint - Gobain
Richard Twinn	UKGBC
Tadj Oreszczyn	University College London
John Miles	University of Cambridge
Charlie Wilson	University of East Anglia
Alice Owen	University of Leeds
Nick Eyre	University of Oxford
Tim Dixon	University of Reading
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The full appendix can be downloaded from www.arup.com/residentialretrofit
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