Overview & Scrutiny

Living in Hackney Scrutiny Commission

All Members of the Living in Hackney Scrutiny Commission are requested to attend the meeting of the Commission to be held as follows

Monday, 8 November 2021 at 7.00 pm

Hackney Town Hall, Mare St, E8 1EA

The press and public are welcome to join this meeting remotely via this link:
https://youtu.be/U25Jrr7tHT4

If you wish to attend otherwise, you will need to give notice and to note the guidance below.

Contact:
Tracey Anderson
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Mark Carroll
Chief Executive, London Borough of Hackney

Members:	**Cllr Sharon Patrick (Chair)**	**Cllr Soraya Adejare (Vice Chair)**	**Cllr Anthony McMahon**
	Cllr M Can Ozsen	**Cllr Ian Rathbone**	**Cllr Penny Wrout**
	Cllr Ajay Chauhan	**Cllr Clare Joseph**	**1 Vacancy (Opposition)**

Agenda

ALL MEETINGS ARE OPEN TO THE PUBLIC

1	**Apologies for Absence**	**7.00pm**
2	**Urgent Items / Order of Business**	**7.02pm**
3	**Declarations of Interest**	**7:03pm**
4	**Climate Change and Buildings** To review the Council's work and plans to meet its net zero carbon target in relation to building maintenance, developments and retrofit of buildings in the borough to ensure they are as green as possible. This will include looking at	**7.05pm**

Hackney

	housing and corporate council buildings. Looking at the retrofit of buildings, materials used and any proposed energy efficient insulation work towards achieving net zero carbon. To consider if the materials used or available are recyclable and/or carbon neutral.	
5	**Minutes of the Previous Meeting**	**8.35pm**
6	**Living in Hackney Scrutiny Commission Work Programme 2021-2022** Work programme for review.	**8.40pm**
7	**Any Other Business**	**8.45pm**

To access the meeting please click in the link https://youtu.be/U25Jrr7tHT4

Access and Information

Public Involvement and Recording

Guidance on public attendance during Covid-19 pandemic

Scrutiny meetings are held in public, rather than being public meetings. This means that whilst residents and press are welcome to attend, they can only ask questions at the discretion of the Chair. For further information relating to public access to information, please see Part 4 of the council's constitution, available at https://hackney.gov.uk/council-business or by contacting Governance Services (020 8356 3503)

The Town Hall is not presently open to the general public, and there is limited capacity within the meeting rooms. However, the High Court has ruled that where meetings are required to be 'open to the public' or 'held in public' then members of the public are entitled to have access by way of physical attendance at the meeting. The Council will need to ensure that access by the public is in line with any Covid-19 restrictions that may be in force from time to time and also in line with public health advice.

Those members of the public who wish to observe a meeting are still encouraged to make use of the live-stream facility in the first instance. You can find the link on the agenda front sheet.

Members of the public who would ordinarily attend a meeting to ask a question, make a deputation or present a petition will be able to attend if they wish. They may also let the relevant committee support officer know that they would like the Chair of the meeting to ask the question, make the deputation or present the petition on their behalf (in line with current Constitutional arrangements).

In the case of the Planning Sub-Committee, those wishing to make representations at the meeting should attend in person where possible.

Regardless of why a member of the public wishes to attend a meeting, they will <u>need to advise the relevant committee support officer of their intention in advance of the meeting date</u>. You can find contact details for the committee support officer on the agenda front page. This is to support track and trace. The committee support officer will be able to confirm whether the proposed attendance can be accommodated with the room capacities that exist to ensure that the meeting is covid-secure.

As there will be a maximum capacity in each meeting room, priority will be given to those who are attending to participate in a meeting rather than observe.

Members of the public who are attending a meeting for a specific purpose, rather than general observation, are encouraged to leave the meeting at the end of the item for which they are present. This is particularly important in the case of the

Planning Sub-Committee, as it may have a number of items on the agenda involving public representation.

Before attending the meeting

The public, staff and councillors are asked to review the information below as this is important in minimising the risk for everyone.

If you are experiencing covid symptoms, you should follow government guidance. Under no circumstances should you attend a meeting if you are experiencing covid symptoms.

Anyone experiencing symptoms of Coronavirus is eligible to book a swab test to find out if they have the virus. You can register for a test after checking your symptoms through the NHS website. If you do not have access to the internet, or have difficulty with the digital portals, you are able to call the 119 service to book a test.

If you're an essential worker and you are experiencing Coronavirus symptoms, you can apply for priority testing through GOV.UK by following the guidance for essential workers. You can also get tested through this route if you have symptoms of coronavirus and live with an essential worker.

Availability of home testing in the case of people with symptoms is limited, so please use testing centres where you can.

Even if you are not experiencing covid symptoms, you are requested to take an asymptomatic test (lateral flow test) in the 24 hours before attending the meeting.

You can do so by visiting any lateral flow test centre; details of the rapid testing sites in Hackney can be found here. Alternatively, you can obtain home testing kits from pharmacies or order them here.

You must not attend a lateral flow test site if you have Coronavirus symptoms; rather you must book a test appointment at your nearest walk-through or drive-through centre.

Lateral flow tests take around 30 minutes to deliver a result, so please factor the time it will take to administer the test and then wait for the result when deciding when to take the test.

If your lateral flow test returns a positive result then you must follow Government guidance; self-isolate and make arrangements for a PCR test. Under no circumstances should you attend the meeting.

Attending the Town Hall for meetings

To make our buildings Covid-safe, it is very important that you observe the rules and guidance on social distancing, one-way systems, hand washing, and the wearing of masks (unless you are exempt from doing so). You must follow all the signage and measures that have been put in place. They are there to keep you and others safe.

To minimise risk, we ask that Councillors arrive fifteen minutes before the meeting starts and leave the meeting room immediately after the meeting has concluded. The public will be invited into the room five minutes before the meeting starts.

Members of the public will be permitted to enter the building via the front entrance of the Town Hall no earlier than ten minutes before the meeting is scheduled to start. They will be required to sign in and have their temperature checked as they enter the building. Security will direct them to the Chamber or Committee Room as appropriate.

Seats will be allocated, and people must remain in the seat that has been allocated to them. Refreshments will not be provided, so it is recommended that you bring a bottle of water with you.

Rights of Press and Public to Report on Meetings

Where a meeting of the Council and its committees are open to the public, the press and public are welcome to report on meetings of the Council and its committees, through any audio, visual or written methods and may use digital and social media providing they do not disturb the conduct of the meeting and providing that the person reporting or providing the commentary is present at the meeting.

Those wishing to film, photograph or audio record a meeting are asked to notify the Council's Monitoring Officer by noon on the day of the meeting, if possible, or any time prior to the start of the meeting or notify the Chair at the start of the meeting.

The Monitoring Officer, or the Chair of the meeting, may designate a set area from which all recording must take place at a meeting.

The Council will endeavour to provide reasonable space and seating to view, hear and record the meeting. If those intending to record a meeting require any other reasonable facilities, notice should be given to the Monitoring Officer in advance of the meeting and will only be provided if practicable to do so.

The Chair shall have discretion to regulate the behaviour of all those present recording a meeting in the interests of the efficient conduct of the meeting. Anyone acting in a disruptive manner may be required by the Chair to cease recording or may be excluded from the meeting. Disruptive behaviour may include: moving from any designated recording area; causing excessive noise; intrusive lighting; interrupting the meeting; or filming members of the public who have asked not to be filmed.

All those visually recording a meeting are requested to only focus on recording councillors, officers and the public who are directly involved in the conduct of the meeting. The Chair of the meeting will ask any members of the public present if they have objections to being visually recorded. Those visually recording a meeting are asked to respect the wishes of those who do not wish to be filmed or photographed. Failure by someone recording a meeting to respect the wishes of those who do not wish to be filmed and photographed may result in the Chair instructing them to cease recording or in their exclusion from the meeting.

If a meeting passes a motion to exclude the press and public then in order to consider confidential or exempt information, all recording must cease and all recording equipment must be removed from the meeting room. The press and public are not permitted to use any means which might enable them to see or hear the proceedings whilst they are excluded from a meeting and confidential or exempt information is under consideration.

Providing oral commentary during a meeting is not permitted.

Getting to the Town Hall

For a map of how to find the Town Hall, please visit the council's website http://www.hackney.gov.uk/contact-us.htm or contact the Overview and Scrutiny Officer using the details provided on the front cover of this agenda.

Accessibility

There are public toilets available, with wheelchair access, on the ground floor of the Town Hall.

Induction loop facilities are available in the Assembly Halls and the Council Chamber. Access for people with mobility difficulties can be obtained through the ramp on the side to the main Town Hall entrance.

Further Information about the Commission

If you would like any more information about the Scrutiny Commission, including the membership details, meeting dates and previous reviews, please visit the website or use this QR Code (accessible via phone or tablet 'app') https://hackney.gov.uk/scrutiny

Hackney

Living in Hackney Scrutiny Commission 8th November 2021 Item 4 – Climate Change and Buildings	Item No 4

Outline
Many councils in London have made climate emergency declarations. The perceptions around the importance of effective, thorough local authority strategies have changed in recent years, with greater emphasis being placed on having clear environmental strategies at local and regional level.

Hackney Council is making strides in its production of a Climate Action Plan (CAP) and putting in place governance structures that will help to ensure this work is embedded across all council services and activities. It is recognised that climate emergency is an ongoing and increasing priority and that sustainability is an organisation wide agenda encompassing economic, environmental, and social objectives, thus needing a diverse range of contributors and leadership at all levels. The Council is working towards publishing its Climate Action Plan in 2022.

The Living in Hackney Scrutiny Commission has received information from the Council about the following:

The **Council's Energy Strategy**. This was discussed at the LiH meeting on 26th October 2021. This covers the management of the Council's assets that aligns with the climate emergency declaration made by the council. It identifies the key carbon footprints resulting from the Council activities and influence.

The Council's planning Services outlined how Hackney's local planning policies can support the work towards net zero caron target. Planning Services outlined at our meeting on 26th October 2021 how **Hackney Council's Local Plan (LP33)** aims to directly shape the built environment and influence development through the planning process. It was made clear that existing buildings that do not require planning permission are not subject to these policies.

London Council's commissioned data modelling revealed homes are responsible for around one third of London's greenhouse gas emissions. By committing to upgrade all housing stock to an average energy performance rating of EPC B by 2030, boroughs will drive a dramatic decarbonisation of

London property and make vital progress on the capital's path towards net zero.[1]

Discussion

To continue our work on climate change and net zero carbon. This meeting will focus on climate change and buildings looking at Hackney's council housing, new build homes, regeneration developments and corporate property.

The planned session will cover:

1. Council Housing - Retrofitting council homes to achieve net zero carbon target
2. Private Sector housing - what the private sector needs to do to achieve the net zero carbon target
3. New Homes Delivery - how new build home and regeneration developments will achieve / deliver the net zero carbon target
4. Council Strategic Property - How the council's maintenance programme aims to retro fit and deliver net zero carbon for all non-residential council property.

Report in the agenda

To support this discussion the following reports are included for background information.

- Retrofit London Housing Action Plan – London Councils
- Delivering net zero carbon in social housing: will it happen in time, and at what cost? - RPS article
- UK housing: Fit for the future? - Committee on Climate Change February 2019
- Social Housing: Leading the Way to Net Zero – Sustainable Energy Association
- The Role of Data In Delivering Net Zero Social Housing Retrofit (March 2021) - Housing Innovation Programme) Connected Places Catapult

Invited Attendees

London Borough of Hackney

- Cllr Guy Nicholson Deputy Mayor and Cabinet Member for housing supply, planning, culture and inclusive economy
- Cllr Mete Coban Cabinet Member for Energy, waste, transport and public realm
- Cllr Clayeon McKenzie, Cabinet Member for Housing
- Cllr Sem Moema, Mayoral Advisor, Private Rented Sector and Affordability
- Aled Richards, Strategic Director, Sustainability and Public Realm
- Steve Waddington, Strategic Director, Housing Services

[1] [2] London Councils commissioned data modelling from environmental analysts Parity Projects to provide an evidence base for the action plan. This research shows that the only 2.5% of London homes are currently at EPC A or B, with the rest in lower energy performance bands. 95% are at EPC C, D, or E.

- Chris Trowell, Interim Director, Regeneration
- James Goddard, Interim Director, Regeneration
- Chris Pritchard, Director Strategic Property

Other stakeholders being invited to attend the session

- Resident Liaison Group

<u>Action</u>

Members are asked to consider the reports, presentations and ask questions.

LONDON COUNCILS





Retrofit London Housing Action Plan

July 2021 | Rev N

Etude ELEMENTA RAFT RETROFIT ACTION FOR TOMORROW

Introduction to the Retrofit London Housing Action Plan

The need to act now

The threat posed by climate change requires all levels of government to act with ambition and at pace if we are to combat and avoid its worst effects.

The London Councils Joint Statement on Climate Change demonstrated London local government's determination to act and established a series of stretching commitments on behalf of all 33 councils that strive for a level of ambition necessary to address the challenges we face.

A collective Action Plan

The Retrofit London Housing Action Plan sets out a path to achieving the first of these pledges: to bring forward a cross-tenure home retrofitting programme in London that can achieve an average EPC B rating by 2030. It also further substantiates this by introducing a series of metrics to guide boroughs' retrofitting activity – including metrics on overall carbon emissions, space heating demand and energy use – to ensure the average EPC B target is achieved in a way that can fully realise London's ambitions to address climate change and alleviate fuel poverty.

Councils are uniquely placed to drive forward retrofit locally, both through acting on their own stock, and by utilising their local connections to residents, private landlords and housing associations to achieve a cross-tenure approach.

Significant benefits can be delivered

The benefits of the plan are substantial. Not only does the action plan provide a framework for achieving the commitments that all levels of government have to drastically reduce carbon emissions, it also provides an opportunity to grow the green economy, create thousands of new jobs and provoke innovation within the sector.

London can and should be at the forefront of this agenda.

This plan is ambitious; successful delivery will require coordinated and consistent action from local, regional and central government, as well as the private sector and other key stakeholders. Most notably, councils face significant funding constraints that present a barrier to the full realisation of this plan, while the wider policy challenges identified, such as in relation to planning, the cost of electricity and trades capacity, require a joined up approach to resolve.

By working collaboratively, the action plan can prompt the necessary step change in home retrofitting across London and support wider efforts to tackle the climate emergency.

LONDON COUNCILS

Contents

Acknowledgments

Thank you to London Councils and the project steering group who have led this Action Plan.

LONDON COUNCILS
Kate Hand
Alex Sewell

PROJECT STEERING GROUP
Sarah Fletcher (GLA)
Dominic Millen (Enfield)
James McHugh (Waltham Forest)

We are also immensely grateful to the following individuals who have generously given their time to share their experience, thoughts and feedback.

LONDON LOCAL AUTHORITIES AND THE GREATER LONDON AUTHORITY

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Sara Bowrey

George Brown
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Amy Mallett

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Rafe Bertram
Ian Guest
Claire Eldred
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JGS
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Etude
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Amber Banbury

The London Housing Retrofit Action Plan project

Retrofitting London's homes is crucial

According to a recent poll[1], the overwhelming majority of Londoners (82%) are concerned about climate change, with 40% describing themselves as 'very concerned'.

In order to respond to their concerns and for London to play its part in mitigating climate change, retrofitting London's homes is crucial. Fossil fuel heating needs to be phased out, houses and blocks of flats need to become more energy efficient, and they should contribute to the generation of solar renewable electricity.

A daunting challenge, which we should address together

Each house and block of flats is different, and tenure is also a key consideration. And the retrofit challenge is happening at a time of huge pressure on local authorities (e.g. limited budgets, building safety, etc.).

Not knowing where to start, we may not retrofit our homes as the challenge seems too complex. It is not: by working together, London boroughs can make it simpler and address the different issues, one by one. This Retrofit London Housing Action Plan is seeking to articulate the actions needed to achieve this.

The aim of this project is to develop a pan-London, borough-owned action plan to determine the most effective suite of retrofitting measures to achieve the key target of average EPC B by 2030, incorporating a radical reduction in carbon emissions and a suite of other complementary targets, together with recommended actions in terms of delivery, skills, costs, funding and communication. The Action Plan looks forward to the ultimate aim of achieving Net Zero by 2050 at the very latest.

[1] *What do Londoners think about Climate Change? Results from London Council's 2020 climate change polling, London Councils, 2021*

Genesis of the project

The project is funded by London Councils, the London Housing Directors' Group, the Greater London Authority and the London Environment Directors' Network (LEDNet).

In December 2019, London Councils agreed an ambitious Joint Statement on Climate Change, which sets out the boroughs' approach to governance, citizen engagement and resourcing for climate change, as well as seven major programmes for cross-borough working.

In 2020, TEC endorsed a lead borough or boroughs for each of these programmes, who will be responsible for overseeing implementation of the action plan for each area:

#1 Retrofit London

#2 Low-carbon development (i.e. new buildings)

#3 Halve petrol and diesel road journeys

#4 Renewable power for London

#5 Reduce consumption emissions

#6 Build the green economy

#7 Creating a resilient and green London.

This project is part of Programme #1 Retrofit London; the lead boroughs are LB Enfield and LB Waltham Forest and it focuses on housing.

Overview of key challenges at each stage of the retrofit process

The Retrofit London Housing Action Plan will only be able to succeed if we are able to meet a number of key challenges.

Demand and take-up

Increasing the quantity of retrofit work being undertaken will support development of the skills and technology needed in London, with many benefits to the local economy beyond the core aim of reducing carbon emissions.

Many homeowners and landlords are currently unaware of what they can or should achieve with retrofit and they will not act until they are confident about what needs to be done.

Technical

Every home presents a different set of issues. The possible solutions can be confusing and the relative benefits and risks are generally not well understood by the general public. Reliable and accessible information is needed if some pitfalls are to be avoided, with the reputational risk to the whole programme that significant failures could bring.

Finance

The plan has to recognise that individual homeowners and many landlords cannot afford to carry out a full retrofit of properties in a single phase, so a process is required which allows smaller steps to be taken which lead to the necessary ultimate performance.

London local authorities have limited means due to the considerable competing demands on their resources. Recent government schemes have increased the public funds available, but not yet to the level required, and private finance solutions are not yet widely available.

Delivery and supply

Once homeowners and landlords have decided what to do and when, they need to be able to call on a capable and reliable supply chain which will deliver the work to a sufficient level of quality.

- Retrofit often appears to be an excessively complex set of measures.
- Tenure adds another element of complexity.
- Retrofit can be over-simplified, leading to inappropriate measures and potential issues (e.g. moisture in walls).
- The risks involved in retrofit are not clearly identified and catalogued per measure.

Delivery and supply

- The customer/client journey is challenging.
- The choice often appears to be between (expensive) professionals or contractors lacking an overview or understanding of the end goal.
- Every new retrofit needs to manage risks on its own (e.g. procurement, heat pump installation and commissioning) instead of mutualising them.
- Planning is a very clear hurdle.

Costs/funding

- The costs of retrofit are high and the financial benefits can be unclear and uncertain.
- Energy cost savings are generally not a sufficient motivation.
- Running costs of heat pumps (including maintenance) are perceived as a concern.
- Application for grant funding is complex and uncertain.
- Procuring the services of an architect or a Retrofit Coordinator can be seen as expensive.

Demand and take-up

- Is my home emitting too much carbon? Can I significantly reduce its carbon emissions and put it on the right track towards Net Zero? It is difficult for Londoners to access responses to these basic questions.
- Finding reliable advice on what to do is also not straightforward.
- It is very difficult to determine the relevance of generic information and there is a clear need for more specific advice.

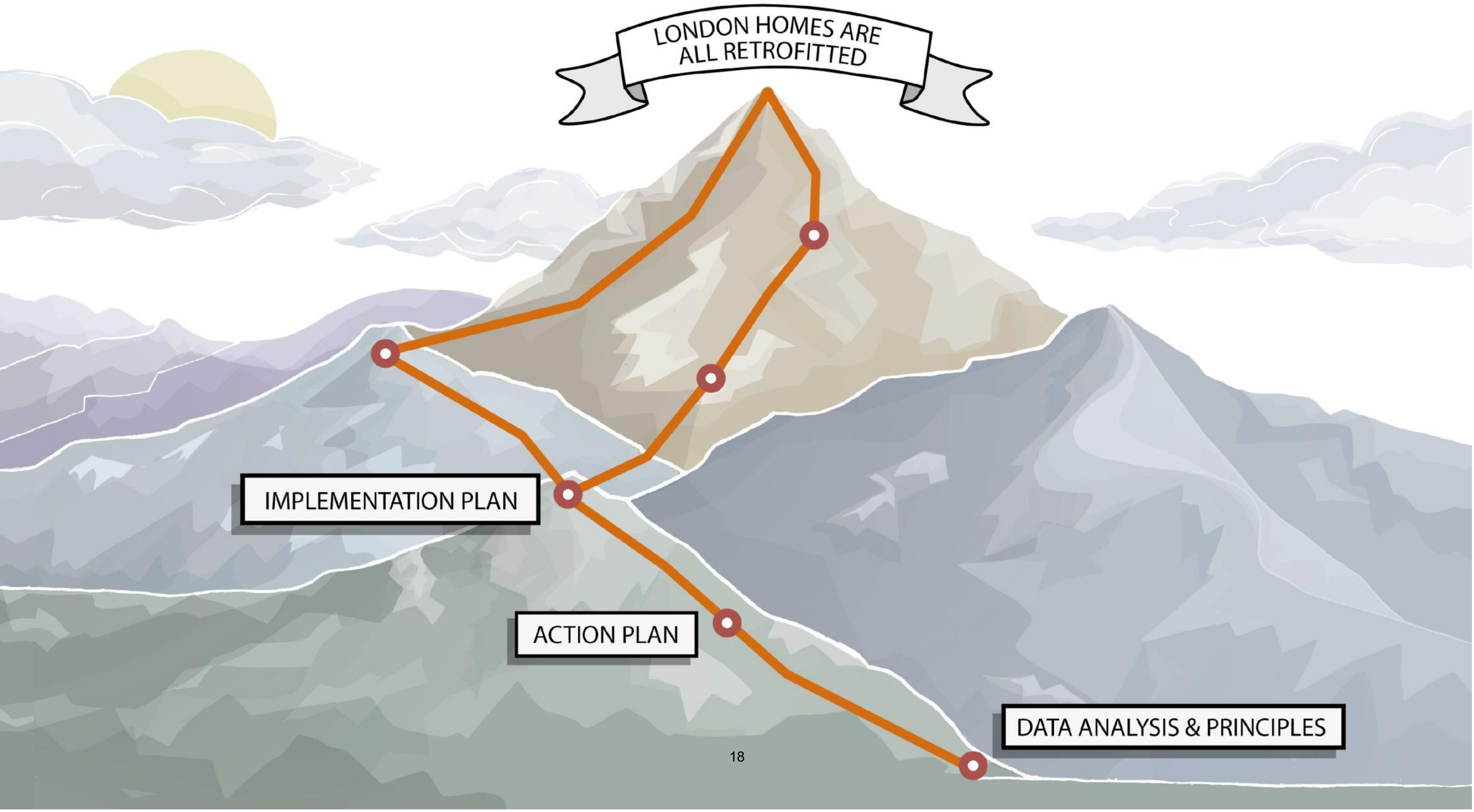
A structured approach to the challenge

This project is part of a wider process to develop the Retrofit London programme.
It has been informed by Parity Projects' data analysis summarised in the *London Councils: Pathways Report*, and includes some extracts of their analysis. It will form the basis of the Implementation Plan which will be led by Enfield and Waltham Forest.

A structured approach to the challenge

Working together on data, principles, this action plan and later the implementation plan helps to prepare and map out the next steps of this challenging and ambitious journey.

We need to avoid paths which go in the wrong directions and focus on those which will achieve the ambition.



The eight key principles underpinning the action plan

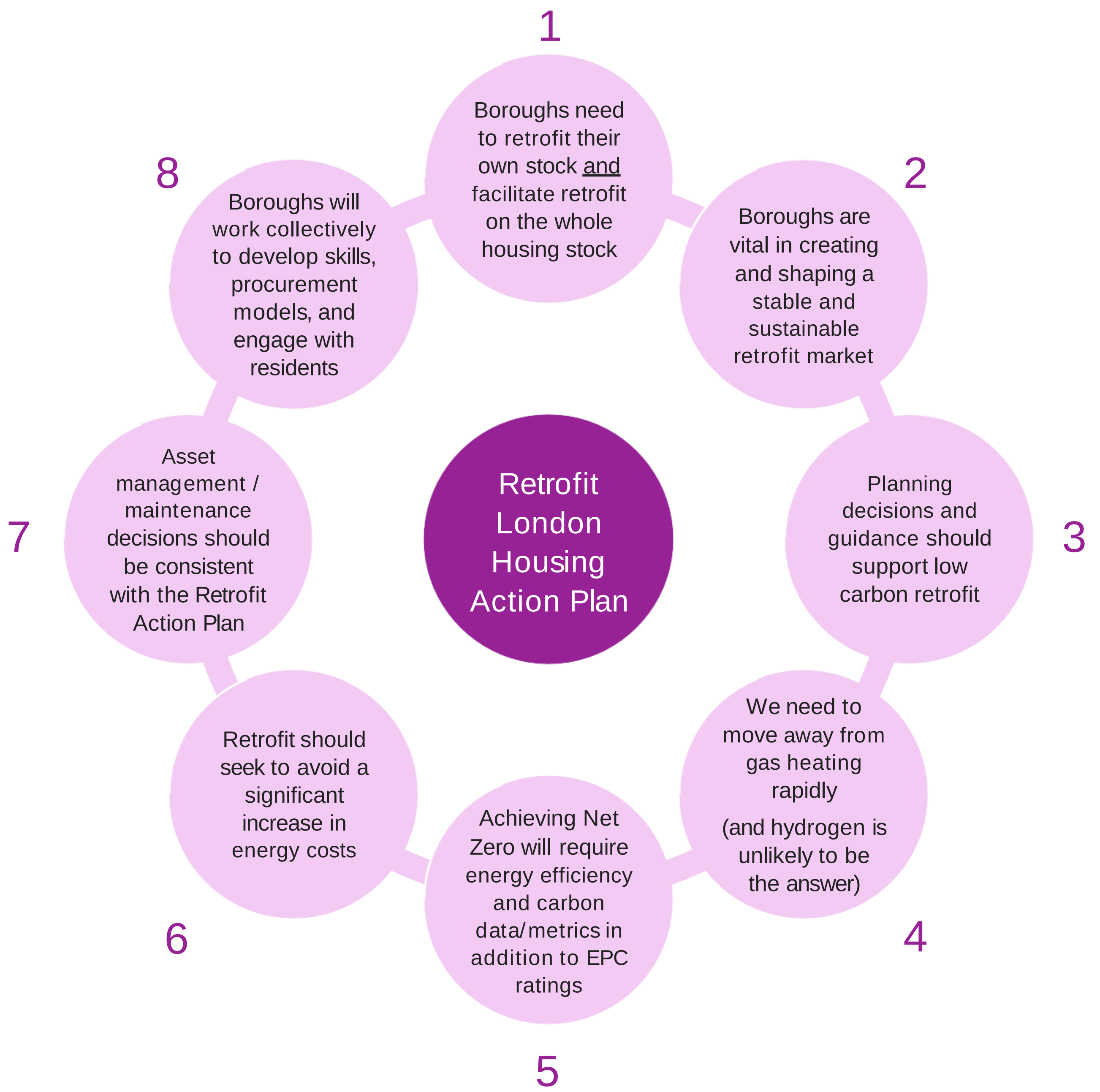
Facing in the same direction

The plan is built around a set of core principles that apply to all boroughs and underpin all of the proposed actions.

It is important for the London boroughs and their partners, including GLA, to be aligned and therefore moving in the same direction, albeit at different speeds and with a varying focus, depending on the particular issues affecting each local area.

Those differences will create different emphasis and potentially altered priorities from borough to borough and even within individual boroughs. However, having a common set of over-arching goals will allow consistent policy to be set so the regional level issues such as infrastructure development, workforce training and housing quality standards are clear and unambiguous to those businesses and other organisations who are vital to the successful delivery of the plan.

For investment in the significant costs of the work needed to be forthcoming, a clear set of aims is a vital first step.



Summary of recommended actions

Decisive steps forward

The key recommended actions of this Retrofit London Housing Action Plan are listed in the adjacent table, split by category:

- Retrofit measures and plans
- Delivery models, skills and supply chain
- Costs, funding and finance
- Engagement, take-up and lobbying

Some of them include more detailed activities and each action and activity is explained succinctly in this report. Together they represent decisive moves towards addressing the housing retrofit challenge in London.

The full list of actions and activities is provided in a separate spreadsheet which London Councils and the lead boroughs of Enfield and Waltham Forest can develop, add to and implement together with the other boroughs when this phase of the project has been completed.

It is important to note that these actions cover all tenures: social housing (including but not limited to councils' own stock), owner occupied homes as well as private rented homes. The following page identifies which actions relate to:

- The retrofit of councils' own stock
- Facilitation of retrofit for the rest of the housing stock in London
- Efforts towards developing and securing additional funding and support.

1	Improve the building fabric of London's inefficient homes
2	Develop a plan for retrofitting ventilation systems to improve health and air quality
3	Electrify heat
4	Deliver smart meters and demand flexibility (controls, storage) in retrofitted homes
5	Increase solar energy generation on London homes
6	Map out each building's journey towards lower energy costs and Net Zero
7	Review current maintenance programmes and identify retrofit opportunities
8	Facilitate procurement of materials and services at a larger scale
9	Enable planning to facilitate low carbon retrofit, including in Conservation Areas
10	Develop retrofit skills actively across London
11	Set up a clear and consistent system to report and monitor progress (and success)
12	Establish the cost of retrofit, business case and funding gap for the different tenures
13	Maximise capital finance for council owned stock (and eligible homes)
14	Create a 'Finance for retrofit' taskforce with finance experts
15	Support the owner occupier and PRS sectors to leverage private investment
16	Social housing: engage with tenants, leaseholders and other registered providers
17	Engage with owner occupiers and the Private Rented Sector
18	Lobby Central Government for more support, guidance and funding
19	Develop and implement the Action Plan together

Summary of recommended actions

		Retrofit of councils' own stock	Facilitation of retrofit for rest of housing stock	Develop and request additional funding and support
1	Improve the building fabric of London's inefficient homes	●		
2	Develop a plan for retrofitting ventilation systems to improve health and air quality	●		
3	Electrify heat	●		
4	Deliver smart meters and demand flexibility (controls, storage) in retrofitted homes	●		
5	Increase solar energy generation on London homes	●		
6	Map out each building's journey towards lower energy costs and Net Zero	●		
7	Review current maintenance programmes and identify retrofit opportunities	●		
8	Facilitate procurement of materials and services at a larger scale	●	●	
9	Enable planning to facilitate low carbon retrofit, including in Conservation Areas	●	●	
10	Develop retrofit skills actively across London	●	●	●
11	Set up a clear and consistent system to report and monitor progress (and success)	●	●	
12	Establish the cost of retrofit, business case and funding gap for the different tenures	●	●	
13	Maximise capital finance for council-owned stock (and eligible homes)	●		●
14	Create a 'Finance for retrofit' taskforce with finance experts	●	●	●
15	Support the owner occupier and private rented sectors to leverage private investment		●	●
16	Social housing: engage with tenants, leaseholders and other registered providers	●	●	
17	Engage with owner occupiers and the private rented sector		●	
18	Lobby central Government for more support, guidance and funding			●
19	Continually develop and implement the Action Plan together	●	●	●

This section provides an introduction to the Retrofit London Housing Action plan.

It sets out why urgent action is needed, which objectives need to be achieved and what is currently happening in this area. It also identifies a number of current challenges.

The project is funded by London Councils, the London Housing Directors' Group, the Greater London Authority and the London Environment Directors' Network (LEDNet).

London Councils represents London's 33 local authorities. It is a cross party organisation that works on behalf of all of its member authorities regardless of political persuasion. One of its committees is the Transport and Environment Committee (TEC).

LEDNet is the membership association for London's Environment Directors.

London Councils' action on climate change

In December 2019, London Councils agreed an ambitious Joint Statement on Climate Change, that sets out the boroughs approach to governance, citizen engagement and resourcing for climate change, as well as seven major programmes for cross-borough working.

In 2020, TEC endorsed a lead borough or boroughs for each of these programmes, who will be responsible for overseeing implementation of the action plan for each area:

#1 Retrofit London

#2 Low-carbon development (i.e. new buildings)

#3 Halve petrol and diesel road journeys

#4 Renewable power for London

#5 Reduce consumption emissions

#6 Build the green economy

#7 Creating a resilient and green London.

#1 Retrofit London

This project is part of Programme *#1 Retrofit London* and focuses on housing. It covers all tenures and not only council-owned stock. The lead boroughs are Enfield and Waltham Forest.

The Joint Statement on Climate Change commits boroughs to working together to retrofit London's building stock to an average level of EPC B by 2030. The aim of this project is to develop a pan-London, borough-owned action plan to determine the most effective suite of retrofitting measures to achieve our target of average EPC B by 2030 or another target which better conceptualises the level of ambition, together with recommended actions in terms of delivery, skills, costs, funding and communication.

Metrics and target

The issue of metrics and targets was discussed right at the outset of this project. It was agreed to go beyond the single metric of the EPC rating (which is only an energy cost metric) for the modelling undertaken by Parity Projects and complement it with additional metrics including $kgCO_2$ (for carbon), $kWh/m^2/yr$ (for energy efficiency) and connection to gas grid (for fossil fuel use). Each metric is accompanied by a target.

Net Zero is recognised as the ultimate goal, it has a legislative footing, significant political traction and is something which must inform the actions now. The risk of having the EPC B target as the key objective is that it may lead to decisions which would not be compliant with the Net Zero horizon we must now all work together towards.

Housing retrofit: the first priority to deliver shared climate ambitions across London

The climate emergency and Climate Action Plans

London local authorities have already committed to a strategic objective to retrofit all domestic buildings to an average level of EPC B. In addition, all boroughs have published or are in the process of developing a Climate Action Plan to address the climate crisis and achieve Net Zero.

Homes are responsible for around one third of London's greenhouse gas emissions and a quarter of them have the worst energy performance rating. The Climate Change Committee advises that that we need a near complete decarbonisation of homes, and that this should be achieved through low carbon heat to all but the most difficult to treat buildings.

The benefits of a Retrofit London Housing Action Plan

The retrofit and decarbonisation of London's housing stock can reward us with many other benefits, including: addressing fuel poverty, improving people's health, benefitting air quality (a significant issue in London) and providing a significant source of jobs for the future and economic benefit. These themes are particularly relevant to a green recovery from Covid-19 and London's Green New Deal mission.

The concept of carbon budgets and what it means

Tyndall Carbon budget reports derive fair carbon budgets for the UK and its local authority areas from IPCC global carbon budgets for staying within a 2°C global temperature rise.

If London were to continue to emit CO_2 emissions at current (2017) levels, its entire carbon budget would be used by 2027. Total CO_2 emissions cuts must therefore average -12% per year to deliver a Paris aligned carbon budget. Achieving the sort of reductions needed will require an immediate and rapid switch away from gas for heating, the majority of which needs to be completed in the next 10 years.

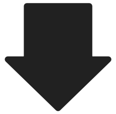
The legal obligation for the UK to achieve Net Zero by 2050, the declarations of climate emergency of many London boroughs and the crucial role of housing justify the development of an ambitious Retrofit London Housing Action Plan (above: CCC Net Zero and Future of Housing reports, 2019)

200 $MtCO_2$

Estimation of London's portion of the remaining carbon budget for staying well below 2°C global temperature rise.

7 years

The number of years it would take London to consume its entire carbon budget at current emissions rates



-12%

Annual reduction in CO_2 emissions London should achieve on average to stay within its carbon budget.

Tyndall Centre carbon budget report for London in numbers. Figures relate to CO_2 from energy only and cover energy used by buildings and transport. Decarbonisation of existing housing stock is a crucial action area.

A common Net Zero horizon

Net Zero Carbon: What are we trying to achieve?

One simple way to translate the ultimate net zero carbon buildings ambition is to see it as the need to generate all of buildings' energy needs from renewable or nuclear energy sources. This will require a reduction in energy use coupled with an increase in renewable energy generation, as well as phasing out fossil fuels. It is now a legal requirement for the UK to achieve Net Zero by 2050 and a large number of London boroughs and the Mayor of London have set an earlier target.

No offsets

The Climate Change Committee is very clear that the housing sector should not rely on carbon offsets/removals (e.g. CCS, afforestation) to achieve Net Zero.

Net Zero operational carbon

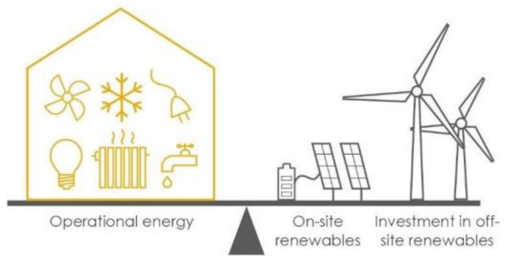
Where possible, Net Zero operational carbon should be achieved on-site. This means that the total renewable energy generated on-site (e.g. through Solar PV) meets or exceeds the energy required by the building.

- Firstly energy use has to be reduced at the point of use.
- Secondly, all fossil fuel heating must be replaced with low carbon heat.
- Thirdly, renewable energy generation should be maximised on site, then provided as locally as possible unless there is a very valid reason not to do it[1].

Embodied carbon

This study focuses on greenhouse gas emissions associated with operational energy use only, not embodied carbon of materials. Embodied emissions are very important though and should be a key consideration.

[1] *Some buildings will not be able to generate sufficient energy on site to match their annual energy use, so we need to maximise generation on all buildings and then generate off-site, but locally. Net Zero balances across the country and in London in this case cannot always rely on solutions off-site. They often appear more convenient or cheaper but may not be so.*



Net zero operational balance

If we want the housing stock in London to achieve Net Zero, we must use have an objective not to use more energy than what can be generated by renewable energy on-site ideally or off-site if it is not feasible (Source: LETI)

6 steps towards Net Zero operational carbon (and associated metrics)

1	Low space heating demand e.g. kWh/m²/yr space heating demand
2	Low total energy use e.g. kWh/m²/yr Energy Use Intensity (EUI)
3	Low carbon heat (no fossil fuels) e.g. $kgCO_2/m^2$/yr for heating system average for 2021-2050
4a	Maximise renewable energy generation on-site e.g. kWh solar energy generation/$m^2_{building\ footprint}$/yr
4b	Maximise local renewable energy generation e.g. kWh in the borough
5	Energy flexibility e.g. Smart Readiness Indicator or kWh/m²/ energy storage
6	Reduced performance gap

The Retrofit London Housing Action Plan needs to consider these 6 steps for each home. What can be achieved at each of these steps will depend on the typology but they are all important if we are to achieve Net Zero. Possible indicators are provided above.

Housing retrofit in the context of the electricity and data revolution

Towards a decarbonised and smarter electricity system

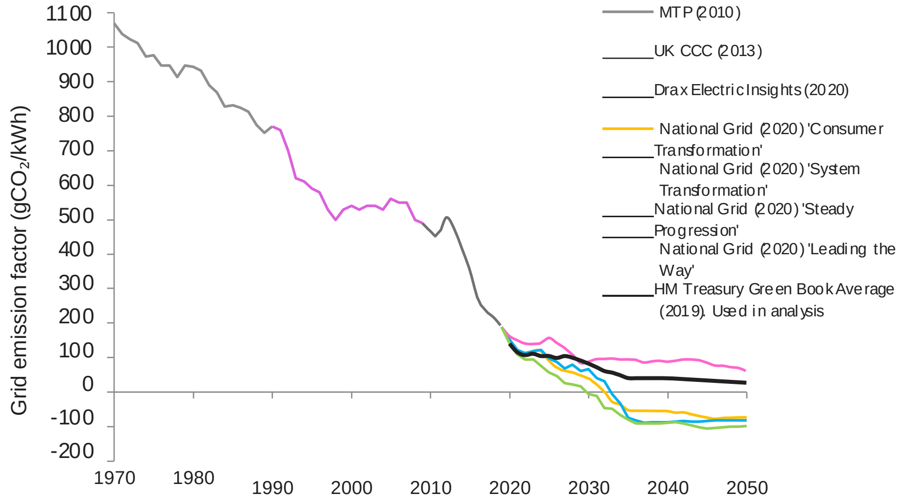
The carbon content of electricity has fallen over the last few years. It is now three times less than 10 years ago and already lower than natural gas. It is forecasted to continue to reduce even further in the next 20-30 years. This explains the current energy revolution and the very likely electrification of transport and heat as the best strategy to move away from fossil fuels.

In order for this revolution to be successful and as cost effective as possible, it is very important to reduce energy use (so that energy demand is not more than renewable and nuclear energy generation by 2050) and for demand to be flexible so that energy is used at times of high renewable energy generation. Energy storage (e.g. hot water tanks) and management (e.g. smart controls) as well as smart meters for Time of Use (ToU) variable electricity tariffs are therefore all likely to become increasingly important for our homes. Electric vehicle charging from homes will also create additional demand for electricity.

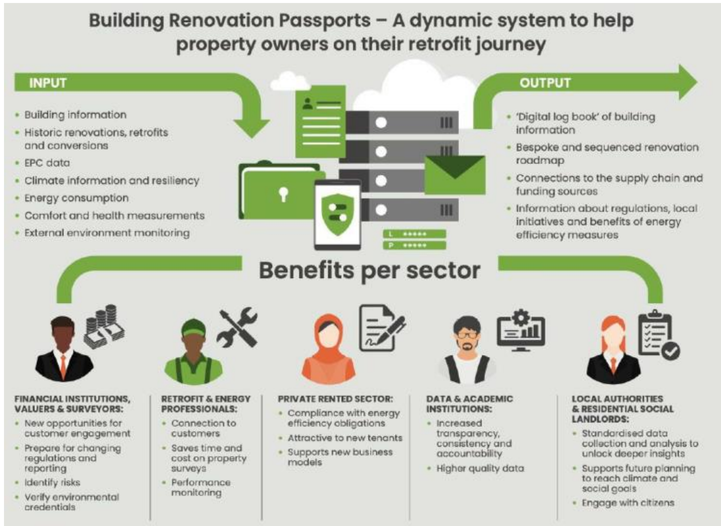
The current disparity in cost between gas and electricity is an issue and is discussed in more detail in this report.

Data and knowledge

We come from a time when very little was known about each dwelling in London to one where data can really help us to understand the problem and address it. There is also a growing need (and demand) for information on each dwelling to be accessible and up-to-date to current and future residents. Building Renovation Passports can play a significant role to slowly develop this data on existing housing and capitalise on it.



Long-term variations in emission factor of grid electricity show the rapid historical reduction in emission factors. © Etude based on data from Market Transformation Programme, UK Committee on Climate Change, Drax, National Grid and HM Treasury.



Recommended data inputs and outputs of a Building Renovation Passport and the benefits such a tool could bring to different sectors © Green Finance Institute

What is currently happening with home retrofit in London, and why it is not enough

There is no regulatory framework

Improving the energy efficiency of existing homes, moving away from gas boilers and installing solar PVs to generate electricity are not sufficiently supported by the current regulatory framework. In particular, it does not encourage enough whole house retrofit and heat decarbonisation and does not capture all opportunities or trigger points.

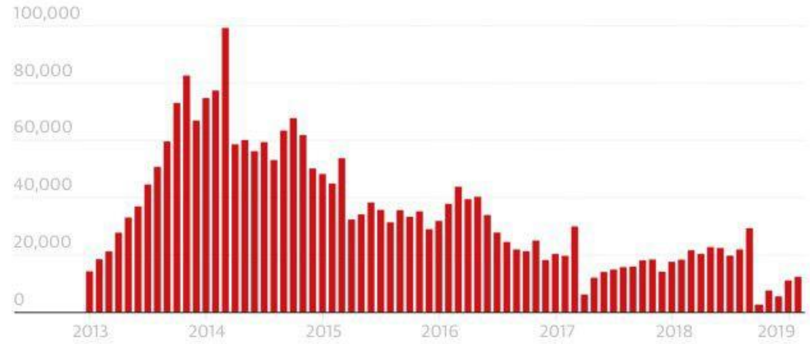
There is also no consistent and coordinated funding that covers all elements of the puzzle: fabric, heat source and renewable energy generation.

Supporting initiatives, while welcome, are still of a very small scale, and they often support individual measures rather than a whole-house approach. They have not yet reached the tens of thousands of homes required to start really building capacity.

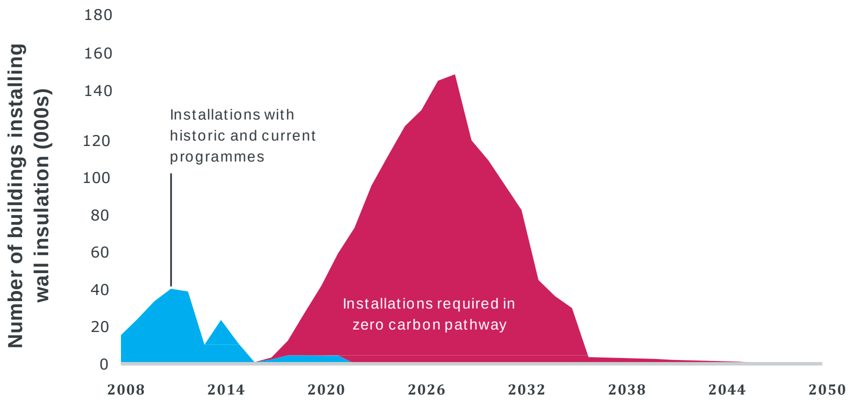
Not enough retrofits in London, and not low carbon enough

As a result, there are not enough retrofits happening and their impact is very variable. Crucially, this does not support the required upscaling and upskilling of supply chains, nor does it realise the job creation and retention potential a full retrofit programme could deliver.

If London were to wait for a sufficiently ambitious national frameworks to be put in place, it is likely that a large portion of its carbon budget would be used. This is one of the key reasons why this Retrofit London Housing Action Plan is required now.



The number of energy efficiency measures installed nationally is very low and has been declining (right - © The Guardian, using BEIS data).



Level of wall insulation achieved with past programmes compared with level required in London's zero carbon pathway (ARUP report, quoted in Mayor of London Zero carbon London - A 1.5°C compatible plan, December 2018)

Overview of key challenges at each stage of the retrofit process

If we want the Retrofit London Housing Retrofit Action Plan to have a positive impact, we need to be honest about what the key challenges are.

Demand and take-up

As individuals and organisations change their behaviour, it is very reasonable to think that more and more will want to retrofit their homes to contribute towards Net Zero Carbon. However, homeowners and landlords are currently unaware of what they can or should achieve with retrofit, partly due to weak regulatory drivers and the lack of robust data. This needs to be addressed if we want to switch the demand on.

Technical

Retrofit needs to be specific to each home and household: there is a technical complexity which can be simplified but not excessively so. This balance has not been achieved yet, leaving homeowners and landlords confused or advised with inappropriate recommendations.

Finance

Most landlords and homeowners are not able to pay for whole house low carbon retrofit in one phase. A long term whole house renovation plan would address these barriers by identifying measures that can be implemented as part of a cohesive long term plan towards a clear end goal. They are however, also underlying funding issues: London local authorities have limited means due to the considerable financial pressures they are under, and the additional building safety improvements now required. Recent Government funding schemes have ramped up public funding, but not yet to the level required, and private finance solutions are not yet widely available.

Delivery and supply

Once homeowners and landlords have decided what to do and when, the next challenge is to facilitate access to a quality supply chain which would deliver part of the plan to a sufficient level of quality.

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- Retrofit often appears to be an excessively complex set of measures.
- Tenure adds another element of complexity.
- Retrofit can be over-simplified, leading to inappropriate measures and potential issues (e.g. moisture in walls).
- The risks involved in retrofit are not clearly identified and catalogued per measure.

Delivery and supply

- The customer/client journey is challenging.
- The choice often appears to be between (expensive) professionals or contractors lacking an overview or understanding of the end goal.
- Every new retrofit needs to manage risks on its own (e.g. procurement, heat pump installation and commissioning) instead of mutualising them.
- Planning is a very clear hurdle.

Costs/funding

- The costs of retrofit are high and the financial benefits can be unclear and uncertain.
- Energy cost savings are generally not a sufficient motivation.
- Running costs of heat pumps (including maintenance) are perceived as a concern.
- Application for grant funding is complex and uncertain.
- Procuring the services of an architect or a Retrofit Coordinator can be seen as expensive.

Demand and take-up

- Is my home emitting too much carbon? Can I significantly reduce its carbon emissions and put it on the right track towards Net Zero? It is difficult for Londoners to access responses to these basic questions.
- Finding reliable advice on what to do is also not straightforward.
- It is very difficult to differentiate the relevance of generic information and the need for specific advice.

Climate justice and the need to help those in fuel poverty

ECO and the Green Homes Grant voucher scheme are not reaching fuel poor homes in London

Around 12% of households in London live in fuel poverty. London local government feels that ECO is not providing the capital with a fair share of funding from energy suppliers. Under the Green Homes Grant there have only been 2,894 applications by low-income households in London out of the more than 350,000 households currently in fuel poverty.

Directing the funding to those most in need

The Government's Fuel Poverty Strategy uses the EPC rating of the home as well as the household's income to define the problem and direct resources to those in most critical need of support. This approach leads to two potential issues: as residents move home, the calculation and therefore the availability of government support varies; and many of those in fuel poverty in London are living in flats, adjacent to families who do not necessarily meet the same assessment criteria and who therefore may not have access to the same support funds.

For retrofit work to progress reasonably consistently, it may be necessary to focus on the decarbonisation of the buildings and to address fuel poverty in conjunction (e.g. through financial support), instead of considering them as single issue.

A whole house approach will help reduce fuel poverty

Replacing a gas boiler with a heat pump without carrying out fabric improvements could, in some cases, lead to an increase in annual energy costs, which would be an issue for those already living in or close to fuel poverty. However, better energy efficiency, better ventilation and improved air quality as well as mitigation of overheating risks will all deliver better living conditions and health outcomes for the groups most at risk of fuel poverty – the very young and the very old. A whole house approach allows prioritisation of the measures carried out to be adapted to the means and needs of residents without compromising the ultimate aim.

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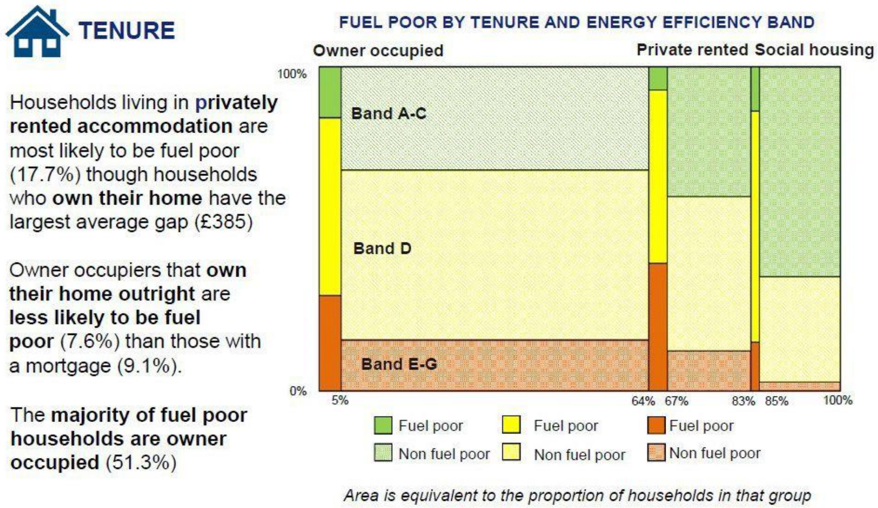
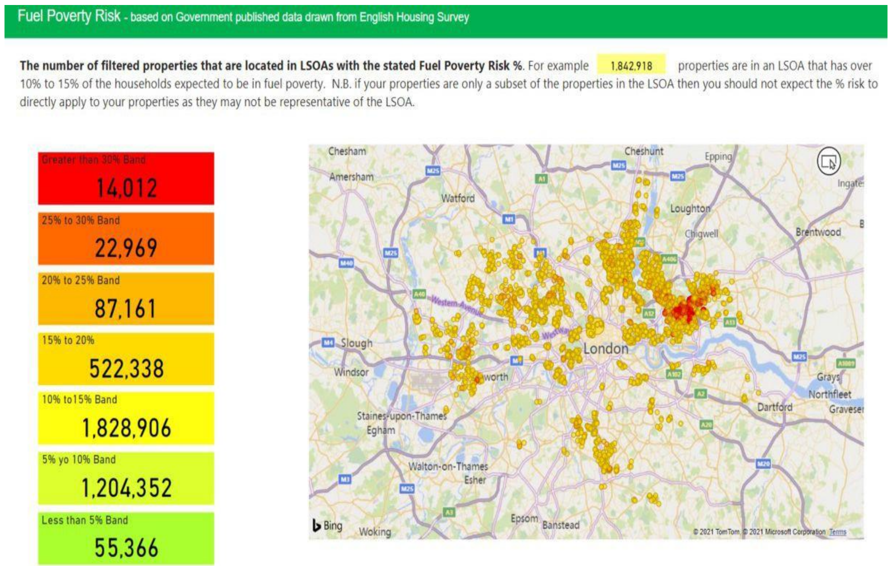


Fuel Poverty in the UK affects all tenure groups.

(Source: BEIS Fuel Poverty Factsheet 2020 (2018 data))



The map shows postcodes in LSOAs with a greater than 20% risk of fuel poverty.
(Source: Parity Projects' London Councils: Pathways Report, April 2021)

A very challenging time for Local authorities

Solving the retrofit challenge is not a simple task. There are many interrelated factors, objectives, requirements, circumstances and constraints to consider. It also comes at a particularly challenging time for London local authorities:

- There are a number of obligations and priorities which all appear essential: providing more affordable housing, improving existing buildings to make them safer, recovering from Covid-19, etc.
- The financial means of local authorities have rarely been so limited. After 10 years of increasing financial pressure, London local authorities are in a much more challenging financial position than when they embarked on their Decent Homes improvement programme.

Climate change action is crucial

We can be forgiven for not giving climate change the sense of priority and urgency it deserves because other issues appear to be more immediate. However, not solving climate change will lead to very significant economic and democratic issues in the medium to long term.

For too long the complexity inherent in the retrofit challenge has also delayed real progress from happening. It is no longer an option to remain stuck and we must implement existing solutions and develop new ones.

Barriers must be viewed as an opportunity to innovate and creatively find solutions that deliver multifarious benefits.

Where does the issue sit within the wider system? What is it dependent on and what depends on it? What is complicit in supporting it as a problem, and what would need to happen for it not to be a problem any longer?

Only through investing time to explore questions such as these will solutions to persistent barriers and challenges be found.

Many London local authorities have to invest in building safety improvements for their own stock (Picture above: the Granville Road tower blocks in Childs Hill during recladding, Source: Google)

"We have to get to the point where each individual, each corporation, each community chooses low carbon, because it makes fundamental sense. It should become a no-brainer."

Christiana Figueres

Former Executive Secretary of the UN Framework Convention on Climate Change (UNFCCC)

Different typologies, different challenges

The challenges and opportunities are not the same

As we all know, the variety of different types of homes that exist across London is large. While we can arrange them into broad typologies, there will still be unique features of each building that will require attention. Two homes are rarely exactly the same.

Houses and flats

Houses typically consume the most energy and emit the most CO_2. They are also in some ways the easiest to retrofit. The owner or landlord will likely have autonomy over the measures chosen, space will likely be more easily found for a heat pump system (internally and/or externally) and the roof is likely to be suitable for PVs which can be directly connected. However, their large external area may require significant investment in retrofit measures to reduce overall energy use. On the other hand flats typically have lower heat loss: some flats may only have one external wall. Replacing the gas boilers with a low carbon heating system may be more challenging though and opportunities for solar PVs more limited.

Building age

The age of the dwellings is another important factor. In general, older properties with solid walls and single glazing are very inefficient. Older properties also need to " breathe" to maintain the integrity of their fabric. Careful retrofit of the fabric of older properties therefore has a lot of potential to reduce energy. For more efficient dwellings it is possible that replacing the gas boiler for an air source heat pump with smart controls is all that needs to happen, or could be a viable first step.

Tenure

The type of tenure has a very significant impact on the opportunities and the incentives to deliver retrofit: not so much in terms of the types of measures applicable but on how they can be delivered. Owner occupied homes, social rented homes and those which are privately rented should be considered separately.

Detached houses vs flats.

Victorian terrace houses

Modern terrace houses

Good work is already taking place in London and we need to build upon it

Current initiatives from London boroughs

Virtually all London boroughs are developing good and best practice retrofit initiatives. These include demonstrator projects (both houses and blocks of flats), specific work on heat decarbonisation, renewable energy generation, demand flexibility, as well as more strategic initiatives on delivery, cost assessment and funding, stock assessment and modelling.

Existing research and guidance published by the GLA

A number of resources are available for homeowners and professionals, including the recent GLA reports on heat pump retrofit in London (2020) and on Building Renovation Passports (2021). In addition, the Retrofit Accelerator - Homes programme aims to help London boroughs and housing associations to develop energy efficiency projects at scale with technical and commercial solutions.

National initiatives

- Policy proposals including measures for the private rented sector (requiring EPC C by 2030) and for mortgage lenders (requiring disclosure and possibly minimum EPC ratings for the stock they lend to).
- The Construction Leadership Council's draft National Retrofit Strategy placing local leadership and local delivery partnerships at its heart.
- Funding initiatives, including the Green Homes Grant Local Authority Delivery scheme and the energy efficiency local supply chain demonstration projects (BEIS): Six across England, including Parity Projects' Ecofurb in London.

Other relevant local initiatives and guidance

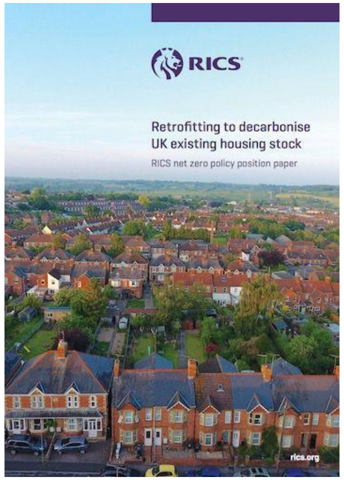
- Nottingham Deep Retrofit Energy Model
- Greater Manchester Combined Authority: People Powered Retrofit with Urbed & Carbon Coop
- UKGBC Accelerator Cities Programme, including the Retrofit Playbook.

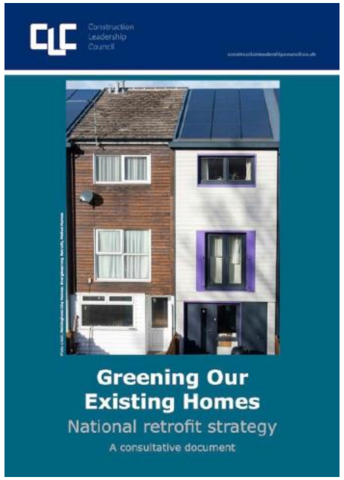
- Houses: Brent, Enfield, Lewisham, Newham, Richmond , Sutton, Wandsworth, Waltham Forest
- Blocks of flats: City of London, Enfield, Greenwich, Hackney, Haringey, Kensington & Chelsea, Redbridge, Richmond & Wandsworth, Sutton

Delivery, skills, supply chain

- Skills: Camden's stakeholder engagement event
- Energiesprong: Enfield, Haringey, Sutton
- Window manufacturing: Newham
- Parity Projects' Ecofurb

Above are examples of current initiatives on demonstrator projects and initiatives in the area of delivery, skills and supply chain by London Boroughs (as of April 2021)





A number of reports articulate the need and benefits of a more ambitious retrofit strategy
(Above left: Retrofitting to decarbonise UK existing stock, RICS, May 2020)
(Above right: Greening our existing homes: National retrofit strategy, CLC, December 2020)

It can be done!

The examples on this page demonstrate that retrofit has taken place successfully across a wide number of types and tenures.

Balfron Tower, Tower Hamlets

Grove Road, Hounslow Homes, Hounslow

Edward Woods, Hammersmith and Fulham

Adams Row(Listed) Grosvenor, RBKC

Artic Street, Housing Coop, Camden

Ernley Close, One Manchester Housing

Great Arthur House, City of London

Wilmcote House, Plymouth City Council

Channel Islands Estate, Enfield

Princedale Rd, Octavia Housing, RBKC

Culford Rd, Hackney

Akerman Rd, Lambeth Homes

Bloomsbury house (listed), Camden

This section sets out the eight key principles underpinning the Retrofit London Housing Action Plan.

A consensus on them between the 33 London local authorities and the Greater London Authority forms the foundations of the Action Plan.

The eight key principles underpinning the action plan

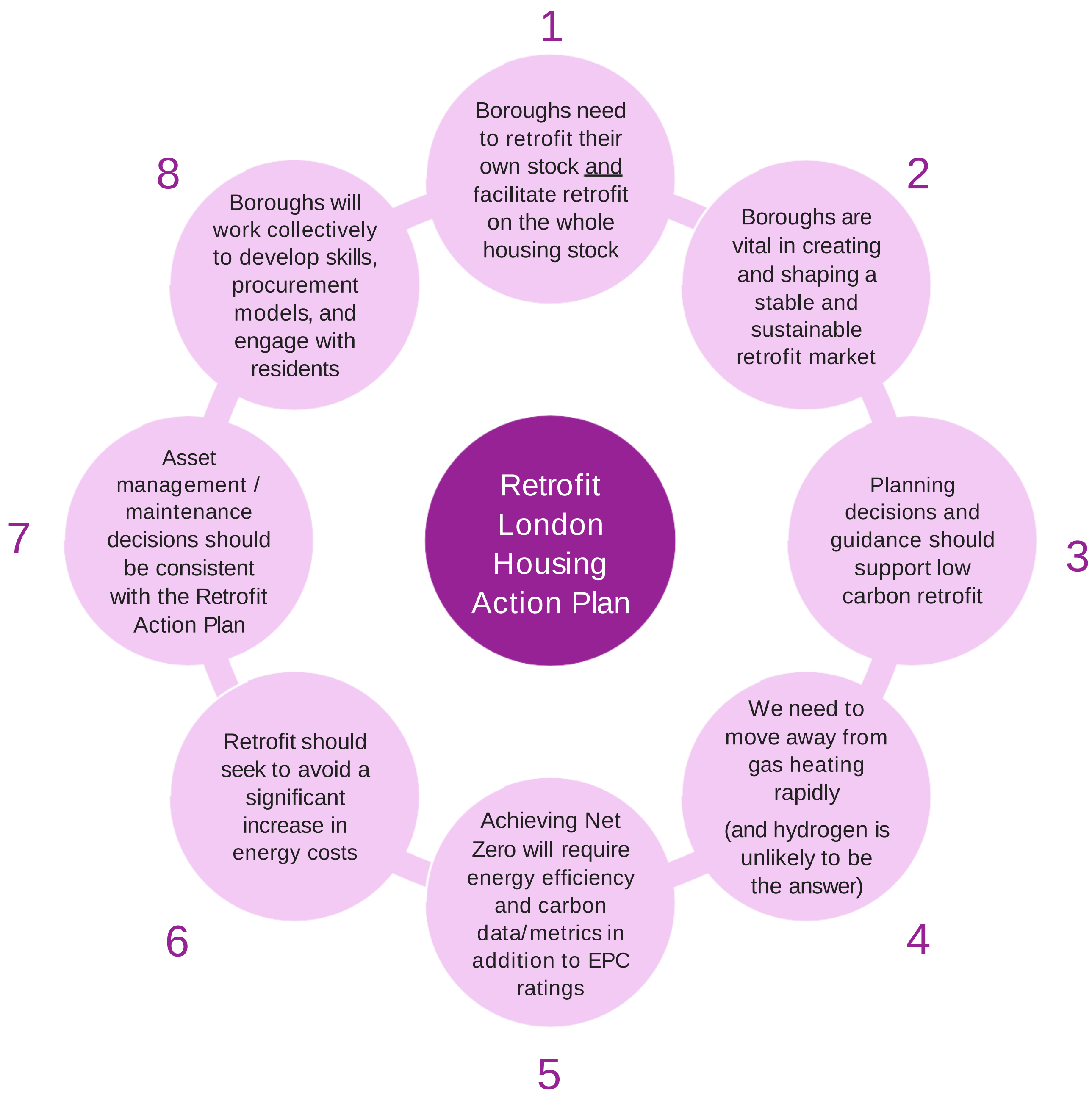
Facing in the same direction

Laying the foundations for a successful collaboration between the London boroughs and their partners, including the GLA, is at the heart of this project led by London Councils.

It is important to move forward together and decisively in order to improve London's housing stock and put it on the right track to Net Zero.

The adjacent eight principles are considered essential to enable London local authorities to face in the same direction and move forward together. Some of them assume that London local authorities will receive additional funding, resources and guidance from central government.

Each of them is explained on the following pages.



1 Boroughs need to act on their own stock and facilitate retrofit on the whole housing stock

Council owned stock

Boroughs have direct influence over their own housing stock which, on average in London, represents between 0 and 20% of all homes. This direct control creates the potential to deliver mass retrofit over the coming 10 years and beyond with aims closely aligned to the principles set out within this Action Plan. London local authorities can programme low energy retrofit as part of their ongoing maintenance programmes and by setting clear, measurable milestones.

Owner occupier sector

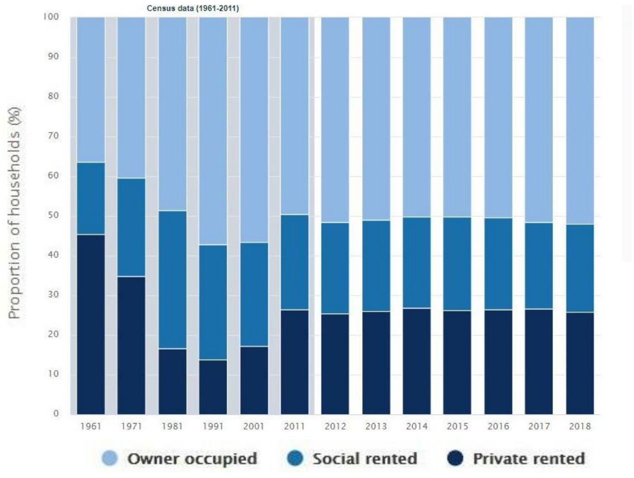
The owner occupier sector represents just over half of all homes in London. It is a very fragmented and diverse sector which include both pioneers and people with little desire or means to improve their homes. Retrofit should be seen in the context of a very large home improvement market though, with trigger points providing key opportunities for retrofit (e.g. rental, sale, change of use, extension, repair or maintenance work). London local authorities can help by raising awareness, making the planning process easier, increasing skills, providing certainty to the supply chain, helping administer retrofit programmes and facilitating access to knowledge.

Private Rented Sector (PRS)

The private rented sector is regulated through the domestic Minimum Energy Efficiency Standard (MEES) but is challenging as low carbon retrofit offers landlords little incentive to invest further. It is an important sector from an environmental and social point of view though, due to its weight in terms of carbon emissions and because it has a larger proportion of households living in fuel poverty and sub-standard homes than in the other sectors.

Mixed ownership

Ownership is often complicated by the distinctions of freehold and leasehold. Leaseholders within blocks or rows of terrace houses can significantly affect the ability to roll out retrofit. For private homeowners who are leaseholders, the terms of their lease may be a barrier to retrofit.



The bar chart above shows the relative proportions of dwelling tenures across London. While this has varied over time, the ratio has been stable for a number of years. Owner occupiers are the dominant category at a little over 50%. The private rented sector is next and the social rented sector is a close third (Source [Housing tenure over time | Trust for London](#))

The UK's first Energiesprong project in Nottingham is an example to follow but it also highlights the problem which leasehold tenure can present in retrofit projects, undermining both the technical and architectural ambition here. For multistorey schemes, leaseholders can potentially block entire projects especially where the planned improvements are reliant on external re-cladding (© Mellus Homes).

2 Boroughs are vital in creating and shaping a stable and sustainable retrofit market

Known and trusted by local residents

The London local authorities are one of the few organisations that are known to all residents in the area, irrespective of tenure. Councils have opportunities to communicate directly with households, landlords and social providers and will have a central role to play in shaping the retrofit market in London.

Although levels of trust in Councils as a whole varies by community and location, Councils also represent trusted organisations and brands. Therefore information and guidance provided by the Council on home advice could be more trusted than from other sources.

Data and insights on local context and building stock

Councils have an intimate knowledge of local social and building context. This gives a solid foundation for planning an intelligent retrofit strategy across housing in the area which is relevant to local people's lives.

Control over policy and local planning

Through the planning process and other policy levers London local authorities are, to an extent, able to incentivise and even mandate upgrades to housing. Although powers are limited this is an important part of encouraging retrofit.

A consistency and scale to steady the market

In the wake of the Green Deal, Green Homes Grant and lack of long term central government policy the retrofit market is very unstable. Councils are already a huge building renovation and maintenance customer, and can be a buffer for local trades and consumers by providing a consistent demand and clear requirements. There is a risk that the supply chain can represent a bottleneck and limit the ability to deliver retrofit in the short to medium term. Providing certainty that there is a sustainable retrofit market is a must for the supply chain to develop and London local authorities can play an important role in this.

3,781,477 properties

33 boroughs

3 Planning decisions and guidance should support low carbon retrofit

Working together across London and sharing expertise

There are significant opportunities for building conservation and climate change officers to work together to make sure that conservation and climate change can go hand in hand and that planning does not constitute an additional hurdle to well considered proposals. It would be particularly helpful if better guidance could be created for conservation areas that actively supported sympathetic retrofit measures.

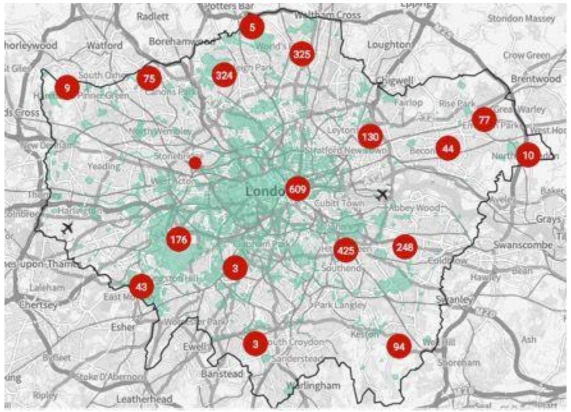
Conservation of heritage and the planet

Greater London includes over 1,000 conservation areas and approximately 17% of all homes in London are in a conservation area. In some boroughs they represent the majority of the housing stock. They have to be addressed in order for these boroughs and London as a whole to achieve their climate ambitions.

Retrofit work to historic buildings needs to be done with particular care and skills. This was stated in the Sustainable Traditional Buildings Alliance's Responsible Retrofit Guide and this principle has been adopted with the PAS 2035. Historic England's Heritage Counts 2019 and 2020 papers acknowledge the importance of retrofit within the world of conservation. Buildings need to be preserved from harm, not from change altogether.

There is significant potential for conservation of heritage assets to work in harmony with efforts to mitigate climate change. In particular:

- Retrofit is often part of a wider programme of repairs and upgrading, which increases the value and functionality of a building, making it more likely to remain valuable and well looked-after in the future.
- Low-energy retrofit does not only have energy, carbon and comfort benefits, it also limits the risk of under-heating by occupants worried about energy bills, and the associated risks of fabric degradation.
- Excessive restrictions may lead to 'rogue' works carried out without any regulatory oversight, with worse consequences to the asset.



Conservation areas (green) and listed buildings (numbers in red) represent a significant proportion of the London housing stock, particularly in the inner boroughs. They cannot be ignored if London is to meet its climate objectives. (© London Datastore)

There is a growing library of resources for responsible retrofit of traditional and historic buildings, including the above Sustainable Traditional Buildings Alliance (STBA) and Historic England guidance

4 We need to move away from gas heating

Cumulative carbon is key

The Climate Change Committee (CCC) have been very clear that the use of fossil fuels must be eliminated in virtually all buildings by 2050 to achieve the legal obligation of Net Zero for the UK.

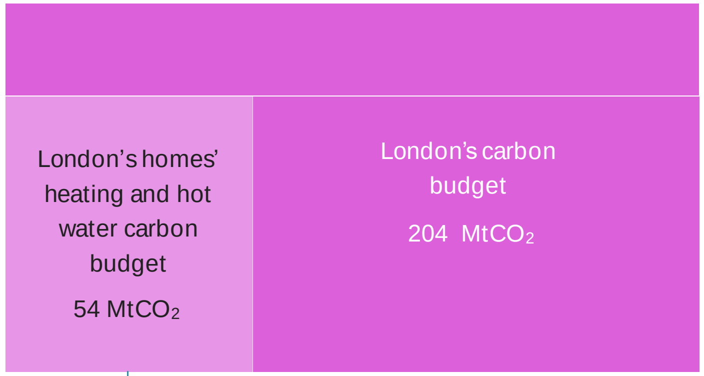
If we are also to meet our obligations under the Paris Agreement in limiting global temperature rises to no more than 2°C, a carbon budget approach helps to understand the impacts of the pace of change between now and 2050. They take into account the effect of cumulative CO_2 emissions in the atmosphere. The Tyndall Centre for Climate Change has taken a Paris aligned global carbon budget and used it to derive a carbon budget for the UK and all the Local Authorities within it. According to this analysis, London's remaining carbon budget is 204 $MtCO_2$, and meeting the budget must not rely on carbon offsets.

Carbon budgets for London's homes

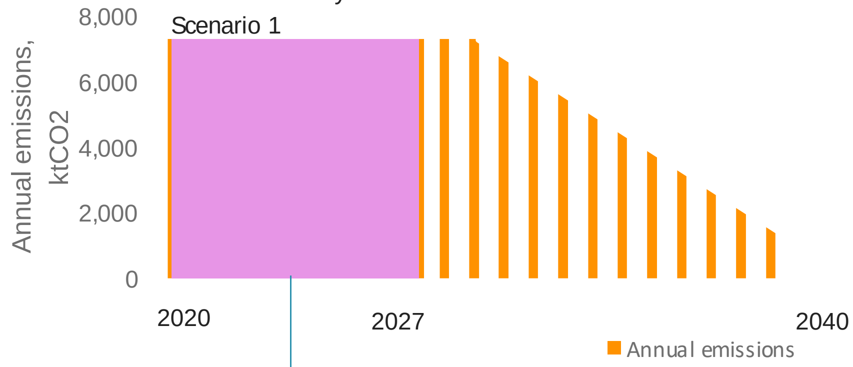
We have used London's carbon budget to derive a carbon budget specifically for heating and hot water for London's homes which we estimate at 54 $MtCO_2$. This helps us understand the impact gas boilers in existing homes are having on achieving carbon budget targets.

We know that in 2019, gas boilers in London's homes emitted 7.3 $MtCO_2$. The graphs on the right show annual emissions in orange, and cumulative emissions equal to 54$MtCO_2$ in the pink shaded area. We can see in scenario 1 that if no action is taken to remove gas boilers and replace them with low carbon heating until 2030, all the carbon budget for heating homes will be consumed by 2027. On this pathway, homes are practically zero carbon by 2040, but they have exceeded their carbon budget by more than 100%. This pathway is therefore not Paris compliant.

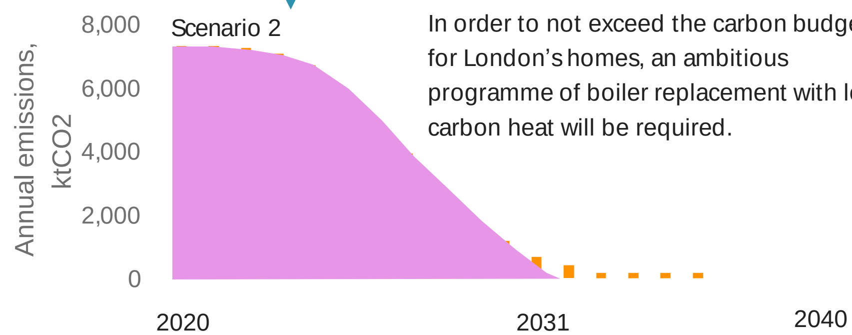
Scenario 2 shows a gradual but highly ambitious programme of boiler replacement. This could enable the carbon budget to be met, but virtually all boilers in existing homes would need to be removed by the early 2030s.



If we compare the carbon budget for homes with the current emissions of domestic gas boilers, we see that the carbon budget is consumed within 7 years at current emissions rates.



In order to not exceed the carbon budget for London's homes, an ambitious programme of boiler replacement with low carbon heat will be required.



... and hydrogen is unlikely to be the answer

A growing consensus

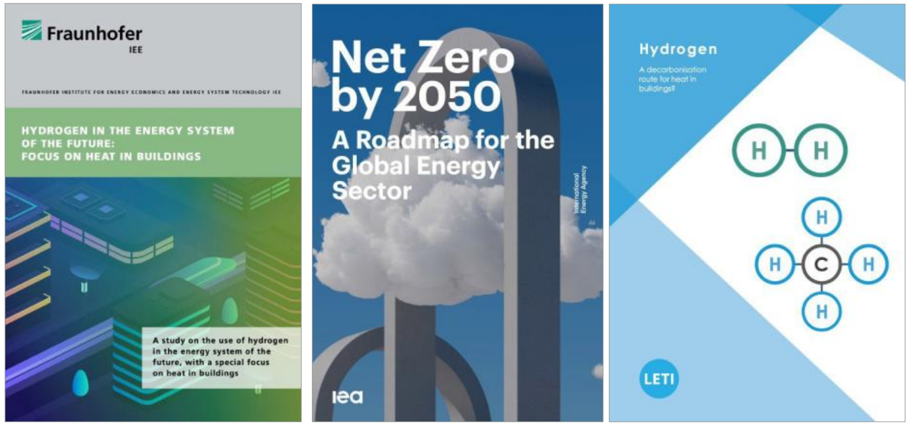
Our team analysed recent publications relevant to the potential role of hydrogen in heating homes in the future and discussed it with several experts in energy and buildings. The growing consensus is that hydrogen is unlikely to play a significant role in the short to medium term (if at all) for this purpose. It is an important issue, as a strategy relying on hydrogen could prove to be flawed when it is already too late to switch to other solutions. It would therefore be a risky decision for London local authorities which may prevent them from achieving their climate change obligations.

Costs will be (very) high

Re-using the existing gas grid network into and within London and turning it into a 100% hydrogen network is not possible without major upgrades. The costs of this combined with hydrogen generation costs and the replacement of all gas appliances into hydrogen-ready ones will be very significant. It is unclear why private investors or the Government would finance this major undertaking when renewable electricity distribution appears comparatively much more attractive and less risky.

The Climate Change Committee view

The Committee on Climate Change sees a limited role for hydrogen where ‘electrification reaches the limits of feasibility and cost-effectiveness’. In practice, this is likely to mean industrial heat, top up heating for some buildings on very cold days, back-up power generation and heavy-duty vehicles. This view is based on a maximum practical capacity to produce up to 44TWh of hydrogen a year by 2050, less than 10% of current gas consumption in buildings.



A number of independent reports suggest that hydrogen is likely to have a very limited role (if any at all) to heat our homes (the above examples are from the Fraunhofer Institute, the International Energy Agency and LETI)

.

‘Blue hydrogen’ is unproven and not carbon neutral

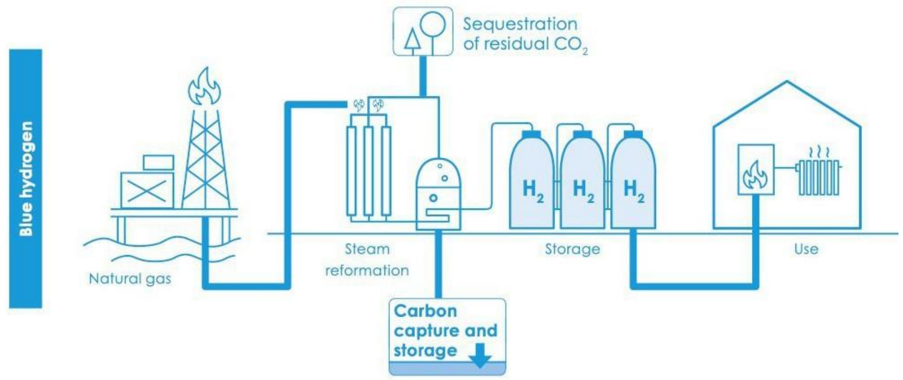
Hydrogen is currently produced via four methods, three of which require a fossil fuel feedstock to create ‘blue hydrogen’ with inherently high emissions. Carbon capture and storage (CCS) is therefore required to reduce emissions (60-85% relative to using natural gas) but economically viable CCS at scale for this purpose is unproven.

Heat pumps are 5 times more efficient than ‘Green hydrogen’

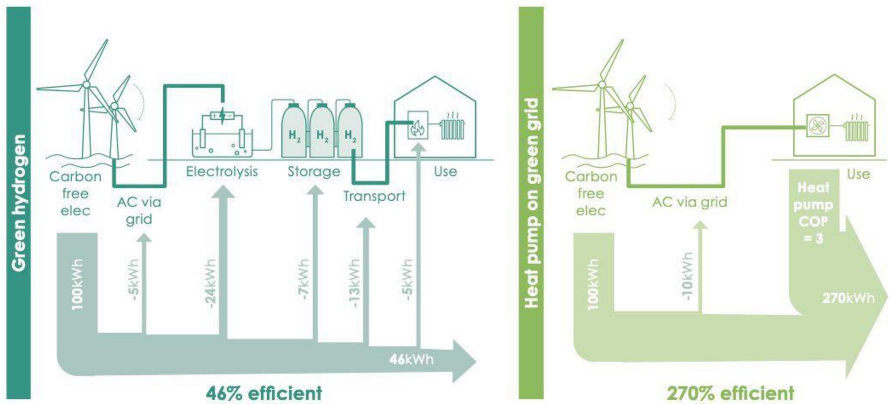
‘Green hydrogen’, produced via electrolysis powered by very low carbon sources of electricity such as renewables and nuclear, offers a more plausible route to create genuinely low carbon hydrogen. However, it is more efficient to use electricity directly for heating and hot water instead of turning it into hydrogen and burning it in boilers. Using renewable electricity to power heat pumps is 5 times more efficient. Using electricity (directly or via heat pumps) is also safer with no risk of explosion.

Safety concerns

Hydrogen is more flammable, has a faster flame rate and burns hotter than natural gas. The first two make it more risky in terms of accidental explosion, especially if it is used in cooking hobs and the last means the flame is generally invisible in daylight so, again in cooking applications, more likely to cause accidents. The smaller molecule size means it is also more likely than natural gas to leak from normal pipework, including through valve seats. More explosions and burn accidents are likely if we switch to hydrogen. Electricity would be much safer.



‘Blue hydrogen’ is produced from fossil fuels. Carbon capture and storage (CCS), yet unproven at scale, is then required to reduce emissions (© LETI)



Heat pumps are a much more efficient way to use electricity generated by renewables than ‘green hydrogen’ (© LETI)

5 Achieving Net Zero will require energy efficiency and carbon data/metrics in addition to EPC ratings

The EPC rating is not the right metric for climate change

There are several reasons:

- It is an energy cost indicator: the current A to G ratings and the associated SAP scores are energy cost indicators, not energy use or carbon indicators.
- The recommendations to improve an EPC rating can be misleading: The continued use of gas boilers is incentivised with a system based on the improvement of an EPC rating, as gas remains cheaper than electricity despite now being a higher carbon energy source.
- It does not cover all energy uses by the home: EPCs only cover part of the dwelling energy use (i.e. the 'regulated' part) and therefore do not form the 'whole picture' of home
- It cannot be measured: an EPC rating cannot be checked by the home/building owner or local authority against in-use energy.
- It is not accurate: studies indicate a relatively small difference in actual energy use between different EPC ratings, suggesting that bringing all homes to a particular EPC rating may actually achieve little in practice.

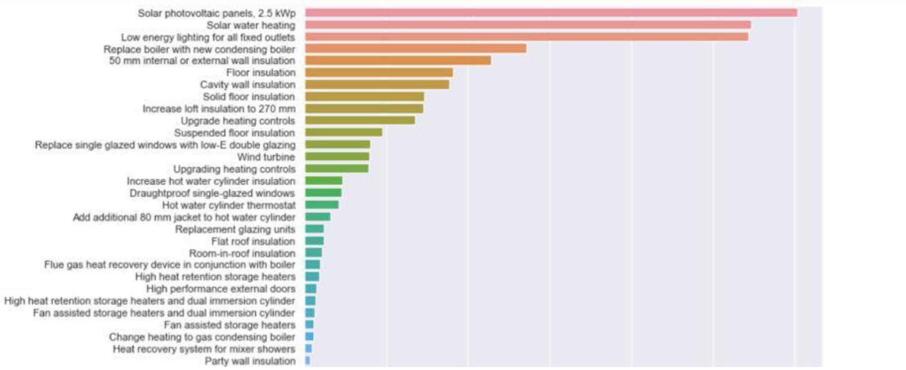
We recommend the following additional metrics

These metrics are already collected and/or can be readily calculated:

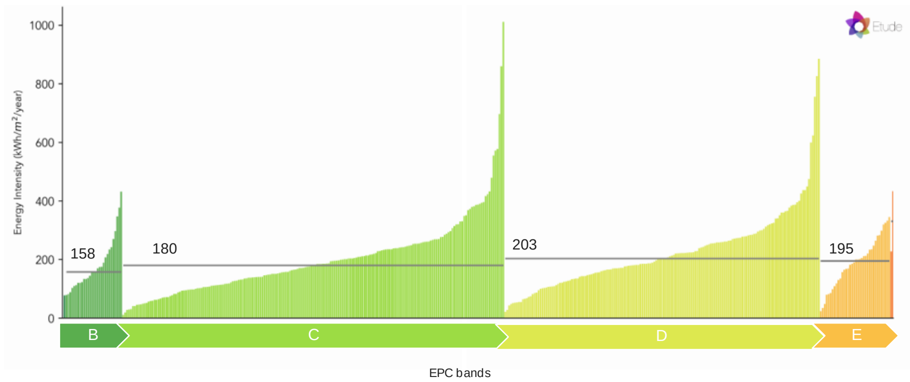
Carbon emissions in $kgCO_2/m^2/yr$. If Net Zero carbon is a key objective, a carbon indicator is required which takes into account the carbon impact of all home energy uses and the need to transition away from gas and other fossil fuels. This should be based on long-term carbon factors (e.g. 2038).

Space heating demand in $kWh/m^2/yr$. Heat demand is a major challenge in existing homes and a key opportunity in terms of retrofit. It is an energy efficiency indicator and also links to comfort, health and wellbeing.

Total energy use (Energy Use Intensity - EUI) in $kWh/m^2/yr$. This is independent from changes to the energy system and prices, is easy to understand for consumers, enables a direct feedback loop from metering, and allows comparisons between dwellings.



Analysis of recommendations on all EPC certificates in the UK: this clearly illustrates that the current system is not fit for purpose to put the existing housing stock on the right track towards Net Zero. For example, the installation of a heat pump is never recommended, which is partially due to the current nature of the EPC rating: a cost indicator rather than an energy efficiency or carbon metric (Source: UCL)



Distribution of metered energy use from 420 dwellings in London

This analysis of actual energy used in homes shows that improved EPC ratings are associated with some reduction in average energy use, but a limited one. For example, there is only a 22% reduction in total average energy use intensity from D- to B-ratings.

The mean total energy use in EPC band A is 161kWh/m2/yr, which is very high.*

6 Retrofit should seek to avoid a significant increase in energy costs

Changing to low carbon heat is an urgent priority

In the UK, electricity per unit currently costs, on average, significantly more than mains natural gas so the shift to low carbon heat could potentially create an overall increase in energy bills for most residents in existing homes. Energy bills can form a substantial part of household expenditure, it is therefore critical that the move away from fossil fuels is managed with particular consideration for low-income families.

In order to enable an early switch to low carbon heat sources, there should be a clear focus on reducing energy demand, especially in low-income homes and specifically to the extent that the switch to a low carbon heat source will not substantially increase annual fuel bills.

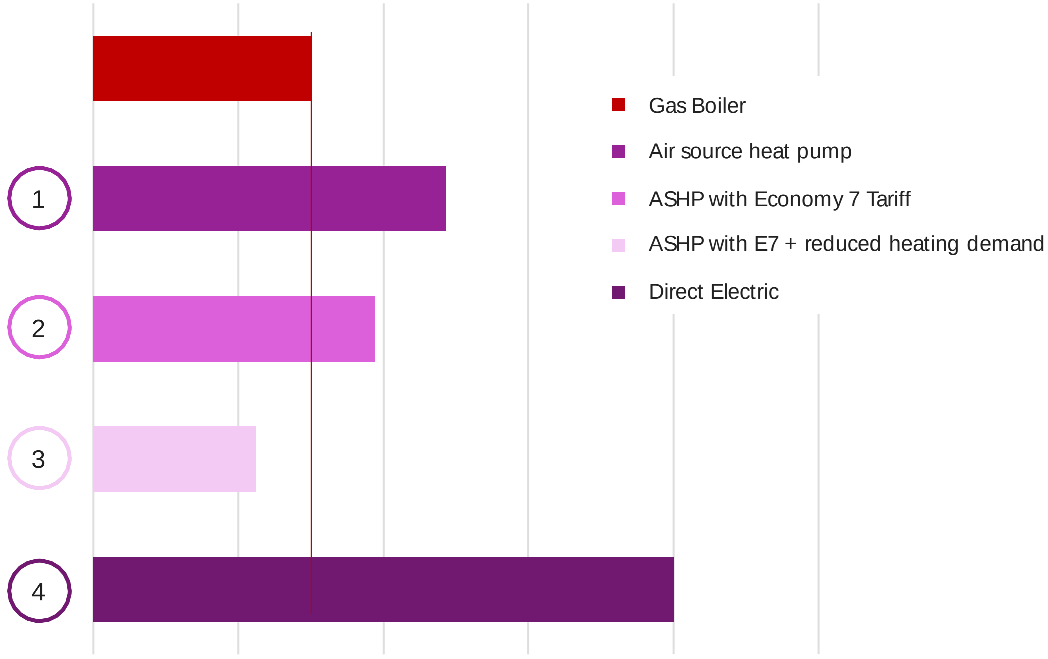
Minimising disruption to residents

Low carbon heat sources such as heat pumps work at lower operating temperatures than gas boilers, so in some cases (not all) the radiators may not be large enough to keep the rooms warm on the coldest days. If all the radiators or even pipework in homes have to be replaced, the cost of the work and the disruption to residents will be far greater than simply swapping over the heat source.

In order to enable an early switch to low carbon heat sources, improvements to the fabric of homes need to be carried out for these homes to reduce the peak heating demand sufficiently to avoid the need for major changes to the installed heating emitters, and a whole house approach is important and helps to enable this.

Access to Time of Use (ToU) electricity tariffs.

The cost of electricity is variable, far more so than the cost of mains gas for domestic customers. The lowest cost tariffs can greatly reduce the margin of difference between gas and electric heating costs, but these are generally only available to consumers who have smart meters. Therefore, the roll out of smart meters across London is a key facilitator for low carbon retrofit.



Indicative annual energy cost for an average home in London (82m^2) based on an existing space heating demand (assumed to be approx. 160 kWh/m^2/yr)

1. *With high existing space heating demands, a direct swap from a gas boiler to an ASHP leads to a relatively poor efficiency for the heat pump and consequently an increase in annual running costs (assumes a coefficient of performance (COP) for heat pump of 1.7)*
2. *Changing the fuel tariff without improving the fabric to a minimum helps to reduce heating costs but is not sufficient to reduce costs below those of the current gas boiler (assumes COP for heat pump of 1.7)*
3. *Reducing the space heating demand to around 100 kWh/m^2/year reduces fuel consumption and improves the efficiency of the heat pump in operation. (assumes COP for heat pump of 2.0)*
4. *Direct electric space heating will only be realistic where substantial fabric improvements are possible or fuel cost subsidies can be paid to residents.*

7 Asset management / maintenance decisions should be consistent with the Retrofit Action Plan

Maintenance and replacement will create opportunities

Routine maintenance will create natural trigger points to implement elements from the Retrofit London Housing Action Plan (e.g. change of heating system due to the existing system reaching the end of its life, internal insulation and ventilation works made easier for a void property etc.). It is particularly important to seek synergies between this Action Plan and the current maintenance and replacement programmes in order to make the most of these opportunities and minimise disruption for the residents. This would also greatly help to minimise costs as they would only represent incremental costs. This Action Plan is doomed to fail if it is not integrated and is instead seen as a separate set of requirements.

Review existing maintenance budgets now

Management and maintenance budgets should be reviewed and need to align with the Retrofit London Housing Action Plan, to ensure existing planned works do not lead to repeated costs.

All work going forward should ideally be compliant with this Action Plan and, more fundamentally, not do things which add to the problem. For example, gas boilers are not compliant with a Net Zero pathway and should now be replaced with low carbon heating systems generation and not gas boilers, which would lead to new retrofit costs in the future to meet the Net Zero carbon target.

Cost uplift

In order not to artificially inflate the cost of retrofit, it is useful to consider some of them as a simple cost uplift and measured above existing budgets for routine management, maintenance and replacement work. For example, re-rendering a wall or building safety works is an ideal time to apply external insulation and would mean the actual extra costs are just the additional insulation material and labour to secure the insulation to the wall.

A number of gas boilers are coming to the end of their lives each year and their replacements are already covered by long term replacement and maintenance plans. We recommend a review of these plans and budgets in favour of low carbon heat.

Scaffolding is a large part of the cost for replacing glazing. By including window upgrades as part of routine maintenance and upgrade work, costs can be minimized.

8 Boroughs will work collectively to develop skills, procurement models, and engage with residents

The 33 London local authorities are all different from one another. However, in the context of the retrofit challenge across London, those differences are relatively small compared to what they have in common and most importantly a stock of housing with strong similarities. Our engagement workshops with different boroughs confirmed the fantastic opportunities for collaboration to minimise complexity, risks and costs.

A shared desire to learn

London local authorities have been undertaking retrofit for a long time and a large number of them are very experienced in particular programmes (e.g. external wall insulation). Others should capitalise on this knowledge instead of going through the same learning curve. Heat pumps represent a new area which would benefit from shared knowledge and experience.

Opportunities for collaboration and efficiency

In order to achieve the retrofit objectives of this Action Plan a number of new activities need to be developed, from the aggregation of demand to communication activities with residents. Collaboration would not only make these tasks easier, it would also make it much more efficient if one London borough was to take the lead, assisted by a few others but for the benefit of all. At a time of pressure on resources, this would be helpful.

The need for joint advocacy

London local authorities and the GLA need help from the Government: articulating their common needs increases the chance of them being heard and securing additional resources, funding and support.

Collaboration with the wider eco system

Transition networks, NGOs, building professionals (architects, engineers, builders, suppliers) and the finance community all have a role to play to meet the retrofit challenge. Working together, including in innovative ways, is our best chance of solving the climate crisis.

A lot of exemplar retrofits already exist across London. There is every reason for London local authorities to learn from them (and from new ones) together instead of each doing their own demonstrator project.

Engaging with Londoners, and in particular with local community and transition groups is essential to engage with other types of tenure, and particularly home owners. The example above is the pop-up space created by Camden Council which hosted a large number of events over a 6-week period on the climate emergency. This included events on retrofit.

- Lessons learnt
- Key retrofitting measures
- Mapping out each building’s retrofit journey
- Key archetypes
- Whole house renovation plan templates

Summary of recommended actions in this area

The key recommended actions and activities in terms of retrofit measures and plans are listed in the adjacent table.

Each action/activity is explained succinctly in the following pages.

The full list of actions and activities is provided in a separate spreadsheet which London Councils can develop and add to when this phase of the project has been completed.

1	Improve the building fabric of London's inefficient homes
	Activity 1.1 > Analyse current characteristics and levels of energy efficiency of the housing stock
	Activity 1.2 > Set an energy efficiency target for each home
	Activity 1.3 > Enable windows upgrades and no more single glazing in London by 2030
	Activity 1.4 > Drive better External Wall Insulation (EWI)
	Activity 1.5 > Reach a London wide consensus on acceptable Internal Wall Insulation (IWI) solutions
2	Develop a plan for retrofitting ventilation systems to improve health and air quality
3	Electrify heat
	Activity 3.1 > Undertake a stock analysis of heating systems
	Activity 3.2 > Establish the most appropriate future low carbon heating system for each home
	Activity 3.3 > Stop the replacement of gas boilers with gas boilers
	Activity 3.4 > Enable a heat pump roll out at scale
	Activity 3.5 > Develop clear guidelines/requirements to 'get heat pumps right'
	Activity 3.6 > Review the carbon impact of heat networks and focus on sustainable connections
	Activity 3.7 > Develop a specific strategy for buildings heated by direct electric
	Activity 3.8 > Work with District Network Operators and utility providers on electrification of heat
4	Deliver smart meters and demand flexibility (controls, storage) in retrofitted homes
5	Increase solar energy generation on London homes
6	Map out each building's journey towards lower energy costs and Net Zero
	Activity 6.1 > Develop whole house retrofit plan templates for key building archetypes

What are the key home retrofit measures?

Energy efficiency improvements

The existing London housing stock is amongst the least efficient in Europe. Improving the fabric by changing single glazed windows to double or triple glazed ones, insulating walls, roofs and ideally floors, reducing unwanted air leakage and retrofitting Mechanical Ventilation with Heat Recovery (MVHR) are the key measures to reduce space heating demand and improve energy efficiency. The level to which these measures should be implemented (i.e. shallow or deep retrofit) depends on:

- the opportunities: whether it is technically easy or challenging (including conservation constraints)
- the level of improvement required to avoid a significant increase in heating costs with the switch to low carbon heat.

Low carbon heat and no more fossil fuels

The main objective of the Retrofit London Housing Action Plan should be to accelerate the move away from gas boilers towards heating systems using electricity. Heat pumps should be the priority as they use electricity efficiently to generate heat but direct electric heating and hot water may be acceptable in a very efficient home. Hybrid solutions with a mixture of direct electric and heat pumps are also possible. Households not served by mains gas should remain off-gas (with funding for other measures). Heat networks may have a role to play but they will have to provide a sustainable source of low carbon heat with a Net Zero compliant plan.

Demand flexibility for a smarter London electrical system

Energy storage (e.g. hot water tank) and smart controls will play an important role in integrating homes into the wider energy system.

Solar PVs

We need to increase solar energy generated in London to reduce carbon emissions and balance energy use. Many homes have a significant roof space and residents can directly benefit from this electricity.

Category	Measure
Energy efficiency	Double or triple-glazed windows Insulation (wall, roof, floor) Airtightness Ventilation (e.g. MVHR)
Low carbon heat and no more fossil fuels	Individual heat pumps Communal heat pumps Low carbon heat networks Direct electric
Demand flexibility	Energy storage Smart energy controls
Renewable energy generation	Solar PVs

Summary of key retrofitting measures which the London Home Retrofit Action Plan should seek to deliver

What did we learn in the last 30 years?

The importance of whole house thinking

Early retrofit projects tended to focus on single measures driven by funding opportunities. Projects often lacked any strategic and building specific design input and there was no evaluation at the end of the process. The results were often undermined by unintended consequences and there was no feedback loop for developing better practice.

Following the Each Home Counts review it was recognised that successful retrofit relies on a structured process including adequate assessment, design, installation and monitoring to feed back into future work.

These principles as well as the idea of whole house thinking and the role of retrofit coordinators have fed into the creation of PAS (Publicly Available Specification) 2035, the UK's first retrofit standard. Adopting PAS 2035 on projects adds some costs but also, very importantly, value and quality. It is generally a requirement of central government funded projects.

The diagram alongside illustrates a more mature approach to retrofit where design and post installation learning are built in.

How far do we go with energy efficiency?

Opinion has varied on how far to go. Schemes like Green Deal set no metric but used 'pay back rules' which tended to undermine whole house thinking and quality. Standards such as EnerPhit may be too rigid and may also risk leading to very high cost.

A consensus is now emerging that whole house plans en-masse should lead to a medium space heat demand (on average) alongside the electrification of heat. These are considered the two key objectives for reducing carbon emissions associated with homes.

This Action Plan has aimed for a 'sweet spot' in terms of a space heating demand of 65 kWhr/m^2.yr on average as a way of optimising risk and cost. We envisage a bandwidth of 20-120 kWhr/m^2/yr (depending on the building type and its retrofit constraints) within which homes should be encouraged to go as far as possible while avoiding technical risks.

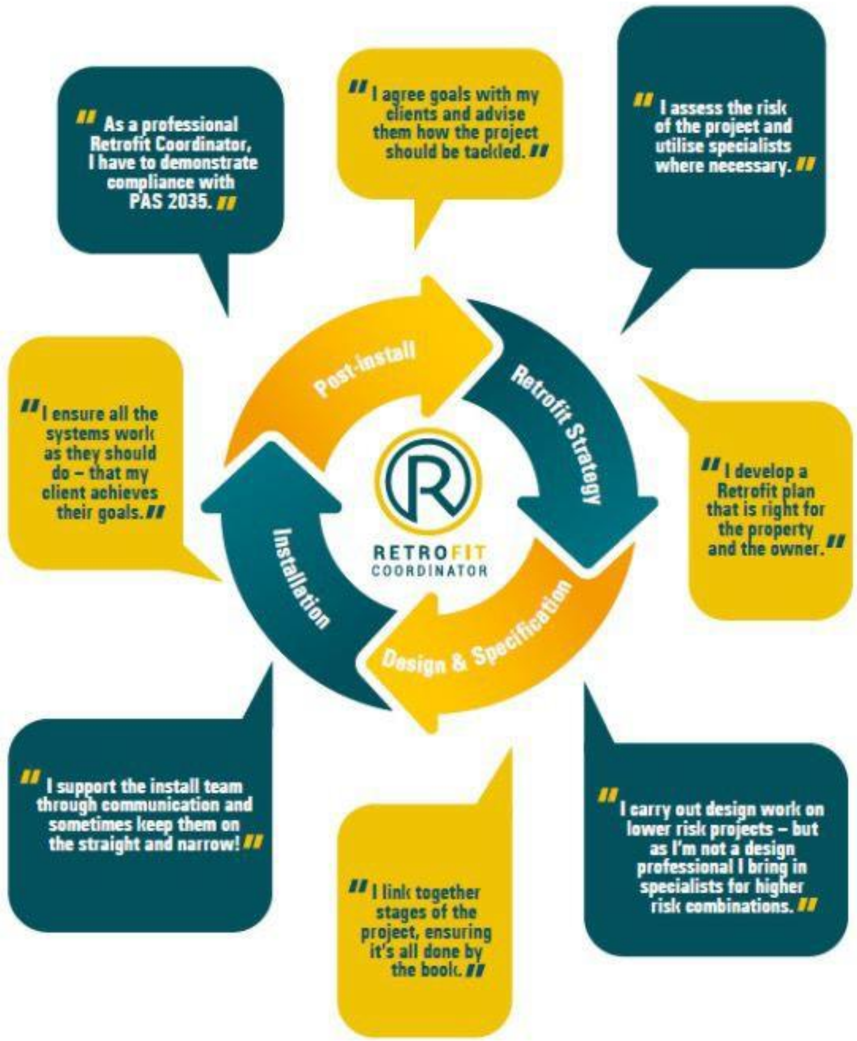


Diagram from Retrofit Academy training showing how the retrofit process should work and how retrofit coordinators should help facilitate this.

Improve the building fabric of London's inefficient homes

Parity Projects' Pathway report for London Councils summarises their data analysis for London's 3.78 million homes spread across 33 boroughs. The interim target assumes that 50% of these will receive fabric measures and the Net Zero target will require fabric measures to 100% of homes.

Fabric efficiency

As heating demand represents over 60% of the energy use within UK homes, intervening with the building fabric to reduce this has been long recognised as an essential means of reducing energy use and the resultant carbon emissions. London's housing stock (like that across the UK) tends to be relatively old and therefore typically lacks high levels of insulation and air tightness.

Parity Projects have concluded that the average SAP score for London homes is around 63 and the table alongside from their report shows the distribution of EPC bands where C, D and E dominate. The interim target aims to achieve an average EPC rating of B. The graphs indicate the scale of challenge in reaching that target.

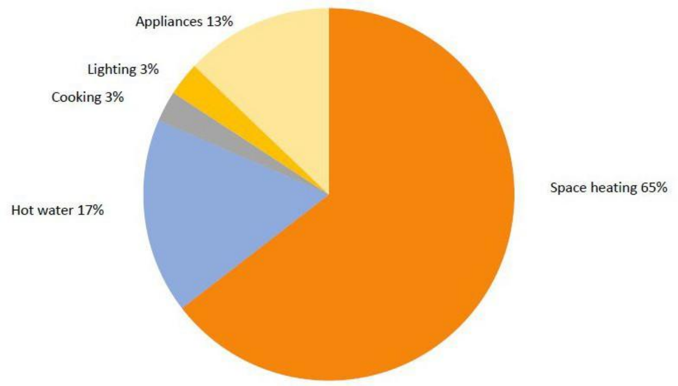
Space heating metric

One of the findings from the workshops held during this project was that EPC ratings have a limited value with regard to expressing fabric efficiency.

Parity Projects have therefore used an average space heating target of 65 kWhr/m^2/yr as a target (for 30% of homes) as a means of reaching EPC B average (interim target). This target is less than half of the current inferred average space heating demand of between 130 and 150 kWhr/m^{2}yr and clearly demonstrates the step change needed in fabric efficiency.

We recommend that, alongside EPC ratings, space heating demand is used as a more suitable measure for fabric efficiency. The target of 65 kWhr/m^2/yr may provide a useful average target.

The following pages summarise the recommended activities to achieve it.



This pie chart illustrates the relative energy use within the UK housing stock in 2019. Heating is the dominant element and needs to be reduced significantly

(Source: ECUK table U3)

This table shows the EPC scores of London homes at present. Note the very low number of homes EPC B or better, and the large numbers of C,D and E rated properties.

Source: Parity Projects London Councils Pathway Report

This table shows the current performance of London's existing housing stock across key KPIs

Source: Parity Projects London Councils Pathway Report

Action 1

Activity 1.1 > Analyse current characteristics and levels of energy efficiency of the housing stock

Each borough needs to review its own stock in greater detail and evaluate the current levels of fabric efficiency and how they can be improved. The Parity Projects report gives a breakdown of the number of homes that have specific characteristics, such as cavity wall insulation or single glazed windows. The model also provides a breakdown of those property characteristics by tenure. Using this data will allow London local authorities to understand the types of work most widely required in the area by tenure type, so plans can be put in place, for example to replace single glazing in all socially rented homes by a defined date.

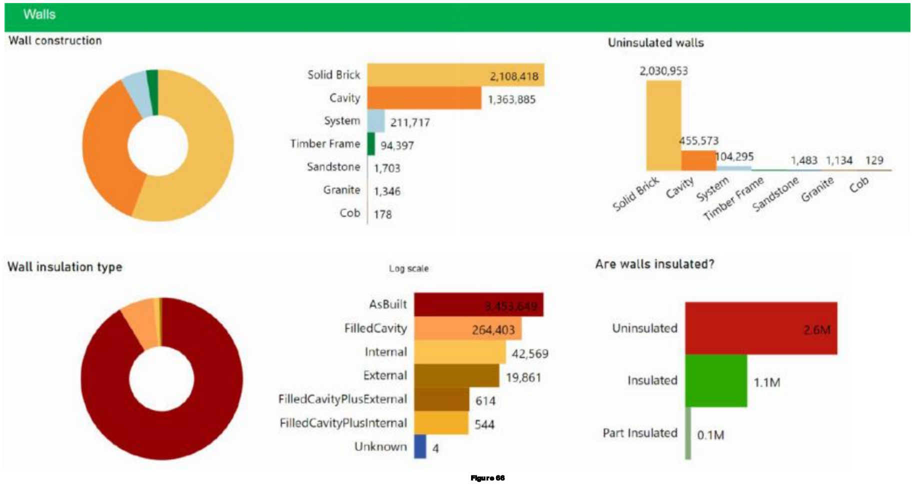
Considering borough specific opportunities and constraints

Each borough has particular constraints and opportunities which should be evaluated alongside the fabric characteristics.

For example, in an area where homes with single glazing are predominantly in buildings with high conservation status, the work required to replace the windows is likely to take longer and cost more. In another area with most homes of relatively modern construction, a strategy for the roll out of External Wall Insulation will be easier to develop.

Towards a Retrofit Action Plan for each Borough

Using BEIS data on energy consumption by postcode together with council tax records for average home sizes, it will be possible to see where the worst performing homes are relative to the general target of 65kWh/m^2/yr space heating demand and with local knowledge of the stock analysis of fabric characteristic, local constraints and opportunities, form a priority plan for the type of work needed.



Breakdowns of specific property characteristics.

(Source: Parity Projects' Pathways report for London Councils)

Postcode	No. of meters	Consumption (kWh)	Mean Consumption (kWh)	Median Consumption (kWh)
W3 6HF	41	615302.7	15007.38	12097.92
W3 6HG	11	161583.6	14689.42	16655.79
W3 6HH	21	417876.4	19898.87	18794.26
W3 6HJ	8	183917.9	22989.74	18248.27
W3 6HL	5	170695.4	34139.07	25512.36
W3 6HN	36	767059.3	21307.2	20439.17
W3 6HP	17	357622.2	21036.6	17264.09
W3 6HR	42	954442.1	22724.81	20719.09
W3 6HT	5	45115.73	9023.145	9839.763

BEIS have begun to publish energy consumption data by postcode (see. extract above. This data can be cross referred to council tax and other records for each postcode to establish an approximate rate of energy consumption per m^2. Comparison of these figures will provide an indication of the average performance of homes and fuel poverty risks.

Activity 1.2 > Set an energy efficiency target for each home

Setting an average space heating demand target

The modelling that Parity Projects have carried out was based on an average target space heating demand of 65 kWhr/m^2/yr, which is around half the current average. Further stock review by boroughs proposed in activity 1.1 will help each establish more clearly how energy efficiency, decarbonisation of heat and renewable energy can be woven together

these categories will need to be met by increases in others.

As heating dominates the energy consumption in the domestic sector, setting an energy efficiency target at a city and borough wide level will help inform high level strategic thinking as well as house by house retrofit

Influencing factors which will affect fabric efficiency targets are:

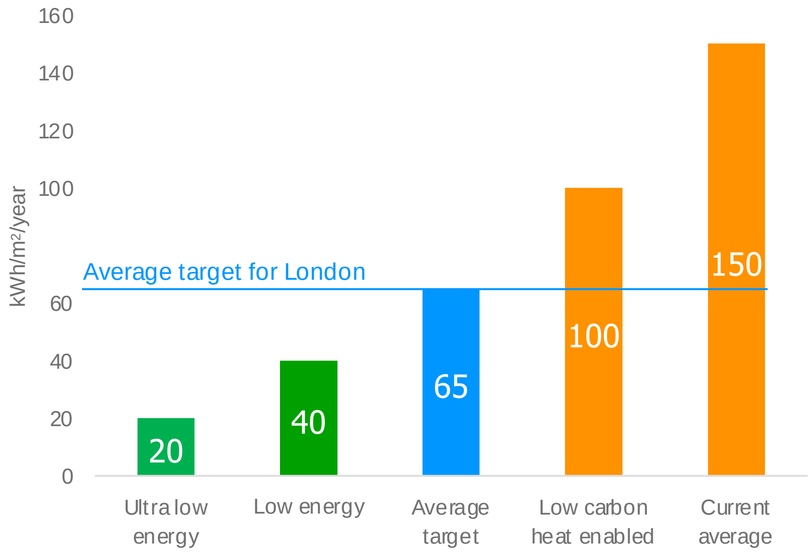
1. Planning considerations/restrictions
2. Managing technical risks such as moisture
3. Economics constraints
4. Approach to decarbonising of heat

Setting a target for each home

As well as deciding on an average space heating target, boroughs should consider that there will be a 'bandwidth' around this average, where some homes fall short and others can exceed the target.

For some homes such as detached properties that also have technical or heritage constraints, achieving the 65 kWhr/m^2/yr target will be challenging. For others, such as flats with fewer constraints on fabric options, it will be possible to get well below 65 kWhr/m^2/yr.

It will be important for boroughs to take advantage of the potential for doing better where possible in order to achieve the target on average. Otherwise there is a danger that the average target becomes the aspiration and that more homes fall short than exceed this aim. Retrofit works are also generally disruptive and expensive, it makes sense to take all opportunities when works are carried out, to maximise the added value from the works and to limit additional disruption and costs in the future.



A key measure of building fabric performance is the overall space heating demand. Lower space heating demand reduces the energy required and also facilitates the use of low carbon heat systems.

To maximise the value of retrofit, for residents and at the system level, it makes sense to maximise the opportunities created by the works by 1) producing a plan for the home to achieve Net Zero 2) ensuring works allow heat decarbonisation but are "Net Zero ready", so it only needs to be done once (example of iSFP step-by-step plan from Germany)

Enabling low carbon heat

Setting a minimum performance level in terms of space heating demand is also necessary to enable the switch to low carbon heat.

It would limit the impact on energy costs. The Carbon Trust's recent report for the GLA, *Options appraisals for heat pump retrofit in 15 London buildings* shows a threshold of space heating demand at around 80-100 kWh/m^2/year, above which fabric improvements are necessary when the heat source is changed for annual heating costs to be equivalent to or less than current gas costs[1]. As an interim step in a phased whole house retrofit plan, reaching this value is the point at which the heating system can be switched to a low carbon energy source, away from fossil fuels, even if further improvement works are to be carried out later to reach an even lower space heating demand. It also makes it possible for the residents to utilise more effective 'Time of Use' fuel tariffs, such as Economy 7, by ensuring that when the heating is switched off, the home retains warmth for longer.

It would enable efficient heat pump operation. If the heat pump has to produce high temperature hot water in order to ensure the home is kept warm because heat emitters are too small, the running costs will increase as the heat pump efficiency drops.

Radiators could be kept, minimising disruption and costs. The result of a change to heat pumps can be an effective drop in output of up to 60%. In practice, radiators are often oversized though so it should not be a problem but it should be checked and may have to be compensated by energy efficiency measures.

It would limit power peak. The UK power network is undergoing significant upgrades to support the switch to electrical heating and electric vehicle charging. Even so, the generation capacity of the system cannot be infinitely increased.

[1] *Please note: the report was not designed to establish this value and further, more direct studies may provide a more accurate or an adjusted value for this threshold.*

The Carbon Trust's recent report for the GLA, "Options appraisals for heat pump retrofit in 15 London buildings", showed that for 7 of the 11 properties studied, fuel bills are not increased when a heat pump is introduced with no fabric improvements.

These were generally the properties with an EPC of C or better. That analysis suggests that, with no other measures, a significant number of homes could immediately swap from fossil fuel to low carbon heat with no, or effectively no, fuel cost increase.

Borough	Type	Floor area (m^2)	Heating fuel	EPC Rating & kWh/m^2/yr	Fuel Costs	
					Current	Forecast - no fabric changes
Camden	Ground Floor Flat	49	Gas	C 69	£302	£311
Barnet	Mid Floor Flat	75	Gas	B 26	£245	£218
Lambeth	Ground Floor Flat	53	Gas	C 74	£294	£276
Wandsworth	Top Floor maisonette	114	Gas	D 105	£800	£949
Hillingdon	Terraced House	60	Electric Boiler	C 66		
Southwark	Semi-detached House	93	Gas	C 72	£823	£1101
Croydon	Detached House	133	Gas	D 123		
Newham	Terraced House	94	Gas	D 94	£823	£741
Lambeth	Terraced House	142	Gas	E 156	£952	£1,133
Greenwich	Block of Flats	5700	Gas - Communal	C – E 116	£27,618	£37,459
Enfield	Block of Flats	2900	Electric Heating	C – E 52	£32,584	£11,849

Activity 1.3 > Enable windows upgrades and no more single glazing in London by 2030

400,000 homes in London still have only single glazed windows and more generally the Parity Projects analysis suggests that window and external door upgrades are required to 1.5 million homes. This represents a large carbon and relatively easy carbon saving and home improvement opportunity. A window upgrade might be part of phase 1 of a whole house retrofit plan for many homes and it is likely the energy savings and peak heat demand reduction from window upgrades may also enable many homes to be 'heat pump ready''. These two measures together, driven by roll out efforts for both, could significantly accelerate and enable a pathway towards Net Zero. London could become the first city in the UK to have a 'No more single glazing' target.

Aesthetic quality

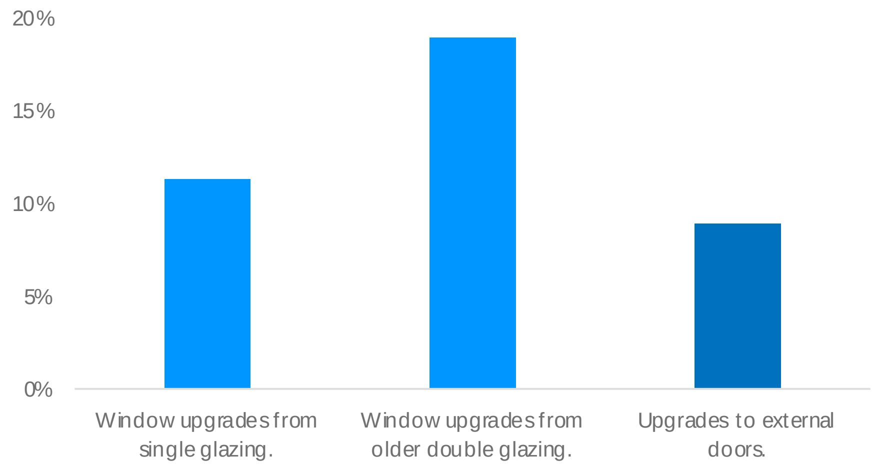
One of the barriers to large scale adoption of better windows are aesthetic and heritage considerations. This has certainly restricted works to listed buildings and in many conservation areas. High quality double, triple and evacuated glass now offer aesthetically compatible options for all building types. Secondary glazing also has its place especially for historic buildings.

Quality installation

While the quality of glazing and windows has transformed over the last decade, the quality of the installation has not necessarily kept pace. Very few installers practice good airtight installation techniques. This skills gap needs to be addressed as part of any push on window replacement, in order to avoid a performance gap.

Embodied carbon

It is recommended that the window choices should be carefully considered in order to maximize energy and carbon saving over time and avoid a large embodied carbon impact, either as a result of short lifespan or inherent high embodied carbon.



Initial data out from Parity indicating that 40% of the stock require window/door upgrades – 11% of homes require window upgrades from single glazing.

An example of a house fitted with various enhanced glazing. New double-glazed sashes on the second floor, secondary glazing to the first and new double glazing into old frames on the ground.

Air tightness . An important but still undervalued aspect of window installation

Activity 1.4 > Drive better External Wall Insulation (EWI)

External Wall Insulation is easier than Internal Wall Insulation

It is tempting to assume that External Wall Insulation (EWI) can be avoided, and that Internal Wall Insulation (IWI) is always easier. It is not the case: IWI can be much more disruptive for residents, reduces available floor space (making it more challenging in terms of residents' support) and introduces energy efficiency and technical risks which are easier to manage with EWI. For blocks of flats, difficulties in securing all residents' support IWI may prevent it from happening altogether.

EWI and reputation

The early roll out of EWI within the UK under schemes like CESP and ECO has resulted in some poor quality work, both technically and aesthetically. One of the consequences of that is an increased resistance to EWI within a number of local authority planning departments, especially to buildings which were originally brick faced. EWI has to be designed with great care in relation to fire standards and building safety as well as moisture, but there are successful examples. Concerns about combustibility may be a barrier to take up and must therefore be addressed.

Encouraging better EWI

Parity Projects' modelling has shown that EWI will be needed at scale (up to 30% of homes). It is likely that mid rise blocks of flats will be a key typology requiring this sort of thermal upgrade. Rather than restricting EWI there is the possibility for London local authorities to promote better designed approaches to the use of EWI. The examples shown alongside demonstrate how the use of color and relief can create visually engaging and pleasing elevations.

This does require design and some additional work on site. Quality work might cost a little more but the results can match and even better the existing elevations.

Dallas Road Estate, Lewisham
The architecture of this housing block was transformed in a positive way by the use of grey coloured render that forms the backdrop to colourfully painted architectural detail.

Southwark Park Estate
The use of colour and pattern to the render of this block has successfully replicated some of the originally features and has lifted the feeling of the whole.

Munich. Housing block renovation.
The uses of relief, variation in tone as well as texture makes this attractive elevation feel as though it has always been this way.

Springfield Garden Charlton
Originally a brick faced series of blocks, the use of colour raises the quality of this cladding above the light white grey so often seen.

Delivering Internal Wall Insulation at scale

Parity Projects' modelling suggests that as much as 35% of dwellings will require Internal Wall Insulation (IWI). The IWI market has remained much smaller than the EWI market due to the disruption involved with installing it and possibly due to perceived risks around it, including those associated with moisture. Tenants frequently refuse to consent to IWI installation due to the substantial disruption caused. Achieving the required scale of IWI will require engagement with residents but also a specific approach to how to address two key risks together: moisture and fire.

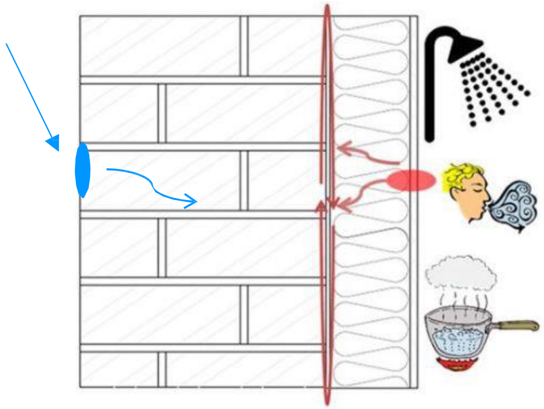
Addressing moisture and fire risks together

It is commonly accepted that the risk of moisture problems is higher with IWI due to potential for moisture trapping to take place at the wall/insulation junction. A consensus is also developing that moisture open insulations may be the safest generally and especially in historic buildings, which often rely on moisture open fabric to manage these issues.

As well as moisture risk and following the increased scrutiny on building safety, there is an onus on local authorities to consider the fire safety of all types of applied insulation. With the exceptions of mineral wool and some recently developed insulating plaster products, all insulants are, to some degree, combustible. Generally, IWI is covered with a non-combustible layer of plasterboard or a wet applied plaster coat. While that covering may minimise the risk of combustion, there remains some notional risk:

- Electrical sockets and conduits that may have been chased into the IWI or that sit within a battened void layer between insulation and plaster finish
- Instances where insulation traverses the joist zone between floors and potentially provides a path for fire spread between separate flats.

We recommend a London-wide review to take place on these risks and guidance to be issued to local authorities on acceptable IWI solutions.



Moisture risk in IWI applications.

The interface between the original wall surface and the IWI has the potential to allow interstitial condensation and trap moisture. These risks can be managed through careful design and specification.

Wet applied insulating plaster

This is one IWI solution that promotes moisture management by reliance on the material property

Action 2 Develop a plan for retrofitting ventilation systems to improve health and air quality

Maintaining and improving indoor air quality

Air quality within homes is a critical factor affecting human health and the building fabric. Controlling moisture load, CO_2 and pollutant levels in the air we breathe requires adequate fresh air from outside and extraction of vitiated air from indoors. Retrofit deliberately makes homes more airtight in order to avoid wasting heat energy. As homes are made more draught free it is important to ensure that adequate controllable ventilation systems are fitted to maintain consistently good air quality.

Where homes are expected to achieve an air permeability better than $5m^3/m^2/h$ @50Pa, which includes most whole house retrofit projects, it is increasingly recognised that continuous mechanically assisted ventilation will be required. Continuous extract ventilation from wet spaces with trickle vent inlets within windows can ensure that better air quality can be maintained. This can be arranged for with individual fans in each wet space or with one centralised fan and a small amount of ductwork.

Further energy savings from heat recovery or demand control

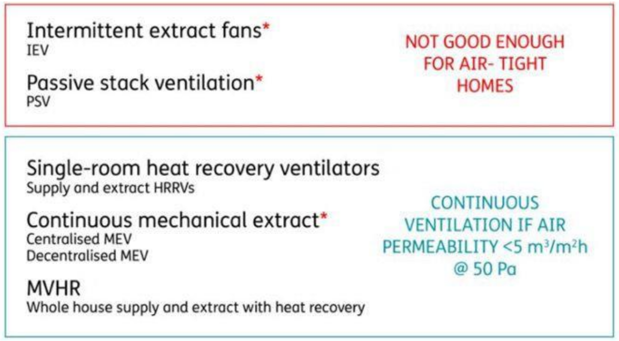
Where a central fan is possible, a further improvement is to provide balanced supply and extract ventilation with heat recovery. This provides the best air quality by guaranteeing the supply air path. Heat recovery saves more than 10x the amount of electricity needed to run the fans through saved heat energy.

Demand control extract ventilation can achieve energy saving by monitoring the air quality and adjusting the ventilation rate.

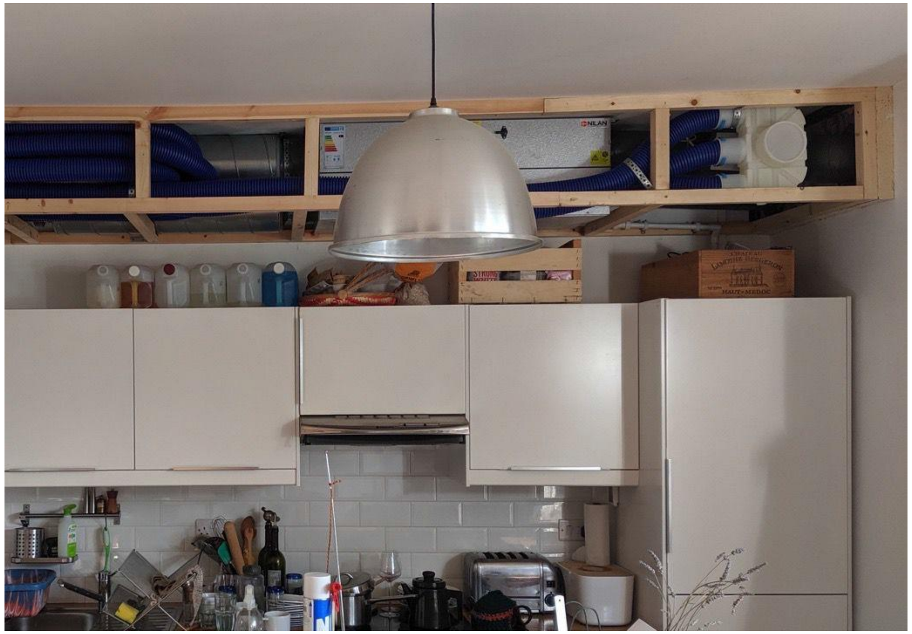
Natural ventilation in summer

All systems should be coupled with opening windows to give residents control and purge ventilation for summer comfort.

London local authorities should consider mechanical ventilation alongside energy efficiency measures and develop a plan to deliver these systems at scale.



A continuous mechanical background ventilation strategy should be adopted wherever a retrofit may improve the airtightness of the home below a permeability threshold of $5m^3/m^2hr$.



Installation of a whole house mechanical ventilation system with heat recovery in a flat as part of a retrofit. In this case installed in the ceiling above a kitchen.

Action 3

Individual gas boilers are the norm – this needs to change

Parity Projects' analysis shows that individual gas boilers currently vastly outnumber other heating systems. This needs to change and is the most important move we need to make to achieve London's climate change objectives.

Heat pumps are the best option

The electricity grid has decarbonised and will continue to decarbonise, thus the most reliably low carbon heat source is electricity. This is done most efficiently, and has lower running costs, when using heat pumps. There are various types of systems available, including air and ground source heat pumps, exhaust air heat pumps, and heat pumps integrated into a domestic hot water store.

Hot water storage is required when using heat pumps.

What other options are available?

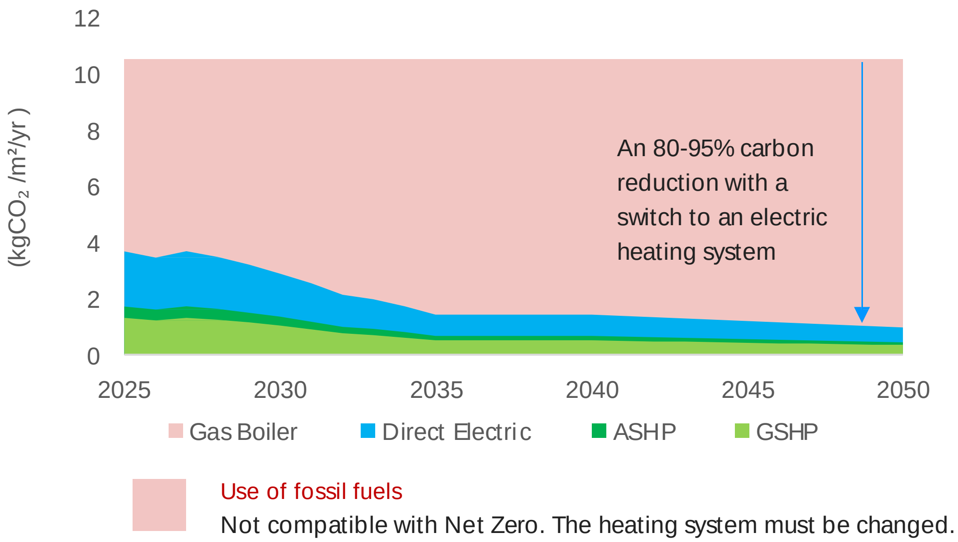
Direct electric heating, for example through panel radiators, will become low carbon in the future, as the grid continues to decarbonise. However direct electric heating can lead to very high heating bills.

Heat networks may have a role to play but they must provide a sustainable source of low carbon heat with a clear Net Zero compliant plan.

Hybrid systems may provide an interim solution for homes with the highest space heating demand to decarbonise quickly. These systems pair a heat pump to provide most of the heating with a gas boiler to provide a top up for the coldest days. With the correct controls in place, and alongside as many fabric improvements as possible, these systems can substantially reduce carbon emissions.

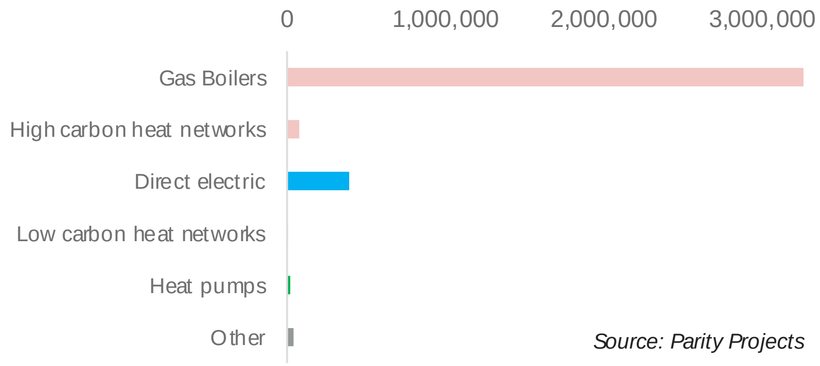
Plotting a course to low carbon heat solutions

The following pages set out the recommended process needed to analyse each home and to determine the most suitable low carbon heat system.



Comparison of carbon emissions associated with different heating systems or a typical home over the next 25 years.

Emissions from a gas boiler stay constant, whereas emissions from direct electric systems and heat pumps reduce over time due to grid decarbonisation. Heat pumps have lower emissions than direct electric systems purely because they are more efficient.



Source: Parity Projects

This chart shows the current number of installations in each main heating system category in London. The move away from gas boilers is necessary but the task is significant. 'Heat networks' include both district heating systems and communal (building scale) systems. Source: Parity Projects

Current heating system and opportunities for each home

Moving away from fossil fuel heating will require a composite approach between heat pumps, direct electric heating, and low carbon district heating (where already available).

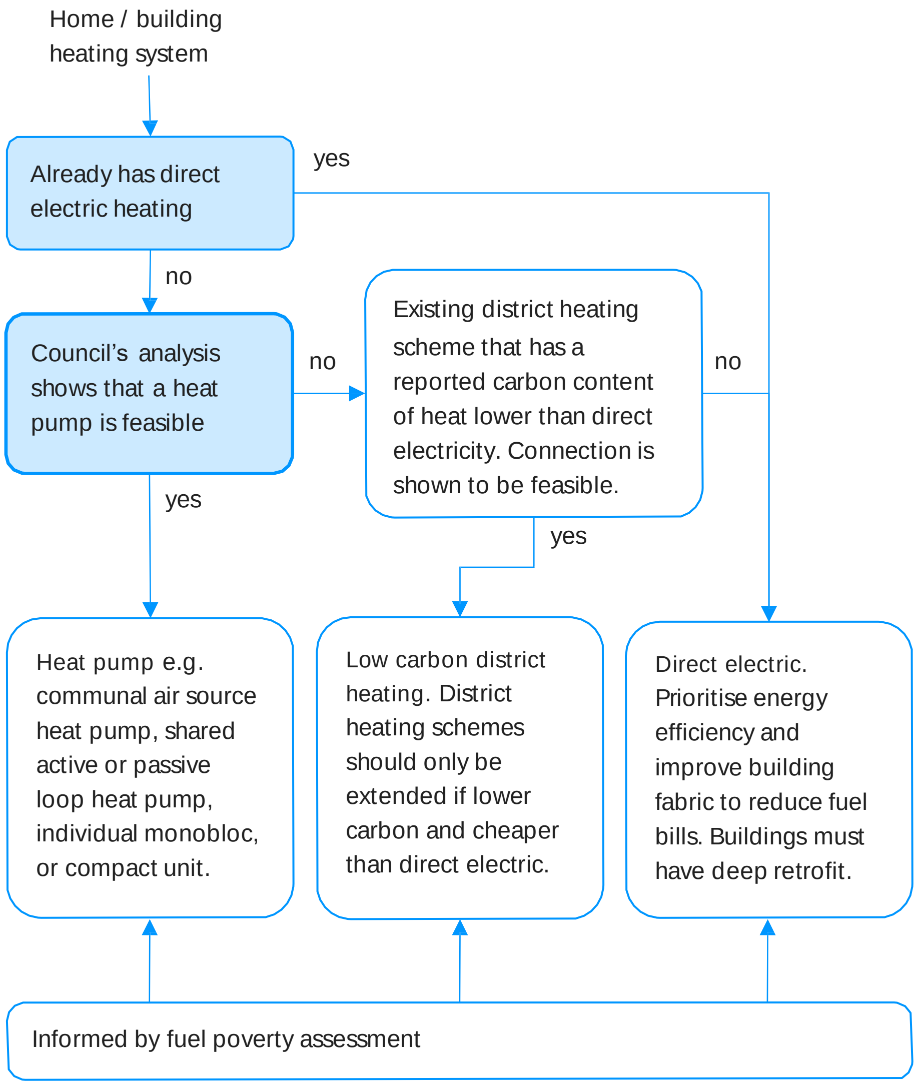
Heat pumps should be prioritised as an energy and carbon efficient technology that is available and can be installed now. This must be as part of a holistic approach, particularly for inefficient homes where there is a risk of fuel poverty.

There are more and more innovative examples of heat pumps being integrated in existing buildings, however they are unlikely to be possible to install in all buildings in London. Example issues include the following situations:

- No space for external unit for air source heat pump
- No space for internal hot water tank (or heat pump if an internal unit is needed)
- No space for communal pump sets and heat pump for communal systems
- Insufficient electrical supply (usually can be upgraded)
- Insufficient building efficiency, heat load is difficult to meet with a heat pump or makes efficiency unacceptable (requires fabric improvements)

London local authorities should undertake a stock analysis of heating systems in their borough. This should include at least their own stock and potentially others' based on publicly available data and/or data provided by homeowners/landlords voluntarily. The Pathways tool developed by Parity Projects, to which boroughs have access for a year under the terms of Parity's work for London Councils, would enable the production of an initial assessment very efficiently which can then be refined.

The stock analysis should aim to include a set of feasibility criteria for finding homes that are appropriate for heat pumps, and use this to categorise housing types suitable for different low carbon heating approaches.



Outline heating system decision flow chart for existing buildings

Activity 3.2 > Establish the most appropriate future low carbon heating system for each home

Consider the alternatives, in a logical order

When dealing with an existing boiler in need of replacement, or if a dwelling is at a trigger point for retrofit, heating alternatives which use electricity should be considered in a logical sequence, starting from the ones which are most efficient at transforming one unit of electricity into one unit of heat.

The recommended sequence is shown on the adjacent diagram.

Enabling low carbon heat

Simply swapping a heat pump to replace an existing gas boiler is generally seen as problematic for both economic and practical reasons.

As the options step down from most to least efficient heat source, the fabric performance – the space heat demand – has to be improved in order to reduce the energy demand such that the change to low carbon heat does not substantially increase energy bills, to limit the changes to the existing heat emitters and pipework and to ensure that fuel poverty is not increased.

Heat networks

For heat networks, the carbon performance should be reviewed and compared to the other options available. The space heat demand threshold has to be set using the same criteria, so that homes on heat networks are not disadvantaged.

Where space heating targets are unachievable

An interim step may be to use a hybrid heat pump while fabric improvement works are undertaken

1

Best efficiency

Suitable for space heat demand <100k Wh/m²

- Individual heat pump with dedicated external unit
- Individual ground source heat pump system
- Individual heat pump connected to a communal low temperature loop

If not

2

Lower efficiency

Suitable for space heat demand <65 kWh/m²

- Individual heat interface unit connected to a communal/district heat pump system
- Exhaust air source heat pump

If not

3

Hot water heat pump with electric space heating

Suitable for space heat demand <40 kWh/m²

If not

4

Direct electric space heating and hot water

Suitable for space heat demand 15-20 kWh/m²

Action 3

Activity 3.3 > Stop the replacement of gas boilers with gas boilers

The carbon impact of different heating systems

Today, there is less carbon emitted for every kWh of electricity delivered than there is for every kWh of gas burned. This is because of the growing proportion of renewables contributing to our electricity grid.

Every year, as grid electricity decarbonizes, the CO_2 emissions from a heat pump will reduce, whereas the CO_2 emissions from a gas boiler will remain constant.

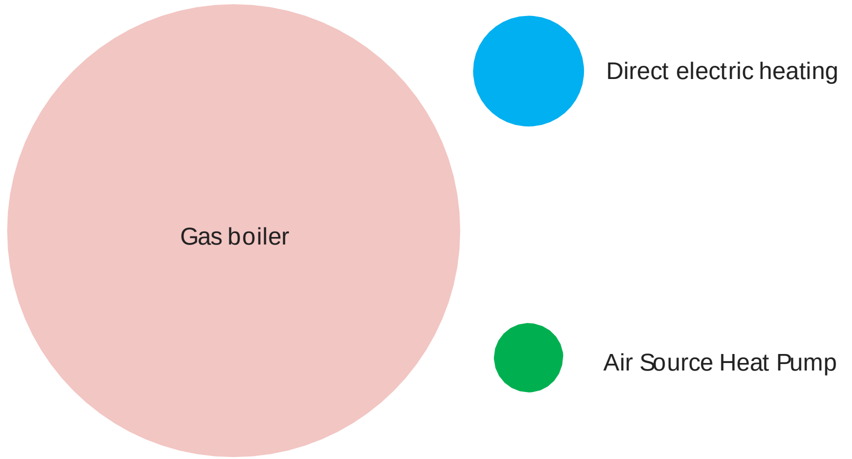
Over the next 30 years, the carbon content of electricity is predicted to drop even further, with an average carbon factor of 58 gCO_2/kWh, compared with gas which has an almost static carbon factor of 230gCO_2/kWh. This means that relative to an Air Source Heat Pump, for the same amount of heat delivered, gas boilers will emit 10x more CO_2 and direct electric heating systems 4x more CO_2.

We need to stop adding to the problem

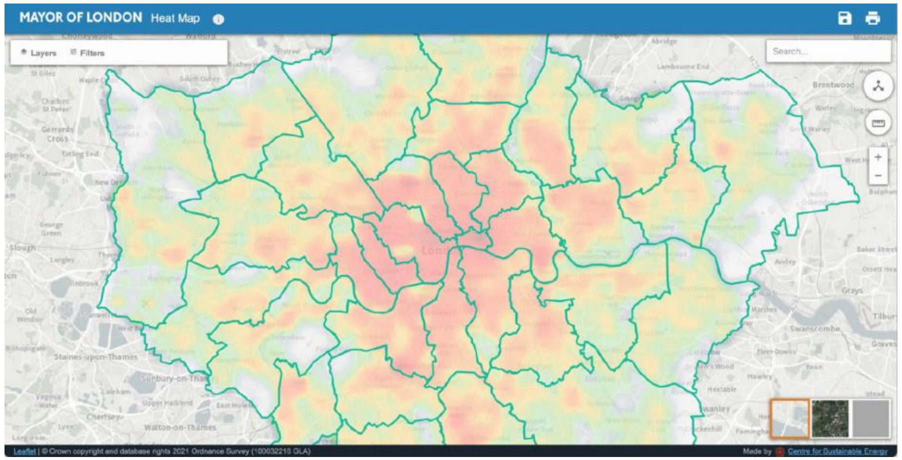
The number of gas boilers in existing homes needs to decrease rapidly in order to meet climate change targets. London boroughs should not be installing new gas boilers – either in new homes or existing homes where old boilers need replacing. Ideally, other actors (landlords, housing associations, homeowners) should be encouraged to adopt the same principle. The planning department in each London borough should be engaged with in order to identify who can help ensure new homes are not connected to communal or individual gas boilers.

Replacing boilers at the end of their lifetime with low carbon heat alternatives provides an ideal opportunity for removing the contribution gas boilers make to cumulative emissions. Approximately 160,000-200,000 gas boilers are replaced in homes in London every year. If all of these were replaced with low carbon alternatives, there would be no existing gas boilers by 2039.

We recommend no new and replacement gas boilers are installed on council-owned stock by 2023 at the latest.



Relative CO_2 emissions of different heating systems: Over the course of the next 30 years, for the same amount of heat delivered, a gas boiler will emit 10x more CO_2 than an Air Source Heat Pump, and 4x more CO_2 than a direct electric heating system using grid electricity.



The London Heat Map could record each connection to the gas grid as their number should be reduced steadily over the next 30 years.

Action 3

Activity 3.4 > Enable a heat pump roll out

The roll out of heat pumps can harness the decarbonisation of the grid and deliver heating at an affordable cost. So far in the South-East, around 30,000 heat pumps have been installed. According to Parity Projects, more than a million heat pumps need to be installed to meet their modelled interim carbon target alone. Local authorities need to enable this heat pump roll out.

Houses

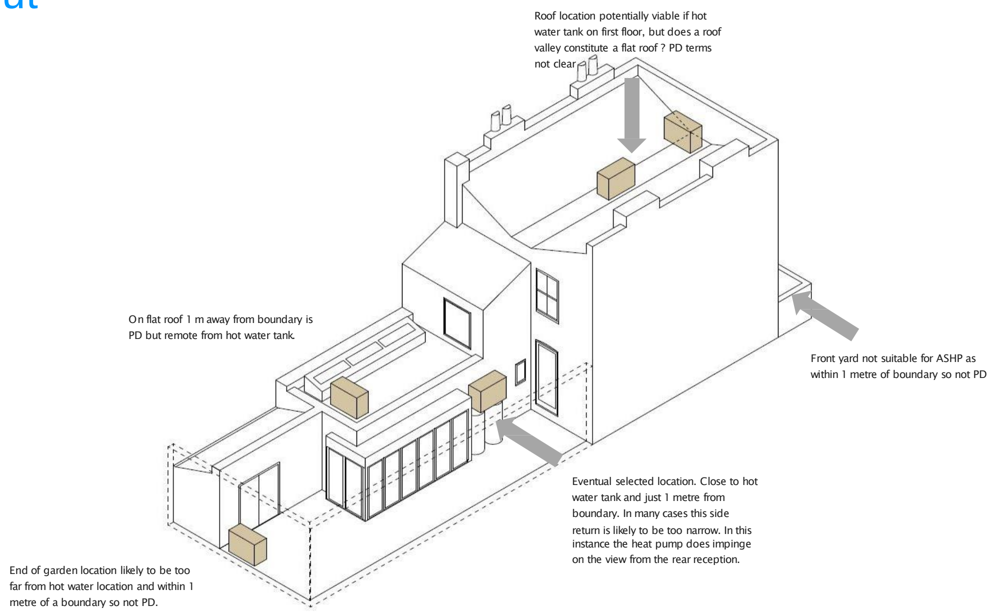
Single dwellings are arguably the 'ideal' type for a heat pump roll out as they can be fitted with an individual air source heat pump (ASHP). Anecdotal experience of fitting these has shown that it is not always easy though; permitted development rights are not always clear, nor do they always help. Clearer guidance on permitted development and possible adjustments to local planning policy by London local authorities, particularly in regard to how supporting noise assessments can be carried more cost effectively would be very beneficial.

Block of flats (with open space)

Large blocks of flats can have limited potential for individual or communal ASHP deployment due to the problems associated with siting the heat pumps and the long runs of pipework. The emerging best solution for these challenging situations appears to be communal ground source heating with local heat pumps within each flat. This allows low temperature heat to be moved over long distances with little heat lost. The local flat heat pump raises the temperature for heating and hot water. This technology relies on having enough space to drill deep boreholes. Local authorities engaged in this type of projects could share their experience of the technical challenges as well as of the long-term performance.

Challenging situations

The biggest challenge for heat pump deployment is likely to be flats within dense blocks of flats without open space and Victorian terrace houses that have been converted to flats. Hybrid solutions and direct electric heating may be required.



The drawing above shows the number of locations that were reviewed for this typical terrace house. The challenges of permitted development clauses and planning in general and the need to have heat pump and hot water tank close to one another frequently makes this exercise harder than it need be.

The Channel Island / Exeter Road estate in Enfield has been retrofitted with a communal ground array and individual water heat pumps in each unit.

Action 3

The table below sets out the popular concerns associated with heat pump retrofits. The actual level of risk associated with this concern has been ranked between high, medium and low. We would recommend developing a London guide to heat pump retrofit to improve quality of design and installations and reduce the risk of associated with heat pump retrofit. This will build on the GLA's report on heat pump retrofit.

Popular concerns on heat pump	Risk level	How to mitigate it?
They do not work in leaky dwellings		Very high space heating demand does diminish the efficiency of heat pumps. Ensuring all homes where a heat pump will be installed have achieved a minimum standard of fabric performance (e.g. 100 kWh/m^2/yr) is a key requirement.
Supply chain is not ready to maintain them		The availability of qualified staff to carry out the maintenance is currently limited. Recruitment and training of staff, including upskilling training for plumbers and gas safety engineers, will answer this issue as the demand increases. Consistent policy will assist in encouraging businesses to invest in upskilling their workforce.
Embodied carbon		Embodied carbon of heat pumps may vary significantly depending on the refrigerants they use and the manufacturer. The selection process should seek to minimise the embodied carbon and consider it as part of the whole house approach to lifecycle carbon.
Refrigerant leakage		Packaged units such as monobloc ASHPs are factory made and tested and the risk of leakage is very low. For split units with site made refrigerant pipework, the choice of refrigerant used will be a key factor, as well as workmanship quality and regular maintenance.
The theoretical efficiency of the heat pump system will not be delivered		The performance of the heat pump is a function of the system design. Installers need to be trained to understand the issue and to give proper advice on which system is appropriate where.
There is not enough internal space		Where space is very constrained, higher fabric performance and direct electric space heating may be a more optimal solution or small 'DX' heat pumps with wall mounted heaters. Hot water storage will almost always be required, which may require some loss of space in homes that currently have combi boilers.
There is not enough external space		Where external space is limited, particularly for high density developments such as towers, communal systems with central heat pumps, possibly located on a roof, may not be possible. Alternatively, exhaust air source heat pumps which are located internally could be appropriate if internal space is not as constrained.
They cost three times as much to run		This is a combination of ensuring the system design achieves a good Coefficient of Performance, space heating demand being moderated, and the users being aware of how to use the systems efficiently. A properly designed system, used effectively in a home with reasonable thermal efficiency will not cost more to run than a gas boiler.
Capital costs are too high		There are some funds available to offset the capital costs, including the Renewable Heat Incentive (RHI), but there will need to be other funding schemes to encourage take up of heat pumps.
User experience		The operation of heat pumps is different to combi gas boilers so information explaining how heat pumps work and are best used should be provided to residents. Smart controls are also crucial for their efficient operation and to keep heating costs downs.
High servicing costs		The typical costs of servicing heat pumps should be comparable to the typical costs of gas safety testing and maintenance for gas boilers.
External noise		Acoustic screening may be required for some large (communal) installations. Individual units now on sale are generally quieter than the background noise levels in urban and suburban areas.
External appearance		Perception is subjective but careful integration is key. Guidance can stipulate the types of installation that are not acceptable, but it is not possible to make all units invisible, so familiarity with the units will grow and acceptability will therefore improve.

Activity 3.6 > Review the carbon impact of heat networks and focus on sustainable connections

Heat networks and the challenge of decarbonisation

Traditional heat networks use the combustion of fossil fuels and distributed heat at relatively high temperatures. They are evolving towards lower distribution temperatures that are better suited to non-combustion based heat sources such as heat pumps. Lower system temperatures also reduce heat losses and overheating risk, which is particularly important as buildings become more energy efficient.

Decarbonisation plans should be implemented for every existing heat network as soon as possible, and ideally within the next 12 months. These plans should be consistent with guidance from the Climate Change Committee.

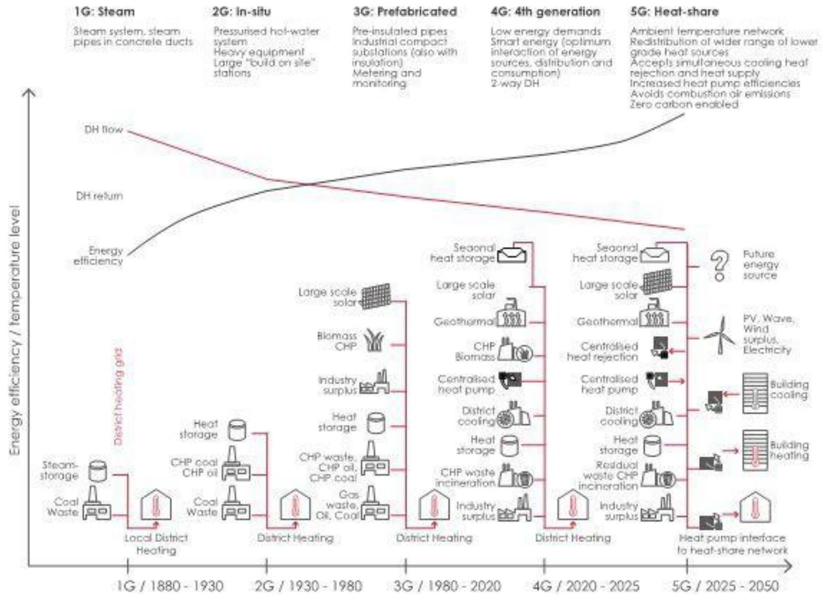
No fossil fuels for new networks

To stay within carbon budgets and avoid locking in high emission heat sources, new heat networks should not use fossil fuels. In practice, this means most new heat networks will use heat pumps. Committing to heat pumps is important as this will affect the design of the entire system. It also provides a great opportunity for heat networks to take advantage of new lower temperature sources of heat than would previously have been viable.

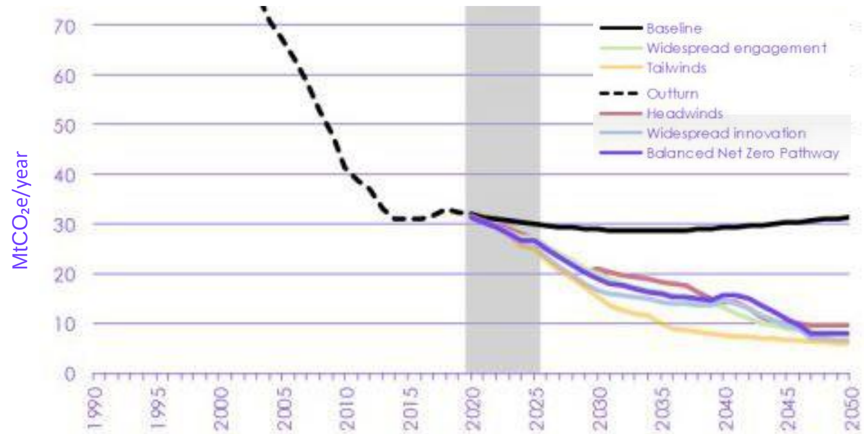
The future of Energy from Waste

Energy from Waste is one of the highest carbon forms of electricity generation, with emissions of around 890 gCO_2/kWh[1]. This is almost five times higher than the 181 gCO_2/kWh emitted by the UK electricity mix in 2020[2]. To achieve Net Zero emissions, the Climate Change Committee report in their Sixth Carbon Budget that emissions from the waste sector must reduce 75% by 2050 through waste prevention, increasing recycling rates to 70% by 2030, and adding carbon capture and storage to waste to energy plants. Any heat network relying on Energy from Waste should be sustainable and therefore be consistent with this trajectory.

1. Jeswani & Azapagic (2016) *Waste management.* (Elsevier)
2. National Grid ESO (2021) *2020 greenest year on record for Britain*



Heat networks must continue to evolve, and each existing heat network should have a decarbonisation plan in place, ideally in the next 12 months (© Chris Twinn for LETI Climate Emergency Design Guide)



Emissions from the waste sector must reduce 75% by 2050. This will require reductions in waste volumes, increased recycling and carbon capture and storage. Heat networks relying on Energy from Waste need to be sustainable (© Climate Change Committee, using BEIS data).

Action 3

Activity 3.7 > Develop a specific strategy for buildings heated by direct electric

Direct electric heating and the issue of energy bills

For homes already served by direct electric heating, retrofit based on energy efficiency measures including fabric and system optimisation will potentially offer significant energy and fuel cost benefits.

For dwellings which are currently served by gas boilers and not suitable for heat pumps, direct electric could be an option but the impact on energy bills should be carefully considered, requiring fabric improvements.

Direct electric system choices

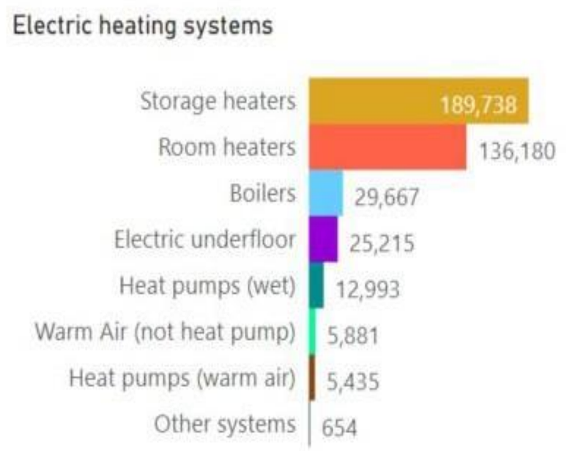
Direct electric heating comes in a number of different forms. According to Parity Projects' modelling, there are around 400,000 homes in London that currently have some form of electric heating. More than half of the electrically heated homes have either storage heaters or electric panel/convector heaters. In many cases these can be replaced or upgraded with modern, more efficiently controlled version of the same type of heater.

For homes that currently have gas boilers and which need to switch to direct electric heating, where a heat pump cannot be installed, the highest priority is to achieve very good levels of fabric efficiency so that the space heating demand can be reduced, ideally to 15-20 kWh/m²/yr.

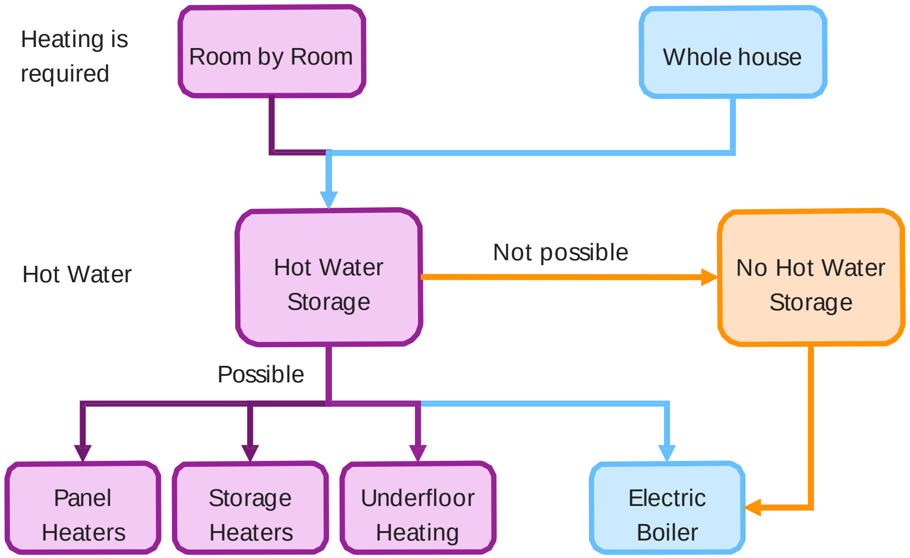
The choice of which electric heating system would be most suitable is then driven by the physical constraints of the building and the needs of the occupants. In a home that currently has a wet radiator system, it may be simplest to install an electric boiler. Storage heaters offer a good opportunity to adopt Time of Use (ToU) tariffs. Panel heaters give a rapid response and can be turned down to very low outputs in homes with particularly good fabric.

Hot Water Storage

In all direct electric heated homes, priority should be given to installing hot water storage, to provide energy storage which can limit peak loads and consequently manage costs.



Parity Projects' summary of existing electric heating systems across London



Choice of electric heating systems: a process largely driven by the physical constraints of the building and the type of user

Infrastructure upgrades are required

In order for the decarbonisation of power generation in the UK to continue to progress, change is required both on the supply side – power generation – and on the demand side. The power network needs to be locally adapted to be able to accommodate more demand from electric heating systems and electric vehicle charging. The network also has to be reconfigured to be able to make use of local generation from roof mounted PV arrays.

Long term plans for major infrastructure works

UK Power Networks and Scottish and Southern Energy, the local District Network Operators (DNOs), are investing in the infrastructure to make it more suited to the developing needs, but they have to have a clear policy basis to demonstrate to Ofgem, the regulator, that the investments they make are supported by demand. A clear statement of timescales and objectives will allow the DNOs to plan the work necessary to make it possible.

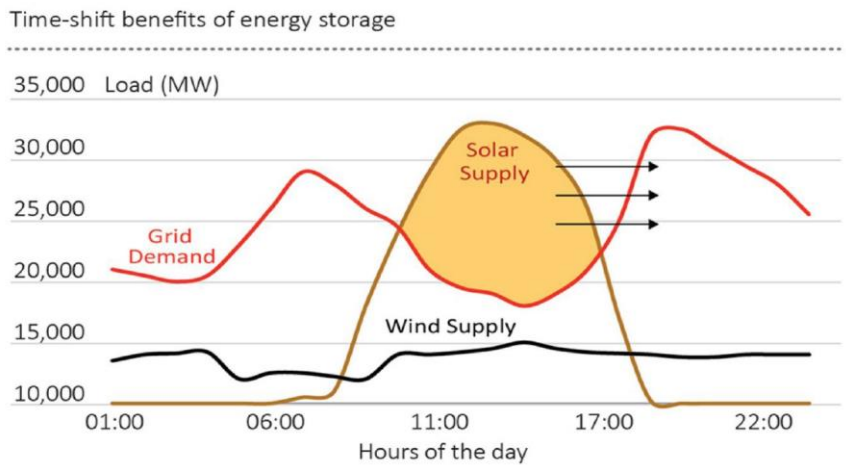
Planning of infrastructure upgrades can be a complex process, requiring negotiation of access and wayleaves and permissions for road closures, all of which can take years. Investment plans are region-wide, crossing borough boundaries and are set out in 5 year budgets, the latest of which is currently in progress. Early engagement with the DNOs by the London boroughs on the strategies that will be adopted across the region is key to their successful and timely delivery.

Make space for demand management

Power demand needs to be flexible, so that energy is used at times of high renewable energy generation. Energy storage and flexible use for homes is a key part of this but there will also be a need for larger scale demand management equipment. Understanding what may be needed and whether Planning Permission may be required is also a part of the discussions with the DNOs to form a city-wide infrastructure that is suitable for the developing needs.

One of the outcomes now in progress from the RII0-ED1 UKPN business plan, which covers the period up to 2023, is the installation of 4 new substations around London. Consultations for the next business plan, RIIO-ED2 are in progress and will form the basis for similar infrastructure work in coming years.

(Source: UKPN published documents including 'Central London Plan Update 2020')



Notional graph of renewable energy supply vs energy demand

Deliver smart meters and demand flexibility (controls, storage) in retrofitted homes

The steep reduction in the carbon intensity of electricity in the UK has been achieved by significantly increasing the renewable energy contribution, especially from off-shore wind and solar. These intermittent renewable energy sources have displaced high carbon, steady output coal fired power stations. For this process to continue and to be sustainable, it is necessary for the demand to be managed to match the supply in a way that was not previously necessary.

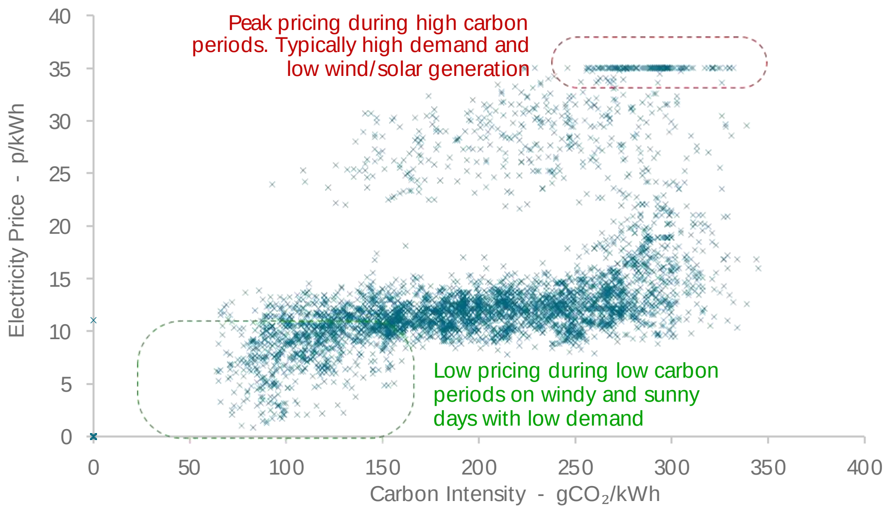
Smart Meters and electricity tariffs

Off-peak electricity tariffs are currently widely available to domestic consumers (e.g. Economy 7). More sophisticated Time-of-Use (ToU) tariffs are likely to play a bigger role in balancing supply and demand for electricity in the near and medium term. They have been commercially available for some years and are now becoming available to domestic customers. These tariffs track the energy price on an hourly or half hourly basis. If customers are able to reduce their use when prices are high and increase it when they are low, they can pay substantially less for their energy, on average. Smart meters will enable access to a far wider range of energy tariffs than standard meters and provide an opportunity to substantially reduce energy costs if the controls and systems in homes are able to respond to fluctuations in energy prices.

The benefits of hot water storage

The facility to store energy, most simply as heat in domestic hot water cylinders, is also a crucial part of demand management strategies. Using cheap electricity to heat a tank of water that is then available to use during the day reduces the cost to the consumer and the carbon emissions of the energy. Batteries can also form part of demand management, but the capital costs are currently relatively high, per unit of energy stored and their embodied carbon, chemical constituents and cost are a concern.

London local authorities should encourage and facilitate the roll out of smart meters, especially to fuel poor homes and the installation of heating controls in all retrofitted homes, as well as hot water storage if possible.



The carbon intensity and price of electricity vary depending on the balance between supply and demand. The above chart shows price vs carbon intensity in London, at half hour intervals over 3 years from 2018 to 2021.

(Source www.energy-stats.uk/download-historical-pricing-data)

Smart Buildings: Smart meters and smart thermostats are a way of unlocking the power of "agile" tariffs and demand side management to provide affordable low carbon heating. Used in combination with services such as If This Then That (IFTTT) they enable users to access cheap low carbon electricity, while helping the National Grid to balance the network.

Action 5 Increase solar energy generation on London homes

Setting a clear target for total solar capacity in London

The Mayor of London has published a Solar Action Plan for London and we recommend building on it. It would be very useful to consider which ambition should be delivered on the roofs of London homes.

By energy balance, according to Parity Projects' modelling, the total installed solar capacity by 2030 should be 3.8GW. A solar capacity of 6GW[1] would then be required if a Net Zero energy balance is to be achieved. We believe these figures should form the basis of London's target for installed solar capacity for homes. The non-domestic sector also should be installing renewable power to match its energy needs.

The CCC's forecast of the UK solar electricity generation requires 85GW by 2050. By population, London (9.5 million people) would need to achieve a solar capacity of 12 GW by 2050. By GDP, the figure would be even higher – close to 28GW.

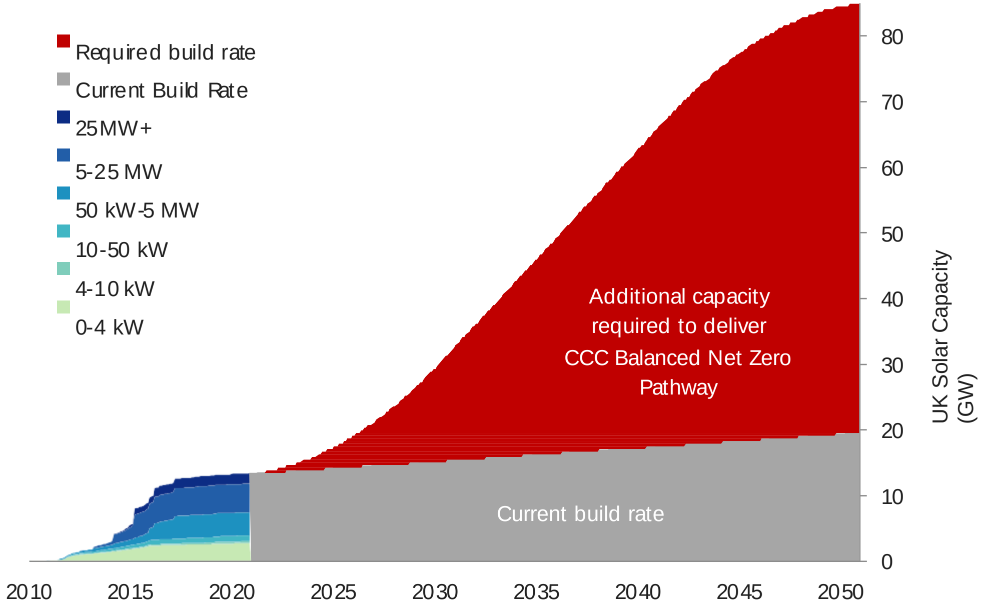
The UK has not yet established how to share out the renewable energy requirement nationally. The density of population and economic activity in London mean that most power is required where there is least space to generate it. This imbalance needs to be addressed but is not in the control of the London local authorities. For now, balancing the energy required seems the fairest option.

Developing a joined-up plan to achieve it

A lot of great work is already happening. More is required to address each tenure and segment of the market but there is a lot to build upon. Residents of individual homes will naturally benefit from the free electricity generated by these PV panels but ways to enable residents from blocks of flats to benefit from this should also be considered.

We recommend that London local authorities and the GLA consider how to accelerate solar PV roll out.

[1] This would represent a significant increase on the solar generation targets in the Solar Action Plan for London of 1GW solar PV installation by 2030 and 2GW by 2050



Solar deployment is very important in order to achieve Net Zero Carbon

(Source: generated from BEIS data to Nov 2020 and then projected forward using 2020 build rates compared to the 85GW target in the CCC Balanced Net Zero Pathway from the sixth progress report).

The GLA and London Boroughs are running the successful Solar Together London project which should be continued and expanded. The new Mayor's Solar Skills London programme has also launched and is looking to support the supply chain. (https://demo.london.gov.uk/what-we-do/environment/energy/solar-skills-London)

Action 6 Map out each building’s journey towards lower energy costs and Net Zero

Each building is different

- Their current condition in terms of energy efficiency and heating system will be different.
- What can be done to improve them will vary and may be constrained by heritage, technical and other considerations.

We have developed the adjacent Retrofit Map to enable the journey of each building towards Net Zero to be summarised and understood.

The Retrofit Map can enable users to understand the current situation of the building (e.g. poor energy efficiency, individual gas boiler) and how it could be improved.

Ultimately, it is recommended that all homes are moved to one of the green squares. The buildings which should be most urgently retrofitted will be in the red squares as they will be consuming most of the carbon budget.

Use of fossil fuels
Not compatible with Net Zero.
The heating system must be changed.

Low carbon heat but risk of high energy costs
A change of heating system may not be required but fabric, ventilation and system should be improved

Low carbon heat and sufficient level of energy efficiency
Compatible with Net Zero

High carbon → HEAT DECARBONISATION → Low carbon

FABRIC AND VENTILATION (High energy → Low energy)

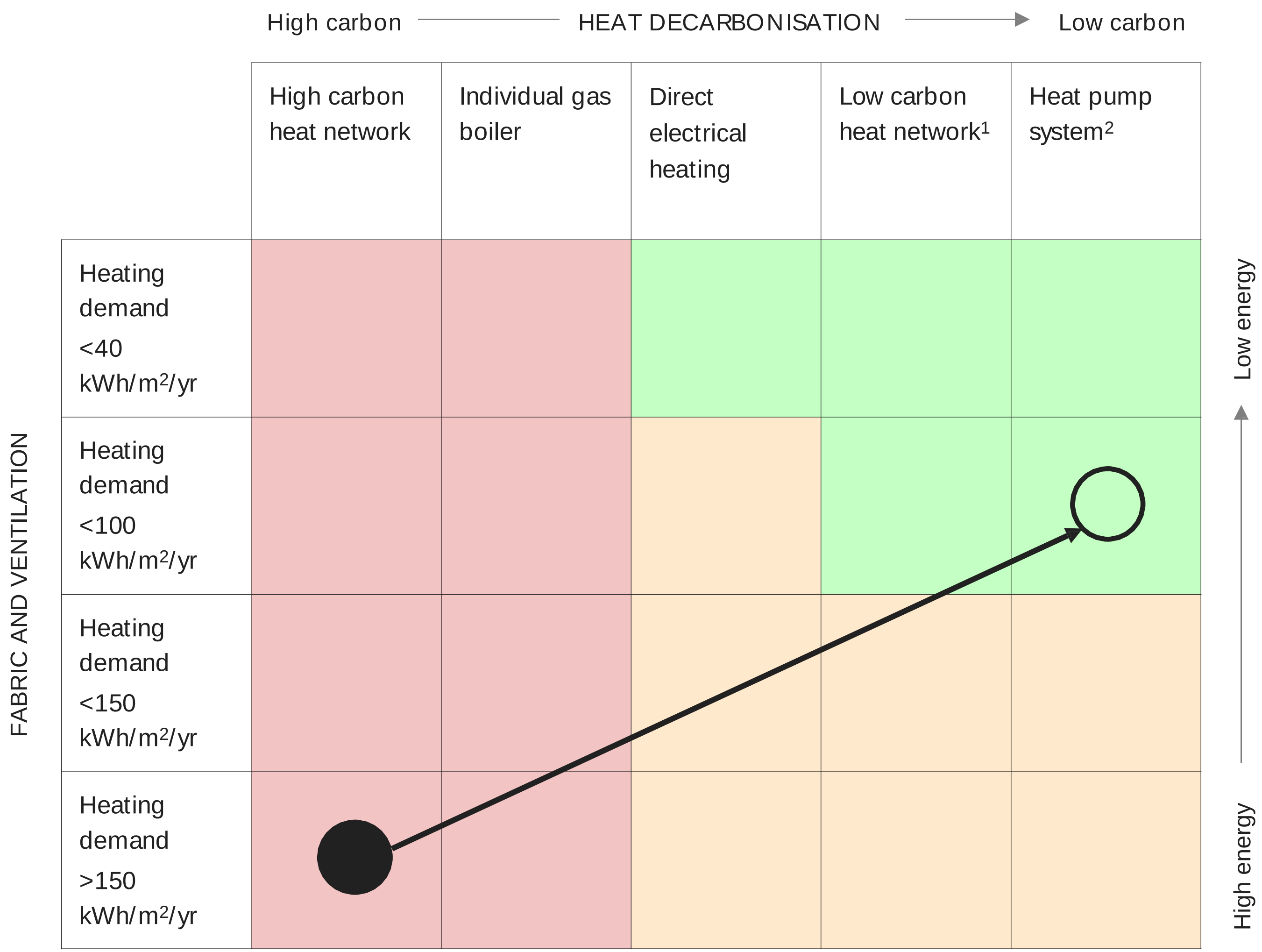
	High carbon heat network	Individual gas boiler	Direct electrical heating	Low carbon heat network[1]	Heat pump system[2]
Heating demand <40 kWh/m²/yr					
Heating demand <100 kWh/m²/yr					
Heating demand <150 kWh/m²/yr					
Heating demand >150 kWh/m²/yr					

[1] A heat network would qualify as ‘low carbon heat network’ for the purpose of this Retrofit Map only if it would have a lower carbon content of heat (per kWh delivered) than direct electric heating. Any system using fossil fuels and/or with high distribution losses is unlikely to qualify.

[2] Could be an individual or building level heat pump with low distribution losses.

Example 1

- Current situation: this building is very inefficient and is heated by a high carbon heat network.
- Changes required: it should be improved with works on building fabric and ventilation and a new communal heat pump system.



Use of fossil fuels
Not compatible with Net Zero.
The heating system must be changed.

Low carbon heat but risk of high energy costs
A change of heating system may not be required but fabric, ventilation and system should be improved

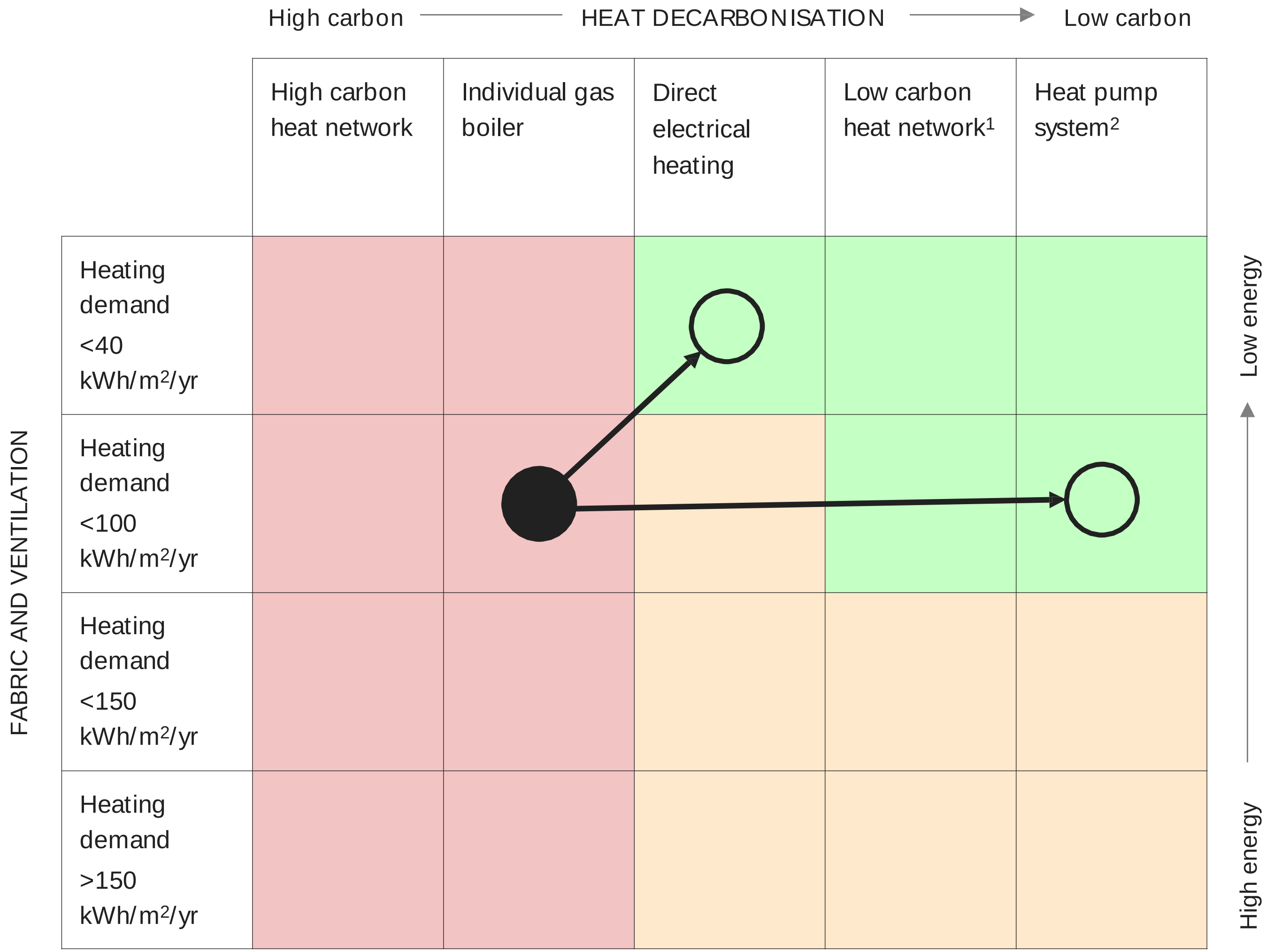
Low carbon heat and sufficient level of energy efficiency
Compatible with Net Zero

[1] A heat network would qualify as 'low carbon heat network' for the purpose of this matrix only if it would have a lower carbon content of heat (per kWh delivered) than direct electric heating. Any system using fossil fuels and/or with high distribution losses is unlikely to qualify.

[2] Could be an individual or building level heat pump with low distribution losses.

Example 2

- Current situation: this building is relatively efficient and is heated by individual gas boilers.
- Changes required: if a heat pump system is feasible, it may be possible that the change of heating system would be sufficient and would not lead to an increase in energy costs even with no fabric and ventilation improvements. However, if a heat pump system is not feasible and direct electric is the selected heating system, improvements to the building fabric and ventilation are recommended.



Use of fossil fuels
Not compatible with Net Zero.
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Low carbon heat but risk of high energy costs
A change of heating system may not be required but fabric, ventilation and system should be improved

Low carbon heat and sufficient level of energy efficiency
Compatible with Net Zero

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[2] Could be an individual or building level heat pump with low distribution losses.

Current stock analysis

Based on the Parity Projects' data, the adjacent retrofit map indicates the current 'position' of London homes currently both in terms of space heat demand and heating system.

Numbers are approximate. The circle sizes indicate relative numbers but are not to scale

High carbon —— HEAT DECARBONISATION → Low carbon

FABRIC AND VENTILATION

Low energy ↑ High energy

	High carbon heat network	Individual gas boiler	Direct electrical heating	Low carbon heat network[1]	Heat pump system[2]
Heating demand <40 kWh/m2/yr	20k	250k	130k	1k	15k
Heating demand <100 kWh/m2/yr	30k	1million	160k	1k	3k
Heating demand <150 kWh/m2/yr	20k	1.5million	60k	<1k	<1k
Heating demand >150 kWh/m2/yr	6k	500k	30k	<1k	<1k

Use of fossil fuels
Not compatible with Net Zero.
The heating system must be changed.

Low carbon heat but risk of high energy costs
A change of heating system may not be required but fabric, ventilation and system should be improved

Low carbon heat and sufficient level of energy efficiency
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[1] A heat network would qualify as 'low carbon heat network' for the purpose of this matrix only if it would have a lower carbon content of heat (per kWh delivered) than direct electric heating. Any system using fossil fuels and/or with high distribution losses is unlikely to qualify.

[2] Could be an individual or building level heat pump with low distribution losses.

Estimated retrofitted systems

Based on the Parity Projects data, and following the processes set out in this report, we anticipate London's homes to move towards these positions on the 'Retrofit Map'.

Numbers are approximate. The circle sizes indicate relative numbers but are not to scale

High carbon → HEAT DECARBONISATION → Low carbon

FABRIC AND VENTILATION (High energy → Low energy)

	High carbon heat network	Individual gas boiler	Direct electrical heating	Low carbon heat network[1]	Heat pump system[2]
Heating demand <40 kWh/m2/yr			600k	55k	1.5million
Heating demand <100 kWh/m2/yr				30k	1million
Heating demand <150 kWh/m2/yr					500k Hybrid systems
Heating demand >150 kWh/m2/yr					

Use of fossil fuels
Not compatible with Net Zero.
The heating system must be changed.

Low carbon heat but risk of high energy costs
A change of heating system may not be required but fabric, ventilation and system should be improved

Low carbon heat and sufficient level of energy efficiency
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[2] Could be an individual or building level heat pump with low distribution losses.

Activity 6.1 > Develop whole house retrofit plan templates for key building archetypes

Whole house approach

The term ‘whole house (building) retrofit’ has emerged over recent years as a fundamental concept underpinning successful retrofit projects. It recognises buildings as complex systems that require whole systems thinking. Consensus is emerging that whole house thinking should include the following:

- Wide ranging assessment of the building
- Identification of repairs required to make the building ‘retrofit ready’
- Evaluation of appropriate energy efficiency measures, taking care to manage risk
- Indoor air quality and the need to design in ventilation systems that deal with winter and summer conditions
- Selection of the most appropriate low carbon heating/hot water system and ensuring that it is compatible with heating load
- Planning for renewable energy generation and energy storage
- Implementation plan over time, taking into account risks and components’ lifecycle

Whole house plans as a lodged resource

Along with the renovation plan which may be implemented over a long period of time, it is crucial to gather and keep digital records of the information gathered on a building and update them. Together they form what is generally referred to as a Building Renovation Passport.

Building Renovation Passports have been adopted in different forms across Europe and were highlighted by the Climate Change Committee as a key component to progress on improving the energy efficiency of buildings in the UK.

The Coalition for the Energy Efficiency of Buildings (CEEB) is currently developing work in this area and London local authorities should engage with it to ensure that their work is consistent and complementary.

ECOFURB
The Low Carbon Home Service

Ecofurb Plan

8. Phasing your improvements (continued)

The measures recommended below aim to significantly reduce your energy use, annual energy costs and CO_2 emissions. This demonstrates a good range of the possibilities available. We can of course limit recommendations to your more immediate needs to fit within your current budget.

Phase 1 Measures	Estimated Costs	Energy Rating	Fuel Bill	tCO_2
Where you are now	**Per Measure**	**58 D**	**£1,320**	**5.73**
Low energy lighting	£80	60 D	£1,260	5.66
Block open chimneys	£480	61 D	£1,230	5.55
Install PV system where potential has been identified	£4,170	69 C	£920	5.02
External insulation to pre 1900 solid walls	£16,890	79 C	£580	3.25
Part L insulated doors	£1,560	79 C	£570	3.20
Triple glazing from partial single	£7,240	81 B	£520	2.95
After Phase 1 Measures		**81 B**	**£520**	**2.95**
Package Cost & % Improvements	**£30,420**		**61%**	**49%**

Phase 2 Measures	Estimated Costs	Energy Rating	Fuel Bill	tCO_2
After Phase 1	**Per Measure**	**81 B**	**£520**	**2.95**
ASHP (55 degree emitters) with existing radiator central heating and hot water, from C rated gas boiler	£12,000	81 B	£540	0.95
After Phase 2 Measures		**81 B**	**£540**	**0.95**
Package Cost & % Improvements	**£12,000**		**-4%**	**68%**
Cumulative Cost & % Improvements	**£42,420**		**59%**	**83%**

9

Whole house plans have been used by retrofit professionals for a number of years to assess a building pre-retrofit and recommend retrofit measures as part of a coherent plan, either in a single phase or over a long time. The example above is an extract from a whole house plan prepared with Ecofurb.

Building Renovation Passports combine a record of the building attributes and a whole house retrofit plan to allow long term planning, proper sequencing of works and a step by step approach that simplifies the process sufficiently for individual householders to be able to understand and engage with the work needed.

Developed schemes include examples in Germany (Individueller Sanierungsfahrplan, iSFP), Belgium Flanders region (Woningpas) and France (Passeport efficacité énergétique, P2E).

Developing whole house plan templates: a game changer

Since the first step to retrofitting each home is having a whole house plan in place, taking steps to accelerate the creation of good quality whole house plans could help trigger more and better retrofit. London local authorities can help facilitate this by developing whole house retrofit templates for key building types within their boroughs, building on the 'solutions based categories' which is summarised on the following two pages.

The whole house plan templates should be based on the most common solution types and should highlight:

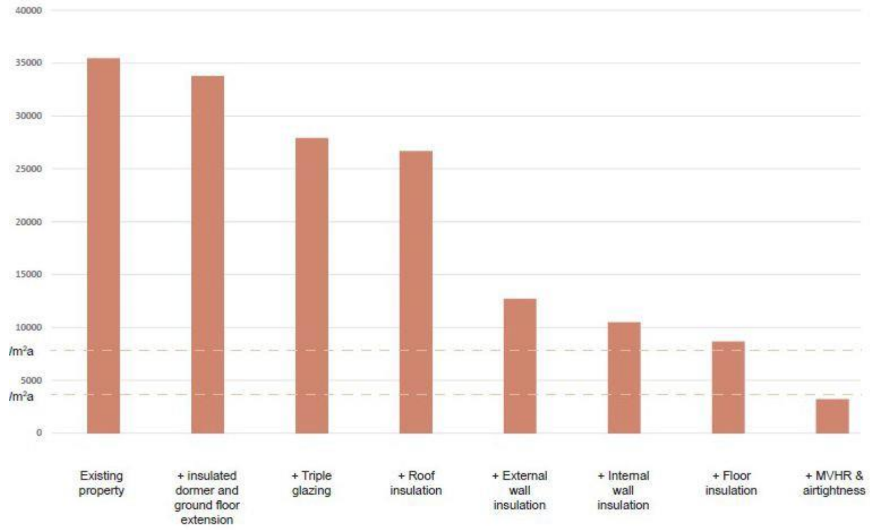
1. Packages of measures that are likely to be applicable
2. Specific risks and how they might be managed
3. Typical detail and interface challenges
4. Potential phasing
5. Expected energy and carbon savings
6. How the fabric measures work alongside the decarbonised heat approach

Templates created at scale would have two far reaching consequences:

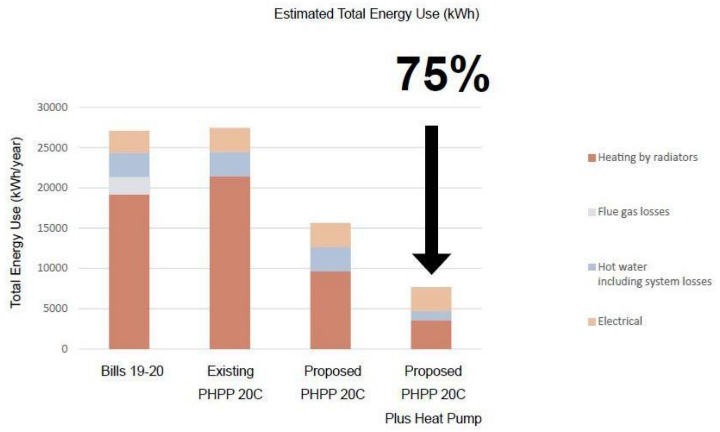
- They would provide homeowners and landlords with a starting point so that they can coordinate carbon reduction measures with their ongoing maintenance / extension and other life plans.
- They would help develop a deeper understanding of the costs, measures, skills and supply chain needed within the borough and in London as a whole. This information could be used to help support and build capacity, leverage finance and build a business plan for retrofit.

The templates should cover all types of tenure.

They have the potential to identify common solutions that can help build larger scale of more efficient procurement, inform emerging planning policy for retrofit, test carbon projections and inform future plans.



Extract from a whole house retrofit plan showing how fabric measures affect the heating demand. This can help to sequence the works.



Extract from a whole house retrofit plan showing the how fabric and electrification of heat generation can affect the overall energy consumption of a specific dwelling.

Categorising the London housing stock to identify key archetypes

Towards archetypes

An important part of the process towards creating whole house plan templates is to define the key or most common archetypes that occur across London.

First step: categories

As a step towards this goal, it was considered that breaking down the retrofit work into around 10-15 categories would be appropriate, of which eight are the most commonly found in the London housing stock.

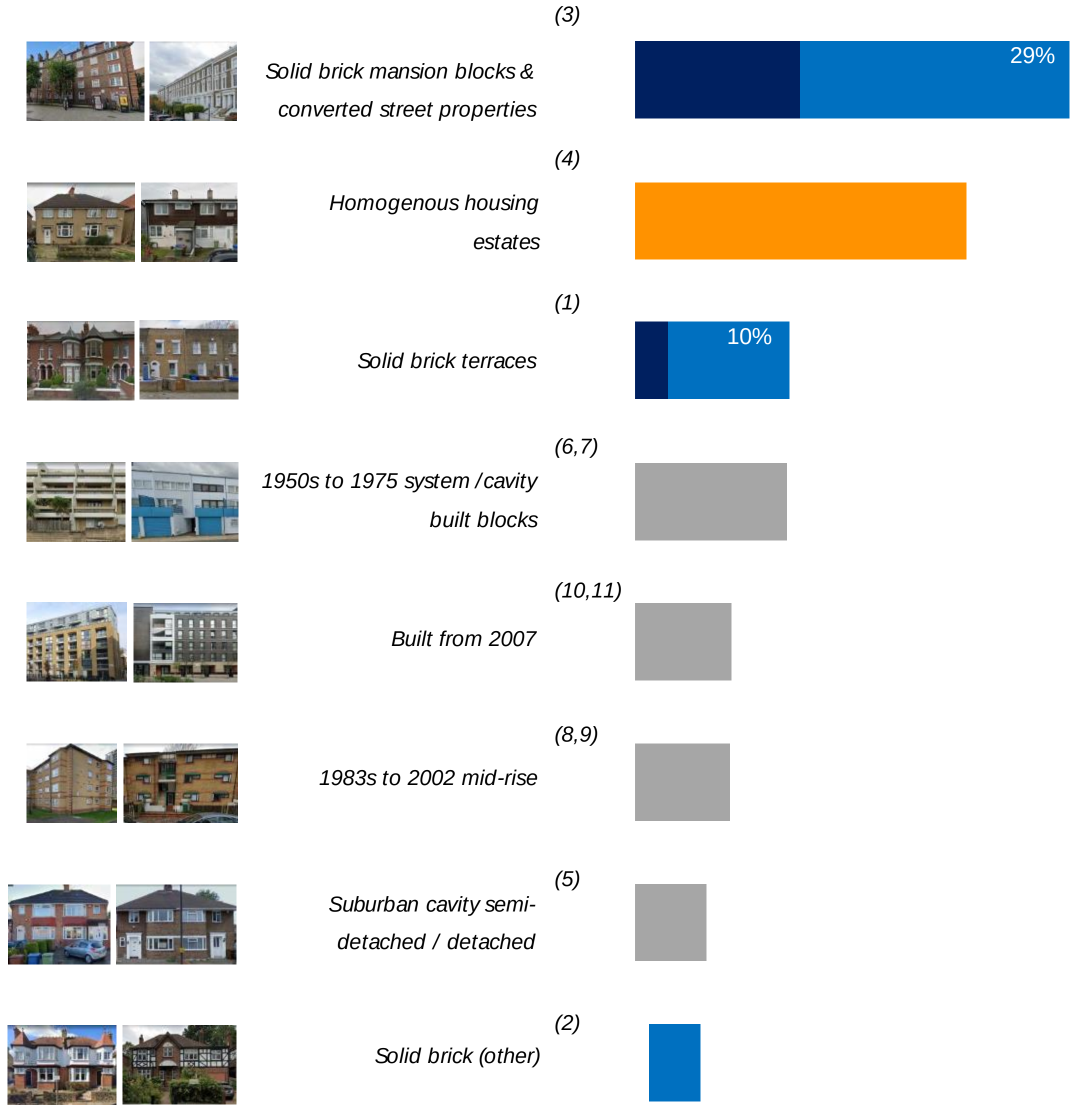
These categories have been arrived at partly by the architectural form and character and partly by considering common groups of retrofit measures. The focus on category by measure rather than architectural style is a helpful way of differentiating for the specific purpose of evaluating retrofit works.

At present the categories are probably still too crude to be used as ‘archetypes’ to create whole house templates, and further work is required to identify key archetypes. However, the categories already provide a real sense of the housing types that are most important. Notably high rise flats do not represent a significant amount of the stock statistically, while they often are considered to be a key archetype. On the other hand, the ‘homogenous housing estates’ represent a substantial proportion of the total stock but the break down of construction types within the overall number are perhaps not yet adequately defined.

The image on the right shows the categories that represent the majority of the stock in London (i.e. 92%)

The light and dark blue bars cover solid walled properties. Together, these categories make up 44% of the entire stock.
The dark blue show portion of homes in conservation areas.

‘Homogenous housing estates’ cover a further 22% of the entire stock.



Analysis based on Parity Projects Data showing eight categories (some combined) which make up 92% of the London housing stock. The numbers in brackets refer to the categories shown on the next page and in the appendices.

Categorising the London housing stock across the 33 London local authorities

The adjacent table profiles each of the 33 London Borough by the categories presented on the previous page. The colour coding highlights the most significant categories within each borough. A few initial conclusions can be drawn from this analysis:

1. Three or four categories dominate the housing stock in each borough. This provides a strong lead on how the most important archetypes in each location might be identified.

2. A number of London local authorities share similar profiles: that may suggest that they should collaborate especially strongly.

3. Around one third of London local authorities have a significant amount of the 'Homogenous housing estates' category. There is therefore a significant need and opportunity to investigate this category in more detail and consider how many archetypes and whole house solutions sit within it. Due to the constraints of the data its has not been possible to split into more specific groups yet.

4. The 'Mansion block / converted street property' is a very significant category. This category also tends to be focused in a few boroughs, and in areas with conservation status so may also warrant specific collaboration between boroughs. It would be helpful to differentiate between purpose built mansion block and converted street properties as the typical solutions are likely to be different for those two main sub-categories.

5. Many of the other typologies appear to be spread more evenly across London. There would be benefit in exploring which archetypes would be useful on a London-wide basis so that adequate whole house templates and guidance on facilitation can be developed.

Right: Table showing each of the 33 London Boroughs by the categories presented on the previous page. Small groups of different boroughs could work together on a particular category of housing. The category numbers are explained further in the appendices.

Local authority	3 Solid brick mansion blocks & converted street properties	4 Homogenous housing estates (solid or cavity or system)	1 Solid brick terraces	6 + 7 1950s to 1975 system/cavity built blocks	10 + 11 Built from 2007	8 + 9 1983s to 2002 mid-rise flats	5 Suburban cavity semis/detached with gas boilers	2 Solid brick non-terraces
City of Westminster	86.2%	1.1%	8.3%	11.0%	4.0%	6.2%	0.1%	1.0%
Kensington and Chelsea	71.4%	0.5%	9.7%	6.7%	2.6%	4.5%	0.0%	1.2%
Camden	66.7%	1.3%	5.4%	10.6%	4.4%	4.2%	0.2%	2.1%
Hammersmith and Fulham	56.8%	1.0%	16.2%	5.8%	5.3%	4.2%	0.1%	1.4%
Lambeth	46.7%	6.4%	10.3%	9.6%	6.0%	5.4%	0.6%	3.6%
Brent	36.8%	23.4%	8.1%	6.5%	5.7%	6.3%	4.2%	4.5%
Hillingdon	6.1%	48.6%	2.7%	10.0%	7.0%	5.7%	17.5%	4.3%
Bromley	11.4%	43.2%	5.6%	8.8%	5.4%	4.5%	17.0%	7.0%
Harrow	15.3%	48.2%	4.0%	6.5%	6.8%	4.6%	11.7%	5.9%
Newham	16.7%	16.2%	25.0%	12.9%	6.4%	7.6%	1.5%	1.3%
Waltham Forest	27.0%	19.7%	23.6%	7.3%	4.9%	5.8%	1.9%	3.0%
Haringey	35.9%	9.8%	22.7%	8.6%	4.0%	5.3%	0.5%	3.5%
Redbridge	13.8%	36.7%	15.5%	7.2%	4.4%	5.1%	5.3%	5.3%
Merton	19.8%	27.4%	15.4%	6.1%	6.1%	5.8%	2.4%	6.6%
City	30.3%	0.0%	0.2%	33.7%	8.1%	12.8%	0.0%	0.1%
Wandsworth	37.7%	4.6%	16.3%	13.3%	6.3%	5.6%	0.4%	3.0%
Islington	48.7%	2.0%	7.8%	13.0%	7.4%	6.5%	0.2%	1.0%
Hackney	45.0%	3.4%	9.3%	12.8%	8.7%	7.1%	0.2%	0.9%
Tower Hamlets	19.0%	2.2%	3.5%	20.4%	13.6%	16.7%	0.4%	0.3%
Greenwich	17.8%	21.6%	12.9%	12.1%	9.5%	4.6%	3.6%	3.8%
Barnet	20.6%	28.3%	5.5%	8.3%	8.8%	7.7%	7.5%	8.0%
Hounslow	15.0%	30.4%	7.1%	10.0%	8.7%	7.2%	6.3%	6.0%
Southwark	34.1%	3.6%	8.8%	12.8%	8.2%	10.3%	0.7%	2.4%
Enfield	13.2%	35.8%	12.6%	10.6%	4.2%	8.6%	4.5%	4.6%
Lewisham	31.4%	16.6%	12.2%	8.8%	6.4%	7.1%	1.8%	4.1%
Havering	4.4%	59.4%	2.5%	8.7%	6.9%	3.7%	12.0%	4.6%
Bexley	4.7%	54.2%	6.1%	8.7%	5.0%	5.4%	15.6%	4.5%
Barking and Dagenham	7.8%	52.1%	6.1%	10.0%	7.6%	4.3%	5.2%	1.3%
Kingston-upon-Thames	10.7%	37.2%	3.3%	8.2%	5.0%	5.8%	10.8%	16.9%
Richmond	21.9%	20.1%	14.2%	8.9%	4.7%	4.7%	4.0%	12.4%
Sutton	9.6%	39.8%	4.3%	11.1%	5.9%	7.7%	6.9%	7.6%
Croydon	16.4%	32.7%	12.7%	9.3%	6.6%	4.6%	10.1%	7.5%
Ealing	24.6%	25.8%	10.9%	10.8%	5.8%	5.6%	5.2%	6.6%

- Overview of the whole delivery process
- Opportunities for council-owned homes
- Co-procurement of materials and services
- Skills, trades and installation
- Monitoring progress (and success)
- Interesting delivery models (UK and beyond)

Summary of recommended actions in this area

The key recommended actions and activities in terms of delivery models, skills and supply chain are listed in the adjacent table.

Each action/activity is explained succinctly in the following pages.

The full list of actions and activities is provided in a separate spreadsheet which London Councils can develop and add to when this phase of the project has been completed.

7	Review current maintenance programmes and identify retrofit opportunities
8	Facilitate procurement of materials and services at a larger scale Activity 8.1 > Share procurement for council-owned homes Activity 8.2 > Develop area-based strategies to enable bulk procurement and delivery Activity 8.3 > Consider a London-wide retrofit programme for homeowners
9	Enable planning to facilitate low carbon retrofit, including in Conservation Areas Activity 9.1 > Provide planning guidance to enable retrofit Activity 9.2 > Provide guidance for planning officers
10	Develop retrofit skills actively across London Activity 10.1 > Work with partners to develop a spending commitment for retrofit Activity 10.2 > Develop a London-wide vetting scheme for retrofit suppliers and subcontractors Activity 10.3 > Upskill Building Control Officers and drive up the quality of retrofit works Activity 10.4 > Work with existing training schemes and programmes to develop local skills Activity 10.5 > Create London retrofit training centres for existing and aspiring tradespeople
11	Set up a clear and consistent system to report and monitor progress (and success) Activity 11.1 > Agree metrics and report retrofit progress between councils

Delivering a home retrofit: overview of the whole process and key opportunities

Retrofit work at any scale is challenging and the delivery and supply chain constraints could be the biggest hurdle to overcome in order to achieve the objectives set out in this Action Plan. This section looks at how London local authorities should intervene to have an impact on the delivery process.

Need for a planned whole building approach

Improvements to energy efficiency might happen in lots of different ways. However in order to successfully deliver a retrofit, a coordinated approach is needed for the whole building or group of buildings (see Action 6 on mapping each building's journey towards lower energy costs and Net Zero). The London local authorities should set an example and ensure that a whole house approach is taken on all projects under their control.

The whole house plan will be unique to the building but could be based on whole house templates derived the Parity Projects Pathway report stock analysis and key London stock archetypes. For example, Warmer Sussex uses recommendations from a similar analysis to offer a developed plan of work through Retrofit Coordinators.

Funding or delivering one element for multiple homes would need eligibility criteria to check the measure fits into the individual plan for each home.

Opportunities for London local authorities to help

A summary of the process and some specific opportunities for councils to have an impact is summarised to the right. Recommended actions and activities are explored and summarised in more detail in this section.

Example retrofit process	*Opportunities for Councils to help*
Building assessment – Context research and building survey. Identify repairs required and reference maintenance schedules. Identify planning and heritage constraints, practical constraints.	Review maintenance programmes. Standardise existing condition surveys. Analyse stock for opportunities. Identify common planning constraints and provide web guidance on what is possible/acceptable.
Identify suitable interventions – propose appropriate interventions based on opportunity and technical feasibility	Offer or recommend defined packages of measures for different types of building. Training for surveyors or builders on these packages of measures Identify routes to retrofit and compile resources for residents.
Plan – package interventions in line with need, impact of maintenance opportunities, and technical requirements. Get consents if needed. Cost and get funding. Identify suitable delivery mechanism with a single stage or phased approach	Aggregate works across multiple homes to give better purchasing power. Make sure offer is compatible with grant funding or finance packages. Standardise application process for common planning constraints.
Procurement – Find trusted and capable tradespeople to deliver the work.	Provide training for tradespeople and Trustmark accreditation. Publicise local trusted tradespeople.
Installation – Carry out works. Manage installation and minimise disruption to residents. Construction quality assurance.	Provide quality assurance checks, e.g. as part of building control and using PAS 2030/2035
Feedback – Monitor quality and performance. Use experience from individual projects to refine offer and suggest new interventions.	Lightweight survey for residents and homeowners on making the process better. Identify new interventions?

Action 7

Review current maintenance programmes and identify retrofit opportunities

Review planned maintenance and upgrade programmes

London local authorities have ongoing regular and planned maintenance programmes for their own housing stock. They generally cover regular maintenance, housing upgrade and more major improvement works.

Current or upcoming projects may be missing opportunities to contribute to reducing carbon emissions and improve energy efficiency, or even making the situation worse. London local authorities should therefore review their current maintenance and upgrade programmes as soon as possible to identify projects where opportunities are being missed. These reviews should recommend which changes in scope of works could contribute to the retrofit programme.

Seek synergies with other housing programmes and priorities

The review should include other housing programmes to cross check changes that could trigger retrofit work to reduce total cost. For example work under the Housing Health and Safety Rating System (HHSRS), Building Safety Programme (BSP) and the Decent Homes programme should seek to find common ground and synergies.

Help others update their maintenance programmes

Maintenance programmes between councils and also other landlords (including Registered Social Landlords (RSLs)) are likely to be similar. The first London boroughs to undertake a review of their maintenance programme against the recommendations of the Retrofit London Housing Action Plan should share the toolkit/framework with other London local authorities and RSLs. The framework/toolkit should:

- list all types of maintenance works that should be included in the review;
- identify an appropriate point in a project where it is not too late to change. For example this could be pre-construction start, or pre-installation of the part of the works in question.

Maintenance item	*Lifetime*	*Retrofit measures to action or consider*
Roof repair (tiles, flat roof)	~30 years	• Roof insulation and airtightness • Airtightness connections to surrounding elements
External render or paint	<10 years (cement) 25 years (BBA certified)	• External wall insulation • Replace windows while there is access • Internal wall insulation while there is access and disruption
Windows & door replacement	10 years guaranteed, typically 20-30 years for new windows.	•Replacement with triple glazed windows or best available for appearance constraint. • Ventilation approach. Recommend new windows don't have trickle vents, move to MVHR. • Airtightness connection to wall and floor.
Replastering wall or ceiling	~20 years	• Internal wall insulation (if appearance constrained) • Roof and wall airtightness
Kitchen replacement	~5-10years	•Ventilation strategy. Replace cooker hood with recirculation type or careful direct extract if strategy is for MVHR, or continuous extract as part of MEV system. • Insulation to kitchen floor (if ground floor) • Internal wall insulation behind units
Boiler	10 - 15 years	• Replace with heat pump system • Improvements required to reduce heat load.
Extract Fan/Cooker Hood	~5-10 years	•Ventilation strategy. Replace cooker hood with recirculation type if strategy is for MVHR, or continuous extract as part of MEV system. • Induction hob and all electric cooking.
Electrical Wiring	Tested every 10 years (homeowner) or 5 years (landlord)	•Spare capacity for heat pump •Metering including submeter for electric vehicle charging and heating • Spare capacity for electric car charging

81 *Example opportunities for reducing carbon emissions in current maintenance programmes*

Action 8

Facilitate procurement of materials and services at a larger scale

The benefits of connecting a fragmented market

A key challenge with retrofit is how dispersed the work is, and the bespoke nature of each project. Finding and connecting common elements of projects would help delivery and financing through:

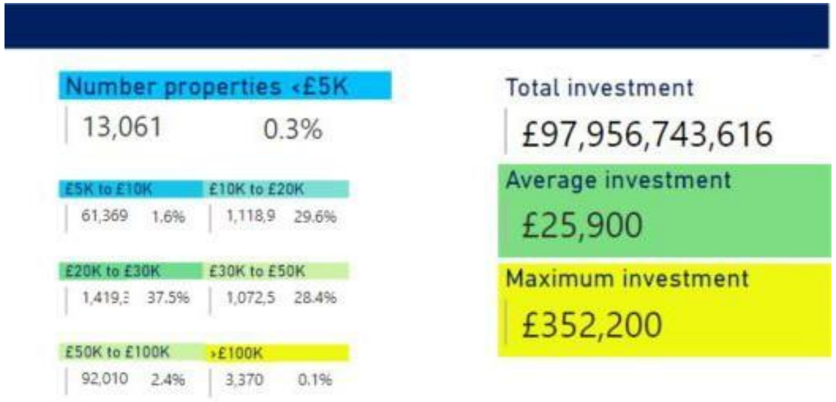
- Access to larger contractors who might only quote for projects above a certain contract value
- Shared project management, consultancy and quality oversight
- More consistent workforce learning and improving between similar work
- Labour buying power through larger contracts
- Product buying power through increased quantities of material
- Reduced administration or overhead costs through shared contracts

Opportunities for London local authorities to make links

Councils are well placed as a trusted local organisation to facilitate procurement of materials and services at a larger scale. This could be directly working with homeowners and landlords, or by supporting other organisations or community groups to do so.

The main mechanisms for joining the various types of work could be:

1. Councils leading the way by comparing works they are carrying out on their own properties and coordinating procurement.
2. Group buying similar work as one package. Councils could help this through:
    - Mapping and sharing planning data on opportunities (see Activity 8.2)
    - Actively helping homeowners and landlords to find others needing similar work, or actively setting up opportunities for homeowners (see Activity 8.3)



Estimated total investment for Net Zero Pathway for all London properties from Parity Projects Pathways Report for London Councils v1.4.

69%

Projects that have a total works value of less than £30,000 if completed in one phase. It is more likely that single domestic homes will have multiple packages of work spread over a number of years.

£8,600

The average project value per home assuming works to a typical home are carried out in three or more phases. The market is very fragmented and aggregation represents a significant opportunity.

Activity 8.1 > Share procurement for council-owned homes

Working together is a no brainer

To meet Net Zero carbon targets, all London local authorities will need to embark on a substantial investment programme to retrofit existing homes.

Although there are always unique cases, the homes and types of work across London are actually similar. This provides significant opportunities for sharing procurement, but also design and specification for common types of work. And councils are experienced clients who are well placed to develop efficiency and effectiveness further by working together.

In some cases an individual borough will have sufficient scale of work to procure directly, for example work to a whole block or estate. However for less homogenous property types it is much harder to coordinate and working together would be beneficial.

Opportunities for sharing work

- Design and specification. Sharing the development of a detailed design and specification that can be repeated. For example, internal wall insulation or the development of a whole house template for a particular archetype.
- Smaller pieces of work, for example pooling work on vacant properties into a larger contract across neighbouring boroughs.
- Quality management and feedback. Setting up a forum for project managers and site teams to share quality issues and experiences for future projects.
- Frameworks are a common way of navigating procurement and offering a pre-selected group of contractors for a particular area or work package. A retrofit framework could be developed, or built on past frameworks (e.g. GLA's RE:NEW) or existing ones (e.g. LHC's energy efficiency measures and associated works).

Any shared procurement should also seek to continue the councils' ambition to work with SMEs in the local area and assist in the development of a local, skills and sustainable supply chain.

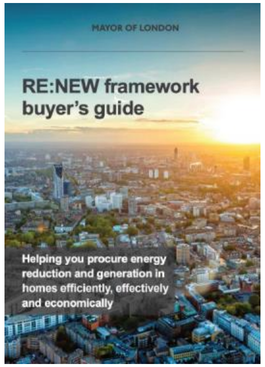
Learning from the Decent Homes Programme

The Decent Homes programme had a similar scale and shared ambition across councils. Much of the knowledge and experience from this programme still exists within councils and in many cases is still operating as a home upgrade programme or to implement the Housing Health and Safety Rating System (HHSRS).

Councils should set up a forum to share experiences and lessons learnt to inform the retrofit roll out.

The retrofit revolution and the Retrofit Centre of Excellence

The Mayor has recently announced a 'Retrofit revolution' that includes a Centre of Excellence for Retrofit to help social housing providers including London local authorities to access funding and share resources. This could be part of a forum for sharing retrofit procurement and experiences. Another initiative is the Mayor's new Innovation Partnership which will link up housing providers and builders through all stages of home retrofitting, from planning through to large-scale delivery



The RE:NEW framework was set up by the Mayor of London. It no longer operates, but the structure and ambition could be replicated and improved for use by London Councils. LHC's energy efficiency framework is an existing resource.

Activity 8.2 > Develop area-based strategies to enable bulk procurement and delivery

Mapping and sharing planning data on opportunities

The target measures and actions for each home should be accompanied by area-based planning to maximise the efficiency of delivery and allow strategic planning with delivery partners. Bulk procurement could apply to preparation and planning as well as the works themselves, for example the production of whole house retrofit plans. Area planning will also help communicate the intention and potential impact to leaseholders and homeowners.

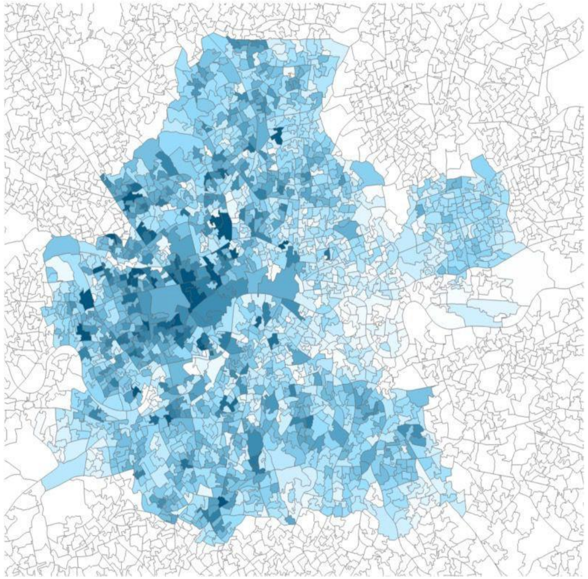
Area-based retrofit planning should help identify:

- Streets and areas which lend themselves to grouped approaches for a whole house strategy, or individual elements. For example streets or estates of repetitive house types or element types. This should apply to the council-owned stock but also to areas of mixed tenures which could then be targeted by engagement campaigns to encourage the various owners to pool together. See next page for example categories.
- Conservation areas which will benefit from specific guidance and possibly retrofit plan templates. Councils could procure guidance on this together, or at least ensure they share lessons across boroughs.
- Socio-economic factors which could help prioritise intervention, for example, areas of high fuel poverty, poor health outcomes, or poor air quality, where retrofit interventions could deliver multiple benefits and for which additional funding sources may be available.
- Areas served by different heating technologies. If an area is to be served by a sustainable low carbon heat network, it should be identified precisely (safeguarding large proportions of the borough can be over ambitious and ultimately misleading).

This area-based retrofit planning should also integrate into wider area-based energy planning, as recommended by the Climate Change Committee and Ofgem and for which guidance is starting to be available from the Energy Systems Catapult (https://es.catapult.org.uk/reports/local-area-energy-planning-the-method/).

Where possible delivering whole house retrofits of an entire street should be the goal. This is the model used by Energiesprong, but cab be a challenge due to tenure and desirability

(© Google Streetview – Southwest London – groups of similar houses)



The Parity Projects Pathways report for London Councils provides mapping for some types of work across Lower Super Output Areas (LSOAs). This type of analysis at a higher resolution could start to show where similar work packages existed between boroughs.

Different housing types and tenure are likely to be more suited to different delivery mechanisms.

Some of these are already being investigated at scale and this table provides a broad categorisation of delivery mechanisms, suitability and how they might scale.

London local authorities should pick the most appropriate route for each context, and prioritise whole building retrofit where possible. Councils should not permit piecemeal renovation of individual elements unless there is a plan in place for how the work fits with the whole retrofit.

For more information about the examples, please refer to the following pages 85 and 86.

Increasing preference

Potential delivery route coordinated by a Retrofit plan and identified in area plan.	*Building type suitability identified in area plan*	*Tenure suitability identified in area plan*	*Potential for scaling*	*Examples*
Whole building refurbishment all at one time. Between tenancy or ownership, temporarily decanting residents, or with residents in place.	Distinct housing archetypes that exist at scale.	All, but requires coordination between residents and shared contracts. More suited to multi-residential freehold or estate properties. Leaseholder engagement is critical.	Medium, limited to repeatable house types and standardisation. Private landlords may be unlikely to opt for this approach. Already being explored in London.	Energiesprong, Retrofit Accelerator: Homes, energy performance contracting
Phased packages of measures delivered across a large number of homes.	Distinct building features that exist at scale.	All, but requires coordination between residents and shared contracts.	Large, but requires aggregation across multiple homes. Familiar to landlords. No large scale success to date.	Solar together, Retrofit Works
Phased packages of measures delivered home by home.	No consistency required. Houses, harder for flats.	More suitable for owner occupied or smaller landlords	Large, but more dependent on the market and supply chain.	Green Home Grant, Carboncoop, Warmer Sussex
Piecemeal intervention with an element by element approach based on opportunity or funding. No retrofit plan.	Not recommended	-	-	ECO grant funding, Green Deal

Activity 8.3 > Consider a London-wide retrofit programme for homeowners

Many urban streets have multiple homes sharing a similar layout, construction or building features. If groups of individuals can be brought together to procure the same intervention – window replacement, for example – on multiple properties, this will allow more effective procurement and more efficient installation works than if each house is approached separately.

London local authorities should consider acting as 'aggregators' to pool work of a similar nature and offer packages of work to contractors and investors. This could be similar in principle to the Solar Together programme. The additional complexity of retrofit measures should be considered as it is likely to represent a significant challenge but a London-wide retrofit programme for homeowners could and should have the following advantages:

- ✓ Trust: the combination of Council-led offer with technical support (webinar, email support) from supply chains is very powerful
- ✓ Ease and clarity
- ✓ Planning: working with planning teams upfront e.g. '*in this area, we have agreed with planning and conservation officers that it's ok to do x under conditions y & z*' would add to the appeal of the programme
- ✓ Stepped process: free step 1, relatively low deposit at Step 2, "get out" options afterwards
- ✓ Community: residents could be told how many people are taking part, which builds a sense of community and reassurance. This could be taken further by creating local networks or forums.

Community-led investment could also be used and promoted for pooled work. London local authorities should liaise with local suppliers and community groups to promote energy efficiency amongst homeowners, landlords and leaseholders, and to bring together buying power for products and provide access to larger providers and contractors.

Council or partnership company identifies a package of complementary measures and invites interest.





Homeowners/landlords register interest. For example a package of measures including replacement sash windows and improved ventilation.

Council or provider tender all applications as one set of works to a suitable designer and contractor.

Homeowners/landlords directed to national or regional resources for advice, such as https://www.simpleenergyadvice.org.uk/

Example outline process for aggregating a package of works across multiple homes

Solar together is an example of a model to increase the project scale for roll out of building mounted renewable electricity generation from solar PV.

It offers group buying for solar panels and battery storage to homeowners. The programme is operated by iChoosr and is currently active in London as well as Essex, Hampshire, and Warwickshire, with emerging programmes in seven other counties. It provides more competitive prices for solar PV and impartial information and management to ensure quality of the system. A retrofit version of this initiative could use a similar model.

Solar Together

iChoosr independent experts in group-buying

Learning from Solar Together to create "Retrofit Together"

Action 9

Enhance planning to facilitate low carbon retrofit, including in conservation areas

Positive action in planning

The planning policy requirements for energy efficiency in new construction have improved over time. However, the same has not happened for works to existing buildings requiring planning consent. Planning policy should seek to highlight the opportunities available for existing buildings, and support projects that include improvements in energy efficiency.

Permitted Development rights and local planning special guidance could be used to give more support to energy efficiency. Current guidance focuses on extensions or restrictions, not areas that are positively viewed by the planners.

Environmental and heritage conservation hand in hand

Low carbon retrofit of heritage and traditional construction buildings is possible; there are a growing number of examples which show it can be done, and the PAS retrofit framework provides a risk assessment methodology and supports a growing supply chain.

Well-planned retrofit programmes can also actually contribute to conservation by incorporating maintenance and repair, and offer a new lease of life to buildings. They limit the risk of under-heating by occupants worried about energy bills, with the associated risks of fabric degradation. By being more comfortable, buildings are also more likely to remain valuable and well looked-after in the future.

Retrofit projects to historic buildings have so far faced an uphill struggle at planning, mainly due to the lack of policy clarity in support of energy efficiency measures. The ‘significant weight’ placed on buildings with heritage value in the National Planning Policy Framework must be balanced with the ‘public benefit’ of energy efficiency improvements. Local policy aimed at encouraging low energy retrofit and advice and support on how to do this responsibly and with appropriate care could help expand a market where there is growing demand.

© Marion Baeli, PDP

It can be done: The Technology Strategy Board “Retrofit for the Future” programme, undertaken over 10 years ago, deliver 80% carbon reductions on 37 pilot homes. This included 11 pre-1919 homes which demonstrated that heritage sensitive retrofit measures can deliver the scale of carbon reduction we need to see happening more.

Recent leading-edge examples of considerate and ambitious retrofit: Grade I Trinity Student Halls, Cambridge (left), and Grade II early Victorian home in Clapham, London (Harry Paticas). Both include the application of internal insulation, with attention to moisture movement and monitoring of interstitial moisture level. The Clapham House achieved AECB Silver certification and is considered as exemplar by Historic England.

Activity 9.1 > Provide planning guidance to enable retrofit

Clear guidance on what is possible

‘Requiring planning’ is seen as a significant barrier to retrofit. Existing policy is not necessarily understood, could dissuade a homeowner/landlord from progressing, and at worse directly prevents retrofit from happening through planning refusal.

London local authorities and the GLA should work together to put in place planning guidance to actively promote the process for key retrofit improvements. In the short term this could be through Supplementary Planning Guidance or Planning Advice Notes at the borough level. Examples for this already exist and could be used as very good starting points: Camden council has a general Retrofit Planning Guidance note, and Brighton & Hove has detailed Planning Advice Notes on external wall insulation and conservation areas.

Directly addressing heritage concern and value

Conservation area assessments do not mention retrofit or energy efficiency. Councils should clarify acceptable interventions in each conservation area, such as where external wall insulation is an acceptable approach, for example to the rear of properties, or to some stucco/rendered properties with certain conditions on detailing.

Provide a simple application process for key interventions

Some interventions for retrofit require a change to the external fabric of the building. Where this is known and is not covered by the planning system, London local authorities should seek to create standardised and simplified processes for applications. Examples of where retrofit could require planning are given opposite.

Removing unused chimneys which, even when blocked, are a large air leakage path and often a large source of moisture ingress. Chimneys that are not protected or critical to a street scape should be decommissioned and removed wherever possible.

Changes to window frame widths or removing glazing bars is often necessary to accommodate improved window performance. Glazing bars significantly impact window performance by being a thermal bridge through the glass and reducing useful solar gain.

Ventilation grilles are needed in external walls to provide supply and extract air and improve air quality. The MVHR location is important, sometimes the best location is on a street facing wall.

Space for external wall insulation and roof insulation in the pitch may require an overhang to the street or neighbour, or an increase in ridge height. Providing clear process for applying to highways, party wall surveyors, and even local permitted development for ridge height increases would make rolling out retrofit easier in many situations. This would need consultation with heritage officers.

Activity 9.2 > Provide guidance for planning officers

Best practice is changing quickly

State of the art in sustainability and retrofit best practice is changing quickly and is likely to continue to do so as momentum builds to address the climate emergency. It can be challenging for sustainability officers, let alone other specialists such as conservation officers, to stay on top of the latest thinking and solutions. Building partnerships between departments within the council specifically on retrofit would be very beneficial.

Using the planning process as a positive opportunity

Questions and comments at pre-application meetings or in planning feedback carry a lot of weight while consequential improvements required by the building regulations are often not considered or given sufficient weight. There is therefore a substantial opportunity for the planning process to influence positively the scope and ambition of projects involving retrofit (e.g. extensions, change of use).

Giving planning officers confidence and support

We recommend that London local authorities develop internal guidance and knowledge transfer mechanisms on retrofit, including:

- Supporting a network of housing delivery, energy and conservation planning officers from all boroughs, to share concerns, solutions, common questions. The network should have access to advice from the energy efficiency and heritage experts.
- Disseminating existing guidance and case studies.
- Training and events tailored to planning officers, on the topic of energy efficiency and low carbon solutions.
- Bringing in external advice for example on design review panels.

Research carried out by Historic England and others has helped to inform advice and guidance on improving the thermal performance of traditional windows. © Historic England

Measures such as internal wall insulation and secondary glazing have been poorly implemented in the past, leading to fabric damage, and as a result they are viewed cautiously by conservation officers who may often recommend their refusal. However, competent professionals understand how and when such measures can be successfully applied and the right type of materials.

Example resources for planning officers

- AECB Retrofit standard and Carbonlite Retrofit course
- Historic England: How to Improve Energy Efficiency
- LETI Climate Emergency Retrofit guide
- London Borough of Camden Energy efficiency and adaptation (2021) and Retrofit Planning Guidance (2013)

Action 10 Develop retrofit skills actively across London

Tradespeople must have confidence in the retrofit market

Several schemes to scale up retrofit from central government have had enormous promise, been heavily publicised and encouraged consumers and the supply chain to scale up and invest. They have then been scrapped without warning. The potential for the retrofit market has been discussed for several years, without substantial evidence of growth. The confidence in the retrofit market from a supplier and consumer perspective is therefore very low. The Pathway analysis by Parity Projects reflects this low confidence, with the estimated total number of tradespeople involved in retrofit still lower than its peak before 2008. In particular the number of general builders and insulation specialists is very low.

Actively encourage retrofit skills in London

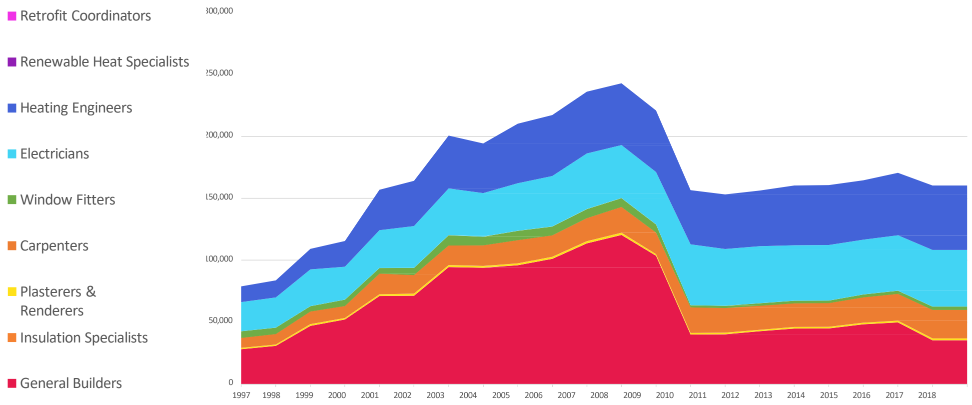
There is a large appetite for home improvement, and a significant opportunity to use the current ‘build back better’ intentions to promote and accelerate a retrofit skills agenda. To capitalise on this and deliver good quality retrofit, there is a need for skilled tradespeople.

Focus on local SME, general builders and insulation installers

SMEs are often cut out of commercial retrofit work. Market engagement should encourage local SMEs, particularly in the largest categories of trades needed. For example giving preference to contractors working with local trades should continue and should be extended to expecting main contractors to provide training to subcontractors. This could focus on a particular insulation installation, or Trustmark registration.

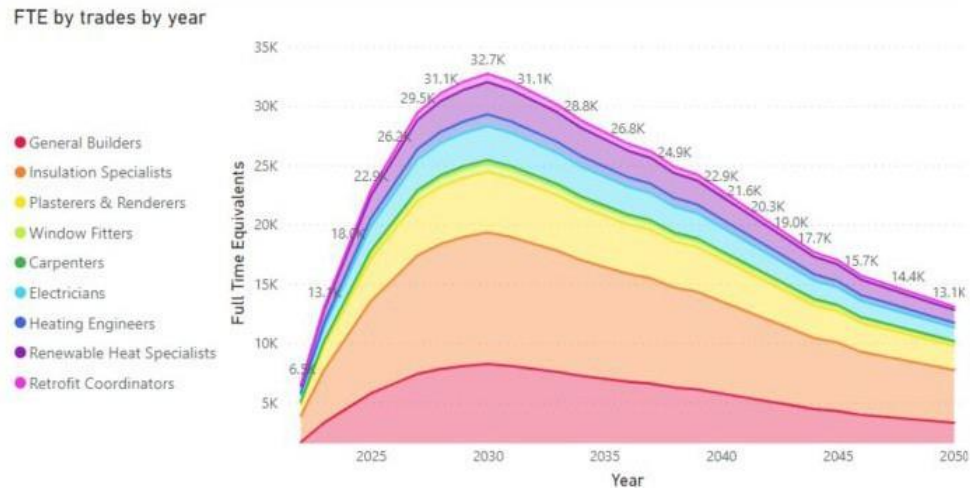
Develop the Retrofit Coordinator role

Retrofit Coordinators are a new and important profession that can provide oversight and enable retrofit work. Creating a clear call for Retrofit Coordinators could drive other parts of the market.



Estimate of number of tradespeople involved in retrofit nationally from historic data (1997 to 2018). The proportion of general builders and insulation specialists is very low and still below the peak in 2008. If anything it is currently falling. The Retrofit Coordinator role did not exist until 2019.

(Source: Parity Projects Pathway report for London Councils)



Forecast number of tradespeople required to achieve a net zero retrofit in London.
The peak number of general builders, plasters and insulation installers is 50% of the entire current national pool.

(Source: Parity Projects Pathway report for London Councils)

Activity 10.1 > Work with partners to develop a spending commitment for retrofit

Giving confidence to the market with a clear pipeline of work

London local authorities and partners should work together to stabilise the retrofit market locally to buffer the ‘boom and bust’ central government grant schemes where they can, and help develop the supply chain.

By working together to develop a spending commitment and a timeline for completing retrofit works, London local authorities and others, for example Housing Associations, could stimulate supplier investment in training and scaling up. This would benefit the whole market locally and improve skills.

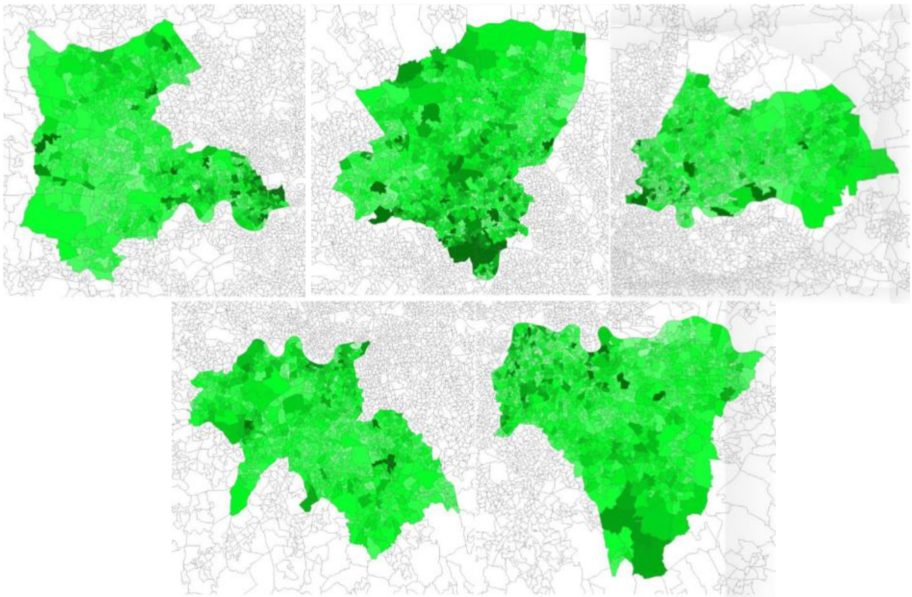
An example of the approximate investment level has been taken from the parallel work completed by Parity Projects. The exact amount and timescale would need to be decided by those involved.

Any publicity should highlight the skills and qualifications that prospective contractors would need, for example being Trustmark registered. It should also require larger contractors to commit to not only employing local workforce and SMEs, but also training them to the required level.

£27m

Investment in Retrofit by London Councils delivered over

10 years



The total investment by LSOA area for all properties including council-owned.

It is not possible to separate out the council-owned properties, but the data provided by Parity Projects shows spending on retrofit is needed in all areas with a relatively even distribution across London.

(Source: Parity Projects Pathway report for London Councils)

Activity 10.2 > Develop a London-wide vetting scheme for retrofit installation

Construction quality is generally poor

The general quality of retrofit work in the UK is poor. There is no entry level barrier to work in the domestic retrofit market, anyone can advertise and there is no formal qualification or skill level required. There have been some poor examples, including retrofit led at scale by local authorities.

Poor construction quality is particularly noticeable in London where the large demand, size and transience of the market means that trades can avoid the impacts of a poor reputation or bad review. In addition, the feedback from clients is often based around experience such as punctuality, cleanliness and communication – rather than construction quality.

Vetting contractors for retrofit skills

Pointing to existing registration schemes and a transparent review process could provide a way of recognising contractors who are working on retrofit projects, which would carry less risk than direct recommendation of specific companies. This could be by partnering with existing consumer websites and through the Trustmark endorsement scheme (see activities 10.3 and 10.4 for more information on this scheme) or through co-op vetting.

Trades get most work through recommendation

Typically through word of mouth, local message boards, or specialist websites. London local authorities should consider engaging with these platforms and actively signpost tradespeople who reach Trustmark accreditation or who have worked successfully on council retrofit projects.

Government endorsed register of tradespeople

Commercial tradesperson recommendation services. Checkatrade is the most established in the retrofit sector.

Social media websites where more organic recommendations often take place

Homeowners are unlikely to go through registered schemes to find a builder and are more likely to rely on consumer lead networks or local recommendation. These support individual installers but do not provide guidance on an overall strategy for retrofit. London Councils could promote the scheme provider as a source of trusted trades in the local area.

Examples of ways to engage with trade recommendations

- Publishing lists of local retrofit companies used by the council. Ensuring that they register with Trustmark.
- Leaving a review on Checkatrade or similar for all tradespeople who work for the council. This should be part of the council standard procurement process.
- Working or partnering with existing consumer websites such as Checkatrade or similar to encourage them to include retrofit skills as part of their trade categories.

Activity 10.3 > Upskill Building Control Officers and drive up the quality of retrofit works

Quality checks of design and on site

Local authority building control could play a key role in quality checking retrofit. Building control can be under-resourced, however by offering an additional service to give homeowners piece of mind there may be an opportunity to increase the role of professionals who are already experts in residential construction.

London local authorities should provide training for building control officers around energy efficiency and retrofit. They should investigate offering an enhanced service through local authority building control to act as a retrofit quality check.

The service could offer continuity from end to end and oversight of the works. It could be supplementary to the Retrofit Coordinator, or ensure quality where a Retrofit Coordinator is not involved.

Learning and improving based on project feedback

Bringing monitoring into the process is critical for successfully rolling retrofit out at scale. Feedback and transparent continuous improvement will reassure residents, tradespeople and building owners that the council is in this for the long haul. This could also help to minimise the impact of inconsistency from central government.

London local authorities should carry out a post project review on all council housing retrofit projects.

Example retrofit process	*Example check by Council service*
Plan – design information produced, or list of measures from the homeowner or builder. For example window replacements and a quote from a supplier.	Design information review to provide impartial advice on level of performance products achieve compared to market, key considerations, key additional work that will be needed (for example ventilation).
Procurement – Find trusted and capable tradespeople to deliver the work.	Review contractor tenders and suitability for the works that have been proposed. Preference for specialists with clear experience carrying out the work.
Installation – Carry out works. Manage installation and minimise disruption to residents. Construction quality assurance.	Construction site quality visits with feedback to the builder and client. Could be part of or supplementary to Building Control visits.
Feedback – Use experience from individual projects to refine offer and suggest new interventions.	Collate lessons learnt from projects to share publicly or with future clients. Provide contractors with feedback on improving installation. Ensure resident experience is captured and considered for future projects. Contact residents 12 months after completion to ask about energy bills and home experience, and to catch any issues.

Part of an example retrofit process showing how a council service could provide quality assurance to homeowners or landlords undertaking improvement works.

Activity 10.4 > Work with existing training schemes and programmes

Specific skills required for home retrofit

Local skills should be developed in retrofit specific trades. The approach to retrofit has to be adaptable to the variability between individual homes. Every home will need some work by variously skilled individuals, which represents excellent local job opportunities.

The Trustmark quality scheme

Trustmark is the government endorsed scheme for quality control and registering trusted tradespeople for Retrofit. To register as a provider, tradespeople need to sign up through a 'scheme provider' and achieve a Retrofit Coordinator Level 5 Diploma.

Future grant funding and delivery is highly likely to require Trustmark accreditation. One of the reasons the Green Home Grant voucher scheme failed is a lack of registered providers. Training should therefore focus around increasing the number of Trustmark registered providers across London.

Council projects should require Trustmark qualifications for contractors and designers.

London local authorities should either partner with a current scheme provider to provide tradesperson training, or set up a dedicated scheme provider to oversee training, marketing of trusted trades, and quality assurance on projects.

TRUSTMARK Government Endorsed Quality

STROMA INSTALLER CERTIFICATION · RETROFITWORKS BUILDING EFFICIENCY TOGETHER · elmhurst energy · PCA Property Care Association

Some example Trustmark scheme providers including companies, suppliers and product associations. London local authorities could create a scheme provider to serve the London area, or partner with an existing scheme provider. Retrofitworks have already carried out significant work in London and others are also very active. The full list is available here: https://www.trustmark.org.uk/ourservices/scheme-providers

THE RETROFIT ACADEMY CENTRE OF EXCELLENCE · THE Green REGISTER OF CONSTRUCTION PROFESSIONALS · AECB building knowledge

The Retrofit Academy and Green Register (Futureproof) are current course providers for Retrofit Coordinators. The AECB have an excellent existing retrofit course and are launching a coordinator course in the summer. One or more of these organisations could be a key partner to set up courses in London colleges.

Action 10

Activity 10.5 > Create London retrofit training centres for existing and aspiring tradespeople

Qualifications required for access to grant funding

Following industry lobbying, the publication of PAS 2035 and the introduction of Trustmark, it is highly likely that any future grant funding scheme will require Trustmark registration and a retrofit qualification. These qualifications also provide the Councils, as clients, a way of distinguishing between trades with Retrofit experience. London local authorities should positively promote these qualifications ready for future grant funding.

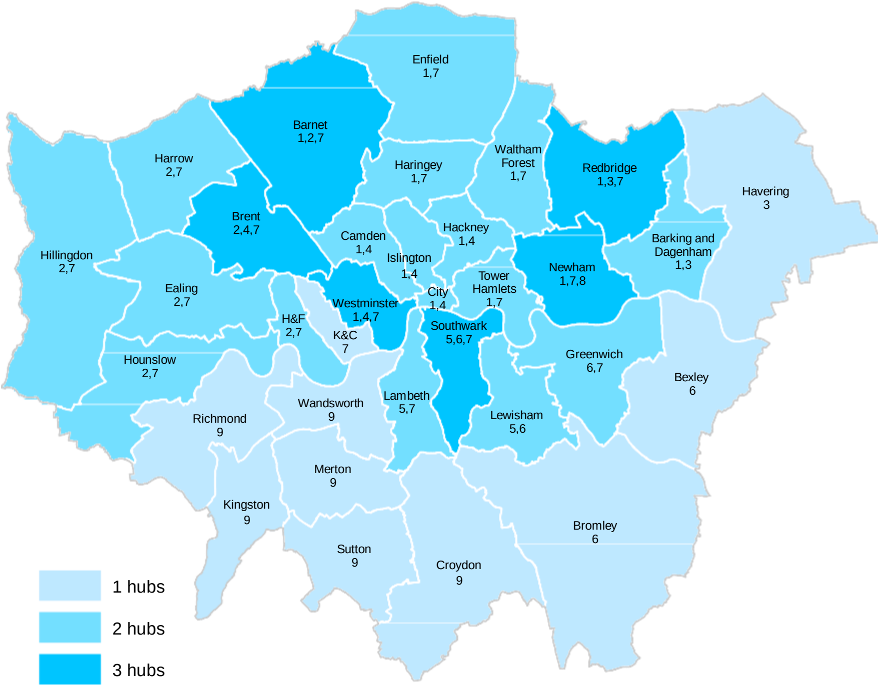
Making training available in London

There are currently no colleges offering Retrofit Coordinator training in London. Existing colleges and training programmes should be made aware of the demand for retrofit qualifications and skills needed including:

- General knowledge on existing buildings and construction types
- Specialist fitting skills such as heat pump installers and window fitters
- Insulation installers
- Risk assessment, project management and the Retrofit Coordinator role.
- Trustmark accreditation.

The Mayor's Construction Academy hubs are a Mayor of London initiative to improve skills in the construction sector and are delivered by existing colleges. They already teach many of the skills required, but are typically focussed around new construction. As part of the London Recovery Programme's Good Work Mission, the Mayor will establish a number of similar hubs in different sectors, including the green economy.

London local authorities should work with the Mayor's Academy hubs and Adult Education Budget (AEB) funded providers to ensure suitable retrofit training is available locally. The providers could partner with existing training organisations using existing courses as a basis.



Key	MCA Hub Lead
1	College of Haringey, Enfield & North East London
2	Ealing, Hammersmith & West London College
3	London Borough of Barking and Dagenham
4	London Borough of Camden
5	London South Bank University
6	London South East Colleges
7	Transport for London London
8	Borough of Newham South
9	London and Partners

Map of Mayor Construction Academy hubs.

London local authorities should contact these hubs to ensure that retrofit specific training is available, review its consistency with the Action Plan and raise awareness of the skills required.

Action 11

Set up a clear and consistent system to monitor progress and success

With the urgency and complexity of retrofit there is a significant risk of failure or repeated mistakes. It is therefore critical that a feedback mechanism and sharing of experiences is built into any retrofit programme. It will require resources and funding, but we consider that the benefits and value justify them.

Monitor improvement at the dwelling level

Building performance evaluation of individual projects can give insights and lessons learnt to take forward on future projects. Energy monitoring and light touch feedback surveys on all projects would be highly beneficial for showing how effective any programme or works are.

Utilise annual dataset releases from BEIS

BEIS release energy and CO_2 emissions datasets every year for each local authority which are relevant to energy consumption in homes, the total domestic gas energy sales and total domestic electricity sales. These should be monitored annually, with a target reduction in annual domestic gas sales of 10-20%. This gives a high level indication of real impact.

Monitor numbers of low carbon installations

Gathering data on the total number of installations for each technology installed in London will give valuable information on whether we are moving in the right direction and how quickly. The number of gas boilers or Air Source Heat Pumps would for example be a good proxy for heat decarbonisation. These numbers are currently monitored in Germany and evidence the acceleration of the move away from gas boilers towards electric forms of heating.

Communicating success and benefits

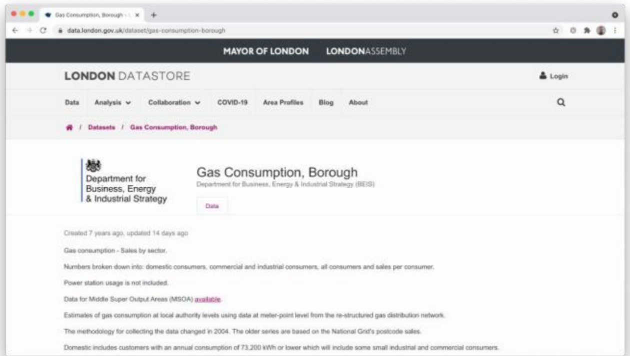
Communicating where retrofit has been carried out successfully, had a positive impact on residents and reduced carbon emissions will help accelerate the take up and communicate benefits to other residents, including leaseholders.

1 Dwelling scale monitoring

2 Borough level gas, energy and CO_2 monitoring

3 Procurement and installation monitoring

Monitoring the impact of the retrofit programme should be implemented at different scales to ensure progress and enable corrective actions along the way.



Borough and post code level domestic gas and electricity consumption is available from BEIS (Subnational gas and electricity) and through the London Datastore website.

This high level data could give a long term indication on whether programmes were achieving real energy reductions.

Action 11

Activity 11.1 > Agree metrics and report Retrofit progress between Councils

London local authorities may independently be progressing retrofit programmes at different speeds and with different approaches. Gathering and sharing data and feedback from retrofitted properties will allow the councils and wider industry to understand and learn from the impact retrofit measures have. This is crucial for successful retrofit. It facilitates identifying and rectifying problems as early as possible.

Potential reporting metrics

Councils should agree a set of reporting metrics that all projects report against. These would be shared between boroughs or could even, with suitable GDPR measures in place, be reported publicly. Example metrics that should be considered include:

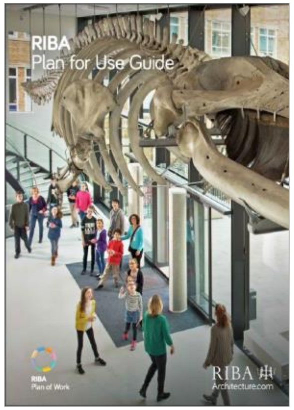
- Number of measures installed
- Number of whole house retrofit plans prepared
- Metered energy consumption per property or per group of properties
- Standardised post completion resident survey
- Post completion spot checks of moisture levels in retrofitted building fabric for higher risk scenarios
- Sample monitoring of indoor air quality to build understanding of existing conditions and what makes robust retrofit

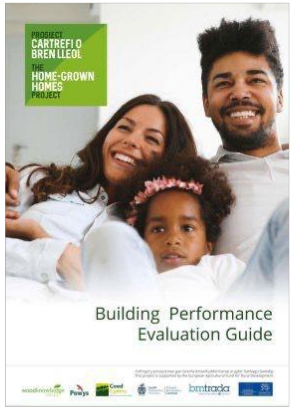
Data should be frequently collected and analysed for discrepancies and to feedback learning to other boroughs and the wider retrofit community.

Aligning with emerging industry initiatives

Guidance for carrying out building performance is available for different scales and scope is now available. A full British Standard (BS 40101) is due to be published later this year. London local authorities should ensure the agreed metrics align with the latest industry guidance on effective building evaluation.

Monitoring and data collection of environmental and energy performance is quickly becoming easier. For example the Switchee room thermostat provides landlords with internal temperature, humidity and heating patterns for their building stock to allow early diagnosis or intervention to provide advice for residents.





RIBA Plan for use (2021) and Wood Knowledge Wales Building performance evaluation guide both provide strategic and practical guidance for implementing a range of scales of building performance evaluation.

Borrowing delivery models from the UK and internationally

There is a lot of excellent and innovative work going on to expand retrofit and refurbishment. Councils can borrow and adapt existing models, some are shown and compared on the following page.

BetterHome, started in Denmark was started by private companies Rockwool, Danfoss and Grundfos seeking to stimulate demand for energy efficiency products. It was a one-stop-shop for homeowners to partner them with an installer who would oversee the whole project delivery. There was no tie to using specific products. The scheme was successful and ran from 2014 to 2020 before being closed to new applications.

Bristol City Council Energy services is a dedicated Council team for improving energy efficiency in domestic properties, similar to that provided by some London boroughs. They provide: central application and dissemination of grant funding, guidance on grant schemes, and practical advice. Exploring crowd funding to raise capital for retrofit of community buildings.

The Carbon Co-op available in Northwest England, and Urbed provide energy services and advocacy for 'People Powered Retrofit' including consultant advice. Their tool, My Retrofit planner, gives a standardised format to give bespoke impartial consultant advice to homeowners. It recommends different strategies and helps householders form a whole house plan with the likely benefits at each step. It is an individual private householder planning tool that costs £550 per home.

Energiesprong is an implementation mechanism for retrofit to a net zero carbon standard. It uses energy cost savings from retrofit in a form of energy performance contracting. There have been a number of Energiesprong projects in the UK and more are currently in the planning stage, mainly through housing associations. The Mayor of London's Retrofit Accelerator: Homes programme is aiming to put example homes on the pathway to net zero carbon, including a Whole House approach using Energiesprong UK.

Engie Zero is Engie's version of the Energiesprong model: they help councils unlock finance on the basis of future savings, alongside an energy and comfort plan. An important difference however is that they act as a one-stop-shop, including delivery and, if needed, maintenance and monitoring (while Energiesprong act more as intermediaries).

Parity Projects provide Whole House Plan web tools that show different 'pathways' and compare carbon and energy improvements across a whole stock to create a costed plan for retrofit of each home. It is aimed at local authorities, housing associations, homeowners and landlords who subscribe to the platform. A platform has been developed for London under the name Ecofurb and can be used for free to prepare an indicative whole house plan. It is available at https://www.ecofurb.com. Additional services and works can be provided to take it further,

Retrofitworks is a co-operative with two types of members, contractors and community groups or authorities. The cooperative brokers retrofit work between members and provides quality assurance. This provides contractors with a work pipeline, and authorities a trusted contractor work force. They have delivered ECO and Warm Homes London projects in London and are one of the largest retrofit providers. Retrofitworks was started by Parity Projects, but is a fully independent member-owned cooperative.

SuperHomes, in Ireland, is led by the Tipperary Energy Agency. It is a one-stop-shop for homeowners taking them through the initial planning, tendering, and overseeing of the works. The packages include essential elements (e.g. homes have to have an air source heat pump, mechanical ventilation (demand control or MHVR) and insulation) as well as some tailored options. SuperHomes also help with grant funding of up to 35% of the works.

Comparison of example existing energy efficiency delivery models

A number of delivery and financing models could be adopted by councils. Some will be better suited to different parts of the stock, tenure / ownership types or building characteristics. The main models are summarised here in terms of how they address the main challenges to make retrofit happen.

Existing model	Financing	Finding and liaising with homeowners	Planning & technical appraisal	Single phase or phased works	Finding / linking with supply chains	QA / overseeing the works	Follow up	Applicability & notes
ENGIE Zero	Yes	Through landlord	Yes	Single	Yes	Internal	Yes, against guaranteed performance parameters	Social and private rent
Energiesprong	No, but savings guarantee opens opportunities	Currently through landlord	By partners	Single	Partners	No, but contractual performance drives quality	Yes, against guaranteed performance parameters	Social and private rent
People Powered Retrofit (Manchester)	No, group buying for reduced cost	Yes	Yes, my Retrofit planner	Either	No	Yes, Retrofit coordinator	Optional	Individual homeowners
Retrofit Works	No	Yes	Yes, by Retrofit coordinator	Either	Yes	Yes	Optional	Typically landlords and houses
Super Homes (Ireland)	No (but in Ireland, attracts a 35-50% public subsidy)	Yes, one-stop-shop for homeowners	Yes	Single	Yes	No	No	Individual homeowners
Betterhome (Denmark)	No	Yes, one-stop-shop for homeowners	Yes	Single	Yes	?	?	Individual homeowners. Set up by private companies to drive product demand. Closed, example only.
Other non-energy efficiency models								
PV delivery : Solar Together	No, group buying for reduced cost	Yes	Yes	n/a	via auction	? MCS installers	No	Typically aimed at homeowners

5.0

How to pay for it:

Costs, funding and finance

- Cost of measures and packages
- Funding opportunities for council-owned stock
- Opportunities for collaboration with the finance community
- How to support owner occupiers and the private rented sector

Summary of recommended actions in this area

The key recommended actions and activities in terms of costs, funding and finance are listed in the adjacent table.

Each action/activity is explained succinctly in the following pages.

The full list of actions and activities is provided in a separate spreadsheet which London Councils can develop and add to when this phase of the project has been completed.

12	Establish the cost of retrofit, business case and funding gap for the different tenures
	Activity 12.1 > Analyse outline cost of retrofit for whole housing stock
	Activity 12.2 > Establish the business case for funding retrofit for council-owned stock
13	Maximise capital finance for council owned stock (and eligible homes)
	Activity 13.1 > Coordinate applications for government funding
	Activity 13.2 > Assess borrowing and private investment opportunities
14	Create a 'Finance for retrofit' taskforce with finance experts
	Activity 14.1 > Assess emerging financial products appropriate for different tenures
	Activity 14.2 > Analyse and develop options for seed funding to leverage future finance
	Activity 14.3 > Collaborate with other boroughs on finance and funding
15	Support the owner occupier and private rented sectors to leverage private investment
	Activity 15.1 > Consider developing innovative finance offerings to support blended funding
	Activity 15.2 > Support homeowners and landlords with funding applications and lending

The London local authorities’ role in financing retrofit

Money is an issue

London local authorities are committed to working together to retrofit London’s building stock to an average level of EPC B by 2030 and many have declared a climate emergency and are targeting net zero emissions by 2030. However, financing and resources are two significant issues as local authorities are under considerable pressure and have limited means. There needs to be a significant amount of public and private finance mobilised for retrofit. And for this to happen there needs to be local and regional co-ordination.

Resources are an issue

Local authorities are also ideally placed to facilitate finance for all stock within their borough, not just council-owned social housing. However, nearly all struggle with a severe lack of resource. So, whilst they are ideally placed to facilitate finance for retrofit, it is recognised that there are significant challenges in funding retrofit for their own stock, let alone the rest of the stock in their borough.

	Social Rented Sector	Owner Occupied	Private Rented Sector
Decision maker profiles	• Housing Association • Local council • Arms-Length Management Organisation	• First-Time Buyer • Mortgage Holder • Own Outright	• Landlord • Corporate Landlord • Asset Manager
Who lives there and who pays?	Tenants in social housing are generally low-income households and have extremely limited ability to contribute to efficiency measures, making owners of social housing the principal investors. Leaseholders can have a different profile.	There is a wide range in purchasing power within this group and a wide range of finance sources available to them to invest in retrofit for their own homes.	The short length of tenancies and lack of disposable income typically seen among private-rented tenants limits their ability to contribute to efficiency measures, leaving landlords as the principal investor.
Financial barriers to retrofit	• Limited funds – new construction, retrofit of existing stock and building safety improvements compete for council budgets • High upfront costs – both councils and housing associations have large portfolios • Long term financing – short term government grant programmes make it difficult to develop long term plans and finance models • Interest rate – housing associations have the highest share of the stock and face higher borrowing rates than local authorities	• High upfront costs • Lack of access to capital • Low confidence in energy bill savings – where homeowners are seeking full repayment via energy savings • Duration of ownerships - the energy bill savings may not accrue to the homeowner if they move out of the property • Improvement not reflected in home value • Availability to financial products and limited options and desire for borrowing	• High upfront costs • Lack of access to capital • Split incentive – most landlords do not pay energy bills and therefore do not financially benefit from the energy bill savings • Improvement not reflected in rental value • Availability of finance products • Freehold owners of leasehold rental properties are typically interested in ground rent only, which is unaffected by property improvements.
Key drivers	• Climate change targets • Broader value of health & wellbeing of tenants	• Climate change action • Minimising running costs • Increase in asset value from measures	• Increase in asset value from measures • Increase in rental value from measures

A different approach to finance for different tenures is required

Activity 12.1 > Analyse outline cost of retrofit for whole housing stock

How much will it cost to retrofit?

It is challenging to provide an accurate cost assessment of the cost of retrofit for housing. It depends on the current building's characteristics and performance and on what works are required.

Parity Projects have provided both London-wide and individual borough data, not only on the profile and performance of existing stock, but also on the number of measures and level of investment required for two different pathways. Broadly, Pathway 1 presents a scenario that cuts carbon emissions by around 56%, and achieves nearly average EPC B; and the Pathway 2 scenario achieves net zero carbon emissions and average EPC B. These reports can be used to understand the total, average and range of investment required. Their analysis suggests a wide cost range between £5,000 and £100,000 per property with averages of £13,000 and £25,900 respectively for Pathway 1 and Pathway 2 to improve the building fabric and ventilation system, change the heating system to a heat pump, generate a significant amount of renewable energy on-site with roof mounted PVs and be able to manage demand with more flexibility.

	Pathway 1 - 56% CO_2 reductions		Pathway 2 - Net Zero	
Total Investment	£49,296,156,159		£97,956,743,616	
Average Investment	£13,000		£25,900	
Properties Affected	3,416,500		3,780,6180	
	Number of Properties	%	Number of Properties	%
< £5K	564,340	14.9%	13,060	0.3%
£5 - £10K	1,115,800	29.5%	61,370	1.6%
£10 - £20K	828,900	21.9%	1,118,900	29.6%
£20 - £30K	515,710	13.6%	1,419,300	37.5%
£30 - £50K	356,840	9.4%	1,072,500	28.4%
£50 - £100K	33,540	0.9%	92,010	2.4%
> £100K	1,280	0.0%	3,370	0.1%

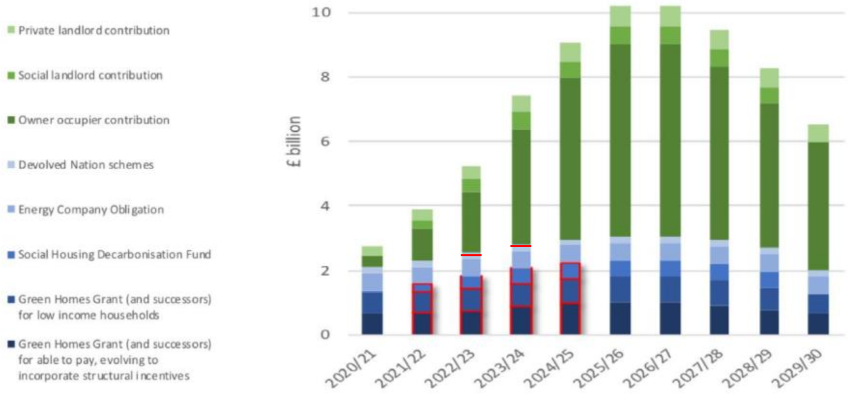
Investment figures from Parity Projects based on analysis of all 3,781,477 properties in the 32 Boroughs and the City of London

Significant leverage of private capital is required

The Energy Efficiency Infrastructure Group (EEIG) and BEIS have both previously provided estimates on investment for a pathway towards EPC C for all homes in the UK by 2030: £73 billion and £65 billion respectively.

Based on the data from Parity Projects, investment for a pathway to towards EPC B by 2030 for homes in London would cost £49 billion.

It is imperative for government to provide further capital funding and incentives that leverage private funding to reach this level of investment. As part of their study the EEIG illustrated the demands for both public and private investment. Public investment includes current, pledged and required public funding, calling for an extra £7.8 billion of public capital over the next four years. The private funding includes the contributions required from social housing landlords, private landlords, and finally owner occupiers, who represent the largest contribution.



Investment pathway towards EPC C for all homes by 2030 developed by EEIG. It includes a requirement for a further £7.8 billion of public capital funding over the four years to the end of this Parliament, outlined in red.

The cost of retrofit should not be exaggerated

It is important to consider whether a measure is undertaken as part of a planned enhancement or maintenance activity. For example, re-rendering a wall would be an ideal time to apply external insulation and would mean the actual extra costs are just the insulation material and labour to secure the insulation to the wall. Retrofit and energy efficiency improvements should be coordinated with planned enhancement, building safety programmes and maintenance activities like this to keep costs down.

Large-scale retrofit programmes will also generate economies of scale which could be factored in when analysing outline retrofit costs.

Consider the cost of retrofit in context

While the level of investment for retrofit represents a huge challenge, it is worth noting that there is already a considerable amount of money being spent on running and improving our homes.

Home improvement market

£2,100 per home

is the average annual spend on renovation and home improvements by people in London. The UK spends £7billion on DIY supplies. Covid-19 has also triggered an increase in home improvement works and planning applications for extensions.

Private rented property repairs

£1,000 per home

is the average spend by landlords each year on refurbishments, replacing or repairing boilers and fixing structural damage. These costs will increase with the Minimum Energy Efficiency Standards (MEES).

Social housing costs

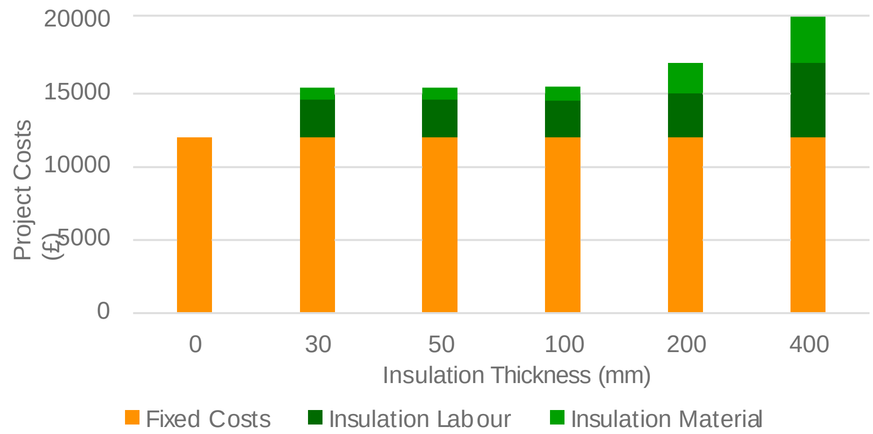
Up to £10,000 per home

was spent over the last 10 years on more than 1 million homes to meet the Decent Homes standard. Social housing providers also have significant budgets for maintenance and repair, with building safety works now a priority.

Energy costs and fuel poverty

£4.2 billion a year

is spent on energy bills by social housing tenants in the UK, with more than half a million households in fuel poverty in London. Schemes such as the Warm Homes Discount help with these payments.



Fixed and variable costs to re-render a 100m² external wall adding an additional insulation layer. This shows that the actual cost of the insulation material and labour is relatively minor. Assuming that the wall had to be re-rendered anyway, for 100mm off insulation, the low carbon retrofit costs should be considered as £3,000 not £15,000

Top 10 most common home improvements
1 - Getting a new bathroom (39%)
2 - Installing a kitchen (38%)
3 - Installing a new boiler or central heating system (34%)
4 - Having a garden make-over (26%)
5 - Installing double glazing (26%)
6 - Building an extension (17%)
7 - Knocking through rooms (12%)
8 - Fitting solar panels (12%)
9 - Getting a loft conversion (10%)
10 Adding an extra bedroom (9%)

The majority of the most common home improvements represent opportunities for energy efficiency improvements, decarbonising heat or generating renewable energy highlighted in orange.

Activity 12.2 > Establish the business case for funding retrofit for council-owned stock

Plan investment using your Homes Revenue Account (HRA)

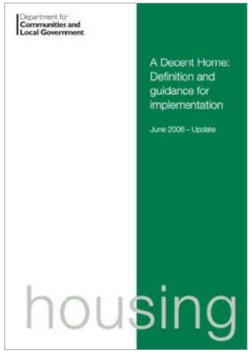
The HRA is the account in which a council's housing revenue (e.g. tenants' rent) and housing costs (e.g. property management and maintenance) are kept. It is a landlord account, recording expenditure and income arising from the provision of housing, it is not a separate fund but a ring-fenced account for certain transactions. By law, this account is separate from the 'General Fund' that local authorities use for other fiscal purposes.

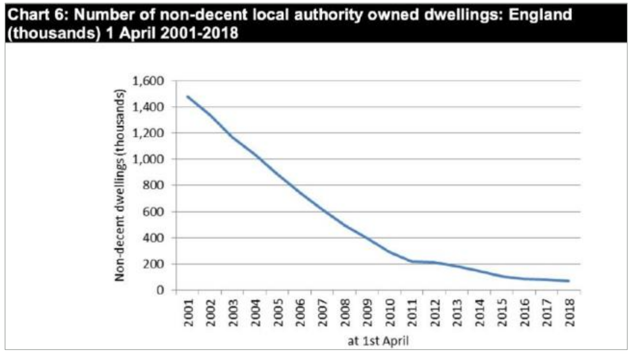
The main sources of income are from tenants in the form of rents and service charges, but public funding and borrowing can provide the capital that would be required for retrofit works and maximising capital finance is explored further under Action 13. There is also revenue from planning policies to consider, such as carbon offset payments under Section 106 agreements.

When establishing the business case for retrofit it is important to develop a financial strategy that can be supported by the borough's HRA. The business case for retrofitting council-owned stock should be reviewed alongside current investment for Decent Homes, building safety works, and maintenance and repair programmes. Efforts should be made to co-ordinate these works as much as possible to reduce costs.

There is a broader financial benefit to retrofit

There are several second-order effects of retrofit which provide public value and social return on investment (see following page). They should be considered in the business case. There are a few methodologies available to establish the public value of a project. Social Return on Investment (SROI) is an organisational method of accounting for value creation, primarily social or environmental value. The key difference between SROI and other methodologies is the assignation of monetary values to the amount of change created. This can be used to support the financial case of retrofit. The Cabinet Office's '*A guide to Social Return on Investment*' provides a comprehensive account of the methodology of SROI.





Over the last 20 years, a very large number of homes have been brought up to the Decent Homes Standard showing that a concerted effort to achieve a retrofit objective is possible, despite challenges and issues.

Suggestions to frame the business case for retrofit

London local authorities could use this structure to develop an investment and business case for retrofit.

- Strategic context – How well does the project fit into the council's strategic priorities?
- Affordability – Are financial resources available within existing sources of funding for the proposed project and what will be the net impact of the options under consideration, in terms of cost to the organisation versus benefits?
- Public value – Is there a consideration of the wider benefits compared with costs to UK society of the proposals? This is not the same as the net effect on the local authority and it considers the same range of options as the financial appraisal but from a wider social perspective.
- Value for money defined as 'Public value divided by financial impact'. It measures the social benefit of an option per pound of public cost. Most public sector organisations will need to develop a business case to secure investment.

Bang for the buck: cost of measures and public value

The most common method of rationalising the cost of retrofit is to divide the capital cost by the annual energy bill savings to give the number of years it will take to payback. But what is a good payback? Should we expect full return on investment from retrofit?

If carbon reductions are our primary goal, we might consider the cost per tonne of carbon saved. However, these figures will depend hugely on the carbon factors used, the building's heat source (which could change) and the timeframe over which they are calculated. It can quickly become difficult to compare like with like.

A more reliable metric would be cost per kWh of energy saved. This would allow easy comparison between different measures and packages of measures. However, as well us understanding comparative cost of measures it is important to understand their second-order effects.

Health

Increasing thermal comfort and improving indoor air quality will have a positive impact on health, especially the vulnerable. The IEA and the OECD suggest health improvements might account for 75% of the overall value of improving the energy efficiency of buildings.

Wellbeing

HACT's Social Return on Investment calculator suggests that an improvement of 3 EPC bands in London improve individual's wellbeing, equivalent to £651 per year.

Energy bills and fuel poverty

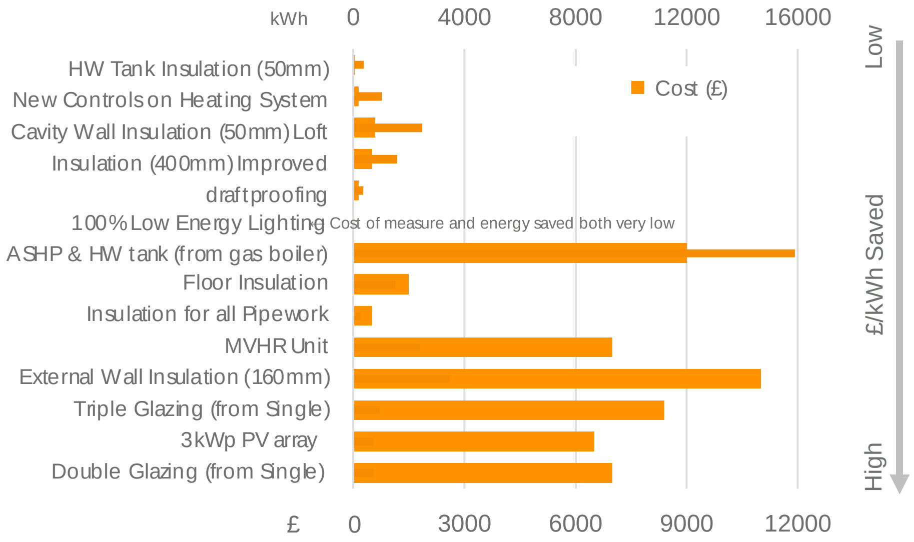
Targeted high energy savings will reduce bills and take more people out of fuel poverty, reducing the need for financial support.

Local economy and job creation

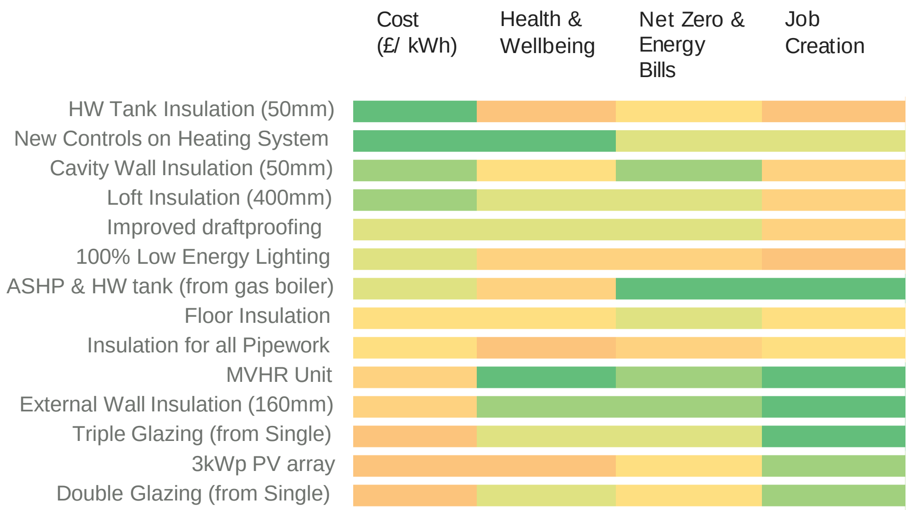
There is a fantastic opportunity for job creation in London. Parity Projects estimate that it can create 40,900 full time equivalent jobs for 9 years to get all homes to EPC B by 2030 and achieve 56% emissions reductions.

Society's cost to achieve Net Zero

There is finite supply and delivery capacity of renewable energy via the grid. The less grid capacity we will need to achieve net zero, the lower infrastructure costs will be.



Indicative energy savings (top axis) and costs (bottom axis) for primary retrofit measures for a medium size dwelling ordered by cost effectiveness (£/kWh saved). The most cost-effective measures do not necessarily deliver the highest energy savings and actual cost must be considered to understand investment vs budget.



A subjective assessment of the impact of retrofit measures on the second-order effects which could help establishing priorities.

Activity 13.1 > Coordinate applications for government funding

A changing landscape of government funding for retrofit

In July 2020, the Government announced a £2 billion Green Homes Grant scheme to upgrade homes across England. It was announced that £500 million of this funding would be allocated to local authorities through the Local Authority Delivery (LAD) scheme. £50 million (later increased to £62 million) were also allocated to demonstrator projects of the Social Housing Decarbonisation Fund. Under a year later there is already a very different landscape: the Green Homes grant voucher scheme has already been closed, and it is estimated only £300 million worth of vouchers will have been issued. In March 2021, the Government have announced £300 million extra funding for green home upgrades to be distributed via the Sustainable Warmth Competition (i.e. LAD3/HUG1).

Details on current government schemes, as of May 2021, are provided in the adjacent table.

An unsatisfactory funding application process

One of the key challenges is that government funding is generally piecemeal and stop-start. There is no recognition that to deliver programmes in many communities, across different tenures, there needs to be a long-term approach that allows local authorities to play a key role.

Councils are not given enough notice of bidding rounds and application deadlines, which often does not allow for a well-considered application. The industry is lobbying the Government to address this, but in the meantime, boroughs should prepare detailed stock assessments and building renovation plans including proposed measures, costs and energy and carbon savings. This will streamline the process, ensuring boroughs are ready to take advantage of government funding as it becomes available.

Obligation

The Energy Company Obligation (ECO)

ECO is a government energy efficiency scheme designed to deliver on the Home Heating Cost Reduction Obligation (HHCRO) and the Carbon Emissions Reduction Obligation (CERO). Capital is allocated to electricity suppliers who deliver measures to eligible households, namely those who receive the Warm Homes Discount or live in social housing with a poor EPC. ECO Flex allows local authorities to identify further eligible households. The scheme is expected to run until 2026 with an increase from £640 million to £1 billion each year.

Grants

The Green Homes Grant Local Authority Delivery scheme (LAD)

The LAD scheme has already been allocated its original £500 million, with £200 million for local authorities to support low-income, fuel poor households and the other £300 million allocated to the 5 Local Energy Hubs. London boroughs should continue to engage with the Greater South East Energy Hub who were allocated £79,600,000, and to apply for LAD3 as part of the Sustainable Warmth competition.

Social Housing Decarbonisation Fund (SHDF)

The Government have also pledged to spend £3.8billion over ten years on the SHDF. Following the £62 million demonstrator scheme, they have announced that a further £60million will be available to Local Authorities for 2020–21 as part of the main scheme, with £240million and £410million provisionally allocated in 2022–23 and 2023–24 respectively.

Home Upgrade Grants (HUGs)

In 2019 the Government manifesto pledged £2.5 billion in Home Upgrade Grants over 5 years for low income households living in inefficient homes. In 2020, it was announced £150 million would be made available in 2021-22, which has now come forward under the Sustainable Warmth competition.

Discount

Warm Homes Discount

The Warm Home Discount is a yearly one-off £140 payment applied to eligible customers' electricity bills to reduce living costs for those on a low income or a state pension. It currently costs the Government £350 million per year, supporting 2.5 million households, with extension proposals to 2025/26.

Incentive

Domestic Renewable Heat Incentive (RHI)

Homeowners and private or social landlords can receive payments for 7 years to fund biomass boilers, solar water heating and certain heat pumps.

Activity 13.2 > Assess borrowing and private investment opportunities

Boroughs can borrow under their Homes Revenue Account

In 2018, the Government confirmed that the HRA borrowing cap was abolished with immediate effect. As a result, London local authorities with an HRA can borrow for any capital expenditure without Government consent, provided they and their auditors are satisfied they can afford to meet the borrowing costs. Borrowing by councils is governed by the Prudential Code for Capital Finance in Local Authorities.

Borrowing can take many forms

Councils can borrow from any willing lender. Most long-term council borrowing currently comes from the Public Works Loan Board (PWLB), but London local authorities can also borrow from banks and investment funds. Increasingly popular are loans between local authorities and community municipal investments.

Sustainable finance now uses ESG considerations

Lender Option Borrower Option (LOBO) loans were developed by banks to compete with the PWLB. They are long-term loans, where the lenders have the option to change the interest rate at pre-agreed dates. The borrower can then repay the loan in full or agree to the new interest rate.

In the 2000's LOBOs were very popular with councils but in recent years, their complexities have come to the fore, making them less appealing.

A growing number of financial institutions are now offering lending products that are based on environmental, social and governance (ESG) considerations, where the borrower receives a set discount on the interest rate if pre-agreed ESG targets are met. An increasing number of housing associations are using Sustainability Linked Bonds for low interest rates and long-term capital to fund retrofit programmes.

Sources of Investment and Loans

Public Works Loans Board (PWLB)

The PWLB is directly managed by HM Treasury and provides loans to local authorities, primarily for capital projects. Local authorities can borrow money from the PWLB at interest rates lower than market rates.

UK Municipal Bonds Agency (UK MBA)

The UK MBA is a Local Government Funding Agency which allows local authorities to diversify funding sources and borrow at a lower cost than is available from central government. The agency sells municipal bonds on the capital markets, raising funds that it can then lend to councils.

The Mayor of London's Energy Efficiency Fund (MEEF)

The MEEF is a £500m investment fund established in 2018 by the GLA with funding from the European Commission, which looks to providing flexible and competitive finance for low carbon projects across London.

Community Municipal Investments (CMIs)

CMIs are a new way to provide a low cost and longer-term form of borrowing for local authorities. It utilises a local investor crowdfunding approach to create a pool of funding. When investors invest in a CMI they are investing directly in the council and the council sets out how it will use the money. CMIs have a dual benefit, they deliver community wealth, while also raising awareness.

Green Investment Group

In 2012 the UK Green Investment Bank plc (GIB) was launched by the UK Government. It was designed to mobilise private finance into the green energy sector. Between 2012 and 2017, the GIB helped to finance more than £12bn of UK green infrastructure projects. In 2017, Macquarie acquired the GIB to create a team of specialist green infrastructure developers and investors.

Coming soon

UK Cities Climate Investment Commission

This partnership between London Councils, Core Cities and the Connected Places Catapult aims to support investment for low carbon projects by:

- creating increased confidence within the investment community in low carbon projects by leveraging the benefits of the scale across the 12 cities
- identifying opportunities for philanthropic investors
- building stronger relationships between UK cities, investment community, supply chain and academic institutions

Activity 14.1 > Assess emerging financial products appropriate for different tenures

Support uptake of finance enabling products

The products presented in the adjacent table have been identified by the Green Finance Institute (GFI) as enablers of green finance. They should help to increase confidence, including confidence in lending, borrowing and payback, by guaranteeing performance, setting out coherent plans and providing certification. Boroughs can look to set up their own versions of these products or look to adopt and use emerging standards.

Guaranteed performance is crucial to finance models

Models such as Energiesprong are financed on future energy cost savings and rely on guaranteed performance for their financing model to work. Under the Energiesprong approach, when a building is retrofitted to Net Zero, the costs of the retrofit are paid back as a service fee with these additional payments being equal to or smaller than the energy bill savings, sometimes complemented by a fixed ‘comfort charge’. This approach is becoming increasingly popular. Products such as metered energy savings can support models like this that rely on energy cost saving to give confidence to investors.

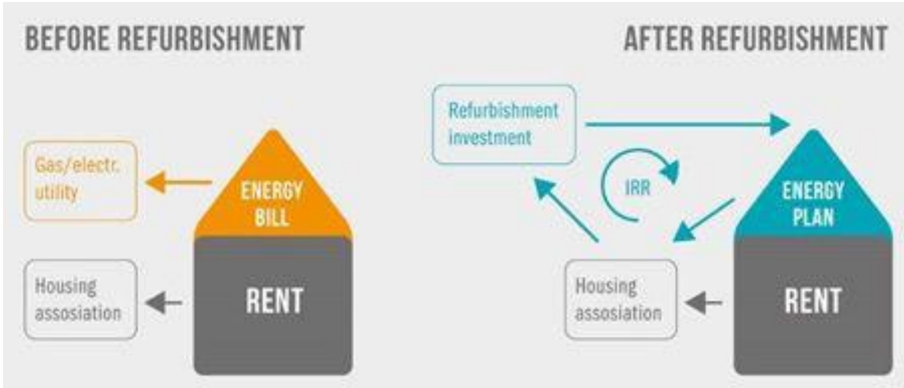
Emerging financial products can help mobilise capital

In their report ‘*Financing energy efficient buildings: the path to retrofit at scale*’ the Green Finance Institute have detailed a series of emerging financial products that be used to help mobilise capital, these are presented on the following page. As the owners of social housing, boroughs should assess if any of the products applicable to the social rented sector would be beneficial to them in funding retrofit for their own stock.

Boroughs should also review the role they can play in the uptake of products for owner occupiers and the private rented sector. For some, legislation and policy may need to be amended, and for others the council may be able to serve as third party facilitator.

Product	Description	SRS	OO	PRS
Metered energy savings	A standardised calculation methodology for energy savings from retrofit to provide confidence in payback.	✓	✓	✓
Building renovation passports	A tool providing information on what measures are possible and a long-term renovation plan for each building that can be achieved at a flexible pace	✓	✓	✓
Trustmark Platform / One Stop Shop	A platform to support customers through the retrofit journey: identifying measures, sources of funding and linking homeowners to a reputable supply chain.	✓	✓	✓
Residential Retrofit Principles	A recognised certification for financial products that support retrofit, to enhance the confidence of lenders and borrowers.	✓	✓	✓
Sustainable Housing Label	A certification scheme for green buildings and retrofit projects, spanning the full breadth of tenures, to stimulate demand and investment.	✓	✓	✓

A table of enabling products for green finance, in different stages of development. For more details see the GFI’s publication ‘Financing energy efficient buildings: the path to retrofit at scale’ (SRS=Social Rented Sector / OO=Owner Occupier / PRS=Private Rented Sector)



The Energiesprong Financing approach (Source: University of Strathclyde)

Type	Product	Description	SRS	OO	PRS	Maturity
Tenancy Agreements	Affordable Rent	Adjustment of the ‘affordable rent’ definition to include energy costs, to incentivise landlords to deliver properties where tenants can afford the combined cost of rent and energy bills.	✓			Requires lobbying
	Green leases and rental agreements	Enables social and private sector landlords to recover the cost of a retrofit through adjusted rent prices based on the predicted energy savings, addressing the landlord-tenant split incentive.			✓	Guidelines being developed by GFI
Third Party Investment or Services	PACE Financing (Property Assessed Clean Energy)	PACE financing enables homeowners to receive capital for retrofit from financial institutions. The liability is secured against the property not the owner and repaid through an additional property tax, collected by the local authority or a third party, typically over extended timescales that make repayments affordable.	✓	✓	✓	Gaining popularity aboard but not uptake yet in the UK
	Community Municipal Bonds	Utilises an investor crowdfunding approach to create a source of funding. They can provide a low cost and longer-term form of borrowing for local authorities.	✓			Gaining popularity
	Comfort as a service	Homes fitted with energy controls that support remote optimisation of the building performance could achieve significant energy savings that outweigh the cost of home energy optimisation paid to a third party.	✓	✓	✓	Needs more innovation
	Insurance backed comfort plans	The Energiesprong model offers guarantee of carbon savings and a household comfort for up to 30 years.	✓		✓	Commonly used on demonstrator projects around the UK
	MEES compliant funding	Private landlords pay a service charge to a guarantor who covers the capital investment required to retrofit the property should MEES regulations be tightened, providing landlords long-term security.			✓	Needs more innovation
	Long-term retail Investment	Retail investors provide capital for home improvements, receiving predictable returns from energy-efficient rental properties.	✓	✓	✓	Needs more innovation
Individual Lending and Savings	Green mortgages	Mortgages that offer preferential interest rates on borrowing for retrofit activities or to purchase energy efficient homes.		✓	✓	Increasing availability from banks
	Green Equity Release and Loans	Enable homeowners to unlock or borrow against the equity in their property for investment in retrofit.		✓	✓	No available examples
	Energy Saving ISA	Energy bill savings from retrofit can be directed towards an ISA or savings product, to help tenants build up their savings for a mortgage deposit.	✓		✓	No available examples
	Domestic energy efficiency salary sacrifice scheme	A salary sacrifice scheme that allows employees to draw a loan through their employer and is repaid through gross salary contributions.		✓		No available examples, ‘Ride to Work’ parallel
	Leaseholder financing	Provides an attractive financing offer to private leaseholders via social landlords to foster positive engagement and consent for multi-property retrofit.	✓			No available examples

A table of innovative and emerging green finance products (SRS=Social Rented Sector / OO=Owner Occupier / PRS=Private Rented Sector)

Action 14

Activity 14.2 > Analyse and develop options for seed funding to leverage future finance

Finance experts can advise how seed funding and demonstrator projects can catalyse future finance

Seed funding is an initial investment to inject money into a project in order to help stimulate growth. Usually, seed funding is used to see a project through to the next round of funding or into a position where the project generates its own income. The experience of the finance community can be invaluable in demonstrating how seed funding can provide the resource and development capital to kick start a retrofit programme, which can be recovered across the projects as they subsequently develop.

The GLA's Retrofit Accelerator: Homes is a key programme that many London boroughs are participating in to get the technical expertise they need to kick-start 'whole-house' retrofit projects. Social housing retrofit programmes are often used as demonstrators, acting as a catalyst for retrofit across the entire housing stock.

The GLA's Retrofit Accelerator for Homes

- Helps London boroughs and housing associations to develop energy efficiency projects at scale with technical and commercial solutions.
- Is targeting 1,600 whole-house retrofits in Greater London over the next three years across different boroughs,
- Aims to create a market for the low carbon and environmental goods and services sector, creating new and sustainable jobs.
- The £3.6m programme is funded on a 50:50 basis by the Mayor of London and the European Regional Development Fund (ERDF).
- The delivery partners, led by Turner & Townsend, include Energiesprong UK, PA Consulting and the Carbon Trust.

Action 14

Activity 14.3 > Collaborate with other boroughs on finance and funding

Collaborations allow boroughs to combine resources and expertise and achieve cost savings

Collaborations where boroughs agree to pool their resources and expertise for the purpose of a specific task can be beneficial to all involved. This may range from applications of public funding, to full regional retrofit delivery schemes. There is a growing consensus that the answer to retrofit delivery is through regional and local authority level strategies, with finance as a key pillar. Collaboration will also provide community wealth and increased awareness and demand for home retrofit.

By using economies of scale, the boroughs can also combine buying power to leverage a lower per-unit cost than they would separately. Other cost savings might include administration, labour or outreach.

An example of borough collaboration

The Borough of Barking and Dagenham led a successful bid for the Social Housing Decarbonisation Fund, in collaboration with the London Boroughs of Ealing, Enfield, Hammersmith & Fulham, Haringey and Lambeth. They were awarded £9.6 million to retrofit an estimated 230 homes in London. They will install external wall insulation and replace oil and gas heating with new air-source heat pumps, along with solar panels, to improve energy efficiency, reduce the carbon footprint and keep residents warm through the winter months. They will work with Energiesprong UK, and Turner & Townsend to deliver the programme.

Activity 15.1 > Consider developing innovative finance offerings to support blended funding

The majority of homeowners are not fully ‘able to pay’

Privately owned properties, including owner occupied and private rented homes, are the largest and most challenging portion of the housing stock to retrofit. Generally, there is a low level of awareness, a perceived ‘hassle factor’, and limited access to attractive finance.

Most past and present retrofit schemes can be split into two categories: the ‘able to pay’ and ‘fully funded’. In reality, the majority of the population lies somewhere between these two groups. Homeowners and private landlords will require a combination of public funding, private investment, and financial products to be able to commit to retrofit. The blend of these will be on a sliding scale, relative to the private investment homeowners can contribute.

Going beyond retrofit measures which pay back

Often, the economic case for retrofit is only attractive for some measures e.g. those that significantly improve energy efficiency or provide local energy generation, resulting in cheaper energy bills. A more thorough retrofit, including more substantial energy demand reduction efforts and low carbon heating, is critical to the decarbonisation of homes. However, the savings they elicit, do not return the same level of investment return. Homeowners will therefore need more backing and support to invest in the range of retrofit measures required to achieve EPC B and Net Zero.

Boroughs can provide different offerings for blended finance

Where possible and resources allow, London local authorities should provide direct capital for retrofits to support homeowners and private landlords. However, most of them are unlikely to be in a position to do this. In those cases, boroughs could offer financial support in the form of an emerging financial product that does not require upfront capital, for example, PACE financing (a loan from a financial institution that is secured against a property and is repaid through an additional property tax). Boroughs could collaborate with financial institutions offering PACE financing and offer their services as a tax collector to provide a financial product to homeowners in their borough.

Economic Groups	Able to Pay	Majority	Fully funded
Blending			
Funding	Savings	Loans and Emerging Financial Products	Grants
Benefits	Better Homes	Energy Savings	Social Impact

Figure illustrating how to majority of homeowner will require a blended of private and capital finance and the range of funding and benefits associated with different economic groups.

Hackney Green Homes

Hackney Council’s publicly owned energy company, Hackney Light and Power have recently launched their Green Homes programme, the first borough-wide programme in London to offer free thermal efficiency measures to privately-owned and rented homes, including cavity, loft and floor insulation. This will lower energy bills for thousands of residents and significantly reduce emissions produced by heating homes within the borough. They are also set to trial low carbon heating systems, such as hydrogen fuel-cell boilers and air-to-air heat pumps.

The Green Homes programme is aimed at people who privately own or privately rent their home no matter the level of income, with the aim to insulate as many homes as possible. Residents in the borough can also sign-up to access free energy saving advice.

Activity 15.2 > Support homeowners and landlords with funding applications and lending

Encourage uptake of public funding and lending

There is currently limited availability of government grant funding for the 'able to pay' market. The recent Green Homes Grant voucher scheme which provided vouchers covering up to two-thirds of the cost of chosen improvements, with a maximum government contribution of £5,000 for homeowners, has now been closed. However, if and when government provides public funding for this sector in the future, London local authorities should facilitate uptake from homeowners by providing details on the scheme and guidance on how to apply.

There are also many emerging financial products that can support homeowners is borrowing money, and London local authorities could inform their residents of these products. Green mortgages such as those provided by Ecology, Barclays and Nationwide offer preferential interest rates on borrowing for retrofit or to purchase energy efficient homes.

One stop shops can make it easier for homeowners

Emerging one stop shop models are aimed at removing a lot of the barriers to retrofit and bringing together compelling financial products. Some one stop shops provide design support and retrofit co-ordination, such as 'Cosy Homes Oxfordshire'.

Change homeowner's perception of investment

Home improvements that directly improve energy efficiency are not currently incentivised and there is often a missed opportunity for homeowners to improve the performance of their homes when they undertake home improvement works. Moving forward, it is hoped that a wider awareness of the benefits of energy efficiency will mean investment is reflected in the property value, therefore incentivising retrofit.

For many homeowners there is also an expectation that retrofitting their home to meet climate change targets should be cost neutral as energy cost savings will enable the initial investment to payback over time. We need to move away from this simplification and understand there may be a pay out, but it is an essential investment that comes with multiple benefits.

£26.6 billion

Current worth of the repair, maintenance and improvement (RMI) market

91,000

Applications for planning in London in 2019 for home improvements.

Source: Home Improvers of Great Britain 2019, BarbourABI

Why was the Green Deal unsuccessful?

- The UK's Green Deal was a government scheme that predated the Green Homes Grants voucher scheme, and was also deemed unsuccessful
- It was an example of a 'pay-as-you-save' scheme, where loans are taken out to pay for the energy efficiency measures and repaid in over a period of time from the energy bill savings.
- However, it had a 7-10% APR interest rate on the loan which was too high.
- It also came with no targets and did not help persuade householders that energy efficiency measures were worth paying for.
- It made many measures unaffordable with its 'Golden Rule' that the cost of works should not exceed the expected energy bill savings.

- Engaging with tenants and leaseholders
- Liaising with other social housing providers
- Increasing take up for owner occupied homes and the private rented sector
- A London-wide retrofit campaign
- Lobbying opportunities
- A dynamic and collective Action Plan

Summary of recommended actions in this area

The key recommended actions and activities in terms of engagement, take-up and lobbying are listed in the adjacent table.

Each action/activity is explained succinctly in the following pages.

The full list of actions and activities is provided in a separate spreadsheet which London Councils can develop and add to when this phase of the project has been completed.

16	**Social housing: engage with tenants, leaseholders and other registered providers**
	Activity 16.1 > London local authorities to develop an action plan for their own stock
	Activity 16.2 > Develop tools to communicate the benefits of retrofit with both tenants and leaseholders
	Activity 16.3 > Liaise with other registered social landlords (e.g. G15) to coordinate actions on retrofit
17	**Engage with owner occupiers and the Private Rented Sector**
	Activity 17.1 > Run a London-wide information campaign on retrofit
	Activity 17.2 > Private Rented Sector: provide incentives to pioneers
18	**Lobby central government for more support, guidance and funding**
19	**Develop, implement and review the Action Plan together**

Action 16

Activity 16.1 > London local authorities to develop an action plan for their own stock

The most promising sector for retrofit at scale

Social landlords tend to care about how much their residents spend on energy bills. In fact, it is very close to their core mission: providing access to housing so that it is sustainable financially for the residents and does not require an excessive proportion of their income.

Social landlords also generally have a longer view than homeowners who can decide to move house and sell their assets. They may also have better borrowing capabilities and/or access to funding (e.g. through the Social Housing Decarbonisation Fund).

Obviously social landlords also face many challenges, including the need to convince leaseholders. However, compared to the other sectors, social housing appears to be the most promising sector for retrofit at scale. It is therefore important for this sector to not only lead the way with demonstrator projects (a selection of which are shown on this page, more are being delivered through the Retrofit Accelerator programme) but to develop action plans specific to each borough but consistent with this Retrofit London Housing Action Plan. It is expected that local authorities will have similar key archetypes, which justifies further collaboration on whole house plan templates relevant to these archetypes.

We recommend that all London local authorities develop their own strategic Retrofit Housing Net Zero Action Plan to take retrofit forward. They should use this document as a starting point but should make it specific to their own stock, and collaborate/share it with the other London boroughs.

City of London

George Elliston House and Eric Wilkins House

Enfield

Walbrook House

Haringey

Broadwater Farm estate

Kensington & Chelsea

Lancaster West Estate

Greenwich

Plumstead Estate

Richmond & Wandsworth

Fitzhugh Estate

Different residents, different drivers

Many residents will already be concerned about climate change and want to understand how they can make changes to help. Communication with residents can tap into this desire to take action and further encourage retrofit.

However, some residents will be worried about what retrofit means for their current home, a place they may have spent time nurturing over many years. Retrofit can change the space and systems in a home. Being honest about what this means will be important, but also emphasise how these changes will benefit them through improvements in the comfort, health, and a possible reduction in ongoing costs. In particular, a clear outcome for any retrofit project should be to create better and healthier places to live. This positive message should be reflected in discussions with residents.

Depending on the measures needed, there may also be concerns around disruption, and following the Grenfell tower tragedy some residents will justifiably be nervous about the safety and the quality of the retrofit project. Engaging residents on the details of what will be included in the works and the associated quality assurance process can help reassure residents.

The situation will differ for all residents, so strategies should be developed afresh rather than using a 'one-size fits all' system.

Guidance from industry

A useful summary of how residents may like to hear about improving the energy performance of their homes has been published by TPAS and Placeshapers earlier this year (2021) in a report titled 'Residents' voices in the UK's Net Zero Carbon journey'. The project worked with focus groups, including over 100 residents as well as sustainability experts.

The resultant report makes a series of recommendations, based on the feedback received, on the best way social landlords can engage with residents.

PLACESHAPERS & TPAS

Residents' voices in the UK's Net Zero Carbon journey

Why how we talk about green homes and places really matters

Author - James Bryson

Recommendations

1. **The social housing sector should work collaboratively to develop clear communications advice for landlords. This should include:**
   - Developing tried and trusted messaging that landlords can use. Our groups provided a number of very useful insights into how best to communicate with residents on why upgrading their heating system is beneficial: saving money, providing 'healthy homes', helping reduce climate change. But there isn't a clear, tested message that social landlords can use. The social housing sector should fund further communications research with a representative cross section of residents from across the country to test key messages and phrases which can help residents to understand the benefits of new heating systems to them and how they help meet the net-zero carbon target.
   - Developing a bank of case study examples of people who have had positive experiences of retrofit and who are saving money on bills by living in low carbon homes.
   - Drafting a high-level road-map which individual associations can adapt and use which shows how the sector will meet the 2050 target.
   - Recruiting resident ambassadors who can talk honestly about the pros and cons of the new technology to other residents and communities.
   - Engaging with local authority leaders and bodies such as the Local Government Association to develop plans for cohesive local sustainability strategies with associated communications plans.
2. **The Government must start now to deliver information and awareness campaigns that provide the context for social landlords' work. Work delivered by the social housing sector is vital, but it must be supported by wider communications from all stakeholders including government. It will be far harder to engage residents with the retrofits needed in their homes unless they can see how it fits into the roadmap to the nation's net-zero carbon target.**

   The UN Climate Change Conference to be held in Glasgow later this year is an ideal opportunity to launch this campaign and demonstrate how we can decarbonise housing across the country.
3. **There are a number of practical, immediate steps social landlords can consider now:**
   - Demonstrate commitment to the net-zero agenda through their wider business strategy by investing in more green space, sustainable vehicle fleets and creating low-carbon office space.
   - Where possible social landlords should aim for whole house retrofits. Residents showed a clear desire for a co-ordinated whole house approach. This will ensure the home is energy efficient and comfortable. Residents who are completely satisfied in their low carbon home will be more likely to recommend the process to neighbours and friends. Some retrofit measures, such as insulation, are popular and sought after by most residents. Combining retrofit methods that are popular with lesser known technology, such as air source heat pumps, can generate goodwill and create demand from residents.
   - Dedicated and trained customer liaison officers should be appointed to co-ordinate engagement campaigns and managing retrofits. An individual who acts as a point of contact for residents from the start to end of the project will provide reassurance for residents.
   - Internal training and communications campaigns are crucial. Residents will want as much information as possible regarding their homes, mixed messages or lack of knowledge can undermine resident engagement. Promoting and explaining the benefits of low carbon housing should be done whenever possible, carbon literate staff means engagement can happen organically during home visits and everyday repairs.

Extract from TPAS and Placeshapers report on residents' voices. This resource is available from the Placeshapers website.

Recognising different priorities

The feedback from London local authorities during the development of this Action Plan was very clear: it is very important to draw a distinction between tenants and leaseholders and recognise that retrofitting properties will impact on them in different ways. Tenants, who will not generally carry the cost of retrofit will likely be more worried about the disruption and changes in space whereas a primary focus for leaseholders will the cost of any change.

Communication strategies are a crucial initial step to correct misunderstandings and widen support for retrofit projects. These strategies will need to reflect the priorities for the targeted stakeholder.

By taking to time to talk with residents at the start of the project, a priority list can then be developed to help communicate with residents in a way that reflects their feelings.

Tenant	Leaseholder
Space changes	Cost
Disruption	Disruption
Safety	Health and wellbeing
Health and wellbeing	Space changes
Cost	Safety

Example hierarchy of priorities - think about how the needs of different residents are to be addressed in the communication strategy on retrofit measures.

Allowing time for engagement

The economics of mass retrofit can be heavily impacted by project scale. We should be aiming to retrofit streets of homes at the same time rather than on a house-by-house basis.

Project programmes should therefore allow substantial time for engaging all residents – this may require the initial stages of project programme to be extended by up 10%-20%.

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The above external wall insulation and window improvement scheme by Hounslow Council has helped making these homes much more efficient and comfortable. In the future, these schemes should ideally be offered and extended to interested leaseholders, which will take time in terms of communication at the outset of the project.

Activity 16.3 > Liaise with other registered social landlords to coordinate actions on retrofit

Councils and Registered Providers share similar challenges

Although there are significant differences between London local authorities and registered providers both in terms of their approach to stock management and their underlying economic model, there is a wide range of actions and activities which will need to be undertaken by both of these groups. Although these could happen in parallel, there is every reason to seek to build bridges between the two programmes.

Create a Retrofit London social housing working group

The adjacent table provides examples of Action Plan activities which represent clear collaboration opportunities between London local authorities and registered providers. They include:

- Technical collaboration on simplifying the retrofit challenge by comparing council and registered providers' social housing stock, identifying common archetypes and sharing whole house retrofit plan templates.
- Procurement collaboration, building on some existing shared procurement models (e.g. LHC) and aggregating demand for the social housing stock in the respective boroughs or in London as a whole.
- Cost and finance collaboration, sharing cost estimate, ideas for cost optimisation and analysis of suitable emerging finance products, including investment from institutional investors.
- Communication collaboration, enabling the development of better engagement tools and material around the benefit and necessity of retrofit.

We recommend that London Councils make the most of these collaboration possibilities by creating a Retrofit London social housing working group, open to interested registered providers as well.

6	Map out each building's journey towards lower energy costs and Net Zero
	Activity 6.1 > Develop whole house retrofit plan templates for key building archetypes
8	Facilitate procurement of materials and services at a larger scale
	Activity 8.3 > Develop area-based strategies to enable bulk procurement and delivery
12	Establish cost of retrofit, business case and funding gap for the different tenures
	Activity 12.1 > Analyse outline cost of retrofit for whole housing stock
14	Create a 'Finance for retrofit' taskforce with finance experts
	Activity 14.1 > Assess emerging financial products appropriate for different tenures
16	Social housing: engage with tenants, leaseholders and other registered providers
	Activity 16.1 > Develop tools to communicate with both tenants and leaseholders

Sample of activities from the Action Plan representing opportunities of collaboration between London local authorities and Registered Providers operating in London

The G15 is made up of London's largest housing associations. Together, they build a quarter of all London's new homes and own or manage more than 600,000 homes.

Action 17

Engage with owner occupiers and the Private Rented Sector

London local authorities will naturally engage with tenants living in their own building stock, as well as leaseholders, and can collaborate with registered providers to engage with social housing residents. In order to deliver their climate change objectives they must also do what they can to facilitate retrofit in the owner occupier and private rented sectors, and this includes significant additional efforts to communicate to a wider group of residents.

Analogy with communication on recycling

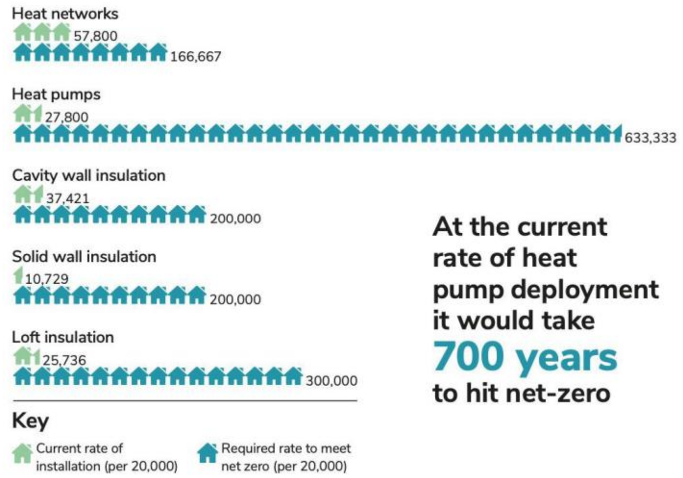
An analogy could be established with the efforts undertaken by local authorities over the last 20 years to encourage recycling. Similarly to that challenge, it is obvious that engaging only with social housing tenants and leaseholders would be insufficient. If insulation and heat pump installation rates are to increase to the level required, engaging with all Londoners about the need and benefits of retrofit, as well as the support available, will be key.

Informing all owner occupiers and helping the pioneers

The appetite for retrofit among homeowners is variable and depends on many factors including financial and sociologic considerations but also building related constraints. It would be beneficial to both raise awareness of the need and solution for retrofit and also support those home owners who do not need convincing but require other types of support.

PRS is a very challenging but important sector

The private rented stock is generally in a poorer state, tenants are often on lower incomes and are more likely to be from Black, Asian or Ethnic Minority groups. 18% of London's PRS households are in fuel poverty, compared with 10% of London households overall (2018 ONS). It is therefore important not to ignore this sector but to acknowledge its challenges - particularly its fragmentation and the lack of incentives for landlords. It is more likely to be a sector which 'follows' the examples set by the social housing and the owner occupier sectors.



Average annual number of installations across low carbon heating technologies compared to the number required to meet Net Zero by 2050 in the housing sector (Source: The pathway to net zero heating in the UK, UK Energy Research Centre, 2020)

Exemplar programmes such as Cosy homes Oxfordshire seek to support motivated homeowners and help then with the retrofit process.

Activity 17.1 > Run a London-wide information campaign on retrofit

Raise awareness

Every year 1.7 million boilers are replaced in the UK: this is a key intervention point at which private homeowners can decarbonise their homes, before investing in another gas boiler for the next 15-20 years. Many homeowners are unaware of options for low carbon heat though and, beyond heating, of which retrofit measures would suit their homes.

Engagement with residents should also focus on the "why?" and enable people to see how their choices impact the bigger picture, whilst recognising that even homeowners are a very broad group. Tackling the "why?" and trying to motivate residents 'en masse' is best dealt with by a large-scale, London-wide information campaign.

The collaboration between London local authorities for this is a significant opportunity, and reaching out to social housing providers and other resident associations to guarantee a unifying message that hits home with residents and does not publish confusing or misaligned information would also be very beneficial. Furthermore, lessons learned from previous campaigns can ensure that messages are chosen that truly reflect the needs of residents. One example of this is to focus on improvements in the quality of homes instead of on fuel bill reductions.

Shed light on the unknowns

Retrofitting our homes is a huge step into the unknown for most residents. A separate campaign should be aimed at informing the wider public about what is involved and the ways in which it can be achieved.

Amplifying resident voices

Perhaps the most effective way to communicate improvements from retrofitting homes is through the voices of residents themselves. Boroughs should work together to bring the positive messages of previous retrofit projects forward in public campaign, showing others what retrofit changes people's home and quality of life for the better.

People Powered Retrofit is a householder-led approach to domestic energy efficiency retrofit in Greater Manchester. It is a partnership led by Carbon Co-op and URBED with funding from the Department of Business Energy and Industrial Strategy (BEIS).

Action 17

Activity 17.2 > Private Rented Sector: provide incentives to pioneers

Regulations may help, but are not enough

Government recently consulted on requiring private rented homes to achieve an EPC of C by 2030. This would obviously help but the target is not ambitious enough and exemptions may leave a large part of the PRS stock not even meeting it. Further action by the London local authorities is therefore required to provide incentives to private landlords to retrofit their buildings in line with the recommendations of this Action Plan.

Licensing schemes and the Landlord accreditation scheme

Some local authorities in London operate a selective licensing scheme, which applies to all privately rented properties and the GLA operates the London Landlord Accreditation Scheme. It is possible to use them to encourage landlords to put in place whole house retrofit plans consistent with this Action Plan, for example through a reduction in the licensing fee.

Communicate with tenants

Produce advice for tenants on their rights, their options, and how to select energy efficient properties (e.g. via the 'advice for renters' GLA webpage).

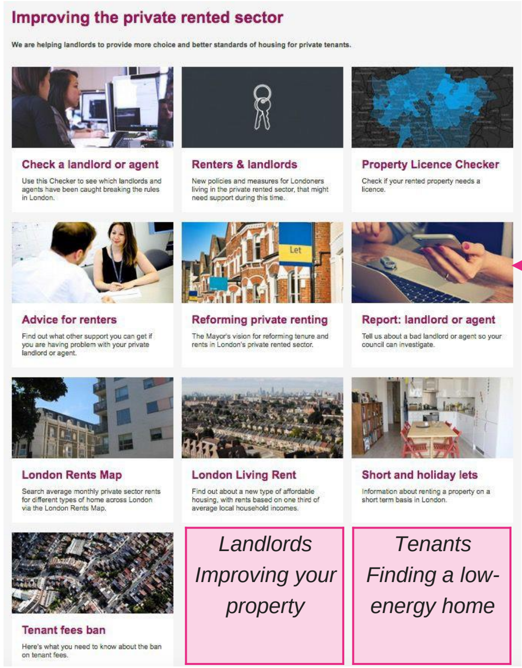
Create an energy use disclosure: Households could submit data on a voluntary, anonymised basis. This would help them become more aware of energy use and the industry to gather much needed data.

Work with utility companies

Utility companies hold a lot of useful data and could play a more active role in identifying and helping the fuel poor.

Work with Environmental Health Officers (EHOs)

EHOs are generally responsible for helping to enforce minimum standards. Minimum Energy Efficiency Standards (MEES) and retrofit requirements could gradually become part of their responsibilities, particularly for properties where interventions are needed to address excess winter cold or mould.



Tenants should not be put at risk of eviction for requesting energy improvements. Not carrying out regulatory energy efficiency standards should put landlords at risk of being on the "rogue landlords" register.

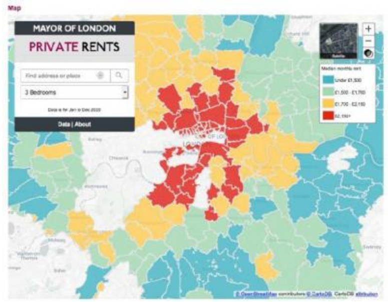
The Boroughs could also work with the London Landlord accreditation scheme to make energy efficiency an accreditation criterion.

Targeted PRS action could include advice to tenants and landlords. It should also be coordinated with protections for tenants and the overall PRS strategy.

Snapshot from GLA PRS information page: PRS retrofit action should be coordinated between Boroughs and with the GLA, and build on the current overall PRS strategy.

Provide energy efficiency indicator as additional search option?

e.g. average energy use, average fuel bills, EPC rating, carbon emissions?



The London rent map (hosted by the GLA) could potentially allow searches not only by number of bedrooms, but by energy efficiency indicator. This could help stimulate demand, but also provide a more comprehensive indication to tenants of overall monthly running costs of properties.

Action 18 Lobby central government for more guidance, funding and support

The need to retrofit the vast majority of London homes happens at a time of unprecedented pressure on local authorities in terms of budget and resources. Although London local authorities acknowledge the central role they will have to play over the next decades, it is absolutely crucial that central government help them. We recommend that the 33 London local authorities and the GLA articulate a number of key demands.

More legal requirements

It is obvious that legally requiring some retrofit measures (e.g. replacement of a gas boiler with a low carbon heat alternative) would massively simplify the challenge for local authorities, even for their own stock. In the absence of legal requirements the onus will be on them to justify and persuade, making the transition to Net Zero much slower.

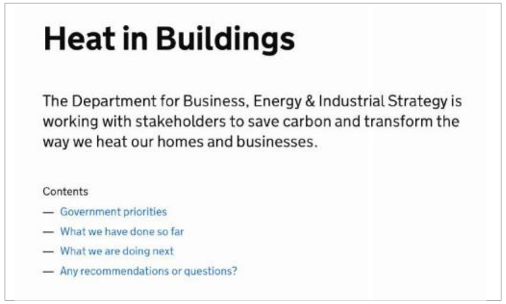
For the private rented sector, providing long-term clarity on the trajectory for Minimum Energy Efficiency Standards (MEES) to inform landlords and guarantors would be very beneficial, and this should reflect much needed reforms to SAP and EPCs.

More and better designed funding for all tenures

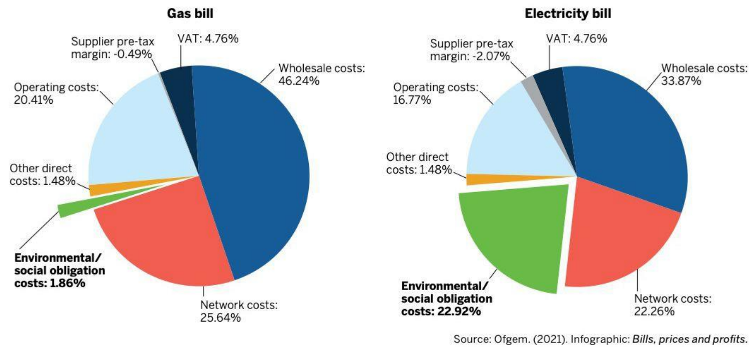
Most government support schemes for retrofit have generally failed due to the poor design and spending timescales, with disastrous consequences. This should stop and the Government should engage with local authorities to design better and more sustainable funding schemes. VAT reform for retrofit would also be very helpful as VAT currently effectively increases the cost of low carbon retrofit by as much as 20%.

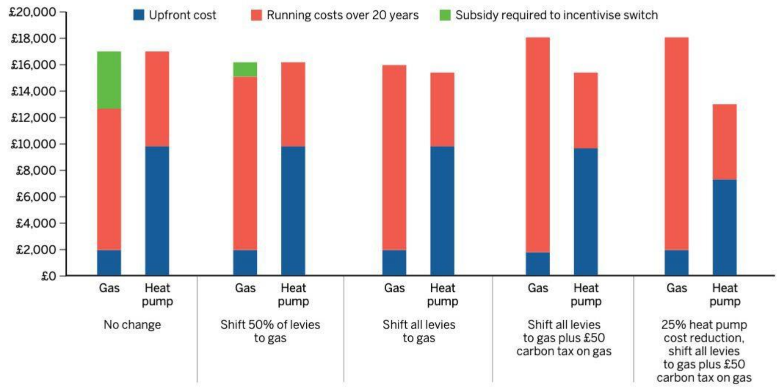
A new approach to electricity prices

The adjacent pie chart shows that environmental and social obligation costs are currently being levied much more significantly on electricity than gas. 23% of the cost of electricity is made up of environmental and social obligation costs compared to only 2% of the cost of gas. Re-adjusting this balance, combined with the roll out of smart meters, would significantly help, making the transition to low carbon heat much easier.



BEIS are currently developing a UK heat strategy which is due to be released by 2021. It has the potential to help accelerate the transition away from fossil fuels





Breakdown of average gas and electricity bill (pie chart)

Total cost of ownership with time-of-use electricity prices (bar chart)

(source: Getting on track to Net Zero, a policy package for a heat pump mass market in the UK, RAP and E3G, 2021)

Action 19 Develop, implement and review the Action Plan together

Sharing knowledge on current initiatives

The climate emergency declarations of many London councils have triggered an assessment of their current housing stock carbon pathway to 2050, and a review of what may be required of the housing stock in general.

The relative failure of national retrofit schemes in the past few years has also led many London councils to realise that the local and regional scale is the most appropriate scale to define and deliver the low carbon retrofits which need to happen over the next 20-30 years. The adjacent diagram summarises the initiatives under way across London. It is crucial that knowledge and findings are shared in the next few months and years.

Develop future activities together

This Action Plan provides a starting point for a coordinated effort on retrofit across all 33 London local authorities, and it should be seen as a dynamic plan. New initiatives on low carbon retrofit being taken forward in the different boroughs across all tenures should also be signposted. There is currently a particular gap in activity related to London's private housing stock (homeowners and PRS).

The role of the Greater London Authority

Although London local authorities are likely to be 'on the front line' of housing retrofit, there is a significant potential for the GLA to accelerate change by:

- Coordinating efforts on infrastructure related works (e.g. solar PVs, electrical grid and smarter London)
- Reducing planning barriers to retrofit
- Providing guidance
- Helping to fund pioneering schemes

- Houses: Brent, Enfield, Lewisham, Newham, Sutton, Richmond & Wandsworth, Waltham Forest
- Blocks of flats: City of London, Enfield, Greenwich, Hackney, Haringey, Kensington & Chelsea, Redbridge, Richmond & Wandsworth, Sutton

- Air source heat pumps: City of London, Westminster
- Ground source heat pumps: Barnet, Enfield, Greenwich, Westminster, Richmond & Wandsworth
- Water source heat pumps: Greenwich
- Waste heat: Camden (hospital), Haringey (Energy from Waste)
- Heat network decarbonisation: LBTH

- Solar PVs: GLA, Tower Hamlets, Waltham Forest
- Demand management/Smart energy system: GLA, Greenwich

Delivery mechanisms, skills and supply chain

- Stock analysis: Camden, City of London, Enfield, Hackney, Havering, Tower Hamlets, Sutton, Westminster
- Skills: Camden's stakeholder engagement event
- Energiesprong: Enfield, Haringey, Sutton
- Window manufacturing: Newham

Costs/funding

- Cost assessment: Enfield, Tower Hamlets, Haringey, Westminster
- Green Homes Grant: Camden, Enfield, Haringey, Lewisham, Redbridge, Waltham Forest, Richmond & Wandsworth
- Funding associated with fuel poverty: GLA. Waltham Forest

- Engagement with residents / Communication: Greenwich, Haringey, Waltham Forest

Making decisive steps forward

In summary, the key recommended actions of this Retrofit London Housing Action Plan are listed in the adjacent table, split by category.

1	Improve the building fabric of London’s inefficient homes
2	Develop a plan for retrofitting ventilation systems to improve health and air quality
3	Electrify heat
4	Deliver smart meters and demand flexibility (controls, storage) in retrofitted homes
5	Increase solar energy generation on London homes
6	Map out each building’s journey towards lower energy costs and Net Zero
7	Review current maintenance programmes and identify retrofit opportunities
8	Facilitate procurement of materials and services at a larger scale
9	Enable planning to facilitate low carbon retrofit, including in Conservation Areas
10	Develop retrofit skills actively across London
11	Set up a clear and consistent system to report and monitor progress (and success)
12	Establish the cost of retrofit, business case and funding gap for the different tenures
13	Maximise capital finance for council owned stock (and eligible homes)
14	Create a ‘Finance for retrofit’ taskforce with finance experts
15	Support the owner occupier and PRS sectors to leverage private investment
16	Social housing: engage with tenants, leaseholders and other registered providers
17	Engage with owner occupiers and the Private Rented Sector
18	Lobby Central Government for more support, guidance and funding
19	Develop and implement the Action Plan together

Excellent work on retrofit has already been done across London by local authorities, the GLA and building professionals. We now need to build on it and accelerate action in order to retrofit London's homes. London local authorities will need help to meet this challenge but they acknowledge the central role they will have to play in the years to come.

The opportunities for London boroughs to collaborate together, with the GLA, and with the construction industry and wider society are very significant. This Action Plan outlines a wide range of recommended actions and activities for this to happen. It would deliver significant potential benefits for London and Londoners in terms of climate change, health, equality and jobs for the future.

The lead boroughs of Enfield and Waltham Forest will now develop the associated Implementation Plan.

2030 is only 9 years away – we must all work together now.

RAFT
RETROFIT ACTION FOR TOMORROW

ELEMENTA

Etude

LONDON COUNCILS

CATEGORY	MOST FREQUENTLY RECOMMENDED MEASURES	NOTES
1A Terraces solid brick	• Solid wall insulation (more EWI than IWI) • Window upgrades • Individual heat pumps • Roof PV	EWI may be hampered by physical features such bay windows or by desire to maintain streetscape.
1B Terraces solid brick in conservation areas	• Solid wall insulation (more EWI than IWI) • Window upgrades • Individual heat pumps	CA restrictions likely to limit EWI (except of rear elevations and gable walls) and PVs. Heat pumps may also be hampered by planning sensitivities. Window upgrades may include secondary glazing.
2A Non-terraces solid brick	• Solid wall insulation (more EWI than IWI) • Window upgrades • Individual heat pumps • Roof PV	EWI may be hampered by physical features such bay windows or by desire to maintain streetscape.
2B Non-terraces solid brick in conservation areas	• Solid wall insulation (more IWI than EWI) • Window upgrades • Individual heat pumps	CA restrictions likely to limit EWI (except of rear elevations and gable walls) and PVs. Heat pumps may also be hampered by planning sensitivities. Window upgrades may include secondary glazing.
3A Mansion blocks / converted street properties.	• Solid wall insulation (more EWI than IWI) • Window upgrades • Individual or communal heat pumps • Vertical PV	EWI and vertical PVs may be hampered by physical characteristics and the need to to the entire block despite likely multiple ownership. Individual heat pumps may sometimes be hard to install for mid level flats.
3B Mansion blocks / converted street properties in conservation areas	• Solid wall insulation (more IWI than EWI) • Window upgrades • Individual heat pumps	EWI likely to be rarely possible.
4 Homogenous housing estates (solid or cavity or system)	• EWI and CWI • Window upgrades • Individual or communal heat pumps • Roof PV	Likely that this group may break down into more archetypes with specific challenges.
5 Suburban cavity semis/detached with gas boilers	• CWI • Window upgrades • Individual heat pumps • Roof PV	Careful detailing between windows and CWI important as possible cold bridge.
6 1950s to 1975 system/cavity built blocks not communal heating	• CWI and EWI • Window upgrades • Heat pump or direct electric • Vertical PV	Individual heat pumps may sometimes be hard to install for mid level flats
7 1950s to 1975 system/cavity built blocks with communal heating	• Community heat pump • Vertical PV • CWI	Low carbon community heating may be the most important measure for this type. Need to ensure that the heating system has capacity to adequately heat all flats. Some supporting fabric measures may be required.
8 1983s to 2002 mid-rise flats with electric heating	• Individual • Heat pumps or direct electric with some fabric measures to support	Locating heat pumps may be challenging
9 1983s to 2002 mid-rise flats with gas heating	• Individual or communal heat pumps • Vertical PV	Locating heat pumps may be challenging
10 Houses built after 2007 (no fabric needed)	• Individual heat pump • Roof PV	Assumption that no fabric measures needed should be tested as there may be a performance gap between RdSAP heating estimate and actual
11 Flats built after 2007 (no fabric needed)	• Individual or communal heat pumps • PV	Assumption that no fabric measures needed should be tested as there may be a performance gap between RdSAP heating estimate and actual

1-6 relay on multiple measures requiring higher degree of coordination. 7-11 relay more on tech and less on fabric, but actual existing performance should be verified. Categories 1-3 rely on SWI. The modelling relies heavily on EWI outside conservation areas and in IWI within. Its likely that a more mixed approach will be required. Categories 1-4 are likely to require the most coordination and these archetypes may therefore require especially highly resolved whole house plans https://www.rpsgroup.com/insights/consulting-uki/delivering-net-zero-carbon-in-social-housing-will-it-happen-in-time-and-at-what-cost/

DELIVERING NET ZERO CARBON IN SOCIAL HOUSING: WILL IT HAPPEN IN TIME, AND AT WHAT COST?

Chris Lavery, Director of Programme Management, discusses the barriers Housing Associations are facing and his recommendations for tackling the decarbonisation challenge ahead.

5 MINUTE READ

CHRIS LAVERY, DIRECTOR OF PROGRAMME MANAGEMENT

The social housing sector is facing a monumental challenge. The clock is ticking, not only to meet net zero carbon by 2050, but also to achieve a C rating on Energy Performance Certificates (EPC) across all homes by 2030. The volume, type, age and current efficiency of the UK's social housing stock means an enormous retrofit operation will be required to meet these targets. But if this wasn't challenging enough, these targets sit against a landscape of tightening fire safety regulation and cladding retrofit in the wake of the Grenfell tragedy; whilst the housing crisis means the foot needs to stay firmly on the pedal in the delivery of new affordable homes.

What needs to be made clear is housing associations shouldn't be retrofitting for retrofitting sake. A fabric first approach, such as looking at the insulation of the building, should be implemented as a priority over technology, which is moving at a rapid rate.

The pressure is certainly on. Yet uncertainty remains over how this will be delivered. Questions can be raised over the lack of a Government roadmap to set out expectations, clarity over funding, as well as no sector-wide definition of net zero in social housing. All would be a huge benefit for shared learning and a more developed supply chain.

But what's for sure is the role that Housing Associations must play if the UK is to meet its legally binding climate change target.

Currently, housing accounts for around a fifth of all greenhouse gas emissions in the UK. This is largely from the oil and gas used for heating and hot water, with around 10% of these emissions coming from the social housing sector.

We explore the challenges and barriers they face and how these can be tackled to help the sector achieve net zero carbon before time runs out.

The cost of net zero carbon

Based on the average decarbonisation cost per property – provided by 207 social landlords across the UK – Inside Housing has estimated that it will cost £104bn to retrofit all social housing in the UK to zero carbon standards. With responses ranging significantly from less than £3,000 to £70,000 per home, the average cost of decarbonisation per social home came out at £20,742.
But even this somewhat eye watering estimation could still at best be a 'finger in the air' assessment, dependant on how comprehensive the retrofit planning and cost-modelling exercise of each association. The varied factors, such as age and arrangement of stock, and the type of homes – for example, whether high rise, terraced, or have solid walls, all make a reliable estimate particularly challenging.

The Government has promised a £3.8bn Social Housing Decarbonisation Fund (SHDF) over the next 10 years, with £60m pledged for 2020/21, £240m in 2022/23 and £410m in 2023/24. And in the November spending review, £60m was confirmed to retrofit social housing. But many in the sector have raised continuous concern over both the level of funding and the time frame for allocation. The question remains over where the shortfall will come from.

Problems in place

Housing associations currently own and manage around 2.7 million homes across England. To achieve an EPC C rating by 2030, and become carbon neutral by 2050, significant barriers exist which currently limit the ability of housing associations to retrofit at scale and pace.

Cost is of course a huge concern. But organisational priorities, policy uncertainty, and the lack of capacity and capability in supply chains being able to deliver key retrofitting plans at scale and pace, are just a number of other issues at hand.

Additionally, a huge obstruction is the lack of fundamental data housing associations know about their property stock. Data hasn't been a priority, and with the numerous mergers that have taken place in the housing market, this has further added to the lack of details and clarity. Once housing associations obtain this information, they can build it into their programme management and bring on the specialised teams to design and plan the optimum investment strategy going forward.

How to tackle the challenge

The key will be identifying archetypes, collecting comprehensive data, building accurate data models, and providing retrofit options that deliver maximum benefits for the least expenditure.

But is it as simple to do as just that? Through our experience gained by working with Housing Associations across the UK, we're sharing our recommendations to help make complex easy.

Our recommendations for success

Funding – The £50m Social Housing Demonstrator Fund is aimed at the best approach to upgrading the energy efficiency of social housing, with a further £60m being rolled out for the next stage of the project in 2021/22. The Department for Business, Energy and International Strategy (BEIS) have written to 16,000 housing associations and 352 local authorities to make them aware of other funding that is available. Along with the National Housing Federation (NHF), both will play a crucial part in advising clients how to best access Government funds.

Technology – innovative solutions are being developed on a daily basis, and there are many options available for retrofitting existing properties – but they will come at a cost. Housing associations should be looking into ground source heat pumps and solar PV, whilst carrying out in-depth feasibility studies, and supporting this with funding opportunities. However, installing these creates an ongoing lifecycle to maintain them, which will need qualified people with the correct credentials to manage it. Customers also need to understand the new technologies and how they operate thus education and information programmes need to be rolled out in conjunction with the technology

Green procurement – a great starting point for any decarbonisation strategy. Using our extensive market analysis, our Procurement for Housing Framework includes the option to bring in renewable elements. This doesn't necessarily mean the cost increases; but what it does mean is us ensuring we get the best possible price for your energy contracts.

Stakeholder engagement - we recommend carrying out a detailed analysis of the stakeholder landscape, including prioritising stakeholders based on their interest and influence in the specific housing projects. By creating a dashboard to provide a snapshot of the status of key stakeholders, this would enable us to prioritise our engagement strategy and adapt it to address issues as they arise. The ability for Housing Associations to form networks or leverage existing networks will be important initially to develop clear strategies around funding and develop carbon modelling approaches including technical specifications as well as building supply chain, and strength in depth in the marketplace.

Efficient planning for the future

The scale of this challenge is immense as it is not just applicable to the housing sector. There is retrofit work already underway across the country to improve the energy efficiency of homes, particularly those with low EPC ratings and homes occupied by poor fuel households.

However, it’s vital that social landlords start developing decarbonisation cost estimates against their housing stock. This needs to be based on a carbon model that identifies what impact retrofit options can have for each property and at what cost. Not only that, but long-term plans should be made for each of their homes, allowing them to choose cost-effective times to upgrade.

And yet despite leading the way so far, social housing will need to continue to reduce energy demand and lower emissions over the coming years. Reducing the energy bills of those living in social housing through these improvements will have the additional benefit of reducing their risk of living in fuel poverty.

We are now seeing the government come forward with new investment and more detail around their net zero plans, which is very welcome. But sustainable funding and policy clarity are still very much needed.

UK housing: Fit for the future?

Committee on Climate Change
February 2019

Acknowledgements

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Contents

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Lord Deben was the UK's longest-serving Secretary of State for the Environment (1993 to 1997). He has held several other high-level ministerial posts, including Secretary of State for Agriculture, Fisheries and Food (1989 to 1993). He has consistently championed the strong links between environmental concerns and business interests. Lord Deben also runs Sancroft, a corporate responsibility consultancy working with blue-chip companies around the world on environmental, social and ethical issues. He is Chairman of Valpak Limited and the Personal Investment Management and Financial Advice Association.

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Executive summary

Key messages

UK homes are not fit for the future. Greenhouse gas emission reductions from UK housing have stalled, and efforts to adapt the housing stock for higher temperatures, flooding and water scarcity are falling far behind the increase in risk from the changing climate. The quality, design and use of homes across the UK must be improved now to address the challenges of climate change. Doing so will also improve health, wellbeing and comfort, including for vulnerable groups such as the elderly and those living with chronic illnesses. This report identifies five priorities for government action:

1. Performance and compliance. The way new homes are built and existing homes retrofitted often falls short of design standards. This is unacceptable. In the long run, consumers pay a heavy price for poor-quality build and retrofit. Greater levels of inspection and stricter enforcement of building standards are required, alongside stiffer penalties for non-compliance. The 'as-built' performance of homes, for example how thermally efficient they are, must also be better monitored. Closing the energy use performance gap in new homes (the difference between how they are designed and how they actually perform) could save between £70 and £260 in energy bills per household per year.

2. Skills gap. The chopping and changing of UK Government policy has inhibited skills development in housing design, construction and in the installation of new measures. Key steps for the UK in reducing emissions, like the wider deployment of heat pumps, require new skills. The UK Government should use initiatives under the Construction Sector Deal to tackle this low-carbon skills gap. New support to train designers, builders and installers is needed for low-carbon heating, energy and water efficiency, ventilation and thermal comfort, and property-level flood resilience.

3. Retrofitting existing homes. The 29 million existing homes across the UK must be made low-carbon, low-energy and resilient to a changing climate. This is a UK infrastructure priority and should be supported as such by HM Treasury. Homes should use low-carbon sources of heating such as heat pumps and heat networks. The uptake of energy efficiency measures such as loft and wall insulation must be increased. At the same time, upgrades or repairs to homes should include increasing the uptake of: passive cooling measures (shading and ventilation); measures to reduce indoor moisture; improved air quality and water efficiency; and, in homes at risk of flooding, the installation of property-level flood protection.

4. Building new homes. There are plans for 1.5 million new UK homes by 2022. These new homes must be built to be low-carbon, energy and water efficient and climate resilient. The costs of building to a specification that achieves the aims set out in this report are not prohibitive, and getting design right from the outset is vastly cheaper than forcing retrofit later. From 2025 at the latest, no new homes should be connected to the gas grid. They should instead be heated through low carbon sources, have ultra-high levels of energy efficiency alongside appropriate ventilation and, where possible, be timber-framed. A statutory requirement for reducing overheating risks in new builds is needed, alongside more ambitious water efficiency standards, property-level flood protection in flood risk areas, and increasing requirements for greenspace and sustainable transport in planning and guidance.

5. Finance and funding. There are urgent funding needs which must be addressed now with the support of HM Treasury: low-carbon heating (currently only funded up to 2021), and resources for local authorities, in particular building control. The UK Government must implement the Green Finance Taskforce recommendations around green mortgages, green loans and fiscal incentives to help finance upfront costs, as well as improving consumer access to data and advice. It should widen the scope of these measures to include resilience.

Householders can also make a big difference with small changes. Even before these actions can be delivered by Government, many householders can make changes immediately to lower their utility bills and improve their homes, for example setting boilers to the correct temperature, installing shading, and increasing insulation.

Committee on Climate Change

Homes of the future are needed today

Decarbonising and adapting the UK's housing stock is critical for meeting legally-binding emissions targets by 2050 and preparing for the impacts of climate change. The UK Government, householders and developers need to implement policies and measures now that ensure new and existing homes are fit for the future.

What does a low-carbon, sustainable home look like?

Current technology, and measures aimed at preparing for the impacts of climate change, can help new and existing homes to become low-carbon and ultra-efficient as well as adapted to flooding, heat and water scarcity.

Existing homes

Improving existing homes can help existing house-holders meet the challenges of climate change

1. **Insulation**
in lofts and walls (cavity and solid)
2. **Double or triple glazing with shading**
(e.g. tinted window film, blinds, curtains and trees outside)
3. **Low-carbon heating**
with heat pumps or connections to district heat networks
4. **Draught proofing**
of floors, windows and doors
5. **Highly energy-efficient appliances**
(e.g. A++ and A+++ rating)
6. **Highly water-efficient devices**
with low-flow showers and taps, insulated tanks and hot water thermostats
7. **Green space (e.g. gardens and trees)**
to help reduce the risks and impacts of flooding and overheating
8. **Flood resilience and resistance**
with removable air brick covers, relocated appliances (e.g. installing washing machines upstairs), treated wooden floors

New build homes

New build homes can and should meet even more ambitious standards in some areas

A. **High levels of airtightness**

B. **More fresh air**
with mechanical ventilation and heat recovery, and passive cooling measures such as openable windows

C. **Triple glazed windows and external shading**
especially on south and west faces

D. **Low-carbon heating** and no new homes on the gas grid by 2025 at the latest

E. **Water management and cooling**
more ambitious water efficiency standards, green roofs and reflective walls

F. **Flood resilience and resistance**
e.g. raised electricals, concrete floors and greening your garden

G. **Construction and site planning**
timber frames, sustainable transport options (such as cycling)

24%
REDUCTION NEEDED IN DIRECT CO_2 FROM HOMES BY 2030, FROM 1990 LEVELS

15%
REDUCTION REQUIRED IN ENERGY USED FOR HEATING EXISTING BUILDINGS BY 2030 THROUGH EFFICIENCY IMPROVEMENTS[1]

What householders can do today

There are number of practical, easy and cheap steps that householders can take now to adapt their homes, and reduce their bills and carbon emissions:

1 Improve home energy, heating and water usage and efficiency

- Install low-energy lighting, hot water tank insulation, low-flow shower heads and draught-proofing
- Turn off the lights/other electricals when not being used
- Turn taps off when brushing teeth, have shorter showers, check pipes for leaks and water gardens only as needed
- Install water and smart energy meters to manage water and energy use and help identify water leaks

2 Is the heating system working correctly?

- Check your boiler annually and ensure your heating system is operating at no more than 55˚C
- Install heating controls like timers and room thermostats
- Turn your thermostat temperature down to 19˚C

3 Reduce the risk of overheating in summer

- Opt for thick curtains or blinds (close them during the day), plant trees to provide shade and open windows at night
- Use fans for bedrooms and living spaces (as long as temperatures are below 36˚C)

4 Flooding

- If you're in a flood risk area sign up to flood warnings and devise your own household plan to prepare for possible floods

Our recommendations to Government

The Government needs to take action in five areas NOW to improve the UK's housing stock and help achieve long-term emissions reduction targets. This includes:

1. Enforcing standards, ensuring compliance with those standards and closing the 'performance gap'
2. Delivering a step-change in construction skills
3. Retrofitting existing homes so they are low-carbon, energy efficient and resilient to a changing climate
4. Ensuring new homes are low-carbon, ultra energy efficient and climate resilient, with sustainable transport options
5. Addressing urgent funding needs

Notes

[1] A 15% reduction relative to 2015

Read our new report! Find it online here:

www.theccc.org.uk/publications

We cannot meet our climate objectives without a major improvement in UK housing. There are 29 million homes in the UK. The UK Government is committed to building around 1.5 million new homes by 2022 - and there are major plans for new housing in every part of the UK. The quality of these existing and new homes has an important role in safeguarding people's health and wellbeing, and in addressing climate change. In this report, we assess progress in improving housing to meet our climate objectives, and make recommendations for further action.

We will not meet our targets for emissions reduction without near complete decarbonisation of the housing stock. Energy use in homes accounts for about 14% of UK greenhouse gas emissions.[1] These emissions need to fall by at least 24% by 2030 from 1990 levels, but are currently off track. In 2017, annual temperature-adjusted emissions from buildings *rose* by around 1% relative to the previous year.

The housing stock is not well-adapted for the current or future climate. Around 20% of homes (4.5 million[2]) currently overheat even in cool summers; 1.8 million people live in areas which are at significant risk of flooding; and the average daily water consumption per person across the UK is around 140 litres, above the sustainable level in a changing climate and higher than many other European countries. Cost-effective adaptation measures are not being taken up at anywhere near the levels they can or should be.

Current policies are not driving the required changes:

- *Policies to support low-carbon measures have been weakened or withdrawn,* including Zero Carbon Homes and the Code for Sustainable Homes. This has led to many new homes being built only to minimum standards for water and energy efficiency; for example, just 1% of new homes in 2018 were Energy Performance Certificate band A.[3] Low-carbon heat and energy efficiency uptake in existing homes has stalled, including uptake of highly cost-effective measures such as loft insulation. Only around 1 million homes have low-carbon heat, and the majority of this is wood stoves or biomass boilers rather than heat pumps. The low uptake of heat pumps is symptomatic of low awareness, financing constraints, concerns around disruption and difficulty in finding trusted installers with the right skills.
- *There are policy gaps in supporting the uptake of cost-effective measures to reduce climate-related risks; such as property-level flood resilience, water efficiency devices and appropriate ventilation and shading.* Often, these measures are not considered or installed by home owners or housing developers, because of a lack of appropriate regulation, guidance and communication with householders. Requirements to minimise overheating risk are inadequate, and there are no targets for the uptake of property-level flood resilience. While efforts are being made to improve water efficiency, further ambition to reduce per capita consumption levels is needed to reduce the risks of water deficits in a changing climate.
- *Building standards are not sufficiently ambitious; they are overly complex and compliance is poor.* The 2018 Hackitt Review of Building Regulations and Fire Safety identified worrying deficiencies in the current system of Building Regulations. Compliance is weak, and there is indifference around build quality and confusion over roles and responsibilities.[4] This is leading to safeguarding risks, needlessly high utility bills and poorer levels of health, wellbeing and comfort for householders. As a result many new homes lose more heat than

[1] Not including electricity consumption in homes - currently 6% of UK emissions.
[2] England only as data not available for the devolved administrations
[3] Data to the end of September 2018 for England and Wales. MHCLG (2018) Live tables on Energy Performance of Buildings Certificates
[4] MHCLG (2018) *Independent Review of Building Regulations and Fire Safety: final report.*

they should, some as much as twice the amount they are designed to. Loopholes that have allowed poor quality housing to be built also need to be closed. The provisions in the Town and Country Planning Act 1990 currently mean that in some circumstances homes can be built now, subject only to the standards in place at the date planning permission was granted - which may be a number of years earlier. Changes to permitted development rights in England mean that it is permissible to convert light industrial and commercial units to residential dwellings, without the need to ensure those properties meet the building standards set out in Approved Documents L and F for new dwellings. These loopholes mean new homes are still being built which do not meet the current minimum standards. The latest Government data show that 12% of the homes built in 2018 were rated EPC C, whilst 7% were rated D or below.[5]

- *Local authorities do not have sufficient resources to address these concerns and there is not enough use of local and urban planning to make progress on climate change mitigation or adaptation*. There have been some positive clarifications to the National Planning Policy Framework in England to address overheating and flooding, but the revisions have removed the requirement for local authorities to give active support to energy efficiency improvements to existing buildings, and have failed to clarify how far local and regional authorities are permitted to go in setting their own tighter standards for new-build homes. The proportion of urban greenspace in England has dropped since 2001 from 63% to 55%, adding to the problem of increased temperatures in cities (the Urban Heat Island Effect). This subsequently increases the risk of homes overheating. Current standards and planning guidance in England do not encourage high quality sustainable drainage systems in all developments. The planning process often leads to green measures put in at the initial design of the project being removed to bring down costs, or areas of greenspace in existing developments being built on. Many new developments are designed for travel by car, with limited or no access to public transport and a lack of high quality pedestrian or cycling routes.

Urgent changes are needed in five areas.

1. Performance and compliance

Closing the 'performance gap' between how homes are designed and how they actually perform when built or retrofitted is a vital first step to ensure improvements to Building Regulations are effective. Depending on the type of house, closing the performance gap could deliver £70-£260 in annual bill savings. An immediate improvement would be to enforce current standards, and to revise monitoring metrics and certification to focus on 'as-built' performance. Further tightening of building standards will have little impact if these issues are left unresolved.

2. Skills gap

Regular changes to key policies have led to uncertainty and poor focus on new housing design and construction skills in the UK. The UK Government should use the initiatives announced under the Construction Sector Deal to tackle the low-carbon skills gap. Developing a better-skilled construction sector will deliver better homes, high-quality jobs and ensure we realise the domestic and international industrial opportunities related to low-carbon building.

Professional standards and skills across the building, heat and ventilation supply trades need to be reviewed, with a nationwide training programme to upskill the existing workforce, along with an increased focus on incentivising high 'as-built' performance. There is an urgent need for

[5] MHCLG (2018) *Live tables on Energy Performance of Buildings Certificates.*

further work to ensure that low-carbon heat and mechanical ventilation systems are designed, commissioned and installed properly, and that householders are supported to use them effectively. Similar efforts are needed to develop appropriate skills and training for passive cooling measures, water efficiency, property-level flood resilience and Sustainable Drainage Systems (SuDS).

3. Retrofitting existing homes

The UK Government must take action to support developers and home owners to retrofit existing homes. Given the scale of the challenge, retrofit must be viewed and supported by HM Treasury and the devolved administrations as a national infrastructure priority.

- *Strengthen policies to drive retrofit energy efficiency measures in homes.* Our scenarios include around a 15% reduction in energy used for heating existing homes by 2030. Polices are needed for households deemed able-to-pay, and a delivery mechanism is needed for social housing minimum standards. Major delivery risks around Private Rented Sector regulations remain. Backstop mandatory targets, as in Scotland, could help create policy certainty and drive innovation and growth. The Green Finance Taskforce's proposals on Green Building Passports should be implemented to provide householders with a holistic and long-term view of renovation needs.
- *Measures to address poor thermal efficiency, overheating, indoor air quality and moisture must be considered together when retrofitting existing homes, and building new homes*. The technology exists to deliver homes with high thermal efficiency (warm in winter and cool in summer), safe moisture levels and excellent indoor air quality, but an integrated approach to design, build and retrofit is needed. Regulations around ventilation must evolve to keep pace with improvements in the energy efficiency of buildings, and there is a need for a more coordinated approach to the requirements for energy and ventilation in buildings. Rather than piecemeal incremental change, long-term investments that treat homes as a system are needed, focussing on improvements at key trigger points such as moving home and renovating.
- *Develop a strategy for low-carbon heat uptake beyond 2021*. Aligning infrastructure investment in low-carbon heat with the UK's climate change targets requires the UK Government to develop a strategy for decarbonised heat. In the 2020s this should include roll-out of heat pumps in homes that are off the gas grid, with a focus on the 1 million homes using high-carbon fossil fuels; a major programme to build and extend low-carbon heat networks in heat-dense areas (e.g. cities), aiming for around 1.5 million homes connected by 2030; support to develop an option to deploy hydrogen for heating homes; continued support for biomethane injected in to the gas grid (with potential to supply up to around 6%of buildings gas demand by 2030); and tackling the current balance of tax and regulatory costs across fuels, which currently weaken the private economic case for electrification. Deployment at scale of 'hybrid' heat pumps[6] in buildings on the gas grid should start soon (up to 10 million by 2035). No new homes should be connected to the gas grid from 2025.
- *Improve awareness of climate-related risks and take-up of resilience measures.* Further action is needed to assess and reduce risks of overheating in existing homes, prioritising passive cooling and behavioural changes. Defra should set an ambitious per capita water consumption target which addresses future supply-demand deficits resulting from both 2 and 4 degree climate change scenarios. This should be met through water efficiency

[6] A hybrid system is capable of switching from electricity to gas, depending on cost and heating requirement.

measures, increased metering, compulsory water efficiency labelling and more ambitious Building Regulations. The UK Government and devolved administrations should increase the number of properties fitted with property level flood resilience. The reinsurance programme Flood Re can help target the most at-risk households, while the insurance and mortgage industries should incentivise uptake of measures in at-risk properties. Householders must have sufficient information on the benefits of adaptation and the incentives to take action so that when Flood Re is withdrawn in 2039, properties remain insurable.

- *A green infrastructure retrofit strategy is needed.* Local authorities should include retrofit programmes when creating local plans. Green infrastructure retrofit can be included as part of regeneration or urban improvement schemes. Funding schemes tailored to multi-benefit green infrastructure are needed, including funding pots that multiple partners can bid into together.

4. Building new homes

Immediate Government action is needed to ensure the new homes planned across the UK are fit for purpose, integrating the highest possible levels of emissions reduction with a package of design improvements to adapt to the changing climate. This will require an ambitious trajectory of standards, regulations and targets for new homes throughout the UK:

- *By 2025 at the latest, no new homes should connect to the gas grid.* Instead they should have low-carbon heating systems such as heat pumps and low-carbon heat networks.
- *Make all new homes suitable for low-carbon heating at the earliest opportunity*, through use of appropriately sized radiators and low-temperature compatible thermal stores. This can save £1,500 - £5,500 per home compared to later having to retrofit low-carbon heat from scratch.
- *New homes should deliver ultra-high levels of energy efficiency as soon as possible and by 2025 at the latest,* consistent with a space heat demand of 15-20 kWh/m^2/yr. Designing in these features from the start is around one-fifth of the cost of retrofitting to the same quality and standard. When installed alongside heat pumps in a typical home,[7] ultra-high levels of fabric efficiency can deliver average bill savings of around £85 per household per year, contribute to reducing annual and peak electricity demand alongside other measures, provide comfort and health benefits for occupants, and create an industrial opportunity for the UK to export innovation and expertise.
- *Statutory requirements should be in place to reduce overheating risk in new-build homes.* Evidence suggests that all new-build homes are at risk of overheating.[8] Passive cooling measures should be adopted to reduce overheating risks before considering active measures such as air conditioning.
- *Improve focus on reducing the whole-life carbon impact of new homes, including embodied and sequestered carbon*. Using wood in construction to displace high-carbon materials such as cement and steel is one of the most effective ways to use limited biomass resources to mitigate climate change. New policies will be needed to support this. Increasing the number of new homes built in the UK each year using timber frame construction systems from around 27,000-50,000 in recent years to 270,000 annually could triple the amount of carbon stored in UK homes to 3 Mt every year. Low-regrets action should also be pursued to support the assessment and benchmarking of whole-life carbon in buildings.

[7] Taken to be a three bedroom semi-detached home.
[8] MHCLG (2018) *Government response to EAC Inquiry on Heatwaves*.

- *Improve water efficiency performance in homes.* Defra should set an ambitious per capita consumption target for water to be met through water efficiency measures, increased metering, compulsory water efficiency labelling, improved behaviours and more ambitious Building Regulation standards. Water efficiency should be included in energy retrofit programmes as standard. There is a need for further research to understand how the design water efficiency level compares to the actual water efficiency of homes once built and occupied.
- *Alongside continued funding for flood defences, strengthen flood resilience measures at property and community level.* Planning Guidance in England and Defra's non-statutory standards must be updated to encourage multi-functional SuDS with clear policy on who should maintain and adopt SuDS by default. The automatic right to connect new developments to the existing sewage network should be made conditional either on national SuDS standards being met or by water company agreement. Local authorities and MHCLG should also incorporate national green infrastructure standards from the 25 Year Environment Plan into local planning. Targets for urban greenspace are needed to drive change. The UK Government should consider the introduction of Flood Protection Certificates and the potential for building standards or regulations to promote property-level flood resilience, as the current uptake is significantly lower than it should be.
- *New developments should enable sustainable travel, which should be a primary consideration from the beginning of the planning process.* This includes planning neighbourhoods around infrastructure to encourage walking, cycling, the use of public transport and electric vehicles. Walking and cycling routes should be well lit, feel safe and be segregated from busy traffic. Integrating consideration of sustainable transport into plans for new houses should ensure developments are easy to serve by public transport. Local authorities must consider where best to locate new homes to minimise the need to travel to work and amenities such as shops and schools. New developments should ensure easy access to electric vehicle charging points for residents in both private and public parking spaces.

5. Finance and funding

In the 2019 Spending Review, HM Treasury must address the multi-billion pound funding gap to deliver low-carbon heating (currently only funded up to 2021). Building control enforcement should also be adequately funded as a matter of urgency.

Green finance can facilitate access to capital, enabling and incentivising householders to take action and realise the benefits of low-carbon and resilient homes. The UK Government should implement the Green Finance Taskforce recommendations around green mortgages and green loans to encourage uptake and support financing of upfront costs. Lenders should incorporate fully energy costs in mortgage affordability calculations. The Government should widen the scope of Green Finance measures, for example including water efficiency, flood and heat resilience and introducing resilience surveys. It should work with the National Infrastructure Commission and others to promote research and development and develop standards for new homes. The insurance industry, and the finance industry more broadly, has a key role in incentivising uptake of property level flood resilience.

Policy frameworks and support need to create an attractive package for householders, aligned to 'trigger points' when important decisions are being made, such as when a home is purchased, a boiler breaks down, or when other renovations are taking place.

Many of the measures analysed in this report have clear, multiple benefits alongside reducing emissions and increasing resilience to climate change: reducing utility bills, and improving comfort, health and the natural environment.

Where properly planned and used, our homes can be low-carbon, more comfortable to live in, better for our health, and more affordable to run. The health cost to the NHS of conditions exacerbated by poor housing is currently estimated to be £1.4 – 2.0 billion per year in England alone.

Thermally comfortable housing could reduce the risk of heat and cold-related deaths. Improved energy efficiency has the potential to reduce energy bills and tackle fuel poverty. Greater water efficiency savings have a positive impact on energy use and bills as well as water bills. Green spaces and SuDS can help to sequester carbon, increase biomass and biodiversity, improve water quality and help control surface water flooding. Green spaces can also bring multiple health benefits. Encouraging walking, cycling and the use of public transport and electric vehicles will improve outdoor air quality. Ensuring local bus services go to places people want, at times they need to travel can help people feel more connected to their community.

The need to decarbonise and improve the climate resilience of our homes has the potential to create big opportunities for businesses and high-quality skilled jobs.

Government support and frameworks for the measures outlined in this report will drive demand for improvements and cut the costs per property as measures are implemented at scale. A stable policy framework and direction of travel will help to provide the long-term policy certainty that is needed to raise awareness and help skills and supply chains develop. Developing expertise in low-carbon, resilient homes represents an industrial opportunity for the UK to export innovation and skills.

Recommendations

To take forward our key messages, we make 36 recommendations for action. These feed into a wide array of current work the UK Government and devolved administrations are planning for 2019, including: the reviews of Part L and Part F of the Building Regulations, an update of the planning practice guidance in England, development of a roadmap for policy on heat decarbonisation, review of a per capita water consumption target in England and the Government's commitment to halve the energy use of new homes by 2030.

Table 1. Recommendations		
Topic	Recommendation	Owner and timing
Compliance and the performance gap	1. Overhaul the compliance and enforcement framework so that it is outcomes-based (focussing on performance of homes once built), places risk with those able to control it, and provides transparent information and a clear audit trail, with effective oversight and sanctions. Fund local authorities to enforce standards properly across the country.	*MHCLG, devolved administrations, HMT* *by 2019*
Compliance and the performance gap	2. Reform monitoring metrics and certification to reflect real-world performance, rather than modelled data (e.g. SAP). Accurate performance testing and reporting must be made widespread, committing developers to the standards they advertise.	*BEIS, MHCLG, devolved administrations, industry* *2020-2025*
Compliance and the performance gap	3. Review professional standards and skills across the building, heat and ventilation supply trades with a nationwide training programme to upskill the existing workforce, along with an increased focus on incentivising high 'as-built' performance. Ensure appropriate accreditation schemes are in place.	*BEIS, industry* *2019*
Compliance and the performance gap	4. Undertake a large-scale study to provide robust quantification and benchmarking of the performance gap for energy, water and ventilation.	*BEIS, industry* *2019*
Building regulations	5. Implement tighter standards for new buildings to ensure they are designed for a changing climate, properly ventilated, moisture-safe, are future-proofed for low-carbon heating and deliver ultra-high levels of energy efficiency. The whole-life carbon and peak demand impacts of new homes should be minimised.	*MHCLG, devolved administrations,* *in force and forward trajectory set out by 2020*
Building regulations	6. Government should develop a targeted package of new measures to incentivise and support those developers and individuals who wish to take early action in building low-carbon and resilient homes.	*MHCLG, BEIS, HMT, devolved administrations* *by 2020*
Building regulations	7. All new homes should be made low-carbon heat ready. By 2025 at the latest, no new homes should connect to the gas grid, and should instead rely on low-carbon heating systems such as heat pumps.	*MHCLG, BEIS, devolved administrations* *trajectory set out by 2020*

Table 1. Recommendations		
Topic	Recommendation	Owner and timing
Building regulations	8. The Standard Assessment Procedure should be reviewed and revised to drive high real-world performance and value properly the benefits of low-carbon technologies. It should formally integrate a forward trajectory for declining grid carbon intensity, in line with Government projections.	*MHCLG, BEIS* *by 2020*
Building regulations	9. New-build homes should deliver ultra-high levels of energy efficiency as soon as possible, and by 2025 at the latest. This should be consistent with a space heat demand of 15-20 kWh/m^2/yr.	*MHCLG, devolved administrations* *trajectory set out by 2020*
Building regulations	10. Regulations around ventilation and indoor air quality must evolve to keep pace with improvements in the energy efficiency of buildings. Part F of the Building Regulations should be reviewed alongside Part L, with a view to tightening standards and coordinating requirements to fully reflect interdependencies. Where updates affect Part B and vice versa, Government should review the standards as a whole. Steps must be taken to improve the design, commissioning, and installation of mechanical ventilation systems, with further research into how challenges in maintaining and operating them can be overcome.	*MHCLG, Defra, devolved administrations* *2019*
Building regulations	11. It is critical that the 2019 reviews of Building Standards by MHCLG, Scottish Government and Welsh Government: • Introduces a new standard or other requirement to ensure that overheating risk is assessed for current and future climates at design stage of new-build homes or renovations. • Ensures that passive cooling measures are installed at build stage where there is a risk of overheating identified. Where active cooling measures are also needed, consideration should be given to potential synergies in the choice and installation approach for heating and cooling systems, for example through the use of air source heat pumps combined with mechanical ventilation.	*MHCLG, Scottish Government, Welsh Government* *2019*
Building regulations	12. Examine the potential role for new-build standards in encouraging deployment of technologies to support peak management and demand reduction.	*MHCLG, BEIS, devolved administrations* *by 2020*

Table 1. Recommendations		
Topic	Recommendation	Owner and timing
Building regulations	13. Close loopholes allowing homes to be built which do not meet the current minimum standards for new dwellings. This includes provisions around the expiry of planning permission, and permitted development rights relating to change of use.	*MHCLG* *2019*
Low-carbon homes	14. In our report on *hydrogen* in November 2018, we recommended that the Government should develop a fully-fledged UK strategy for decarbonised heat within the next 3 years. Subsequently, BEIS has committed to publication of a new heat roadmap within 18 months. It is essential that Treasury should commit now to working with BEIS on development of the roadmap/strategy. This must include clear signals on the future use of the gas grid in the UK and commitments to funding and, as a minimum: • A clear trajectory of standards covering owner-occupied, social- and private-rented homes, announced well in advance (including detailed plans on phasing out the installation of high-carbon fossil fuel heating and improvements in the efficiency of existing heating systems). • A support framework for low-carbon heating (heat pumps, biomethane, and networked low-carbon heat). • A review of the balance of tax and regulatory costs across fuels in order to improve alignment with implicit carbon prices and reflect the progressive decarbonisation of electricity. • An attractive package for householders aligned to trigger points (such as when a home is sold or renovated). • A nationwide training programme to upskill the existing workforce. • A governance framework to drive decisions on heat infrastructure through the 2020s.	*HMT, BEIS* *within the next 18 months - 3 years*
Low-carbon homes	15. Following UK exit from the EU, product standards should remain in place or be replaced with equivalent or more ambitious regulation.	*BEIS* *ongoing*

Table 1. Recommendations		
Topic	Recommendation	Owner and timing
Low-carbon homes	16. Develop new policies to support a substantial increase in the use of wood in construction. This will need to focus on overcoming a range of cultural, skills and financial barriers in the construction sector. Undertake low-regrets action to support the assessment and benchmarking of whole-life carbon in buildings with a view to informing the future policy framework.	*MHCLG, BEIS, devolved administrations* *new policies for wood in construction in 2019, with groundwork on whole-life carbon by 2024*
Low-carbon homes	17. BEIS, Ofgem and National Grid should implement the remaining actions set out in the Smart Systems and Flexibility Plan, alongside the continuation of wider improvements that are already underway. Actions include encouraging suppliers to offer smart tariffs and capitalising on EV potential to provide demand-side response and storage services.	*BEIS, Ofgem, National Grid* *actions implemented by 2022*
Low-carbon and resilient homes	18. Improve consumer access to data and advice by implementing the Green Task Force proposal on Green Building Passports, improving EPCs and access to data underpinning EPCs and SAP, and identifying options to go further in particular to include resilience measures. Water efficiency, flood resilience and other resilience measures should be considered in digital 'green passports', and resilience surveys or Flood Protection Certificates developed alongside EPCs.	*BEIS, HMT, devolved administrations* *2019-2020*
Low-carbon and resilient homes	19. Implement GFT recommendations around green mortgages and fiscal incentives to encourage uptake and support financing of upfront costs. To help drive the market for resilient products and services the Government should also look to widen the scope of green finance to include resilience.	*BEIS, HMT* *2019*
Overheating	20. Further action should be taken to better understand when overheating occurs in existing homes in order for passive cooling measures and behaviour change programmes to be targeted effectively.	*Department of Health and Social Care, MHCLG, Scottish Government, Welsh Government,* *by 2020*

Table 1. Recommendations		
Topic	Recommendation	Owner and timing
Overheating	21. In England the Government must ensure that Planning Guidance is updated to clearly require local authorities to include overheating risk in Local Plans, as set out in the updated National Planning Policy Framework. Guidance should contain a requirement for local authorities to include an assessment of overheating risk as part of the planning process. This should require developers to carry out an initial assessment of the strategic features that increase risk, such as site location, building layout, façade, green space availability, and introduce appropriate mitigation measures at the early planning stages.	*MHCLG* *by 2020*
Water efficiency	22. Local authorities should include water efficiency measures in energy efficient retrofit programmes. Water efficiency should be included in social housing standards (such as the Decent Homes and Welsh Housing Quality Standard).	*Local authorities* *Ongoing*
Water efficiency	23. Defra should set a per capita consumption target which can address future supply-demand deficits resulting from both 2 and 4 degree climate change scenarios. Further research should be undertaken to understand the costs and benefits of targets between 50 and 100 litres per day by 2050. The devolved administrations should consider whether it is necessary to introduce similar targets. As a first step to meeting a target and improving water efficiency in homes, the UK Government and devolved administrations should: • Enable water companies to implement compulsory metering beyond water stressed areas by amending regulations before the end of 2019 and requiring all companies to consider systematic roll out of smart meters. • Review new-build regulation standards to allow local authorities to set more ambitious standards, especially in current and future water-stressed areas. • Introduce compulsory water efficiency labelling of household water products. • Work with water companies and local authorities to run partnership retrofit and behaviour change programmes in existing homes.	*Defra* *by 2021*

Table 1. Recommendations		
Topic	Recommendation	Owner and timing
Property level flood protection	24. Defra should develop a long-term strategy to manage flood risks in each part of the country (as first recommended in 2015), so that as Flood Re is withdrawn properties can remain insurable at reasonable costs. This should include: • Continuing to support the industry round table in communicating risk and possible adaptation actions to households and communities that are expected to remain or become at high flood risk by the 2030s. The Flood Re database should be used to initially target those at risk. • Pilot schemes to test and increase understanding of potential PFR options and their benefits to homeowners and landlords. • The introduction of resilience surveys and Flood Protection Certificates which can be used by homeowners, insurance companies and lenders. The UK Government should work with BRE to further develop and widen the use of the Property Flood Resilience database tool. • Detail of how the new Code of Practice will ensure skills are improved and better compliance and enforcement of installing measures. • Plans to work with the insurance industry to ensure they have the evidence needed in order to confidently make informed judgements about which resilience and resistance measures installed in properties lead to reduced risk. Insurers should insist that resilience and resistance measures be implemented during post-flood repairs as a condition of continuing insurance cover.	*Defra, Environment Agency, Insurance companies* *by 2020*
Property level flood protection	25. MHCLG and the devolved governments should examine the potential for regulations on flood protection approaches for both refurbishment and new-build homes.	*Defra, MHCLG, devolved administrations* *by 2021*

Table 1. Recommendations		
Topic	Recommendation	Owner and timing
Green infrastructure	26. Policy is needed in England to address the outstanding barriers to deliver high-quality, effective green SuDS in new development and retrofit: • The Planning Guidance for England must be updated urgently to encourage multi-benefit SuDS in all developments, to bring together other aspects of planning related to green infrastructure and to help address skills and knowledge gaps. • Defra should update the non-statutory standards using latest evidence on the full costs and benefits of SuDS. To promote water company adoption of SuDs Defra should consult with Water UK to ensure that standards are aligned to the most up to date 'Sewers for Adoption'. • The automatic right to connect new development to the existing sewerage network should be made conditional on national SuDS standards being met or by water company agreement. • A clear policy is required on who should maintain and adopt SuDS by default, unless agreed otherwise. • Improved information on the implementation of green SuDS across the UK.	*Defra, MHCLG and local authorities* *by 2020*

Table 1. Recommendations		
Topic	Recommendation	Owner and timing
Green infrastructure	27. The UK Government and devolved administrations should take steps to monitor and reverse the decline in urban greenspace through clearer policy and more support for schemes that deliver multiple benefits: • The UK Government should set a national target for increasing the area of urban greenspace, as part of the 25 Year Environment Plan metrics. New standards for green infrastructure should be set in England (as actioned in the 25 YEP) and embedded within planning policy. • The UK Government should assess the need for a national green infrastructure retrofit strategy to help guide local authorities and water companies in creating and including green infrastructure in drainage and local plans. • Options for funding schemes tailored to multi-benefit green infrastructure schemes. This could include providing funding pots that multiple partners can bid into together. • The devolved administrations should monitor changes in urban greenspace over time, and if declining should also take steps aligned with those suggested for England to reverse the decline.	*Defra, devolved administrations* *by 2021*
Transport	28. Sub-national transport bodies should play a role in coordinating regional housing plans and sharing good practice across local authorities.	*Sub-national Transport Bodies* *by 2021*
Transport	29. The Government should review the powers of planners and develop mechanisms to fund costs of building high-quality walking, cycling and public transport infrastructure, even when outside the immediate housing site boundary.	*MHCLG, DfT, devolved administrations* *by 2020*
Transport	30. MHCLG and DfT should explore the potential for new rail stations, and light rail, tram and bus (including bus rapid transit) routes to unlock areas for housing development whilst mitigating transport impacts.	*MHCLG, DfT* *by 2020*
Transport	31. Local authorities must consult the bus industry at the Local Plan stage to ensure new housing areas can be serviced by commercially viable routes.	*Local authorities* *by 2020*

Table 1. Recommendations

Topic	Recommendation	Owner and timing
Transport	32. For areas within walking distance of high-quality public transport (such as local rail, trams and bus rapid transit), MHCLG and DfT should set minimum density guidelines to ensure local authorities concentrate housing in these areas wherever possible.	*MHCLG, DfT* *by 2020*
Transport	33. Government must strengthen the importance of sustainable transport plans that are integrated into the development throughout the design process, including the development of walking and cycling routes and early consultation with public transport providers.	*MHCLG, DfT, devolved administrations* *by 2020*
Transport	34. To encourage uptake of electric vehicles, the government should immediately consult on regulations to include appropriate cabling ready for installation of electric vehicle chargers or electric vehicle chargers themselves in all new parking spaces for housing developments with off-street parking.	*OLEV* *by 2020*
Local action and planning	35. MHCLG must clarify the rights and obligations of local and regional authorities in relation to climate change mitigation and adaptation. This includes clear statutory duties, and clarification of how far local and regional authorities are permitted to go in setting tighter new-build standards.	*MHCLG* *2019*
Local action and planning	36. Fund local and regional authorities adequately to drive and influence emissions reductions and adapt their localities to a changing climate, and to discharge their responsibilities in relation to the enforcement of building regulations and wider Government policy.	*HMT* *2019 spending review*

Chapter 1: Introduction and context

1.1 Purpose and aim

This is a joint report by the Committee on Climate Change's Mitigation and Adaptation Committees. This report aims to assess the measures that need to be adopted in the housing sector to both manage climate change impacts and reduce greenhouse gas emissions.

There are currently 27.2 million households in the UK.[9] The Government is committed to build around 1.5 million new homes by 2022.[10] The quality of these existing and new homes not only has a critical role in safeguarding people's health and wellbeing, but in addressing climate change.

In previous reports the Committee has assessed adaptation and mitigation requirements of homes separately. However, this report takes a more detailed holistic approach. The way homes are designed and lived in affects both the level of greenhouse gas emissions from the buildings sector, and how exposed people are to the impacts of a changing climate such as hot weather and flooding. Mitigation and adaptation measures are best designed and implemented together, to make the most of potential synergies and avoid negative trade-offs.

This report includes an assessment of policies and actions for both existing homes and new builds across the UK. The report considers the current state of play and what is needed for low-carbon heat, energy efficiency, cooling and ventilation, broader life-cycle carbon associated with homes,[11] peak electricity demand management, water efficiency, property level flood resilience, surface water flood alleviation, green spaces and infrastructure, and sustainable transport.

The report is intended for Government, developers, builders, householders and financial institutions in order to help focus priorities for climate change mitigation and adaptation when building new homes and improving our existing housing stock. It will help inform the UK Government and devolved administrations, and provide a focus for actions now, over the coming decade and beyond.

1.2 Why housing is important for addressing climate change

1.2.1 Reducing greenhouse gas emissions from homes

Heating and hot water for UK homes make up 25% of total energy use[12] and 15% of our greenhouse gas emissions.[13]

A further 4% of greenhouse gas emissions are the result of electricity used in the home for appliances and lighting.[14] Nearly all homes are naturally ventilated, although cooling energy demand is increasing and projected to increase further with rising temperatures.[15]

[9] ONS 2017: https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/families
[10] BEIS (2018) *Industrial Strategy - Construction Sector Deal.*
[11] Such as carbon embodied in construction.
[12] BEIS (2018) *Energy Consumption in the UK*, Table 1.04: Overall energy consumption for heat and other end uses by fuel 2010 to 2017.
[13] CCC (2018) *Reducing UK emissions – 2018 Progress Report to Parliament*. This includes emissions from electricity demand for heating and hot water in homes, which accounts for 1% of UK GHGs.
[14] CCC (2018) *Reducing UK emissions – 2018 Progress Report to Parliament.*
[15] BEIS (2018), *Energy consumption in the UK*; DECC (2013), *The future of heating: Meeting the challenge.*

Progress in reducing emissions from homes is set out in our annual Progress Report to Parliament. A near complete decarbonisation of how we heat our homes is required to meet the UK's legally binding targets to reduce emissions by at least 80% on 1990 levels, and prepare the stock for future net-zero ambitions.[16]

Emissions are not falling at the rate needed to meet the UK's carbon targets:

- Direct emissions from homes were 64 million tonnes (Mt) CO_2 in 2017.
- When adjusting for annual temperature variation, emissions rose by 1% in 2017. [17] Emissions were just 9% below 1990 levels. This compares to a 13% reduction in residential emissions in our cost-effective pathway for meeting carbon budgets, on track to a 24% reduction by 2030.
- Whilst energy use per household and per person have fallen since 1990 – by 21% and 14% respectively – this does not include any progress since 2014.[18]

The reasons for this are clear.

Current policy is failing to drive uptake of energy efficiency in existing homes – installation of loft and wall insulation is at just 5% of peak market delivery in 2012 (Figure 1.1), despite significant remaining cost-effective potential.[19] The overall efficiency of the housing stock remains low (Box 1.1), and UK homes lag behind other comparable countries.[20]

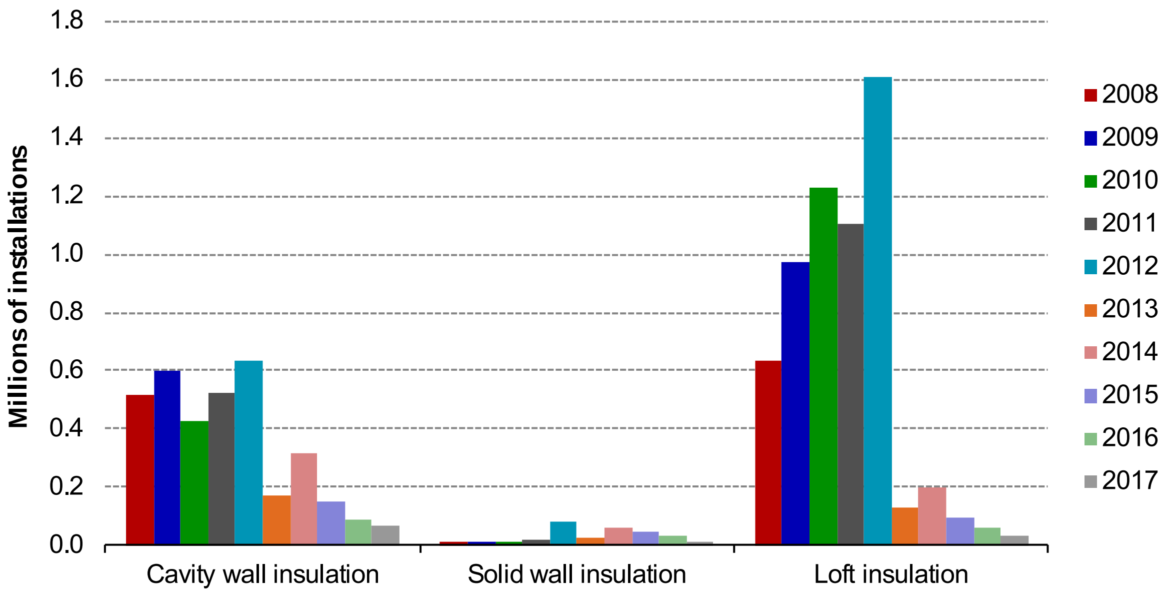
The UK Government is currently working towards low-carbon heat in every home by 2050. However, fewer than 500,000 homes currently have some form of low-carbon heating when not counting closed stoves or wood used on open fires:

- Around 24 TWh of woody biomass was used for heating UK homes in 2017.[21] A 2014 survey suggests that around half of this is used on open fires, which are not an efficient use of fuel and which we do not count as low-carbon heat uptake.[22] A further 45% was used in closed stoves, leaving an estimated 90,000 with pellet stoves, boilers or range cookers. Biomass for heat is in general not consistent with the long-term best use of limited bioenergy resources except in niche uses.[23]
- Deployment of heat pumps remains very low at around 160,000 heat pumps, with only around 18,000 units sold in 2016.
- Whilst delivery of heat through heat networks appears to be broadly on track with our assessment of what is required to meet future targets, only 7% of heat in these networks currently comes from low-carbon primary fuel sources.

[16] The Government has now sought advice on the date by which the UK should achieve a net zero greenhouse gas or carbon target following the Paris agreement. See: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/748489/CCC_commission_for_Paris_Advice_-_Scot__UK.pdf
[17] Temperature adjustments are made to account for the varying length of the heating season year-to-year, with heating demand adjusted in line with the long-term average.
[18] BEIS (2018) *Energy Consumption in the UK*, Table 3.04 Domestic energy intensity 1990 to 2017.
[19] Including insulating a total of 5 million cavity walls and lofts, and one million solid walls. A further million solid walls are included in our fifth carbon budget scenario because of the fuel poverty and related health benefits.
[20] Association for the Conservation of Energy (2015) *The cold man of Europe - 2015*.
[21] BEIS (2018) *Digest of UK Energy Statistics*.
[22] BEIS (2016) *Summary results of the domestic wood use survey*, available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/517572/Summary_results_of_the_domestic_wood_use_survey_.pdf
[23] CCC (2018) *Biomass in a low-carbon economy*.

The numbers of homes connected up to natural gas heating has risen from 14 million in 1990 to 23.9 million currently.[24]

Figure 1.1. Annual installation rates of loft insulation, cavity wall insulation and solid wall insulation (2008-2017)



Source: BEIS (2018) *Household Energy Efficiency National Statistics;* previous DECC publications.
Notes: Installations under Government schemes.

Box 1.1. Energy efficiency of the UK housing stock - SAP scores and EPC ratings

The Standard Assessment Procedure (SAP), is the methodology used by the Government to assess and compare the energy and environmental performance of dwellings. It is the basis for establishing compliance with Building Regulations, and for Energy Performance Certificates (EPCs). EPCs have two metrics, a fuel cost-based energy efficiency rating (commonly called the 'EPC' rating, in £/kWh/m^2) and a rating relating to emissions of CO_2 (the Environmental Impact (EI) rating, in CO_2/m^2). Ratings are banded A-G, with A being the highest performing.

The EPC rating is based on a 'SAP' score. A higher 'SAP' score indicates lower running costs, with an EPC rating of A being equivalent to a SAP score of 92 to 100 points. A score of 100 indicates that no heating or hot water costs are required for that building.

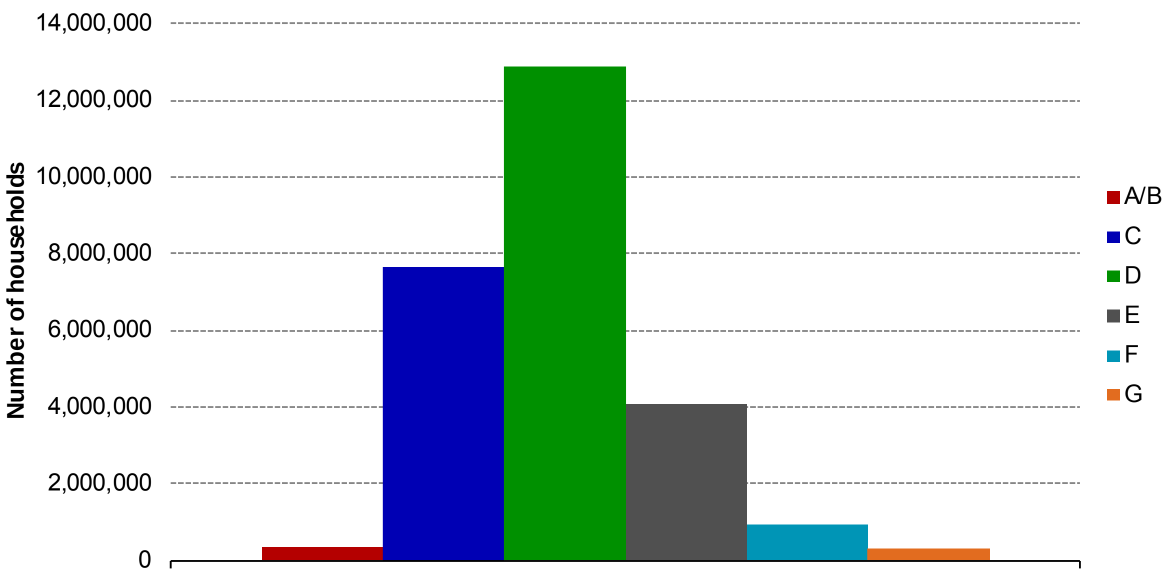
In 2016, the average SAP score of English dwellings was 62 points, up from 45 points in 1996. This increase was evident in all tenures. However, the increase appears to be slowing and there was no change in the average SAP score of homes between 2015 and 2016 (in any tenure).

Energy Performance Certificate (EPC) data indicates that D is the most common EPC rating across Great Britain. Few properties have A or B ratings (estimated to only make up 1.4% of all properties in England and Scotland in 2016) (Figure B1.1).

[24] BEIS (2018) *Energy Consumption in the UK*; Table 3.18: Installed central heating by type in UK 1970-2016. Latest data available is for 2014.

Box 1.1. Energy efficiency of the UK housing stock - SAP scores and EPC ratings

Figure B1.1 Distribution of the English and Scottish Housing Stock by SAP band (2016)



Source: MHCLG (2018) *2016-17 English Housing Survey Headline Report, Annex Table 2.6*; Scottish Government (2017) *Scottish house condition survey 2016: key findings*.

Source: MHCLG (2018) *2016-17 English Housing Survey Headline Report*.

1.2.2 Climate risks and progress in adapting to climate change

The major risks related to the UK's housing stock are set out in the second UK Climate Change Risk Assessment (CCRA2).

The quality of the design and construction of homes determines how vulnerable people are to flooding, heat, cold and other forms of extreme weather. Indoor air quality, relating to a wide variety of pollutants (including moisture), is also a key concern. Of the six urgent areas of climate change risk to be tackled as a priority,[25] three identified in the CCRA were particularly relevant to residential buildings:

- Flooding and coastal change:
  - Across the UK, approximately 1.8 million people are living in homes which are in areas of significant river, surface water or coastal flooding (defined in the UK Climate Change Risk Assessment as a 1 in 75 (1.3%) or greater annual chance). This could rise to 3.5 million under a 4°C climate change scenario by the 2080s.[26,27] People living in properties located within the UK's most deprived communities face even higher increases in risk. At present

[25] CCC (2016) *UK Climate Change Risk Assessment 2017: Evidence Report*.
[26] Sayers et al. (2015) *Climate Change Risk Assessment 2017: Projections of future flood risk in the UK*.
[27] Assuming current levels of adaptation are continued and no population growth.

there is a low uptake of low-regret actions to reduce impacts, such as property level flood resilience.[28]

  - The impacts of flooding and coastal change in the UK are already significant and expected to increase as a result of climate change.[29] Improving protection for some communities will be possible through community scale defences, but others will face significantly increased risks. If unmanaged, these risks will affect property values, business revenues and in extreme cases the viability of communities.
  - Warming of 4°C or more implies inevitable increases in flood risk across all UK regions, even in the most ambitious adaptation scenarios considered in producing CCRA2.[30]

- Heat-related health impacts:
  - The average number of hot days in the UK has been increasing since the 1960s. The chance of a summer as hot as 2018 is around 50% by 2050.[31] Projections show that maximum summer temperatures could rise by 6 - 9°C by the end of the century compared to the 1981-2000 average.[32]
  - Studies based on sample buildings in England show around 20% of homes overheat in the current climate.[33] The south of the UK is more severely affected by indoor overheating problems, but there are few studies of overheating in buildings in northern England and in Scotland, Wales and Northern Ireland. Dwelling types that have been found to be more prone to overheating include 1960s – 1970s and post-1990s mid- and top-floor purpose-built flats that lack sufficient ventilation and protection from heating by the sun.[34]
  - In the absence of action, annual UK heat-related mortality is projected to increase from a current baseline of 2,000 heat-related deaths per year to 5,000 per year by 2050 (7,000 per year by 2050 taking account of population growth).[35] High temperatures are also associated with heat-related illnesses. The elderly, very young and people with pre-existing heart and respiratory diseases are particularly at risk. In otherwise healthy people overheating can cause discomfort leading to lack of sleep, productivity and alertness.
  - The Urban Heat Island effect may be considered beneficial in winter, since it reduces somewhat both the impacts on health from cold weather and heating demand. However, in summer, and especially during heatwaves which are expected to become more common, it can exacerbate overheating since it prevents buildings cooling down, particularly at night.
  - Cold-related deaths are still projected to remain high in the future. Current estimates suggest there could be around 41,000 cold-related deaths per year, projected to decline

[28] CCC (2017) *Progress on preparing for climate change.*
[29] CCC (2018) *Managing the coast in a changing climate.*
[30] CCC (2016) *UK Climate Change Risk Assessment 2017: Evidence Report.*
[31] Met Office (2018) *UKCP18*. Under a high climate change and population scenario.
[32] *Ibid*.
[33] Kovats, R.S., Osborn, D., et al. (2016) *UK Climate Change Risk Assessment Evidence Report: Chapter 5, People and the Built Environment*.
[34] CCC (2016) *UK Climate Change Risk Assessment 2017: Evidence Report.*
[35] CCC (2016) *UK Climate Change Risk Assessment 2017: Evidence Report.*

by 1,000 per year by the 2050s. Reducing exposure to cold in winter through better insulation of homes could reduce this much further.[36]

- Water scarcity:
  - Population growth will increase the demand for water, whilst climate change is projected to make summers drier. The potential for water deficits is most acute in London and the south east, but routine deficits between available water and demand may emerge in northern and western UK areas by mid-century.
  - There remains an urgent need for more co-ordinated action to ensure resilient supplies especially in times of drought, and further steps to achieve the ambitious reductions in water demand and leakage that are likely to be required.

The CCRA2 Evidence Report also found that by making homes more air tight, the ingress of externally sourced pollution may reduce, however it can also increase the concentrations of indoor sources of pollution unless properly ventilated. Conversely, when overheating increases, more windows are opened and households could increase their exposure to outdoor pollutants – this is especially an issue in cities with high pollution levels.

The Committee's latest adaptation progress report to Parliament identified a number of housing-related adaptation priorities in England where the level of action at the national level is currently insufficient to manage the risk:[37]

- Surface water flood alleviation. The scale of the investment to tackle surface water flooding has yet to be assessed and the ownership of the problem is fragmented between different bodies.
- New development and surface water flood risk. Survey data from CIWEM suggests there is little confidence among relevant practitioners that high quality SuDS are being built in the majority of major new developments.[38] In many cases the SuDS being built are below-ground retention systems, rather than surface level 'green' SuDS (e.g. grassed areas, swales and ponds) that deliver a range of benefits and can be more readily adapted to cope with future change.
- Property level flood resilience (PFR). It would be cost-effective to protect at least 153,000 properties using PLR measures. This is expected to increase to more than 217,000 by the time Flood Re (the re-insurance scheme set up for flood risk properties) is withdrawn (in 2039).
- Health impacts from heat. There are no legal safeguards to avoid new homes overheating, and no policies in place to begin the process of adapting the existing housing stock to higher temperatures.

Progress is being made in managing river flooding, and improving water efficiency in homes, though more remains to be done:

- Investment in flood alleviation schemes has increased since 2015, and for the period between now and 2021 is consistent with the most recent assessment of long-term funding needs. Between April 2015 and April 2017, 97,000 homes in England benefited from new or replacement flood defences.

[36] CCC (2016) *UK Climate Change Risk Assessment 2017: Evidence Report.*
[37] CCC (2017) *Progress in preparing for climate change.*
[38] CIWEM (2016) *A place for SuDS?*

- Household water consumption per person in England and Wales has continued to decline, from 155 litres per person per day (l/p/d) in 2003/04 to 141 l/p/d in 2017/18. Water companies have implemented a range of actions to reduce household water demand, including encouraging the uptake of water metering (one of the most effective ways to encourage reduced water use), although this has been slower to occur in devolved administrations.[39,40] However, the CCRA highlighted that current planned action is not sufficient in the longer term to meet projected supply-demand deficits.

The Adaptation Committee also assessed the Scottish Climate Change Adaptation Programme in 2016:[41]

- Action is being taken to reduce the vulnerability of communities to flooding. However, there are limited data at a national scale to determine how much progress is being made. The report highlighted that development in the floodplain, along with ongoing increases in impermeable surfacing, were likely to be adding to long-term costs and risks. There was also a lack of data on the uptake of property-level flood protection and sustainable drainage, and trends in urban greenspace.
- Further action was deemed to be needed to adapt the housing stock to extreme wind and rain, cold and hot temperatures, to better protect health and wellbeing. While risks from cold, wind and rain are well-acknowledged, the risks from overheating in homes are less well known. Heat currently contributes to fewer deaths than cold in Scotland but the number of heat-related deaths is expected to increase. There may be between 70 – 280 heat-related deaths per year in Scotland by the 2050s in the absence of adaptation (compared to around 40 deaths per year at present). The future effects of heat on health and wellbeing more generally have not been estimated. There are currently no plans in place that aim to prevent heat-related risks to people during periods of hot weather.
- Little progress was being made in reducing the demand for water, despite the potential risk of water scarcity in some parts of Scotland in the future. Building Regulations have included water efficiency standards in new developments since 2014, and Scottish Water has a water efficiency plan. However the overall consumption of water per person is still high even though it has decreased over recent years.

An updated assessment of the SCCAP by the CCC is due in early 2019.

1.3 Socio-economic factors

1.3.1 Housing Condition and health

Housing plays a key role in protecting the health and wellbeing of occupants, as well as addressing climate change.

Due to differences in how housing condition is calculated it is not possible to directly compare figures across nations, but the figures below summarise condition data for each of the four UK countries:

[39] For example we reported in our assessment of the Scottish Climate Change Adaptation Programme in 2015 that only 400 properties out of 2.4 million are metered in Scotland. CCC (2016) *Scottish Climate Change Adaption. Programme: An independent assessment for the Scottish Parliament.*
[40] More than 45% of households in England now have water meters installed, compared to 43% in 2013.
[41] CCC (2016) *Scottish Climate Change Adaptation Programme - An Independent Assessment.*

England:

- 4.7 million dwellings in England (20%) failed to meet the Decent Home Standard in 2016, although this had fallen from 7.7 million homes in 2006.[42,43]
- The private rented sector in England continues to have the highest proportion of poor quality housing, as defined by the Decent Homes standard, at 27%.[44]
- It has been estimated that spending £10 billion to improve all of the 'poor' housing in England would save the NHS £1.4 billion per annum in health costs. Such investment has been estimated to pay for itself in just over seven years – and then accrue further benefits.[45,46]
- There were an estimated 2.55 million (11%) fuel poor households in England in 2016,[47] using the low income, high cost definition.[48]

Scotland:

- Around 1% (or 24,000) of all dwellings fell below the Scottish Government's Tolerable Standard in 2017.[49] The Scottish Housing Quality Standard (SHQS), applicable only to social housing, has a 37% failure rate in the social sector (not allowing for abeyances and exemptions), an improvement on the 60% failure rate in 2010. In social housing, 80% of homes are compliant with the Energy Efficiency Standard for Social Housing (EESSH).[50]
- There were estimated to be 613,000 fuel-poor households[51] in 2017, equivalent to 24.9% of all households.

Wales:

- In Wales, 23% of households are currently classed as fuel poor. The most recent housing condition survey found that condition has improved across all tenures. The private rented sector generally has the oldest housing stock and a higher proportion of poor quality housing (for example, homes showing problems with damp, mould or other hazards).[52]

[42] MHCLG (2018) *2016-2017 English Housing Headline Report.*
[43] The Decent Homes Standard is a minimum standard that council and housing association homes should meet according to the UK Government. Under the standard, council or housing association homes must: be free from any hazard that poses a serious threat to health or safety; be in a reasonable state of repair; have reasonably modern facilities; have efficient heating and insulation.
[44] MHCLG (2018) *English Housing Survey Private Rented Sector, 2016-2017*.
[45] Nicol S. et al. (2015), *The cost of poor housing to the NHS.*
[46] The Academic – Practitioner Partnership (2016) *Good Housing Better Health*.
[47] BEIS (2018) *Annual Fuel Poverty Statistics Report*, *2018* (2016 Data).
[48] Low Income, High Costs definition is the new definition of fuel poverty. A household is in fuel poverty if their income is below the poverty line and their energy costs are higher than is typical for their household type. The devolved administrations have retained the previous ten percent definition, which means a household is deemed to be in fuel poverty if it needs to spend more than 10% of household income on fuel.
[49] The tolerable standard is a condemnatory standard; a house that falls below it is not acceptable as living accommodation.
[50] For more information on EESSH, see: https://www.gov.scot/policies/home-energy-and-fuel-poverty/energy-efficiency-in-social-housing/
[51] A household is in fuel poverty if, in order to maintain a satisfactory heating regime, it would be required to spend more than 10% of its income (including Housing Benefit or Income Support for Mortgage Interest) on all household fuel use.
[52] Welsh Government (2018) *Welsh Housing Condition Survey 2017-18: Headline Report.*

Northern Ireland:

- In Northern Ireland, 21.5% of properties are classed as fuel poor. Approximately 2% of properties have been classified as being unfit under the Northern Ireland Standard of Fitness for Habitation.[53]

It is likely the number of vulnerable people receiving community care in their own homes will increase in the future.

The NHS 2019 Long Term Plan highlighted the likely shift from hospital-focused systems in the future to community-based care.[54] GP care is likely to continue to be important as well as community-based speciality care facilities. The NHS may rely increasingly on the voluntary sector and on a public and private network of providers to deliver health care within patients' homes. This will be coupled with increasing pressure on NHS, public and community transport services, as patients who are no longer able to drive will rely on these to attend medical appointments. The housing stock needs to be improved so that patients can be increasingly cared for at home.

Health inequalities will also be an important future factor to consider in improving housing condition.

Healthy life expectancy in the UK has not risen as fast as life expectancy.[55] There are also important regional differences in longevity and other measures of population health. Poor quality housing particularly impacts the health of people with lower incomes, and can exacerbate health inequality.

Impacts of future hazards such as heatwaves and flooding on vulnerable people may be exacerbated by changes in social protection measures and the level of social care that elderly or vulnerable individuals receive at home. Making homes adaptable for each stage of life and to the climate could help to manage increasing ill health. For example, improving thermal comfort in homes is a win-win-win situation – improving the health and well-being of occupants, in turn taking pressure off the NHS, and reducing greenhouse gas emissions.

1.3.2 Tenure

Tenure is important for considering barriers and incentives to climate change mitigation and adaptation measures.

Demand for housing in the UK has increased, partly as a result of increasing population together with decreasing average household size. A number of local authorities have transferred much of their housing stock to housing associations and registered social landlords. The number of private rentals has more than doubled between 1996 and 2016 (Figure 1.2). In the UK, Wales has the greatest percentage of owner-occupied dwellings (73%) and Scotland had the least (63%). Scotland has the largest share of social rented dwellings (28%).[56] Different types of tenure need different approaches:

- A person in rented accommodation is more likely to be in fuel poverty, which may mean they have limited resources for measures such as energy efficiency and property-level

[53] Northern Ireland Housing Executive (2017) *House condition survey revised preliminary report 2016.*
[54] NHS England (2019) *NHS Long Term Plan.*
[55] House of Commons (2010) *The ageing population.*
[56] BRE (2018) *The cost of poor housing in the European Union.*

adaptation.[57] Many landlords have little incentive to invest in improvements to their property given that for most measures, the tenant would receive the reward for this through reduced energy bills and better comfort. Regulations have been introduced to protect tenant rights, for example over safety features of the property and in relation to energy efficiency. However, initial evidence suggests that many landlords are refusing tenant requests for energy efficiency improvements.[58]

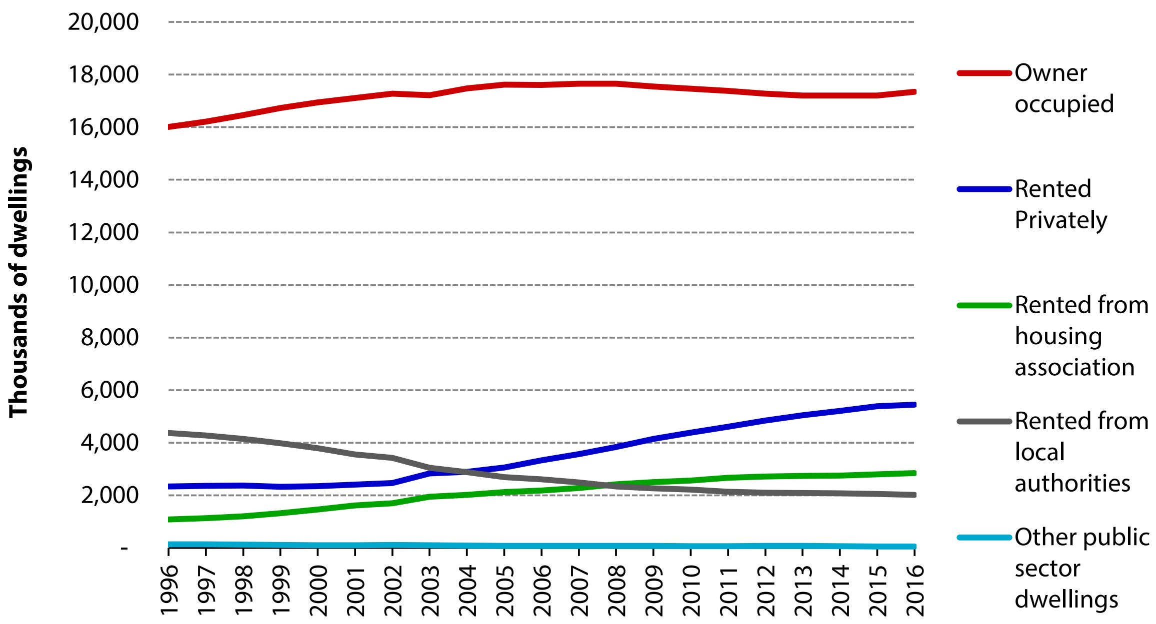
- Social landlords can also be well-placed to oversee mitigation and adaptation action. They are driven by the social and charitable objectives of providing decent and affordable housing that complies with regulation, have control over whole estates and have better access to capital. These objectives determine their asset-management strategies, including the pursuit of affordable heating. They tend to approach investment in terms of coordinated stock upgrades (and planned maintenance cycles in the case of heating systems, for example).
- However, an upcoming report by Sustainable Homes has found that UK social housing is not fit for 2050.[59] Long-term strategies do not exist to make homes ready for 2050, despite it being within reach of most landlord financial planning cycles.
- Owner occupiers are often able to make changes most easily, and see the direct benefit of investments. However, there is a lack of advice on improvements needed to bring homes up to appropriate standards. Home owners of newly built homes are not thought to have any legal basis to demand that their homes be brought up to Building Regulations standards or to correct any issues that would come up in any house quality assessments in the UK, unless their home is still under warranty. During the first two years after a new home is built a warranty will cover issues with build works. After this, typically up to year 10, a builder is only responsible for major problems with the structure of the house.[60]

Tenure can also affect the type of adaptations that can be made. For example:

- Changes to building fabric are easier if the building is owned by a single household or entity, for example a detached house or a housing association block of flats.
- Leasehold properties may require the agreement of the freeholder to undertake modifications, and properties which are listed may have further restrictions to what can done without gaining approval from local authorities.
- Multi-tenement flats[61] can also be hard to alter given that the agreement of all households is needed to make changes. There is also the difficulty in attributing costs and benefits of measures to each flat.[62] This may be a particular issue in Scotland where flats make up a larger proportion of the housing stock (37%).[63] The Scottish Government's area-based energy efficiency scheme tries to address these issues by allowing occupied and private rental flats to access funding if they meet certain criteria and are covering social tenant contributions through the Energy Company Obligation.

[57] BEIS (2018) *Fuel Poverty statistics 2016.*
[58] Cornwall Energy Daily Bulletin 3rd August 2016 reports a survey by online letting agent PropertyLetByUs that shows 58% of tenants surveyed have had requests for energy efficiency improvements refused.
[59] Sustainable Homes (2019) *Housing 2050 – How UK social housing can meet the challenge of climate change.*
[60] Homes Owners Alliance, https://hoa.org.uk/advice/guides-for-homeowners/i-am-buying/new-home-warranties-cover/
[61] For example blocks of flats which include owner occupiers, private rentals and social housing.
[58] Citizens Advice (2013) *Communal Improvements Energy efficiency in tenements in Scotland.*
[63] Scottish Government (2018) *Scottish condition survey 2017: key findings.*

Figure 1.2. Trends in property numbers by tenure, Great Britain (1996-2016)



Source: MHCLG Live Tables (2018). See: https://www.gov.uk/government/statistical-data-sets/live-tables-on-dwelling-stock-including-vacants

1.3.3 Demographic change

The UK population is growing and growing older, increasing the demand for housing. There are more elderly people living on their own due to better health and a desire for people to stay in their own homes longer.

The UK population is expected to increase from 65.6 million in mid-2016 to 73 million by 2035 and 86 million by 2085, with England projected to grow more quickly than the other UK nations.[64]

The building of new homes is set to increase, with a Government commitment to build 1.5 million new homes by 2022.[65] The number of households is also projected to increase due to population growth and more people living alone – from 23.0 million in 2018 to 31.5 million by 2040 in England alone.[66]

The biggest population increases will be in those aged 85 and over, which will increase the vulnerable population to climate-related risks, such as overheating.

A significant trend over the last 20 years has seen a larger proportion of homes containing one person:

[64] ONS central population projections.
[65] BEIS (2018) *Industrial strategy - Construction sector deal.*
[66] ONS (2018) *Household projections for England.*

- According to the General Lifestyle Survey (2013) 17% of households contained one person in 1971.[67] This has risen to around 28% in 2017.[68] Although the total number has not changed much in the last decade, those living alone aged 65 to 74 years have increased by 15% between 1996 and 2017, and those aged over 75 years increased 24% over the same period.[69]
- This could be attributed to the improvement in the health of the population and the increase in unpaid carers (e.g. care provided by a spouse or family member)[70] as well as a desire for people to stay in their own homes longer.
- Reports by Scottish Widows[71] and Country Wide lettings in 2017[72] found that the number of people renting in retirement is on the rise. Retired people in 2017 accounted for 8.0% of all tenants, compared with 5.2% in 2007. The largest proportion is in Wales, where nearly 1 in 5 of tenants are retired. By the early 2030s one in eight retirees in Great Britain are projected to live in rented accommodation.[73]

In addition to population growth and ageing, the distribution within the UK is likely to change.

A large proportion of homes in the UK are located in towns and cities, for example in England and Scotland around 80% of dwellings are in urban areas.[74] There is limited information regarding future trends in urbanisation in the UK (either development of new towns or expansion of current cities):

- The expansion of urban areas is restricted by the policy to avoid building on greenbelt sites, however populations within cities in the UK continue to rise.[75]
- In recent years there has been an increase in planned and constructed high-rise blocks of flats in cities across the UK. The majority of these are being used for residential flats.[76]
- Locating new homes within towns and cities can reduce the demand for travel, as employment opportunities, retail and leisure activities, and public services are already located nearby.

Coastal communities tend to have higher than average populations of over-75s, higher unemployment, and poorer infrastructure compared to communities inland.[77]

[67] ONS (2013) *General Lifestyle Survey 2011*.
[68] ONS (2017) *Families and Households: 2017.*
[69] *Ibid.*
[70] ONS (2014) *Changes in the Older Resident Care Home Population between 2001 and 2011.*
[71] Scottish Widows (2017) *Retirement report 2017: Renters in retirement*.
[72] See https://www.countrywide.co.uk/news/2017/retirees-spend-a-record-37bn-paying-rent/
[73] Scottish Widows (2017) *Retirement report 2017: Renters in retirement.*
[74] ONS (2018) *Rural population 2014/15*. Scottish Government (2018) *Scottish condition survey 2017: key findings.*
[75] Centre for cities data (2001-2016).
[76] AMA research (2017) *Construction in the high-rise buildings market report UK 2016 – 2020 analysis.*
[77] England and Knox (2016) *Targeting flood investment and policy to minimise flood disadvantage*, Joseph Rowntree Foundation.

1.3.4 Technological changes

A number of technological changes are affecting how much time people spend indoors, and what is important to occupants in their homes and their behaviour.

An increasing number of people in the UK are installing 'smart' measures in their homes, such as smart meters, smart appliances, and smart heating and lighting systems and controls.

These new technologies can be used to help improve energy efficiency, save money on bills and potentially reduce vulnerability to climate change by monitoring risks such as indoor temperature. However they also mean more households are reliant on digital and ICT infrastructure – networks which can be at risk from severe weather.[78] It is important that the sector is resilient to future climates by taking steps now to protect ICT infrastructure from flooding and overheating.

An increasing number of people are also working from home, meaning that more time is being spent in homes during the day:

- Between January and March 2017 nearly 14% of the UK workforce were home workers.
- The number of home workers has grown by 1.3 million since 1998 to 4.3 million.
- Home workers tend to work in higher skilled roles compared to the rest of the population, with almost two thirds of them being self-employed in 2014.
- Working from home is more prevalent among older individuals.
- The South of England has the highest levels of home working rates, the highest being in the South West at a rate of 17%. The lowest rate was in Northern Ireland at just 2%.[79, 80]

Smart meters have an important role to play within a wider package of support to enable more informed energy choices and to facilitate behaviour change. They can give occupants more control over energy use, and support improved understanding of energy costs and bills. They can also be used to track progress in, and performance of, energy efficiency and heating measures.

The Government wants energy suppliers to install smart electricity and gas meters in every home in England, Wales and Scotland, with every home being offered a meter by the end of 2020. Approximately 9.5 million smart meters were installed by December 2017, with 4.5 million of these added in 2017. This is behind the original expected deployment trajectory, and a recent NAO report concluded that there are serious issues that need to be addressed if smart meters rollout is to progress successfully and deliver value for money.[81]

Water meters can help incentivise conservation of water and provide a much more precise picture of water use to customers, including identifying leakage. Smart metering can also help companies identify households with the highest water consumption, who might struggle to pay

[78] CCC (2017) *Progress in preparing for climate change – 2017 report to Parliament.*
[79] See: https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/adhocs/008283homeworkersratesandlevelsjanuarytomarch2016and2017
[80] Home workers include those who worked within their home or its grounds, and those who use their home as a base but worked in different places.
[81] National Audit Office (2018) *Rolling out smart meters.*

their bills. Smart meters could better enable variable tariffs and more regular and transparent billing (which helps households to budget).[82]

Energy providers are increasingly providing specialised charging tariffs and equipment to facilitate the smart charging of electric vehicles. The potential to charge vehicles when most beneficial for the electricity system as a whole could reduce the need to upgrade local electricity grids, reduce costs for the electric vehicle owner and enable greater deployment of intermittent renewable electricity generation. For these reasons, the Government has taken primary powers to ensure that charging points have smart capability in the 2018 Automated and Electric Vehicles Act.

Going beyond smart meters, the growing trend for 'smart' systems could play a bigger role in helping to reduce energy demand and vulnerability to climate risk. Smart systems can be used to control services such as heating, ventilation and lighting, as well as other appliances such as showers, washing machines and kettles. They can provide for more comfortable homes, and create opportunities to save bills and emissions through better managing or reducing use.

As well as enabling all households to better manage energy use, the availability of affordable real-time monitoring data on energy, temperature and humidity can deliver information that could help vulnerable households in particular. For example, data could be used to trigger warnings for care givers or health professionals when a home is consistently under heated, or overheating.[83, 84] On a neighbourhood scale, collecting data such as travel use could be used to target and encourage smarter travel choices.

However, concerns around reliability, perceived need, cost, security and ease of use must be addressed to ensure that smart technology can be easily usable by all individuals.

1.4 What low-carbon, sustainable homes look like

The homes we live in should be low-carbon, resilient to weather-related impacts, affordable to run, comfortable to live in and good for our health.

The technology already exists to create homes that are low-carbon, climate resilient, better for health and the natural environment. Taking action will lead to multiple benefits:

- Energy efficiency measures, if implemented correctly, can reduce emissions and energy bills, improve health and wellbeing, and help tackle fuel poverty.
- Water efficiency savings reduce demand, but also have an impact on energy, carbon and bills (Chapter 2). Studies in Scotland and Wales have shown the multi benefits of linking up water and energy efficiency policy and retrofits.[85,86]
- Green spaces (also known as green infrastructure when present in urban areas) and sustainable drainage systems (SuDS) can help to mitigate surface water flooding, but also

[82] National Infrastructure Commission (2018), *Preparing for a drier future: England's water infrastructure needs.*
[83] CSE (2017) *Smarter homes workshop findings*, https://www.cse.org.uk/downloads/file/smarter-warmer-homes-workshop-oct-2017.pdf
[84] There are a number of examples of projects developing platforms using smart monitoring for safeguarding purposes. The SPHERE project at Bristol University is analysing the relationships between the health of building occupants, the conditions of their home and their activities as revealed by their energy consumption patterns. Other platforms, such as Switchee and Howz monitor housing conditions using sensors that can alert social housing landlords, carers or others if people are living in dangerously cold or damp homes.
[85] Waterwise (2018) https://www.waterwise.org.uk/delivering-changes-in-scotland/
[86] Burton (2013) *Integrating water efficiency into energy programmes – a case study from policy to implementation.*

help to sequester carbon, increase biomass and biodiversity and improve air and water quality. Green spaces and designing neighbourhoods to facilitate active transport (cycling and walking) can also bring health benefits through improving air quality and encouraging exercise.[87]

A wide range of design features influence the sustainability and resilience of a home.

The infographic presented in the Executive Summary of this report sets out the types of measures that can help to improve sustainability and resilience, including those measures that can be installed easily by householders. Table 1.1 illustrates the cost savings that can be achieved by installing measures in new homes at the outset.

[87] Bozovic, Ranko & Maksimovic, Čedo & Mijic, Ana & Smith, K.M. & Suter, Ivo & Van Reeuwijk, Maarten. (2017). *Blue Green Solutions. A Systems Approach to Sustainable, Resilient and Cost-Efficient Urban Development*.

Table 1.1. Costs of designing in measures for a new home at the outset, relative to trying to achieve the same outcomes later

Measure	Cost (£) – new build	Cost (£) - retrofit (equivalent outcome)
Building a home with an air source heat pump and ultra-high levels of fabric efficiency (equivalent to a space heat demand of 15 kWh/m^2/yr)[1]	4,800	26,300
Passive cooling measures package[1,2]	2,300	9,200
Water efficiency package of measures[2]	300	3,300
Flood resilience and resistance package of measures[2]	1,500	3,100

Source: [1] Currie & Brown and Aecom for the CCC (2019) *The costs and benefits of tighter standards for new buildings*. [2] Wood PLC (2018) for the CCC.
Notes: All values are rounded to the nearest £hundred. The retrofit costs provided are illustrative of the costs that would be incurred where retrofitting the same measures as we recommend in a new build, and are not representative of the costs of recommended retrofit measures more widely. For a number of these measures, the prohibitively high retrofit costs mean that they would not be cost-effective and would be unlikely to be retrofitted in practice. This illustrates the importance of setting the right standards at the outset.
Mitigation measures (air source heat pump and energy efficiency) - new build costs are based on a semi-detached home built in 2020. Costs represent the incremental costs of incorporating an air source heat pump and ultra-high levels of energy efficiency (equivalent to a space heat demand of 15 kWh/m^2/yr), relative to building a home to current standards with a gas boiler. Retrofit costs represent the costs of retrofitting an air source heat pump and ultra-high levels of energy efficiency in 2030, to a home built in 2020. Retrofit costs have not been discounted back to 2020 prices.
Passive cooling measures - are for a small semi-detached house. Measures include high thermal mass floors, walls and natural ventilation (numbers from Wood PLC), and shading through inward opening windows fitted with external shutters (Numbers from Currie & Brown).
Water efficiency measures - are for a small semi-detached house. Measures include dual flush WC, low flow shower and taps (all zero cost for new builds), low water-use dishwasher and washing machine, and a water butt. Retrofit costs are for a discretionary retrofit and are therefore higher than if replacing or upgrading a product at its end of life.
Flood resilience and resistance measures - are for a three-bed semi-detached house at high risk of flooding (greater than 1% Annual Exceedance Probability). These compare the costs of installing in a new build compared to repairs following a flood. Resilience measures include floors (dense screed and new floor with treated timber joists), wall-mounted boiler, moving a washing machine to first floor, raised ovens and electrics, raised service meters. Resistance measures are a 'fit and forget' package'.

Homes are already being built to deliver a range of these outcomes, with a number of standards in existence internationally to improve quality of homes.

Examples of good practice internationally include:

- The ‘Energiesprong’ standard. Energiesprong is a new-build and whole house refurbishment approach including guaranteed actual whole-home measured energy consumption, as opposed to modelled performance. It originated in the Netherlands as a Government-funded innovation programme and has since been adopted in a number of other countries. Nottingham Council has been the first to adopt this housing approach in the UK (Box 1.3).

- The 'Passivhaus' standard. Passivhaus buildings are designed to use very little energy for heating and cooling, with the design characterised by high levels of fabric efficiency and airtightness as well as measures to address overheating risk. According to the Passivhaus Trust, there were around 1,000 Passivhaus units in the UK at the end of last year.[88]

Box 1.3. Nottingham City Homes - 2050 'Energiesprong' homes

Nottingham City Homes are retrofitting 200 social homes with a view to minimising total social housing spend over a 30 year period. The homes are being retrofitted to the Energiesprong standard, through substantial fabric improvements, ground-source heat pumps with a shared borehole and solar panels on roofs. The costs of the retrofit are covered by bringing forward planned maintenance spend, a 'comfort plan' fee levied on tenants, and subsidies/income from installed renewables, with innovation funding bridging the funding gap in advance of cost reductions through industrialised delivery.

Source: For further information see: https://www.energiesprong.uk/projects/nottingham. Photo courtesy of Melius Homes.

[88] Including both new buildings and buildings retrofitted to the EnerPHit standard, based on similar design and testing criteria. For further information see: http://www.passivhaustrust.org.uk/news/detail/?nId=787#.XFHlQ5XKBQs

Lessons are being learnt from pilot projects and innovative schemes.

The UK Government recently launched a Grand Challenge Mission to halve energy use of new buildings by 2030, and to make sure that every new building is safe, high quality, much more efficient and uses 'clean' heating.[89] The mission is backed by £170 million of public money, over the 4 years to 2021-22, through the Transforming Construction Industrial Strategy Challenge Fund. This is expected to be matched by £250 million of private sector investment. As part of the Mission, a design competition for the 'Home of the Future' is due to be launched in 2019.[90]

The Welsh Government launched the 'Innovative housing programme' in 2017 – a demonstrator scheme which seeks to stimulate the design and delivery of new high quality and affordable homes.[91] The programme has been allocated £90m of funding over three years. These homes aim to significantly reduce or eliminate fuel bills and will help inform the Welsh Government about the type of homes it supports in the future. Entering its third year, the programme is now focusing on mainstreaming some of the innovative schemes tested in year 1 and 2. The approaches planned to be tested at scale are those which have potential to be cost-competitive with traditional homes whilst significantly reducing fuel bills (to less than £100 per year), or eliminating fuel poverty completely (in the case of the 'Homes As Power Stations' initiative).

Now is the time to get our approach right to retrofitting existing houses and building new homes.

The next few years will present significant opportunities to change the way homes are designed, built and retrofitted in the UK. The time to get the approach right is now:

- The UK Government is committed to building around 1.5 million new homes by 2022.[92] Getting standards right now is a fraction of the cost of retrofitting to the same quality and standard later (Table B1.2).
- A review of Part L (which covers conservation of fuel and power) and Part F (ventilation) of Building Regulations is expected in England and Wales in 2019 and 2020, which will have impacts on both existing and new homes. A review of the energy standards of the building regulations in Scotland has also commenced which is programmed for implementation in 2021.
- Substantial progress in reducing greenhouse gas emissions from homes will need to be made in the next few years in order to have a good chance of meeting the UK's existing 2050 target. The Committee's review of long-term targets will be completed early in 2019, to inform Government decisions and plans for any further strengthening of policies. The UK Government's aspirational target to halve emissions in new homes by 2030 is out of step with the urgent timeline the UK has signed up to under the 2015 Paris Agreement.
- The need for homes to be adapted to rising temperatures and flooding is becoming more acute. Around 90,000 homes are projected to be built in high flood risk areas over the next

[89] See https://www.gov.uk/government/publications/industrial-strategy-the-grand-challenges/missions
[90] BEIS (2018) *Clean Growth - Transforming Heating, Overview of Current Evidence*.
[91] See: https://gov.wales/topics/housing-and-regeneration/housing-supply/innovative-housing-programme/?lang=en
[92] BEIS (2018) *Industrial Strategy, Construction Sector Deal*. New homes will include around 120,000 social and affordable housing.

five years.[93] Summers like that of 2018 have already become 30 times more likely due to climate change.[94]

The Government should act now to set an ambitious trajectory of standards, regulations and targets for new homes, ensuring they are fit for 2050 and beyond. Many of those changes are needed urgently, to start over the next two years.

The rest of this report looks at the current state of UK housing from a low-carbon and climate-resilience perspective, identifies what needs to be done, the barriers and gaps to effective action, and recommends where improvements need to be made to ensure that housing quality is brought up to where it needs to be, both to support meeting climate objectives, as well as health and wellbeing.

1.5 Structure of this report

The remainder of the report is structure as follows, considering mitigation and adaptation together where possible:

Chapter 2 sets out our analysis of the fabric measures that are needed to ensure that current and future homes will be fit for the future, focussed on measures inside the home: measures to support heating decarbonisation; energy efficiency, overheating, indoor air-quality and moisture; whole-life carbon; flexibility measures in homes, and water efficiency.

Chapter 3 considers measures around the home and communities, including property level flood resilience and resistance; green infrastructure, and sustainable transport.

Chapter 4 considers four cross-cutting areas where progress is needed, building on the advice of previous chapters: addressing compliance issues and closing the 'performance gap', building regulations, wider principles to guide the retrofit of existing homes and local authority action to deliver low-carbon, resilient homes.

[93] CCC (2017) *Progress in preparing for climate change*. 'High' flood risk in this context means areas at greater than 1% annual flood risk.
[94] See: https://www.metoffice.gov.uk/news/releases/2018/2018-uk-summer-heatwave

Chapter 2: Low-carbon, low-energy and water efficient homes

Key messages

UK homes have a critical role to play in meeting the twin climate goals of reducing emissions and adapting to the current and future climate. It will not be possible to meet the legally-binding 2050 emissions reduction target (or future ambitions for net-zero emissions) without a near complete decarbonisation of how we heat our homes. Retrofitting of measures offers substantial opportunities for addressing climate risks and improving people's health and wellbeing. Upcoming reviews of building regulations provide an opportunity to make sure new homes are built for the future. Our homes must be low-carbon, energy efficient, have safe moisture levels, excellent indoor environmental quality, and be climate resilient.

This is not happening at present. Greenhouse gas emissions from existing homes are not falling, policy is failing to drive sufficient uptake of energy efficiency and low-carbon heat, the Government's own research has concluded that all new build homes are at risk of overheating[95], and household water consumption needs to come down from around 140l/p/d to well below 100l/p/d by 2050 to address risks of future lower water availability:

- **Low-carbon, energy efficient homes.** Decarbonising how we heat our homes requires a strategic approach which a) deploys low-regret options now (energy efficiency, heat pumps in homes off the gas grid and in new builds, hybrid heat pumps in homes on the gas grid, low-carbon heat networks, biomethane injected in to the gas grid) and b) builds towards strategic decisions on the future of the gas grid (and role of hydrogen for heat) in the mid- to late-2020s. Switching to low-carbon heating must be done alongside energy efficiency, so as to size the new heating system properly and guarantee high-performing, low-energy systems. HMT and BEIS must commit to a fully-fledged heat strategy which includes a clear trajectory of standards set well in advance, funding for low-carbon heat from 2021, incentives for able-to-pay householders and a governance framework to drive decisions on heat infrastructure.
- **Thermal comfort, ventilation and indoor air quality.** The technology exists to deliver homes which have high levels of thermal efficiency (staying warm in winter while cool in summer), while being moisture-safe and with excellent indoor air quality. Achieving this requires a holistic approach in design, build and retrofit, which is currently not being driven effectively by existing policy. Standards for overheating must be put in place. Passive cooling measures should be adopted in existing and new homes to reduce overheating risks before considering active measures such as air conditioning. Regulations around ventilation must evolve to keep pace with improvements in the energy efficiency of buildings and there is a need for better coordination across energy and ventilation requirements. Further work is needed to ensure mechanical ventilation systems perform as they should.
- **Electrical energy efficiency, flexibility and peak management**. Fabric efficiency (walls, lofts) and other measures such as glazing will reduce space heating demand, but more is needed to reduce energy requirements for hot water and appliances. This means insulating hot water tanks and pipes, putting in hot water thermostats, low-energy lighting and highly efficient appliances. Measures such as batteries and smart appliances also allow householders to use energy more flexibly, helping to shift consumption away from peak and towards periods when renewable energy is available.
- **Whole-life carbon impacts and wood in construction**. We need more focus on the whole-life carbon impact of new homes, including embodied and sequestered carbon. As part of this, using wood in construction to displace high-carbon materials such as cement and steel is one of the most effective ways to use limited biomass resources to mitigate climate change, because it both displaces industrial carbon emissions and stores carbon long-term in buildings.[96] In the 2017 *Clean*

[95] MHCLG (2018) *Government response to EAC Inquiry on Heatwaves*.
[96] CCC (2018) *Biomass in a low-carbon economy*.

Key messages

Growth Strategy, the Government committed to developing new policies to support a substantial increase in the use of wood in construction - these are needed to overcome a range of cultural, skills and financial barriers in the construction sector. Low-regret action should also be taken to support the assessment and benchmarking of whole-life carbon in buildings, with a view to informing the future policy framework.

- **Water efficiency**. Reducing water use in homes is one of the most important ways of enhancing the resilience of water supplies across the UK. Defra should set an ambitious per capita consumption target for water to be met through water efficiency measures, increased metering, compulsory water efficiency labelling, improved behaviours and more ambitious building regulations. Reducing water consumption also reduces energy use and household bills. There is a need for water and energy retrofit programmes to be better aligned, and for research to better understand how the designed water efficiency level compares to the actual water efficiency of homes once built and occupied.

2.1 Purpose of this chapter

This chapter sets out how UK homes can contribute to long-term emission reductions and be well-adapted to the current and future climate.

Where possible we consider the costs and benefits of measures and identify those which are low-regret. The chapter is structured into sections on: heating decarbonisation; energy efficiency, overheating, indoor air quality and moisture; whole-life carbon; flexibility measures in homes; and water efficiency.

2.2 Decarbonising heating – a strategic approach

This section summarises our strategic advice on decarbonising heating in the 2016 Heat report and 2018 Hydrogen review.

Energy efficiency must be pursued alongside heat decarbonisation. We cover energy efficiency in more detail in the next section, as well as how this can be implemented without adverse impacts on indoor air quality or exacerbating overheating risks**.**

Deployment of low-carbon heat cannot wait until the 2030s. In the next decade, there is a set of measures that are sensible regardless of the longer-term path to decarbonising heating in buildings. In our 2016 Heat report we identified low-regret opportunities for heat pumps to be installed in homes that are off the gas grid and in new build, for low-carbon heat networks in heat-dense areas (e.g. cities) and to increase volumes of biomethane injection into the gas grid (Box 2.1).

Low-carbon heating must be installed alongside the continued rollout of energy efficiency measures (walls, cavities, lofts, glazing and draught proofing) and passive cooling (e.g. shading), so as to enable new heating systems to be sized properly and to guarantee high performing, low-energy systems. Risks from overheating, inadequate ventilation and moisture must be considered and mitigated (Section 2.3).

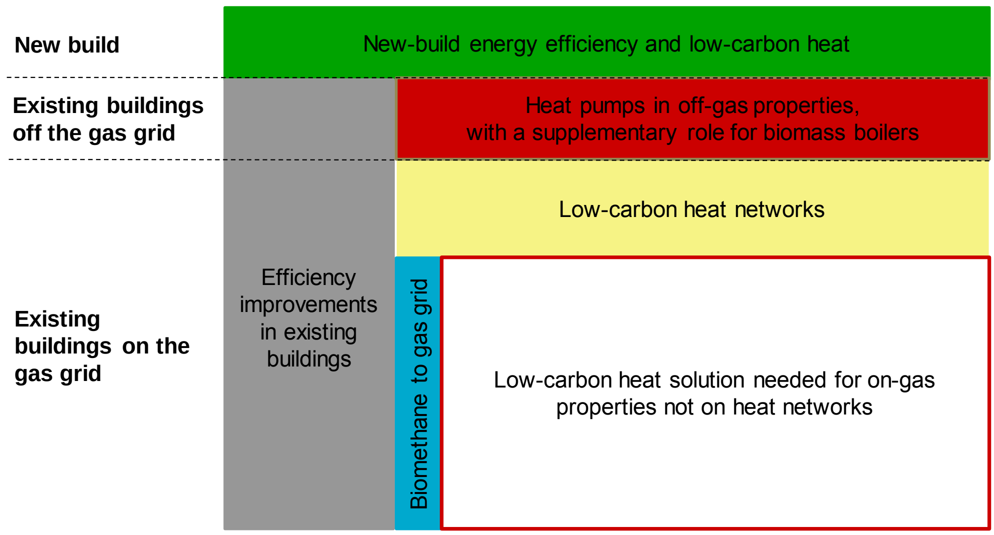
Box 2.1. Low-regret actions for buildings decarbonisation

In our 2016 report, *Next steps for UK Heat Policy*, the Committee identified low-regret routes to reducing emissions from heating buildings that the Government should pursue immediately: energy efficiency improvements to existing buildings; ensuring that new buildings are efficient and low-carbon from the outset; installation of heat pumps in buildings off the gas grid; roll-out of low-carbon heat networks in population-dense urban areas; and injection of biomethane into the gas grid:

- **Heat pumps in buildings not on the gas grid.** Heat pumps are the leading low-carbon option for buildings not connected to the gas grid. Together with new build properties, installation of heat pumps in buildings off the gas grid can help create the scale needed for supply chains to develop, potentially in advance of accelerated heat pump roll-out in on-gas grid properties after 2030.
- **Low-carbon new build.** Installing low-carbon heating from the outset in new homes means that costs of connecting to the gas grid can be avoided and the system designed optimally for the property. This makes heat pumps cheaper to install and run in new homes than in existing gas-heated homes.
- **Low-carbon heat networks.** District heating schemes require a certain density of heat demand in order to be economic, which means that they are suited to urban areas, new build developments and some rural areas. Low-carbon heat sources can include waste heat, large-scale (e.g. water-source) heat pumps, geothermal heat and potentially hydrogen.
- **Biomethane.** Injecting biomethane into the gas grid is a means of decarbonising supply without requiring changes from consumers, and provides a route for capture and use of methane emissions from biodegradable wastes. However, its potential is limited to around 5% of gas consumption.

We consider energy efficiency improvements and new build in greater detail in subsequent sections of this report.

Figure B2.1. Low-regret measures and remaining challenges for existing buildings on the gas grid



Source: CCC (2016) *Next steps for UK Heat Policy.*
Notes: The sizes of the blocks broadly reflect the scale of emissions reduction, but not precisely. Some potential for heat networks will be in new build and off the gas grid, rather than all on-grid as presented.

Source: CCC (2016) *Next steps for UK Heat Policy.*

Whilst the low-regrets measures set out above can make a significant contribution to reducing emissions from buildings, they still leave a substantial challenge over what to do about existing buildings on the gas grid, especially those in less heat-dense areas.

We have recently updated our advice in this area, identifying potential for near-term deployment of 'hybrid' heat pumps at scale on the gas grid (e.g. 10 million hybrid heat pumps by 2035).[97] This approach would have a number of benefits including enabling greater reductions in near-term emissions from buildings and providing a potential route, with hydrogen, to reach very low emissions by 2050 (Box 2.2). This is effectively a further 'low-regret' action which Government can pursue now – compatible with a range of future pathways, developing options and delivering near-term emission reductions.

Box 2.2. Low-carbon heat in existing homes on the gas grid

Our 2018 report, *Hydrogen in a Low-Carbon Economy*, examined the merits of a range of scenarios for decarbonising on-gas buildings using different combinations of electrification and hydrogen for heating. Our assessment is that:

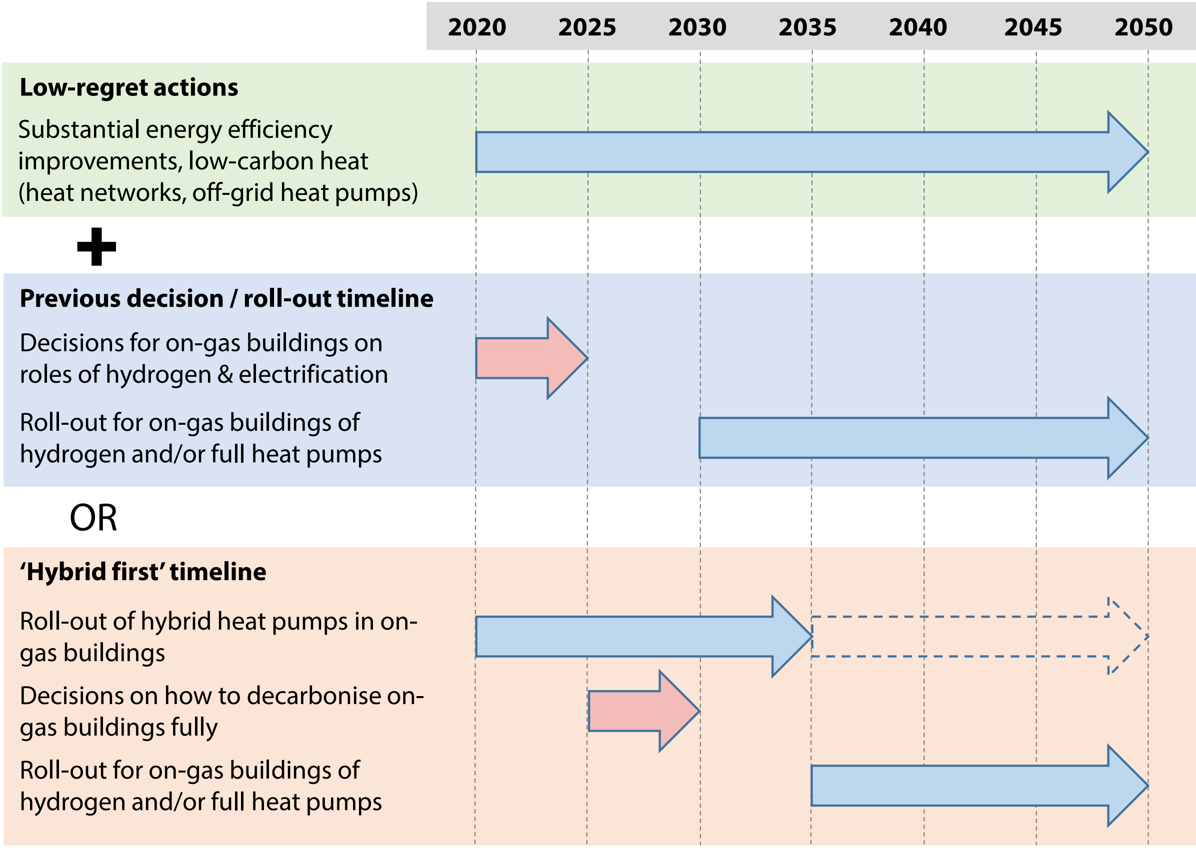
- Hydrogen could play a valuable role as part of a heating solution for UK buildings, primarily in combination with heat pumps as part of 'hybrid heat pump' systems. Heat pumps, powered by increasingly low-carbon electricity, offer the potential to provide heat efficiently for most of the time, with hydrogen boilers contributing mainly as back-up to meet peak demands on the coldest winter days.
- Whilst early deployment of hybrid heat pumps would predominantly be expected to be in combination with natural gas boilers, in the longer-term hydrogen could displace this fossil fuel use. While not without challenges, this would enable the energy system to reach very low emissions. Feasibility and public acceptance issues look likely to be easier than strategies for the full electrification of heat, or the full use of hydrogen as a like-for-like replacement for natural gas as we use it today.

We have previously identified the need for key strategic decisions in the early 2020s on low-carbon heat for properties on the gas grid. The new evidence suggests there is now a case to deploy hybrid heat pumps at scale from 2020. This will allow the decision over how to decarbonise heat fully for on-gas properties to follow slightly later than we had previously set out (Figure 2.2).

[97] CCC (2018) *Hydrogen in a low-carbon economy*. 'Hybrid' heat pumps use a heat pump to meet the bulk of heat demand, while retaining boilers to provide heat on colder winter days. A hybrid heat pump can be retrofitted around the existing boiler, making it part of an upgraded, smart heating system.

Box 2.2. Low-carbon heat in existing homes on the gas grid

Figure B2.2. Pursuing a 'hybrid first' approach alongside other low-regret actions



Source: CCC (2018) *Hydrogen in a low-carbon economy.*
Notes: 'Low-regret' actions are those that the Committee recommended in 2016 should be pursued immediately, with subsequent decisions to be made by the mid-2020s on the respective roles of hydrogen and electrification in on-gas buildings outside heat network areas, for roll-out between 2030 and 2050 (shown the middle section of the diagram). The 'hybrid first' timeline would entail pursuing the low-regret actions now alongside deployment of hybrid heat pumps in on-gas properties, with decisions on achieving full decarbonisation able to come slightly later.

Source: CCC (2018) *Hydrogen in a low-carbon economy.*

Further policy progress will be needed to deploy the low-regret options.

A UK strategy is needed for decarbonising heating and hot water demand, with HM Treasury taking a lead role. This should build on the Heat Roadmap the Government have committed to publishing within the next 18 months.[98] Alongside greater action on energy efficiency (considered further in section 2.3), early clarity is needed on the support framework for low-carbon heating, including a long-term policy framework for heat networks and financial support for heat pumps and biomethane post-2021. Detailed plans are needed on phasing out the installation of high-carbon fossil fuel heating (including the proposed regulatory approach). Standards should drive continued efficiency improvements in boilers and heating systems,

[98] BEIS (2018) *Clean Growth - Transforming Heating, Overview of Current Evidence*

including through upcoming reviews of Building Regulations where needed. Hydraulic balancing can boost overall system efficiency but has been overlooked in Boiler plus (which focuses on the boiler rather than the system). [99] Appropriate training for installers and heating engineers will be needed to underpin the transition.

Important questions remain to be resolved around the current balance of tax and regulatory costs across fuels: costs are significantly larger for electricity than gas or oil heating, and the full carbon costs are not reflected in the pricing of heating fuels. These factors currently weaken the private economic case for electrification.

Recommendation: In our report on hydrogen in November 2018, we recommended that the Government should develop a fully-fledged UK strategy for decarbonised heat within the next 3 years. Subsequently, BEIS has committed to publication of a new heat roadmap within 18 months. It is essential that Treasury should commit now to working with BEIS on development of the roadmap/strategy. This must include clear signals on the future use of the gas grid in the UK and commitments to funding and, as a minimum:

- A clear trajectory of standards covering owner-occupied, social- and private-rented homes, announced well in advance (including detailed plans on phasing out the installation of high-carbon fossil fuel heating and improvements in the efficiency of existing heating systems).
- A support framework for low-carbon heating (heat pumps, biomethane, and networked low-carbon heat).
- A review of the balance of tax and regulatory costs across fuels in order to improve alignment with implicit carbon prices and reflect the progressive decarbonisation of electricity.
- An attractive package for householders aligned to trigger points (such as when a home is sold or renovated).
- A nationwide training programme to upskill the existing workforce.
- A governance framework to drive decisions on heat infrastructure through the 2020s.

(*Owner: HMT, BEIS. Timing: within the next 18 months - 3 years).*

All new homes should be future-proofed for low-carbon heating, and by 2025 at the latest, no new homes should be connecting to the gas grid.

We have previously recommended that Government strengthen new build standards to future-proof for low-carbon heating, with a further tightening of standards in 2025 to support deployment of low-carbon heat.

We recently commissioned Currie & Brown and Aecom to undertake research on the cost-effectiveness of new lower-carbon and lower-energy buildings.[100] This research has yielded new insights on the cost savings that can be delivered through future-proofing measures and the

[99] For further discussion see: https://uk.grundfos.com/content/dam/UK/Brochure/E3915%20Hydronic%20Balancing%20report%203.pdf and https://www.sustainableenergyassociation.com/resources/next-steps-for-boiler-plus/. Lime scale build up is also an issue.

[100] Currie & Brown and Aecom for the CCC (2019) *The costs and benefits of tighter standards for new buildings.*

timescale on which low-carbon heat can be expected to offer cost-effective carbon savings in new build homes.

Future-proofing new homes for low-carbon heating, through the use of appropriately-sized heat emitters and low-temperature compatible thermal stores, has been estimated to save £1,500-£5,500 of costs compared to later having to retrofit low-carbon heat from scratch.[101] All new homes should therefore be future-proofed for low-carbon heating at the earliest opportunity:

- A range of low-carbon heating systems rely on low flow and return temperatures to operate efficiently. This includes heat pumps and low-temperature district heat networks.
- Two future-proofing measures reduce the costs of retrofitting low-carbon heat at a future date: heat emitters suitable for low temperature heating (radiators approximately 2.5 times the output capacity of standard radiators, achieved through double emitter panels and increased length or height, or underfloor heating); and low-temperature compatible hot water stores in homes where thermal stores are necessary (incorporating larger heat exchangers such as double coil heating elements).[102]
- Low-temperature radiators add around £150-£500 to the upfront cost of building a home.[103] Where a hot water store is to be added to a new build home (e.g. for the purposes of meeting hot water demand in larger properties), the incremental costs of making it low-temperature ready are expected to be negligible where deployed at scale.[104]
- If these features were to be retrofitted at a later date, additional costs of £1,500-£5,500 would be incurred reflecting the need for radiator replacement, adjustments to plumbing, removal and disposal and making good. This is expected to be an underestimate on the basis that 'hassle' costs would be additional. Installing larger radiators from the outset has the additional benefit of enabling gas boilers to operate more efficiently.

The evidence indicates that low-carbon heat is now cost-effective in all new build homes by 2025 or earlier. On this basis, no new homes should connect to the gas grid from 2025 at the latest. Instead, new homes should make use of low-carbon heating systems such as heat pumps and low-carbon heat networks. Early deployment of low-carbon heat in new homes will help reduce the retrofit challenge by increasing familiarity amongst installers and the general public, better prepare the stock for net-zero ambitions, and help develop supply chains for broader uptake:

- As part of our 2015 analysis for the fifth carbon budget we identified the potential for cost-effective deployment of heat pumps in 1.1 million new homes to 2030, based on assumed

[101] Cost range reflects £1,500 for a small flat, extending up to £5,500 for a detached house.
[102] The analysis did not highlight a significant efficiency benefit from underfloor heating in comparison to appropriately sized radiators running at the same temperature. It therefore focused on modelling radiators as the lower cost option. However, underfloor heating may be preferable for other reasons in some new build homes, e.g. for convenience, and to minimise use of wall space.
[103] Cost range reflects £150 for a small flat, extending up to £500 for a detached house. These costs are based on the assumption that radiators in homes built to current standards are sized to match heat demand. To the extent radiators are typically oversized in new build homes, this will reduce the incremental costs further.
[104] Currie & Brown and Aecom for the CCC (2019) *The costs and benefits of tighter standards for new buildings.* For homes which do not have hot water stores at the point of build, this will need to be added as part of any heat pump installation. The assumed sizing is 200-210l for flats and semi-detached homes. There must be adequate space provision in properties to allow for this. National space standards set out minimum areas for different types of property. The required storage space includes an allowance of 0.5m^2 for services (e.g. hot water storage and boilers). This is expected to be adequate.

uptake in 50% of new build homes from 2025, alongside heat networks for 1.5m new and existing homes.[105]

- The evidence now indicates that low-carbon heat, and heat pumps specifically, are expected to deliver cost-effective carbon savings in all new build homes by 2025 or earlier:[106]
  - The modelling undertaken by Currie & Brown and Aecom finds that heat pumps become cost-effective across new build homes by 2021.
  - New evidence since our fifth carbon budget analysis - including updated electricity costs and costs of gas grid connections - also points to cost-effectiveness earlier in the 2020s.
    - Relative to our previous analysis, estimates of the long-run variable cost of electricity in 2050 have been revised down.[107]
    - We have also revised our assessment of projected electricity grid carbon intensity to reflect recent progress in closing coal generation and installing renewable electricity generation capacity.
    - Updated modelling now accounts for the gas network costs that can be avoided where low-carbon heat is installed from the outset (assumed to be c. £350-£1100 per home).[108]
- Of all of the measures examined as part of Currie & Brown and Aecom's analysis of tighter standards in new build homes, heat pumps were found to offer the most potential for carbon savings, delivering around 25-85 tCO_2 savings per home over a 60 year lifetime, relative to a new home built to current standards with a gas boiler.[109] This represents a reduction in lifetime regulated carbon emissions of over 90%.[110]
- Alongside carbon savings, there is scope for heat pumps to deliver average annual bill savings. For a semi-detached home these are expected to be in the region of £55 per year on average, relative to a home built to current standards with gas heating.[111]
- Heat pumps are expected to add £800-£2500 to the costs of building a home in 2020 depending on the type of house. This represents a 0.6-2.0% increment on total build costs.[112]

[105] CCC (2015) *Sectoral scenarios for the Fifth Carbon Budget.*
[106] Recent modelling by the CCC, and Currie & Brown and Aecom, has focused predominantly on heat pumps as one of the leading low-carbon heating options in new homes. See Currie & Brown and Aecom for the CCC (2019) *The costs and benefits of tighter standards for new buildings*. Findings remain applicable to low-carbon heating more broadly.
[107] This is to reflect changes in wholesale electricity costs and to be consistent with the cost reductions implied by recent modelling undertaken by Imperial College London for the Committee on the decarbonisation of the UK's energy system, and a reduction in subsidy payments to low-carbon generators beyond 2030.
[108] Aqua Consultants for the CCC, as part of Frontier Economics and Aqua Consultants (2016) *Future Regulation of the UK Gas Grid, Impacts and Institutional implications of UK gas grid future scenarios.*
[109] Costs reflect homes built in 2020. Carbon savings vary by building archetype, ranging from around 25 tCO_2 of lifetime savings in a small flat (50m^2) to 85 tCO_2 savings in a 4 bedroom detached house (117 m^2).
[110] Currie & Brown and Aecom for the CCC (2019) *The costs and benefits of tighter standards for new buildings.*
[111] Figure denotes average annual bill savings for a home built in 2020. The scale and nature of the bill impact is in part a function of the standing charges associated with gas and electricity bills, and will vary with the scale of standing charges assumed. For more detail on the assumptions underpinning the modelling see Currie & Brown and Aecom for the CCC (2019) *The costs and benefits of tighter standards for new buildings.*
[112] Range reflects costs for a small flat (£800) relative to a semi-detached home (£2500). The uplift cost is higher for a semi-detached property than for a detached home, due to the need to install a hot water store which would not otherwise be necessary.

Costs are expected to come down by c. 4-5% by 2025, reflecting learning around installation practice.[113]

A pathway for delivering on uptake for 2025 could imply roll-out of low-carbon heat in up to 50% of homes from 2020.

Recommendation: All new homes should be made low-carbon heat ready. By 2025 at the latest, no new homes should connect to the gas grid, and should instead rely on low-carbon heating systems such as heat pumps.

(*Owner: MHCLG, BEIS, devolved administrations. Timing: trajectory set out by 2020*).

There are a range of regulatory routes which could be used to drive low-carbon heat in new build homes. Last year the Dutch Government introduced regulations which by default prevent new homes connecting to the gas grid.[114] Alternative approaches might include a heat supply standard ($kgCO_2e$/kWh of heat) or carbon standard ($kgCO_2/m^2/yr$) as used in the building standards framework currently. However, a reliance on heat or carbon standards can be associated with sub-optimal outcomes where there are deficiencies in the mode of application (e.g. where standards are set on an average basis across groups of dwellings), or in the calculation methodology (e.g. inaccurate valuation of grid carbon intensity).

The latter is already a significant issue in the Standard Assessment Procedure (SAP). SAP undervalues the carbon savings that can be delivered by heat pumps and other electricity-based heating systems because it does not account for the declining carbon intensity of the grid (Box 2.3). The grid carbon intensity in the current version of SAP (SAP 2012) is 4 times higher than the projected 15-year grid average, with the planned grid carbon intensity in the forthcoming version of SAP (SAP 10) remaining around twice as high.

Box 2.3. The influence of SAP assumptions on the uptake of low-carbon technologies

The Standard Assessment Procedure (SAP), is the methodology used by the Government to assess and compare the energy and environmental performance of dwellings. It is the basis for establishing compliance with Building Regulations, and for Energy Performance Certificates. SAP makes assessments based on a range of assumptions around things like the efficiency of heating systems and the emissions intensity of fuels. These assumptions can have a profound influence on the extent to which low-carbon measures are deployed in homes. There are a number of areas where SAP currently fails to properly value the benefits of low-carbon technologies.

The first is in relation to emission factors for electricity. SAP calculates the energy and carbon implications of a building component by using a single emissions factor for each fuel. These emission factors reflect the average carbon intensity forecast over a 3-5 year period following the SAP update - for SAP 2012 the electricity carbon intensity was set at 0.519 $kgCO_2$ per kWh and this carbon intensity remains the basis of SAP calculations today.

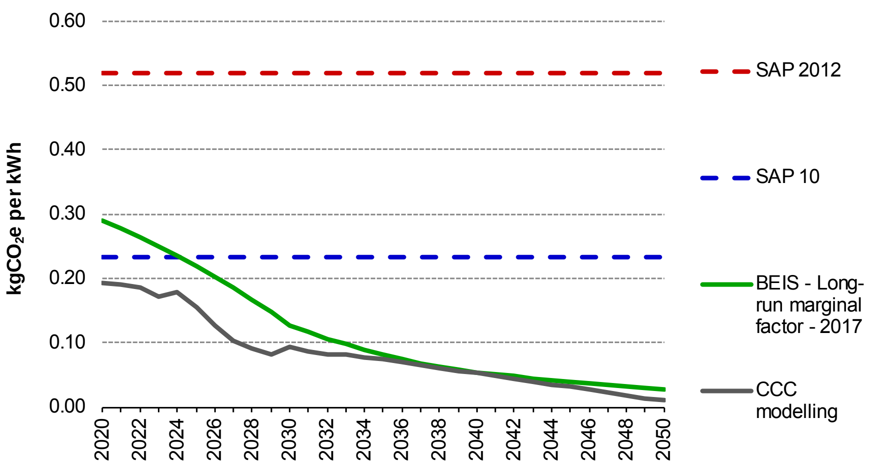
[113] Currie & Brown and Aecom for the CCC (2019) *The costs and benefits of tighter standards for new buildings*.
[114] As of 1st July 2018, the default situation for all new building permit applications in the Netherlands is that the building will not be allowed to connect to the gas grid. Local authorities have the power to grant exemptions, although the exemptions regime is planned to become stricter with time. Vivid Economics and Imperial College (2017) *International Comparisons of Heating, Cooling and Heat Decarbonisation Policies, Annex*; Delta EE (2018) *Do gas boilers still have a role to play in Dutch new build homes?* Delta-EE Research Blog.

Box 2.3. The influence of SAP assumptions on the uptake of low-carbon technologies

In reality, building components have much longer lifetimes (15 years in the case of heat pumps) and electricity emission factors are not static, but decreasing. The carbon intensity of electricity has more than halved since 2012 and is projected to fall by over 50% again by 2030.

Figure B2.3 illustrates the difference between the current SAP assumptions on average electricity carbon intensity, and Government and Committee projections for electricity carbon intensity out to 2050.

Figure B2.3 Comparing assumptions on the trajectory of electricity carbon intensity



Source: Currie & Brown and Aecom for the CCC (2019) *The costs and benefits of tighter standards for new buildings.*
Notes: Based on SAP 2012: The Government's Standard Assessment Procedure for Energy Rating of Dwellings; SAP 10: The Government's Standard Assessment Procedure for Energy Rating of Dwellings; BEIS (2018) Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal, Data tables 1 to 19; CCC assumptions.

In order to properly value the benefits of low-carbon technologies, it is critical that the methodologies underpinning standards accurately reflect the Government expectations on declining grid carbon intensity over the lifetime of the measures being installed.

Secondly, SAP can materially influence the uptake of low-carbon technologies through the technologies it includes and the assumptions it makes around the efficiency of low-carbon heating systems. Committee assessments of achievable Seasonal Performance Factors (SPFs) for air source heat pumps indicate space heating efficiencies significantly higher than those assumed under the SAP default values.[115] In our fifth carbon budget scenarios, we assume a current SPF of 2.5 for air source heat pumps in retrofit, with potential to increase to 3.0 with learning. For new build, we assume an SPF of 2.75. Recent evidence suggests CCC assumptions may remain pessimistic for new homes.

Source: Currie & Brown and Aecom for the CCC (2019) *The costs and benefits of tighter standards for new buildings*
BRE (2011) *Technical papers supporting SAP12,* available at: https://www.bre.co.uk/filelibrary/SAP/2012/STP11-HP-01_Heat_Pumps.pdf

[115] CCC assumptions are based on results from two sets of field trials conducted by the Energy Savings Trust and DECC, along with results from monitoring of heat pumps installed under the Renewable Heat Premium Payment (RHPP) scheme and stakeholder views of the scope for improvement over time.

Recommendation: The Standard Assessment Procedure should be reviewed and revised to drive high real-world performance and value properly the benefits of low-carbon technologies. It should formally integrate a forward trajectory for declining grid carbon intensity, in line with Government projections.

(*Owner: MHCLG, BEIS. Timing: by 2020).*

2.3 Energy efficiency, overheating, indoor air quality and moisture

2.3.1 A holistic approach

Measures to address thermal efficiency, overheating, indoor air quality and moisture must be considered together when retrofitting or building new homes.

The technology exists to deliver homes which have high levels of thermal efficiency, are better adapted to a changing climate, with safe moisture levels and with excellent indoor air quality. However, the lack of a holistic approach in current design and build practices can lead to build quality issues. Close interlinkages between these various objectives drive the need to consider them alongside one another:

- Loft and wall insulation can help to prevent heat penetration through roofs and walls. However, once heat has entered a home, insulation also can reduce heat loss through the building fabric at night.[116] Access to purge ventilation has been found to be a key determinant of whether insulation exacerbates or mitigates overheating risk.[117,118] Studies show that overheating risks can, in principle, be largely mitigated with adequate ventilation and other measures such as external shading.[119]
- Achieving very high levels of thermal efficiency requires increased airtightness and the use of Mechanical Ventilation and Heat Recovery (MVHR) systems.[120] MVHR technology has significant potential to improve air quality in homes, where properly designed, commissioned, installed, maintained and operated. However, there is also evidence that this is not always the case in current installations:
  - The use of MVHR, if implemented correctly, can result in better levels of ventilation compared to naturally ventilated houses and can also have benefits for health and wellbeing where wider issues prevent natural ventilation strategies (e.g. external

[116] Mavrogianni, A; et al. (2012) *Building characteristics as determinants of propensity to high indoor summer temperatures in London dwellings.* Building and Environment, 55 117-130.
[117] Purge ventilation is manually controlled ventilation of rooms or spaces at a relatively high rate to rapidly dilute pollutants and/or water vapour. Purge ventilation may be provided by natural means (e.g. an openable window) or by mechanical means (e.g. a fan).
[118] Fosas, D. et al. (2018) *Mitigation versus adaptation: does insulating dwellings increase overheating risk?* Building and Environment, 143, 740-759.
[119] *Ibid*.; Tink, V. Porritt, S. Allinson, D. and Loveday, D. (2018). *Measuring and mitigating overheating risk in solid wall dwellings retrofitted with internal wall insulation.* Building and Environment, 141, 247-261; Schnieders, J. (2003) CEPHEUS - measurement results from more than 100 dwelling units in passive houses. *ECEEE 2003 summer study - time to turn down energy demand.*
[120] Based on modelling in SAP undertaken by Currie & Brown and Aecom, the tightest standards (25kWh/m^2/yr and below) cannot be achieved without improved airtightness and the use of MVHR systems in at least some archetypes. 15kWh/m^2/yr would require MVHR in all. See Currie & Brown and Aecom for the CCC (2019) *The costs and benefits of tighter standards for new buildings.*

pollution, security concerns or noise).[121] This benefit is particularly relevant in cities with high outdoor pollution levels, which are often the site of low-income housing.

  – As well as enabling heat recovery in the winter, MVHR can support comfortable internal temperatures during the summer, providing systems have effective summer bypasses. There is also potential for MVHR systems to support cooling functionality where designed appropriately (e.g. alongside a cooling unit).
  – Nevertheless, a range of studies have also found cases of poor environmental conditions in houses with MVHR due to issues such as poor design and commissioning, and lack of education around use.[122] As a result, inadequate ventilation can then exacerbate health risks relating to a range of pollutants e.g. volatile organic compounds. The effectiveness of summer bypasses can also vary across products, as a result of limited guidance and standards in this area.

- Unless properly addressed, creating low-energy buildings with increasing amounts of insulation and airtightness can lead to an increased risk of moisture-related damage to the structure and internal environment, as well as adding to the risk of mould growth, with implications for occupant health. These risks can be addressed through testing of materials and appropriate design and installation, including taking a 'whole building' approach.[123]

The current regulations relating to thermal efficiency, overheating, air quality and moisture penetration are set out in Building Regulations across the UK. There are also a range of wider regulations, standards and guidance documents that are relevant (Table 2.1). The technical guidance documents are periodically updated, with different components generally being reviewed at different times. Upcoming reviews are expected of Approved Document L and Approved Document F in England, with a review of the Scottish energy standards already underway.

The regulatory and policy framework should require holistic approaches to delivering energy efficient, better ventilated, moisture-safe and thermally-comfortable homes. This should include an update to building regulations, requiring appropriate assessment and mitigation of overheating, indoor air quality and moisture risks during the design and build process for new homes and retrofits.

[121] Sharpe, T. Mawditt, I. Gupta, R. McGill, G. and Gregg, M. (2016) *Characteristics and performance of MVHR systems - A meta study of MVHR systems used in the Innovate UK Building Performance Evaluation Programme*. Technical Report. Innovate UK.
[122] *Ibid.*
[123] BSI (2017) *Moisture in buildings: an integrated approach to risk assessment and guidance;* BRE (2016) *Solid wall heat losses and the potential for energy saving*.

Table 2.1. Relevant legislative frameworks				
	England	**Wales**	**Scotland**	**Northern Ireland**
Regulations	The Building Regulations 2010 and (Amendment) Regulations 2013	The Building regulations 2010 and (Amendment) (Wales) Regulations 2014	The Building (Scotland) Regulations 2004	The Building Regulations (Northern Ireland) 2012
Technical guidance	Approved Document L, F, C	Approved Document L, F, C	Domestic Technical Handbook	Technical Booklet F1, K and C
Supporting guidance	Domestic Building Services Compliance Guide, Domestic Ventilation Compliance Guide	Domestic Building Services Compliance Guide, Domestic Ventilation Compliance Guide	Domestic Building Services Compliance Guide, Domestic Ventilation Guide, Accredited Construction Details (Scotland) 2015	
Calculation procedure	SAP 2012			

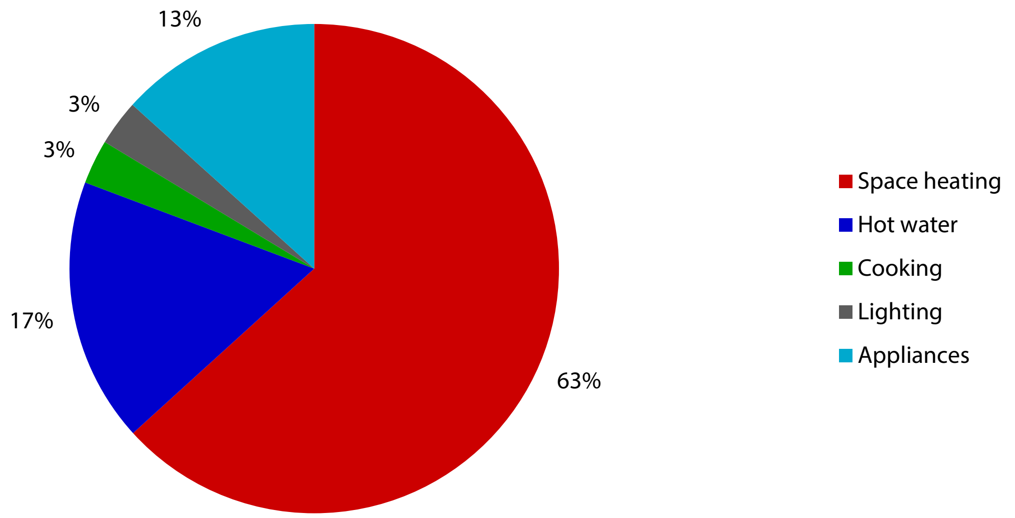
2.3.2 Energy efficiency retrofit

There is an urgent need to retrofit energy efficiency measures in existing homes as part of a broader programme of heat decarbonisation.

Energy efficiency is critical to reducing emissions and energy bills, improving health and wellbeing, helping tackle fuel poverty and making buildings better suited to low-carbon heating. Expertise in highly energy efficient buildings also represents an industrial opportunity for the UK.

Space heating is the dominant driver of energy consumption in existing homes (making up 63% of annual energy consumption), followed by hot water demand (17%) and appliance demand (13%) (Figure 2.1).

Figure 2.1. Breakdown of energy consumption in existing homes, TWh (2017)



Source: BEIS (2018) *Energy Consumption in the UK.*

There is considerable potential to improve the energy efficiency of existing buildings at reasonable cost. Our scenarios include around a 15% reduction in energy used for heating existing buildings by 2030 through efficiency improvements, requiring insulation of about 7.5 million walls and lofts in homes,[124] glazing improvements, draught proofing, hot water efficiency, and heating controls (Box 2.4).

Box 2.4. Summary of carbon savings from energy efficiency measures (Central Scenario for the fifth carbon budget)

Solid wall insulation: we assume cost-effective uptake in around one million homes, focused on properties not connected to the gas grid, alongside uptake in a further one million homes for wider fuel poverty benefits.

Cavity wall and loft insulation: we assume that almost all of the potential for low-cost cavity wall and loft top-up insulation is delivered in the 2020s. For cavity walls, this includes four million easy-to-treat walls and two million hard-to-treat walls where the cavity can be treated cost-effectively. Cavity walls that would require more expensive solid wall treatment are excluded.

Other fabric measures: measures are focused on reducing heat loss from flooring, doors and windows through the installation of floor insulation, insulated doors and draught strips.

Glazing: this covers two types of glazing improvements – switching from single to double glazing, where energy savings would be higher, and from pre-2002 double to new double glazing.

Heating controls: these comprise three controls: thermostatic radiator valves (TRVs), timers and thermostats. The largest savings potential comes from installing TRVs.

[124] In both cases, relative to 2015.

Box 2.4. Summary of carbon savings from energy efficiency measures (Central Scenario for the fifth carbon budget)

Hot water efficiency measures: insulating hot water tanks, the installation of hot water cylinder thermostats, and the use of reduced flow showers all save hot water use.

Behavioural change: turning down the thermostat by one degree centigrade and switching lights off are low-cost changes households can make.

Lighting: Savings from switching from incandescent lamps to compact fluorescents and from halogens to LEDs are focused on indirect emissions. There is however, a corresponding increase in direct emissions of 1 $MtCO_2$ by 2030 due to the heat replacement effect. This occurs because as lighting and other electricity products become more efficient, they produce less waste heat. Our assessment allows for a small amount of additional heating requirement.

Appliances: Driven by end of lifetime replacements and tightening EU energy efficiency standards, we expect a high uptake of the most efficient cold and wet energy efficient appliances (e.g. fridges and dishwashers). This will provide a significant electricity saving but would increase direct emissions by 0.8 $MtCO_2$ by 2030.

Annual direct emissions savings from all the residential energy efficiency measures considered could save 6 $MtCO_2$ by 2030.

In addition, we estimate that take-up of energy efficiency measures can reduce electricity use by around 30 TWh by 2030. Electricity demand reduction is driven by the large uptake of the most efficient white appliances, electric ovens and televisions which deliver over 60% of the savings by 2030. A further 6.8 TWh is due to householders switching to more efficient lighting.

Source: CCC (2015) *Sectoral scenarios for the Fifth carbon budget*. Supporting research is set out in Element Energy and Energy Savings Trust (2013) *Review of potential for carbon savings from residential energy efficiency*, and considered in CCC (2013) *Fourth Carbon Budget review*, both available online at: https://www.theccc.org.uk/publication/fourth-carbon-budget-review/

Current policy is failing to drive uptake.

In many areas current policy is failing to drive uptake, including for highly cost-effective measures such as loft insulation. Policies have yet to be set out to deliver the stated ambition on home retrofits (EPC band C by 2035), including for those households deemed 'able-to-pay', and a delivery mechanism for social housing minimum standards. Policy needs to incentivise efficient long-term investments, rather than piecemeal incremental change. Backstop mandatory requirements can support this, as in Scotland, creating policy certainty and driving innovation and growth (Box 2.5).

Box 2.5. Energy Efficient Scotland Route Map and Consultation

In March 2018 the Scottish Government published their route map and consultation on delivering an 'Energy Efficient Scotland'.

Ambition

The route map sets out an ambition to ensure all Scottish homes achieve an EPC band C rating by 2040, where technically feasible and cost-effective. Since publication of the route map, the Scottish Parliament has given majority backing for proposals to bring forward these energy efficiency targets by a decade to 2030. This sits alongside commitments to maximise the number of social-rented homes achieving EPC band B by 2032 (becoming carbon neutral by 2040 as far as reasonably practical), and a detailed trajectory for private-rented homes to reach EPC band C by 2030 where technically feasible and cost-effective. Finally, a target is set to bring all homes with households in fuel poverty to EPC band C by 2030 and EPC band B by 2040, where technically feasible and cost-effective.

As well as improving the energy efficiency of all Scottish buildings the Route Map is focussed on decarbonising heat – with an initial focus on off-gas grid areas. To support the work on energy efficiency and low-carbon heat, the Scottish Government has consulted twice on Local Heat and Energy Efficiency Strategies (LHEES) which aim to link long-term targets and national policies with delivery in local authorities. The Scottish Government is currently funding 22 local authorities to support the development of LHEES and proposes to fund the remaining local authorities over the next 2 years.

Framework for achieving the ambition

The proposed delivery framework includes a mix of existing and new measures. These include continuing the existing programme of grants and loans, funding support for fuel poverty programmes, local authorities and LHEES, and for nationally delivered support to cover those households and businesses not covered by area-based schemes. Alongside this there is a broader framework for consumer protection, skills and training, the supply chain and quality assurance as well as assessment. The roadmap recognises the need to make sure EPCs more accurately record the energy efficiency of buildings.

The Scottish Government will be undertaking further consultation in early 2019 on the intended approach to legislating for Energy Efficient Scotland, as well as seeking views on the impacts of accelerating the Programme.

Source: Scottish Government (2018) *Energy Efficient Scotland: route map.*

Standards and labelling for appliance efficiency also provide a positive example of where regulation has been used effectively to drive energy efficiency improvements.[125] The latest government estimates suggest that these policies have saved around 30 $MtCO_2e$ since 2008.[126]

Recommendation: Following UK exit from the EU, product standards should remain in place or be replaced with equivalent or more ambitious regulation.

(*Owner: BEIS. Timing: ongoing*).

[125] The EU Ecodesign Directive and the Energy Labelling Framework Regulation respectively operate by setting minimum performance and information requirements for energy using products, taking the least efficient products off the market and giving consumers clear information to make informed purchasing decisions. This is implemented through product specific EU regulations.

[126] BEIS (2018) *Updated energy and emissions projections 2017, based on traded and non-traded savings.*

2.3.3 Ultra low-energy new homes

We have consistently recommended that Government strengthen new build standards to ensure that all new homes are highly energy efficient.

Ambitious standards were set under the Zero Carbon Homes policy which would have come in to force in 2016, had they not been cancelled. The UK is also signed up to delivering nearly-zero energy homes by 2021 under the Energy Performance in Buildings directive, although the status of this is now unclear. Meanwhile, the aspirational target to halve emissions in new homes by 2030 under the Government's Building Mission is out of step with the urgent timeline the UK has signed up to under the 2015 Paris Agreement.

Over the past year we have undertaken research to assess what level of energy efficiency can best support long-term decarbonisation needs. This has included the research we commissioned from Currie & Brown and Aecom on the cost-effectiveness of new lower-carbon and lower-energy buildings, alongside a broader programme of stakeholder engagement.[127] Below we set out our recommendations based on the findings of this work.

New homes should deliver ultra-high levels of energy efficiency as soon as possible, and by 2025 at the latest.

Ultra-high energy efficiency standards have potential to represent a more cost-effective option than some more moderate levels of tightening, due to the cost savings associated with the reduced need for radiators and associated heating distribution pipes (Box 2.6). Implementing ultra-high levels of energy efficiency (consistent with space heating standards of 15-20 $kWh/m^2/yr$) can save consumers money on bills, provide comfort and health benefits, deliver some reduction in annual and peak electricity demand, and provide an industrial opportunity for the UK to export innovation and expertise. It could also support the delivery of European requirements around nearly-zero energy buildings:

- Ultra-high energy efficiency standards, installed alongside an air source heat pump, represent a 1.1-4.3% uplift on **build costs** relative to current standards, depending on the type of building.[128] This cost would affect housebuilder profits, be reflected in land values and/or be passed through to the house buyer (see section 4.3). A significant (up to c.£3,300) saving in the capital cost of the heating distribution system helps to offset the additional costs associated with the most energy efficient fabric specifications.[129]
- For a semi-detached home built with a gas boiler in 2020, the modelling indicates that ultra-high energy efficiency standards can deliver annual average bill savings of around £55 over the lifetime of the build.[130] When installed alongside heat pumps, ultra-high energy efficiency standards are expected to deliver average annual bill savings of around £85

[127] Currie & Brown and Aecom for the CCC (2019) *The costs and benefits of tighter standards for new buildings.*
[128] Equivalent to incremental costs of between £1,300 for a small flat and £6,900 for a detached house. Costs based on buildings constructed in 2020 with an air source heat pump and a space heat demand of 15 $kWh/m^2/yr$ when modelled in SAP 2012 software.
[129] Currie & Brown and Aecom for the CCC (2019) *The costs and benefits of tighter standards for new buildings.* Based on a detached house. This is contingent on the closure of the performance gap, which may be associated with additional costs (not included in the modelling).
[130] Relative to a home built to England and Wales Part L, 2013.

relative to a home built to current standards with gas heating, and around £30-40 relative to installing a heat pump alone.[131]

- As well as bill savings, ultra-high energy efficiency standards can deliver **carbon savings** in gas-heated homes.[132] In a semi-detached home built with a gas boiler in 2020, ultra-high efficiency standards can deliver carbon savings of around 27 tCO_2 over the lifetime of the build.[133]
- Ultra-high energy efficiency standards, as part of a wider set of measures, can make some contribution to minimising the impact of new homes on **annual electricity demand and on peak demand.** This can reduce system costs and drive additional carbon savings to the extent further reliance on high-carbon peaking-plants can be avoided. Total annual energy consumption in existing homes is currently 467 TWh.[134] Where all new homes are built to current standards with an air source heat pump, they are estimated to add up to 43 TWh to annual demand by 2050.[135] Ultra-high energy efficiency standards could help reduce this by around 4 TWh. Ultra-high energy efficiency standards could also help reduce the peak demand associated with heat pumps in new homes (estimated to be up to 15-16 GW).[136] This would need to be further supplemented with action to reduce the demand associated with appliance and hot water use (considered further below).
- Highly energy efficient homes can provide **comfort and health benefits,** offering warmer homes in the winter and, if implemented correctly, enhanced protection from overheating in the summer alongside improved indoor air quality. Insulation and airtightness can also reduce noise disturbance, with associated physical and mental health benefits.
- Finally, developing expertise in highly energy efficient buildings represents **an industrial opportunity** for the UK, in retrofit as well as new build. The construction sector, encompassing contracting, product manufacturing and professional services, exported over £8bn of products and services in 2016.[137] European requirements on net-zero energy buildings, and growing interest in markets such as Canada and China could represent export opportunities for UK innovation and expertise.[138]

[131] The scale and nature of the bill impact is in part a function of the standing charges associated with gas and electricity bills, and will vary with the scale of standing charges assumed. Where moving to and from a tariff which does not include standing charges (i.e. where these costs are incorporated in the unit rate), the saving associated with ultra-high energy efficiency standards and a heat pump relative to installing a heat pump alone could be up to £40. For more detail on the assumptions underpinning the modelling see Currie & Brown and Aecom for the CCC (2019) *The costs and benefits of tighter standards for new buildings.*
[132] Standards which deliver a space heat demand of 15 $kWh/m^2/yr$ in gas heated homes become cost-effective in most homes against a high carbon price in the mid-2020s.
[133] Currie & Brown and Aecom for the CCC (2019) *The costs and benefits of tighter standards for new buildings.*
[134] BEIS (2018) *Energy Consumption in the UK.*
[135] This reflects energy demand associated with space heating, hot water demand, pumps and fans, lighting, appliances and cooking, based on Currie & Brown estimates and CCC modelling.
[136] Figures represent a broad estimate based on National Grid data on current residential peak demand drawn from National Grid's Future Energy Scenarios for 2017 and recent modelling undertaken by Robert Sansom.
[137] Published in HM Government (2018) *Industrial Strategy: Construction Sector Deal*, based on Office for National Statistics - UK Balance of Payments Pink Book (2017). Table 9.11 and Table 3.8 for data construction contracting and services exports. BEIS, Monthly Statistics of Building Materials and Components, 2017 for data on construction products exports.
[138] British Columbia has a goal for all new buildings to be net-zero energy ready by 2030. In 2017 it introduced the British Columbia Energy Step Code, which is a voluntary provincial standard that paves the way for this progress; British Columbia (2017) *BC Energy Step Code: A Best Practice Guide for Local Governments*. China aims to increase the share of new green buildings in urban areas to 50% by 2020, and China Green Building Council has recently

Designing in appropriate standards from the start is a fraction of the cost of trying to retrofit later (with retrofits being in the order of five times more expensive).[139] In the case of ultra-energy efficient fabric measures, the prohibitively high retrofit costs (£20,000+) mean that this is unlikely to be done in practice.[140]

Box 2.6. Research on the costs and benefits of tighter standards for new buildings

In 2018 we commissioned research to look at the cost-effectiveness of new lower-carbon and lower-energy buildings. This included examining how costs vary across different combinations of measures - by building type and size - and how these costs are expected to change over time. The work has also examined approaches to standard-setting more broadly, identifying those which have potential to represent 'best practice' in the UK context.

The research has generated a wide range of important insights, which underpin the recommendations in this report:

- **Low-carbon heat supply is a priority and the penalty of delayed action is significant.** Air source heat pumps are found to be cost-effective in homes by 2021, against central carbon prices. Air source heat pumps are found to offer cost-effective reductions in regulated carbon emissions of more than 90% over the lifetime of a building relative to a gas-heated home built to current standards. Where a home is built with gas heating in 2020, and has an air source heat pump retrofitted in 2030, the lifetime emissions are found to be more than three times higher than a home built with an air source heat pump at the outset.
- **There is potential to cost-effectively tighten efficiency standards for new buildings.** In 2025 ultra-high energy efficiency standards (with a space heat demand of 15 kWh/m^2/yr) are cost-effective alongside heat pumps across almost all archetypes at central carbon prices.[141] Ultra-high levels of energy efficiency are generally found to be more cost-effective than tightening to 20-30 kWh/m^2/yr of space heat demand, due to a significant (up to c. £3,300) saving in the capital cost of the heating distribution system which helps offset some of the additional costs associated with the most energy efficient fabric specifications.
- **Achieving higher standards via retrofit is very expensive compared to doing so in new buildings.** To improve fabric standards and install low-carbon heat via retrofit costs up to five times more than achieving the same standards when first constructing the home. Targeted preparatory measures (low-temperature compatible heat emitters and thermal stores) in new buildings can reduce retrofit costs by up to £5500.

A range of wider recommendations are also made around the performance gap and compliance tools which are reflected elsewhere in this report.

Source: Currie & Brown and Aecom for the CCC (2019) *The costs and benefits of tighter standards for new buildings.*

partnered with the World Green Building Council (World GBC) and committed to introducing a 'nearly net zero' standard for its Three Star rating system in 2018 as part of World GBC's Advancing Net Zero project. See: https://www.worldgbc.org/news-media/world-green-building-council-and-china-green-building-council-announce-partnership-0

[139] Currie & Brown and Aecom for the CCC (2019) *The costs and benefits of tighter standards for new buildings*. Multiple reflects the costs of retrofitting a home with an air source heat pump to a space heat demand standard of 15 kWh/m^2/yr, relative to installing these measures in a new build home.

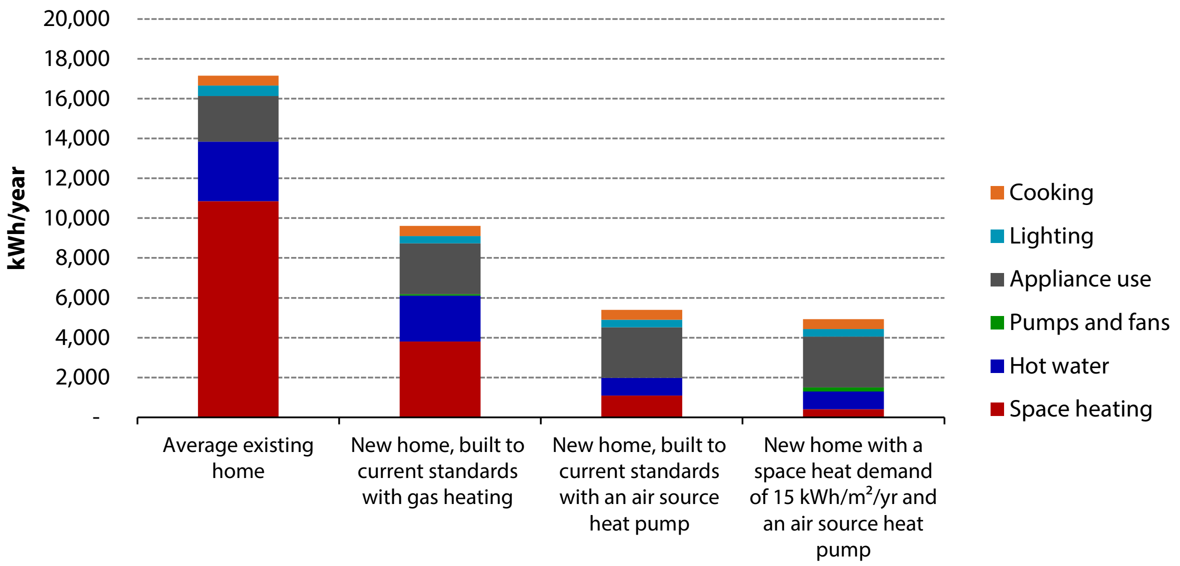
[140] Currie & Brown and Aecom for the CCC (2019) *The costs and benefits of tighter standards for new buildings*. Based on a new semi-detached home built to current standards in 2020 and retrofitted in 2030 to a space heat demand standard of 15 kWh/m^2/yr.

[141] The exception is the semi-detached house, where ultra-high energy efficiency standards alongside a heat pump become cost-effective shortly after.

We consider the implications of the costs associated with delivering these tighter standards in greater detail in Chapter 4.

In addition to the important role for fabric energy efficiency in new build homes, the energy required for hot water and appliance use represents an increasingly significant contribution to total demand (Figure 2.2).

Figure 2.2. Breakdown of energy consumption in existing and new homes



Source: BEIS (2018) *Energy Consumption in the UK*; Currie & Brown and Aecom for the CCC (2019) *The costs and benefits of tighter standards for new buildings.*
Notes: Average existing home drawn from ECUK data, pump and fan use is not separated out. Cooking demand for all homes based on current average consumption implied by ECUK. Appliance use for new homes drawn from SAP. Other new home consumption based on modelling undertaken by Currie & Brown and Aecom in SAP. 'New home' represents a three bed semi-detached home, with 'current standards' denoting England and Wales Part L, 2013 and assumed to be performing as designed.

This reinforces the importance of driving uptake of a wider range of energy efficiency measures in new build homes, including tightening appliance standards, hot water efficiency measures (such as reduced flow showers, considered further in section 2.6), and low-energy lighting.

Recommendation: New build homes should deliver ultra-high levels of energy efficiency as soon as possible, and by 2025 at the latest. This should be consistent with a space heat demand of 15-20 kWh/m^2/yr.

(*Owner: MHCLG, devolved administrations. Timing: trajectory set out by 2020).*

2.3.4 Indoor air quality

Regulations around ventilation must evolve to keep pace with improvements in energy efficiency and to deliver excellent levels of indoor air quality in homes.

All buildings need adequate levels of ventilation to maintain indoor air quality and reduce the risk of overheating in the summer.

Current ventilation requirements are set out in Approved Document F. This examines three aspects of ventilation in buildings: whole building ventilation, local extract ventilation and purge ventilation:

- The regulations relating to background ventilation are based around a two tier system, where default guidance is intended to cover all levels of design air permeability and alternative guidance is provided for dwellings designed to an air permeability leakier than $5m^3/(h.m^2)$ at 50 Pa.[142] Under these lower levels of air tightness, lower levels of ventilation provision are deemed necessary.[143]

The regulations covering required air permeability are set out in Approved Document L. Compliance is assessed by measuring the airtightness of dwellings through pressure testing. Testing is mandatory for a required sample for each dwelling type on a development.

Buildings with ultra-high levels of energy efficiency require high levels of air tightness[144] and in turn active ventilation strategies. There is a need for regulations around ventilation to evolve to keep pace with improvements in the energy efficiency of buildings. Coordination should be improved to fully reflect the interactions and interdependencies (for instance, through combining into a single Approved Document and/or integrated approaches to testing compliance). Ventilation and energy requirements should be reviewed together to ensure they are fit for purpose as our buildings become more energy efficient. We welcome the Government's recent commitment to do so. Considerations should include:

- How Part L and Part F of Building Regulations can be better coordinated to reflect interdependencies. An approach which supports the holistic consideration of energy efficiency, overheating and ventilation strategies is likely to support the best outcomes for occupants. Combining energy efficiency and ventilation requirements could drive this.
- Whether building regulations should restrict the use of single aspect dwellings in favour of dual aspect dwellings, building on the requirements set out in the London Plan.[145]
- Whether the current 'two tier' system (based around a boundary air permeability level of $5m^3/(h.m^2)$ at 50 Pa) remains appropriate. A recent paper by Crawley et al. has recommended ranges of air permeability be matched with categories of ventilation at each design stage.[146]
- Whether the current approach to compliance testing is fit for purpose. The current approach focuses on measuring air tightness rather than air quality. Furthermore, evidence suggests that the current approach is not leading to an accurate assessment of 'as-built' air permeability performance, and may drive an overreliance on secondary sealing rather than

[142] MHCLG (2013) *Approved Document F: ventilation (2010 edition incorporating 2010 and 2013 amendments).*
[143] The regulations in Scotland recommend trickle ventilation based on infiltration rates of 5 to $10m^3/h/m^2$ @50 Pa as a matter of course in a modern house. However, where lower infiltration air rates of less than $5m^3/h/m^2$ @ 50Pa are proposed, alternative mechanical ventilation systems should be adopted.
[144] Recent modelling by Currie and Brown has indicated that a semi-detached home with a space heat demand standard of 15 $kWh/m^2/yr$ can most cost-effectively be achieved with an air-tightness of $1m^3/h.m^2$ at 50 Pa. See Currie & Brown and Aecom for the CCC (2019) *The costs and benefits of tighter standards for new buildings*.
[145] In the London Plan a single aspect dwelling should only be provided where it is considered a more appropriate design solution than a dual aspect dwelling and it can be demonstrated that it will have adequate passive ventilation, daylight and privacy, and avoid overheating. See Mayor of London (2018) *Draft New London Plan showing Minor Suggested Changes.*
[146] Crawley, J. Wingfield, J. & Elwell, C. (2018) The relationship between airtightness and ventilation in new UK dwellings. *Building Services Engineering Research and Technology*.

focusing on the quality of the primary air barrier. [147] This is problematic due to the potential lack of durability of remedial measures (e.g. draught excluder tape).

- Whether the current air flow rate metric is fit for purpose or whether an alternative volumetric approach could better support high indoor air quality across a range of building forms (e.g. based on air change rates per hour).There is also a question about whether regulations need to evolve to reflect different needs across existing buildings and new build homes.
- Whether the current regulatory framework relating to pollutants is sufficient, particularly as homes become more airtight.[148] There is scope to better address risks through source control and labelling requirements, alongside considering whether the list of pollutants addressed in Appendix A of Part F is appropriate.[149]

Regulatory changes should be accompanied by wider policy initiatives to deliver learning and skills development for key technologies. Given the central role of mechanical ventilation systems in ultra-energy efficient homes, there is an urgent need for further work to ensure these systems are designed, commissioned and installed properly, and that householders are supported to use and maintain them effectively:

- Steps must be taken to improve the design, commissioning and installation of systems. This includes addressing the skills gap through appropriate training, providing practical installation guidance, and improving quality control onsite to avoid installation defects.
- Further research is needed into how challenges in operating and maintaining mechanical ventilation systems can be overcome. There is a need for further consideration of design approaches to ensure that systems are designed around the needs and preferences of those using them. This includes making sure that systems are designed to facilitate easy access, whilst minimising noise disturbance in the home. Innovative approaches to design and maintenance can also play a role. This includes incorporation of MVHR systems in heating system maintenance contracts, and alarm systems to alert users to when filters need changing. There is also a need for improved handover processes and occupant guidance.

Effective operation of these systems is a critical precursor to ultra-high energy efficiency standards and must be addressed as a priority in advance of any uplifts to mandatory standards.

Recommendation: Regulations around ventilation and indoor air quality must evolve to keep pace with improvements in the energy efficiency of buildings. Part F of the Building Regulations should be reviewed alongside Part L, with a view to tightening standards and coordinating requirements to fully reflect interdependencies. Where updates affect Part B and vice versa, Government should review the standards as a whole. Steps must be taken to improve the design, commissioning, and installation of mechanical ventilation systems, with further research into how challenges in maintaining and operating them can be overcome.

(*Owner: MHCLG, Defra, devolved administrations. Timing: 2019).*

[147] Love, J. Wingfield, J. Smith, AZP. Biddulph, P. Oreszczyn, T. Lowe, R. and Elwell, C.A. (2017) *Hitting the target and missing the point: Analysis of air permeability data for new UK dwellings and what it reveals about the testing procedure.* Energy and Buildings, 155, 88-97.
[148] Including the Control of Substances Hazardous to Health Regulations 2002 and the Volatile Organic Compounds in Paints, Varnishes and Refinishing Products Regulations 2012.
[149] The European Union EU-LCI working group is developing a harmonisation framework for health-based evaluation of indoor emissions from construction products, which has potential to form the basis for a source control and labelling framework in the UK.

2.3.5 Overheating

There are a number of adaptation measures available to builders and home owners to reduce the risk of overheating in homes, improve comfort levels for occupants and avoid the need to invest in alternative cooling measures, such as air-conditioning.

The determinants of overheating risk in homes include location, orientation, house type, ventilation strategy, and occupant behaviour. A combination or package of adaptation options is likely to be needed to reduce the risk:

- Passive cooling measures (as opposed to mechanical) consist of reducing internal heat gains, enhancing natural ventilation and reducing solar gain through the windows and fabric of the building. When installed and operated correctly they have been found to be effective at reducing the number of hours during which overheating occurs.[150] A 2018 study has found that external shutters provided the largest reduction in heat mortality risk, while closed windows caused a large increase in risk. Ensuring adequate ventilation, targeted installation of shutters, and openable windows in dwellings with heat-vulnerable occupants may save energy and significantly reduce heat-related mortality.[151]
- Additional green measures such as trees, green roofs and green walls can also help to provide shading and absorb heat plus bring a range of multi-benefits (Chapter 3). The uptake of green roofs in London is supported by the London Plan.[152]

Research for the Committee found that a number of passive cooling measures are cost-effective[153] for householders as part of retrofit and new build in south west England: [154,155]

- The most cost-effective measures are those that improve ventilation (for example opening of windows and night ventilation) and provide shading (for example blinds, curtains, tinted window films and external shading). Other measure such as using energy efficiency appliances to reduce waste heat are also cost-effective.
- In addition, installing external shutters and improving roof albedo (white roofs) are cost-effective in new builds. These measures should be installed at new build stage to avoid the need for costly retrofit later.[156] For example the costs of installing opening inward windows and shutters at build stage in a flat would be around £650 compared to £3,600 to retrofit.[157]
- Some measures are more effective in certain types of properties. Internal blinds are more cost-effective in flats compared to other types of dwelling.

[150] Mavrogianni et al. (2014) *The impact of occupancy patterns, occupant-controlled ventilation and shading on indoor overheating risk in domestic environments*.
[151] Taylor et al. (2018) *Estimating the influence of housing energy efficiency and overheating adaptations on heat-related mortality in the West Midlands, UK*. Atmosphere 2018, 9 (190).
[152] The London Plan requires all major development proposals to include roof, wall and site planting, especially green roofs and walls where possible, to deliver cooling benefits as an adaptation measure to climate change.
[153] Cost-benefit analysis (CBA), which compares costs with benefits, is preferred for ranking of options. However, cost-effectiveness analysis (CEA) provides an alternative approach in cases where benefits cannot be monetised and compared directly with costs.
[154] Wood Plc et al. for the CCC (2019) *Updating an assessment of the costs and benefits of low-regret climate change adaptation options in the residential buildings sector.*
[155] David Langdon for the CCC (2011) *An assessment of the costs and benefits of low-regret climate change adaptation options in the residential buildings sector.*
[156] *Ibid*.
[157] Currie & Brown and Aecom for the CCC (2019) *The costs and benefits of tighter standards for new buildings.*

The package of low-regret adaptation options we have identified for reducing the impact of overheating in the south-west may also deliver savings to other parts of the country, particularly in areas of heat stress. Other factors will influence the cost-effectiveness of measures, for example:

- Additional benefits to some of these measures that have not been included in analysis, such as energy efficient appliances, will reduce electricity consumption and carbon emissions.
- A major source of uncertainty in building performance relates to occupancy and behavioural assumptions. The way inhabitants occupy and operate a building has a measurable impact on thermal discomfort and health risks to occupants associated with their exposure to high indoor temperatures. [158] Appropriate occupant behaviour (such as opening windows when outside temperatures are lower than inside, and closing curtains during the day to limit solar gains) are an additional effective, no-cost adaptation option to address overheating.

For some properties, particularly in cities, it may not be possible to achieve temperatures which are comfortable for occupants in the future using only passive cooling and behaviour measures. Generally in urban areas householders may be less able to open windows for ventilation, particularly at night, due to issues with security, noise and pollution. In London and the south-east other active cooling measures may be required due to high external temperatures and the undesired ingress of outdoor pollutants (Box 2.7).

Box 2.7. Use of air conditioning and active cooling measures

Passive cooling measures are a preferable adaptation to air conditioning, which is energy-intensive and expels waste heat into the environment. Air conditioning can increase carbon emissions (if powered from non-renewable energy), contribute to the Urban Heat Island Effect and increase occupant bills (potentially increasing the risk of summer-time fuel poverty). For example, our research has found that air conditioning could cost households up to £266 per year in a flat and £140 per year for a detached house in energy bills in order to mitigate overheating risk.

For those dwellings where it is not possible to improve overheating completely with passive cooling and behaviour change, additional active cooling solutions could be considered. For example air to air heat pumps when combined with ventilation systems such as Mechanical Ventilation and Heat Recovery could be used for both heating and cooling.

Source: Wood Plc et al. for the CCC (2019) *Updating an assessment of the costs and benefits of low-regret climate change adaptation options in the residential buildings sector;* IEA (2018) *The Future of Cooling.*

[158] Mavrogianni et al. (2014) *The impact of occupancy patters, occupant-controlled ventilation and shading on overheating risk in domestic environments.* Building and Environment, 78 (2014), 183-198.

There remain limitations in assessing the extent of overheating risk in existing homes across the whole of the UK.

A methodology for identifying both dwellings and affected populations which are at risk of overheating is needed. There is a general lack of information around how occupants currently use and operate their homes which makes it difficult to understand the overall scale of the risk across the UK, and how to target packages of mitigating measures.

Recommendation: Further action should be taken to better understand when overheating occurs in existing homes in order for passive cooling measures and behaviour change programmes to be targeted effectively.
(*Owner: Department of Health and Social Care, MHCLG, Scottish Government, Welsh Government. Timing: by 2020).*

Overheating risk is not adequately addressed in the current policy and regulatory framework, including Building Regulations. The current approach is not sufficient for identifying current or future levels of overheating.

An investigation by the Ministry of Housing, Communities and Local Government (MHCLG) carried out in 2015 found that 'all new homes exceed the overheating threshold to some extent'.[159] There remain no legal safeguards to avoid new homes overheating, despite the Committee's previous recommendations. Policies to address overheating are not generally included in Local Plans that are used to assess planning applications.[160]

The Building Regulations Part L Approved Documents include limiting effects of heat gains in summer, however the main purpose is for conservation of fuel and power (to limit solar gain to either eliminate or reduce the need for air conditioning). There are no requirements in Building Regulations to consider the risk of overheating in terms of minimising the risks to health and safety. This urgently needs to be revised as part of the MHCLGs, Welsh Government and Scottish Government's reviews of Building Regulations in 2019. Alongside the review of Part L and Part F of Building Regulations MHCLG plan to consult on a method for reducing overheating risk in new homes.

The calculations of solar gains in current regulations have also been widely criticised.[161] BEIS have produced draft changes to these calculations which could be a positive step towards reducing overheating risk alongside better regulation (Box 2.8).

[159] Environmental Audit Committee (2018) *Heatwaves: Adapting to Climate Change inquiry.*
[160] Adaptation Sub-Committee (2017) *2017 Report to Parliament – Progress in preparing for climate change.*
[161] Zero Carbon Hub (2015) *Overheating in Homes - The Big Picture*.

Box 2.8. Overheating assessment methodology - SAP 2012 vs SAP 10

The Approved Document accompanying Part L of Building Regulations for dwellings provides a test for solar gains (SAP Appendix P). It is currently simplistic in its approach and assumptions, and is seen as not sufficient to identify either current or future levels of overheating risk in dwellings. The recently published draft SAP10 changes the methodology for the assessment of the risk of summer-time overheating under Criterion 3 in Approved Documents and makes it more robust.

If taken forward to the final document, this may result in more properties failing this Criterion within SAP, and therefore failing to meet building regulations without mitigation measures.

The previous methodology was said to be very difficult to fail due to a number of unrealistic assumptions such as that windows are constantly open, so this could be a positive step towards overheating risk mitigation in UK housing.

However, BRE highlight that Appendix P should not be relied upon to assess thermal comfort, and without better regulation there is a risk that this could encourage developers to opt for active cooling measures, instead of prioritising the implementation of passive cooling strategies. Active cooling may be seen as an easy fix in locations with significant air pollution, noise, and security and safety issues.

Source: CIBSE (2018) Building Regulations Part L & F Briefing; AES (2018) *Potential Impact Assessment, Changes in wording and methodology between SAP 2012 (SAP 09) and Draft SAP 2016 (SAP 10) with regards to the assessment of summertime overheating;* Zero Carbon Hub (2015) *Overheating in Homes - The Big Picture*.

Recommendation: It is critical that the 2019 reviews of Building Standards by MHCLG, Scottish Government and Welsh Government:

- Introduces a new standard or other requirement to ensure that overheating risk is assessed for current and future climates at design stage of new build homes or renovations.
- Ensures that passive cooling measures are installed at build stage where there is a risk of overheating identified. Where active cooling measures are also needed, consideration should be given to potential synergies in the choice and installation approach for heating and cooling systems, for example through the use of air source heat pumps combined with mechanical ventilation.

(Owner: MHCLG, Scottish Government, Welsh Government. Timing: 2019).

Recommendation: In England the Government must ensure that Planning Guidance is updated to clearly require local authorities to include overheating risk in Local Plans, as set out in the updated National Planning Policy Framework. Guidance should contain a requirement for local authorities to include an assessment of overheating risk as part of the planning process. This should require developers to carry out an initial assessment of the strategic features that increase risk, such as site location, building layout, façade, green space availability, and introduce appropriate mitigation measures at the early planning stages.

(Owner: MHCLG. Timing: by 2020).

2.4 Addressing the broader whole-life carbon impacts of homes

In the previous sections, we have considered a range of measures to decarbonise heating in homes, alongside energy efficiency measures to reduce wider energy use. These measures abate the emissions associated with the 'operational' life of homes (those associated with energy use during a building's lifetime). Alongside this it is necessary to consider how the construction of our homes, and the disposal of construction materials at the end of life, can contribute to minimising atmospheric carbon. Our 2018 report, *Biomass in a low-carbon economy*, finds that the use of wood in construction is one of the most effective ways to use limited biomass resources to reduce atmospheric CO_2 (Box 2.9).

Box 2.9. Embodied emissions and sequestration potential

Embodied emissions (those caused by the extraction, manufacture and assembly of materials plus maintenance and end-of-life disposal) account for 25% to 50% of the overall carbon footprint of new buildings.[162] There will also be embodied emissions associated with the renovation of existing homes. Addressing the embodied carbon associated with homes will be a necessary part of any ambition to drive towards future 'net zero' greenhouse gas or carbon targets.

In addition to the potential for savings in the embodied carbon associated with buildings, there is also potential for sequestered carbon to be stored in buildings through the use of materials such as wood in construction. Wood in construction does not currently provide permanent sequestration of carbon. However it provides storage on timescales of decades to centuries and there is significant potential to grow the overall store of carbon in the built environment provided inflows of timber (through new build) exceed outflows (from disposal).

Between 27,000 – 50,000 new homes (15%-28%) built in the UK each year already use timber frame construction systems and wood is also widely used in traditional masonry systems.

Modelling undertaken for our recent report, *Biomass in a low-carbon economy*, found that currently, timber frame construction can reduce embodied emissions by up to around 3 tCO_2e per home[163] through the displacement of high-carbon materials such as cement and steel, although there are uncertainties related to end-of-life processes.[164]

Increasing this to 270,000 each year could would result in annual net carbon storage of around 3 Mt CO_2e by 2050, accounting for losses due to demolition and disposals. This level of timber construction could further reduce embodied emissions in the residential sector by 0.5-1 Mt CO_2e per annum in 2050.

There is a risk that the Government's intended ban on combustible materials will affect the uptake of wood in construction (both engineered wood and timber frame homes), with some anecdotal evidence that this is taking place. Clarity from Government on the role and fire safety of wood in construction is needed.

Source: CCC (2018) *Biomass in a low-carbon economy;* MHCLG (2018) *Final Impact Assessment: Ban on combustible materials in external wall systems.*

[162] NHBC (2012) *Operational and embodied carbon in new build housing*; UKGBC (2017) *Embodied carbon: developing a client brief*.
[163] Bangor University calculates that the structural elements of a new detached 3-bed timber frame house has 'cradle-to-gate' emissions around3.2 tCO_2e lower than a masonry alternative. A 2012 NHBC study (which takes into account refurbishment and disposal) finds this saving to be around 7 tCO_2e over a 60 year period. See NHBC (2012) *Operational and embodied carbon in new build housing*.
[164] An example is the impact of carbonation on concrete. Concrete can absorb CO_2 throughout its life although this generally occurs at very low levels during the operational phase of a building's life. However during disposal this may increase due to crushing and increased exposure to air. Some estimates conclude that carbonation could reduce the embodied CO_2 of concrete by 7.5% over the full lifecycle - See: MPA (2016) *Whole-life carbon & buildings*. Other sources estimate a smaller reduction of 3-4% - See: NIBIO (2018) *The environmental impacts of wood compared to other building materials*. It may be possible to further reduce the embodied emissions by reusing old concrete or processing outputs from waste incinerators as recycled aggregates.

There are a wide range of potential policy levers that could, and in some cases already do, seek to address the whole-life carbon associated with homes. Regulation can be used to control the carbon intensity of new build, through measures such as carbon pricing and standards such as whole-life carbon intensity targets in Building Regulations. Minimising the need for new build (e.g. through measures to reduce under occupation in existing buildings) could also play a role in delivering carbon savings where those buildings can be decarbonised cost-effectively.

Whilst further work is needed to determine the best overall package of measures to address the whole-life carbon impacts of homes, low-regret measures include:

- Policies which support a substantial increase in the use of wood in construction.
- Action to support the assessment and benchmarking of whole-life carbon over the next 3-5 years, with a view to informing a decision on a future mandatory framework.

Recommendation: Develop new policies to support a substantial increase in the use of wood in construction. This will need to focus on overcoming a range of cultural, skills and financial barriers in the construction sector. Undertake low-regrets action to support the assessment and benchmarking of whole-life carbon in buildings with a view to informing the future policy framework.

(Owner: MHCLG, BEIS, devolved administrations. Timing: new policies for wood in construction in 2019, with groundwork on whole-life carbon by 2024).

2.5 Flexibility measures in homes

As we decarbonise heating and transport and increase our reliance on renewable forms of generation, meeting electricity demand will face new challenges:

- By 2050 we can expect substantial electrification of surface transport and electric heating loads, such that electricity demand could be around double today's level. Our central estimate for electricity generation required to meet the demand in our 2030 scenarios is 365 TWh, including electricity demand from 2m heat pumps and 20 TWh of demand from EVs. With accelerated uptake of EVs or heat pumps, electricity demand could increase to 390 TWh.[165]
- Increasing penetration of variable renewable energy into the UK's electricity system provides a need for more electricity grid services - such as balancing and frequency response - to ensure that variable supply can match electricity demand at all times, and power quality can be maintained. Several options are available to provide this 'system flexibility',[166] including flexible generators, battery storage, interconnection and demand-side response.[167] Flexibility measures have potential to bring electricity system costs down by £3-8bn/yr[168] by 2030 or up to £16bn/year by 2050.[169]

Energy systems are designed to meet energy demand at all times. This can be particularly challenging during 'peak demand' periods, which often occur on cold winter evenings, and may

[165] CCC (2018) *Reducing UK emissions - 2018 Progress report to Parliament.*
[166] Defined as the modification of generation and/or consumption patterns in reaction to an external signal (such as a change in price) to provide a service within the energy system.
[167] Demand-side response is where consumers (the 'demand-side') can sign up to special tariffs and schemes which reward them for changing how and when they use electricity.
[168] Imperial College for the CCC (2015) *Value of flexibility in a decarbonised grid and system externalities of low-carbon generation technologies*
[169] Imperial College for the CCC (2018) *Analysis of alternative heat decarbonisation pathways*

coincide with periods of low electricity supply from variable renewables such as wind and solar. New electricity demands could add to this challenge.

We have considered in previous sections the steps that could be taken to minimise electricity demand in existing and new homes. Our homes, and the way we use them, can also help by shifting consumption away from peak, and towards periods when renewable energy is available. The demand profile and characteristics of each household will determine how flexible their energy demands can be. Some key enablers include:

- **Fabric efficiency and thermal storage.** Homes which are better insulated and have high levels of fabric efficiency retain more heat in the building itself. This can be used to smooth out demand from heating systems or allow heating demand to follow variations in generation, known as 'pre-heating'. Hot water tanks and phase change-based materials can also provide thermal storage.[170] Analysis by Imperial College London suggests that current new build standards, alongside deployment of household level energy efficiency measures in existing homes consistent with the Committee's scenarios for 2050, provide significant pre-heating potential. Imperial's analysis assumes 100% of the heating demand for new houses to be flexible and available for pre-heating, and 50% of post-1952 buildings to be capable of shifting their heating demands via preheating or thermal storage for up to 4 hours away from peak periods. The scale of pre-heating which actually takes place will also be a function of other factors such as price signals and the installation of smart control systems.
- **Batteries.** Whilst fabric efficiency and thermal storage can enable shifting of heat demands, batteries can enable peak management for all demands associated with electricity use. Currie & Brown and Aecom's modelling of tighter new build standards found the current costs of a 2kW battery to be in the region of £2,000 per home, reducing to £1,600 by 2020.[171]
- **Smart meters and smart appliances.** The Government has a manifesto commitment to ensure that every home and business in the country is offered a smart meter (Chapter 1). Smart meters create a platform for more cost-reflective energy pricing, and a medium through which smart appliances can communicate. In October 2018 Government also announced the steps it will be taking to set regulatory requirements for smart appliances. These measures will act as enablers for smart control of heating and appliances.
- **Smart charging of electric vehicles.** 'Smart charging' functionality in EV charging points (e.g. where charging is timed to take advantage of off-peak periods, or where the power of a charge is altered to help balance the frequency of the electricity grid), is important to help manage the system impacts of EV electricity demand. There is also potential for EVs to facilitate wider demand flexibility in homes, for instance by storing excess household power in the EV battery for use during high electricity grid demand. Regulatory changes are underway to facilitate smart charging for electric vehicles.

Recent modelling by Imperial College London finds that more cost-effective methods for balancing the grid, such as demand-side response (e.g. shifting demand for electric heating via thermal storage in domestic premises or electric vehicle charging) are likely to play a greater role

[170] In their 2019 research *The costs and benefits of tighter standard for new buildings*, Currie & Brown and Aecom found the costs of a hot water cylinder, suitable for shifting >90% of heating load to off-peak ranged from £2,000 for a small flat up to £4,500 for a detached house.
[171] Assumes a Lithium Ion battery at c. 10-15kg per kWh.

in providing electricity system flexibility than methods such as battery storage or electrolysis. This illustrates the central role homes can play in providing flexibility.

In 2017 BEIS and Ofgem jointly launched the Smart Systems and Flexibility Plan, which committed to a series of actions necessary to remove barriers to smart technologies, enable smart homes and businesses, and facilitate markets for flexibility. A progress update was published in October 2018. Regulatory changes are underway that involve smart meter data sharing, half-hourly settlement and smart charging standards for electric vehicles. These should promote opportunities for consumers to provide electricity system flexibility services, whilst providing adequate protection for consumers on levels of service and participation, cost and data privacy.

The Government has also committed to giving consumers more control over how they use energy through smart technologies, as part of its Grand Challenge Mission to halve the energy use of new buildings by 2030.

If all new homes between now and 2050 are built to current standards with air source heat pumps, the associated energy demand is estimated to add up to 16 GW to peak demand,[172] with an increase in total annual demand of 43 TWh.[173] On this basis there is value in minimising the impact of new buildings on peak and annual demand, and of maximising the role these new homes could play in providing flexibility to the system. There are a range of measures that are available to developers to design into new homes (including hot water efficiency measures, thermal stores and batteries), which the new build standards framework could play a role in incentivising.

Recommendation: BEIS, Ofgem and National Grid should implement the remaining actions set out in the Smart Systems and Flexibility Plan, alongside the continuation of wider improvements that are already underway. Actions include encouraging suppliers to offer smart tariffs and capitalising on EV potential to provide demand-side response and storage services.

(Owner: BEIS, Ofgem, National Grid. Timing: actions implemented by 2022).

Recommendation: Examine the potential role for new build standards in encouraging deployment of technologies to support peak management and demand reduction.

(Owner: MHCLG, BEIS, devolved administrations. Timing: by 2020).

2.6 Water efficiency

One of the major risks identified for the UK from climate change is reduced water availability.

The UK Climate Change Risk Assessment sets out the risks to people from changes in water availability. Higher temperatures are likely to drive up the demand for water (alongside population growth). Water shortages are projected to become an increasing problem in London and the South East of England, as well as the Yorkshire, Humber and East Anglia regions.

[172] Figures represent a broad estimate based on National Grid data on current residential peak demand drawn from National Grid's Future Energy Scenarios for 2017 and on recent modelling undertaken by Robert Sansom.
[173] This reflects energy demand associated with space heating, hot water demand, pumps and fans, lighting, appliances and cooking, based on Currie & Brown estimates and CCC modelling, assuming no improvements in heat pump efficiency over time.

However, the CCRA found that deficits are also projected in other parts of the UK as well including areas of south Wales and the central belt of Scotland.[174]

As well as substantial impacts on the natural environment, the impacts from increased supply-demand deficits could include higher water bills, and more frequent use of measures to restrict consumption (Temporary Use Bans, Non-Essential Use Bans and potentially more extreme measures such as standpipes or rota cuts). The National Infrastructure Commission (NIC) assessed that in the event of a drought it is more likely that emergency action, including tankering water across the country and removing more water from the environment than would otherwise be allowed, would be taken rather than cutting off supplies to homes and businesses. The NIC have estimated that the cost of maintaining current levels of resilience and relying on emergency action for more severe droughts to 2050 was between £25 and £40 billion, not including further impacts on the environment and public health.[175]

Whilst the water industry and its regulators are rigorously planning for resilient water supplies, additional action is needed to manage the risk and impact of future water supply-demand deficits.

Projected supply-demand deficits could be substantially reduced if leakage and household consumption were reduced as set out in current Water Resource Management Plans. However the CCRA found that this is still not sufficient in the longer term. Substantial additional action will be required to mitigate supply deficits in all water resource zones, in particular under a high climate change and population growth scenario by the 2080s.

Household water consumption per person in England and Wales has declined from 155 litres per person per day (l/p/d) in 2003/04 to 141 l/p/d in 2017/18.[176] The latest figures for Northern Ireland and Scotland are 152 and 153 l/p/d respectively. These are estimated to be higher than in many other European countries.[177] A study for the Environment Agency concluded that a strong national focus on water efficiency combined with metering and economic instruments, was responsible for the differences in per capita consumption of the countries reviewed. [178]

The CCRA found that a package of adaptation measures, including per capita consumption of 92/l/p/d by 2050 could significantly, but not fully alleviate projected future supply-demand deficits under a high climate change scenario.

Updated research for the Committee has identified a number of low-regret adaptation options to improve the water efficiency of both existing and new homes.[179] Measures not only reduce household water consumption but also save energy and carbon emissions and reduce water and energy bills.

[174] CCC (2016) *Climate change risk assessment evidence report.*
[175] NIC (2018) *Preparing for a drier future.*
[176] Defra (2018) *Water conservation report.*
[177] These comparisons are not straightforward as the ways in which other countries collect and analyse data on household water use varies and therefore estimates must be treated with a large degree of caution. Some of the more consistent estimates across different evidence sources are for current per capita consumption in Germany, which tend to be around 120 l/p/d, while estimates for Belgium over the last 15 years fall between 85 and 110 l/p/d. A recent cross-country analysis using data for 2009 to 2011 placed England and Wales 16th of the 24 European countries in the analysis. While not included in the study, the estimates we have for per capita consumption in Northern Ireland and Scotland would place them roughly just below England and Wales in this ranking.
[178] Aquaterra for the Environment Agency (2008) *International comparisons of domestic per capita consumption.*
[179] Wood Plc et al. for the CCC (2019) *Updating an assessment of the costs and benefits of low-regret climate change adaptation options in the residential buildings sector.*

These improvements can be achieved at a much lower cost at the time when products need replacing or at the new build stage than what is incurred when retrofitting buildings.

For existing homes:

- Analysis for south east England shows that there are a number of upgrade measures including low-flow taps, click lock kitchen taps, dual-flush WCs and low-flow showers that could be installed at zero additional cost to homes over the lifetime of the equipment.
- In the case of discretionary retrofits, installation of a low flow shower was shown to be the only low-regret measure and only when considered from a householder perspective. When including energy and carbon savings installation of low-flow taps also becomes a low-regret adaptation measure.
- For these measures, and others such as water efficient dishwasher and washing machines, savings to householders through lower water bills, outweigh any additional costs associated with fitting the water-efficient measures (Figure 2.3).
- The research did not include fixing leaks found in private pipes running from public pipes to people's homes, and this is an area that requires further investigation.

There are strong links between water and energy efficiency which could be maximised through upgrades and retrofit, especially by local authorities and housing associations as there is an opportunity to procure water efficient devices to help reduce water and fuel poverty (Box 2.10).

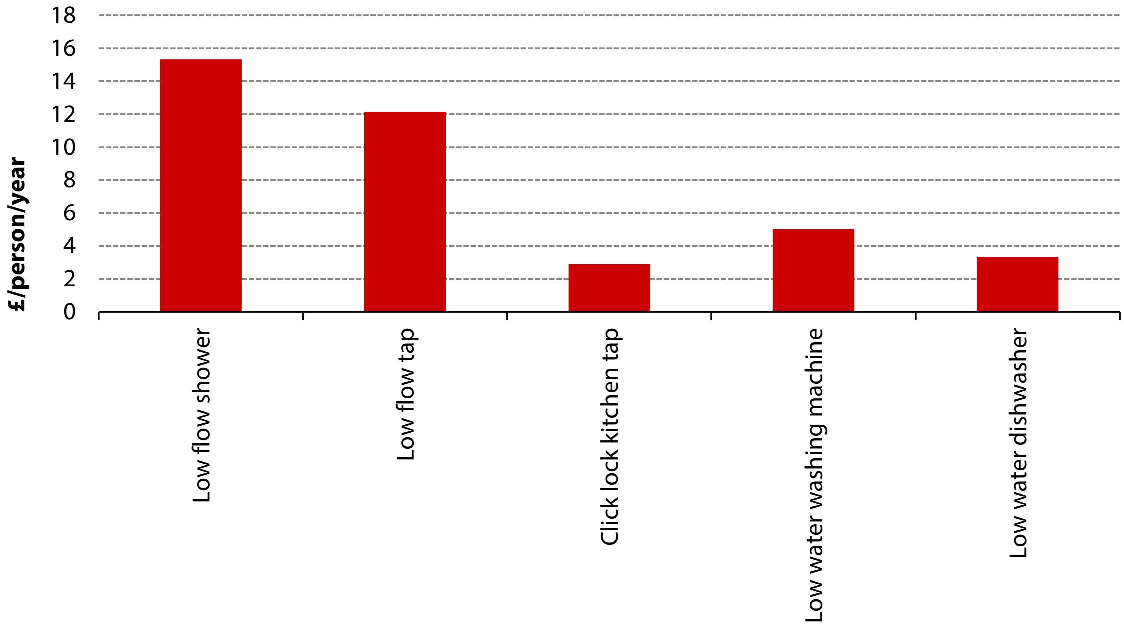
Recommendation: Local authorities should include water efficiency measures in energy efficient retrofit programmes. Water efficiency should be included in social housing standards (such as the Decent Homes and Welsh Housing Quality Standard).

(Owner: Local authorities. Timing: Ongoing.)

For new builds, research for the south east shows that a water efficiency standard of 105 litres per person per day by the 2030s is cost-effective and could be achieved at a small additional build cost.[180,181] This assessment of cost benefit analysis for water stress measures represents a conservative view on anticipated benefits due to the use of current Long Run Marginal Costs, which could be higher in future. As the identified replacement measures and new build package can be installed at zero or low additional costs in the south east, it suggests that these same adaptation measures will be low-regret across all other water stressed regions.

[180] Wood Plc et al. for the CCC (2019) *Updating an assessment of the costs and benefits of low-regret climate change adaptation options in the residential buildings sector.*
[181] Under a best case scenario (assuming low costs and high benefits). One-off cost estimated to be £281. A new build package of 110 l/p/d would be zero additional cost.

Figure 2.3. Estimated energy bill savings from reduced water use



Source: Wood Plc et al. for the CCC (2019) *Updating an assessment of the costs and benefits of low-regret climate change adaptation options in the residential buildings sector.*

Box 2.10. Water and energy efficiency

Local authorities and housing associations regularly run retrofit programmes (fixing and amending water-using fittings in homes) and there is an opportunity to procure water efficient devices to help reduce water and fuel poverty.

- Waterwise research (for the Greater London Authority) revealed that 80% of social housing in London has baths but not showers – this is in part because much of the stock was constructed before showers were considered a standard fitting, and in part because social housing standards such as Decent Homes do not require consideration of water efficiency. This is significant as an average bath uses 80 litres of hot water compared with 32 litres for a 4-minute shower with a water efficient shower head.
- Hot water demand accounts for 40% of energy used for a 'Part L' semi-detached house. Research to support changes to the devolved administration's Building Regulations showed that bill savings of up to £48 per year, increasing to £180 with behaviour change, are possible if water and efficiency standards are tightened.

Research to support the Welsh Housing Quality Standard estimated that if every social housing property in Wales had water-efficient taps and a retrofitted toilet and shower, combined energy and water bills could be reduced by £3.5 million a year. Similar guidance could be developed for the Scottish Housing Quality Standard or the Decent Homes Standard in Northern Ireland.

Source: Waterwise (2017) *Waterwise efficiency strategy for the UK*; BEIS (2018) *2017 domestic energy use UK*; Burton (2013) *Integrating water efficiency into energy programmes – a case study from policy to implementation*; Waterwise (2017) *Waterwise efficiency strategy for the UK*.

Ambitious reductions in per capita consumption are possible and beneficial.

Defra is committed to putting out a call for evidence on a per capita consumption target in 2019 to support the commitment for a target in the 25 Year Environment Plan. The target will be a national, non-binding target that can be used to judge the effectiveness of Government actions and those of the water industry in reducing water use.

The research results presented above are consistent with other studies. Box 2.12 summarises some of the recent reports that have considered consumption targets for existing and new homes.

Box 2.11. Water efficiency studies

There have been a number of studies to assess what level of consumption per person is possible technologically and cost-effectively:

- NIC sets out an aim for water efficiency to provide 34% of the recommended level of resilience. The NIC found that it is possible to reduce consumption to 118 l/p/d by 2050 through metering alone – assuming meters are rolled out everywhere by 2030. This level is in line with work also done by Water UK.
- Waterwise recommend a more ambitious target of 100 l/p/d or less for all England and Wales water companies by 2045. Southern Water has already set a target of 100 l/p/d across its region by 2040.
- A recent study by Ofwat shows that average household consumption of 50-70 l/p/d in 50 years is possible technologically, although the study did not consider costs.
- The Code for Sustainable Homes found that it would be possible for new build homes to get down to 80 l/p/d through efficiency measures only (including using just over 28 l/p/d of recycled water). Applying this to existing homes and excluding water recycling due to costs of retrofit (as it would require a separate plumbing system), it could be possible to retrofit homes to around 110 l/p/d by replacing appliances at their natural end of life:
    - Most appliances would reach the end of their useful life before 2050 so would be replaced anyway, providing an opportunity for home owners and landlords to purchase new water efficient products.

A per capita consumption target and compulsory product labelling could help to drive demand and reduce costs for water efficient appliances.

Source: National Infrastructure Commission (2018) *Preparing for a drier future: England's water infrastructure needs*; See: https://www.waterwise.org.uk/southern-water-target-100/; Ofwat (2018) *Deep reductions on household water demand*; Defra (2008) *Future Water*.

In order to meet a per capita consumption target there is a need for reduction in household usage. This should be driven in part by improving building standards and an increase in water metering. Behaviour change also plays a role in reducing consumption with a need for better incentives and information, such as compulsory water labelling of products to drive change.

Reducing per capita consumption will require improvements in the way households use water and further action by water companies, beyond current levels of ambition:[182]

- Changes in lifestyles, occupancy and technology will create opportunities to improve the way households use water and are important contextual factors for long-term demand management. Examples include changing per person demand (e.g. as individuals use showers instead of baths, or purchase more water-efficient washing machines) and changing living practices (e.g. water use is lower in multiple occupancy homes because of economies of scale in use of washing machines, cooking and dish-washing).
- The water industry has a critical role to play. Water companies will need to be more ambitious and take action to go further in managing demand and in improving water efficiency. They will need to work with households to help improve water efficiency and waste less water.

Defra should consider the following as part of its 2019 per capita consumption target consultation:

- New build homes provide the opportunity to be ambitious at much lower cost. Current **new build regulation standards** (Part G) should be strengthened to allow local authorities, especially those in current or future water stressed areas, to be more ambitious in order to drive reductions and help meet a per capita consumption target.
  - The current water efficiency standard in Building Regulations in England is 125 litres per person per day (l/p/d), or an optional 110 l/p/d for water companies in current water stressed areas.
  - Existing homes built to a Part G Building Regulations standard of 125 l/p/d could be using more than this in practice. There is evidence that homes in London built to 105 l/p/d under the Code for Sustainable Homes shows a range of between 110 l/p/d and 140 l/p/d depending on occupancy.[183] More work is needed to understand and address the reasons for this (see Section 4.2 on the performance gap of homes).
  - In Wales regulations are somewhat tighter and require that the estimated consumption water in all new homes should not be more than 110 l/p/d (calculated in accordance with the 'water efficiency calculator for new dwellings').
  - Requiring all homes in England to be built to 110 l/p/d is possible under Part G of regulations and would be no additional cost. However, in order to help alleviate future supply-demand deficits much tighter standards are required.
  - Further savings could be achieved in England with a 'fittings based approach' as modelled for Wales and Scotland where potential water, energy and bill savings of greater water efficiency are modelled in building regulations.[184] Measures required for much tighter standards, such as rainwater harvesting and water re-use are available, more work is needed to understand the current costs and benefits of these measures.
- **Reducing leakage** in household pipes and appliances. For example, one study has identified leakage (such as drips from pipes or cisterns) occurs in approximately 4% of WCs in the UK.

[182] As recommended by the NIC it will also be necessary, alongside reductions in per capita consumption, for water companies to reduce leakage from pipes and increase supply-side measures such as building new infrastructure and developing ways of transferring water from areas of surplus to areas of deficit
[183] Waterwise (2018) *Advice on water efficiency new homes for England.*
[184] Waterwise (2018) *Advice on water efficiency new homes for England.*

Average leakage rates of 72 litres per WC per day were derived, with new properties (post-2000) most likely to have leaks. The overall contribution of WC leakage to average per capita consumption is between 1.7% and 4.6%.[185]

- Standard **waters meters** can reduce average consumption by 15% and smart meters by 17%, whilst helping customers and water companies to **identify leakage**.
  - At present, water companies in England can only impose mandatory metering in water stressed areas. The Committee agree with the recommendation made by the NIC in 2018 that compulsory metering should be allowed by all water companies, not just those currently in water stressed areas.
  - Defra should enable companies to implement compulsory metering beyond water stressed areas, by amending regulations before the end of 2019 and requiring all companies to consider systematic roll out of smart meters as a first step in a concerted campaign to improve water efficiency.
- Innovative water products are being developed all the time, but customers are not always aware of them.[186] An **effective water labelling scheme** is essential for transforming the market so customers can be aware of and buy water-efficient products. Manufacturers in the UK make voluntary use of the European Water Label, but uptake is still relatively low:
  - Labelling can help to reduce water via building regulations for new builds, encourage behaviour change and increase use of water-efficient products in water company incentive and retrofit programmes.
  - Waterwise reported that many UK water companies are keen to see a mandatory label, as has been the case with the energy label now widely recognised at point of sale.[187]
  - Research by the Energy Saving Trust for the Waterwise Water Efficiency Strategy for the UK has identified that mandatory water efficiency labelling could save around 30 litres per person per day by 2050.[188]
  - A more efficient appliance may initially be marginally more expensive to purchase. However as the technology for these is well-tested marginal costs may drop quickly as appliance market increases.
- **Household behaviour** can have a significant impact on water demand. For example, if every household in the UK took one minute off a shower every day, it would save £215 million on collective energy bills a year. If everyone in a four-person metered household with a power shower did this, it could save the household £60 on energy bills and a further £60 on water bills every year.[189] Water companies can also run awareness and educational campaigns:
  - Examples include water companies informing people of the water saving efforts of their neighbours to nudge further water saving behaviour and use of experimental trials of information provision.
  - Partnership retrofitting (for example between local authorities and water companies) and behaviour change programmes tend to show greater uptake, greater engagement and

[185] Ricardo Energy & Environment (2015) *Leaky Loos Phase II*.
[186] Examples include smart point of use water management devices, smart rainwater butts, air flush toilets, ultra-low-flow products and improved customer engagement displays and devices.
[187] Waterwise (2017) *Water Efficiency Strategy for the UK*.
[188] https://www.waterwise.org.uk/resource/water-efficiency-strategy-for-the-uk-year-1-full-report/
[189] http://www.energysavingtrust.org.uk/sites/default/files/reports/AtHomewithWater%287%29.pdf

greater water, carbon and financial savings, and to be more innovative than solo approaches.

– There is a role for social enterprises, cooperatives and community organisations to work together with governments and the water sector to deliver water efficiency.

– The establishment of partnerships and trusts for resource efficiency could also deliver social and economic benefit to local communities.

– As delivery is scaled up there may be a skills and capacity gap – a partnership approach between the water companies, plumbers and builders to identify gaps could help with long-term delivery. Waterwise have been delivering water efficiency training to water company staff, plumbers and energy retrofit staff across the UK to help improve skills.[190]

Recommendation: Defra should set a per capita consumption target which can address future supply-demand deficits resulting from both 2 and 4 degree climate change scenarios. Further research should be undertaken to understand the costs and benefits of targets between 50 and 100 litres per day by 2050. The devolved administrations should consider whether it is necessary to introduce similar targets. As a first step to meeting a target and improving water efficiency in homes, the UK Government and devolved administrations should:

- Enable water companies to implement compulsory metering beyond water stressed areas by amending regulations before the end of 2019 and requiring all companies to consider systematic roll out of smart meters.
- Review new build regulation standards to allow local authorities to set more ambitious standards, especially in current and future water-stressed areas.
- Introduce compulsory water efficiency labelling of household water products.
- Work with water companies and local authorities to run partnership retrofit and behaviour change programmes in existing homes.

(Owner: Defra. Timing: by 2021).

[190] Discussion with Waterwise (2019).

Chapter 3: Climate-resilient neighbourhoods and sustainable transport

Key messages

How homes are used and how the areas around them are utilised is key to addressing climate change. There are 1.8 million people living in areas of significant flood risk, and this could grow to 3.5 million by the 2080s. Cost-effective measures to reduce the impacts of flooding through property-level protection are not being taken up. Greenspace can act to help mitigate flood risk as well as provide cooling and a host of other benefits, but the proportion of urban greenspace in England is declining rather than increasing, and trends in the devolved administrations are not known. Many new developments are also designed only for travel by car, with limited or no access to public transport.

The following measures are required:

- **Property-level flood protection**. The planned rate of uptake in England, at 500 properties per year, is currently five times lower than it should be to ensure homes that are not cost-effective to protect through community flood defences are protected at the property-level. There is a need for a long-term strategy to increase the uptake of property resilience and resistance measures. Householders must have the incentive to take action so that when Flood Re is withdrawn in 2039, properties can remain insurable. Government, industry and the insurance companies all play a key role in achieving this. A new Code of Practice should help to improve skills, compliance and enforcement of installing measures. The UK Government should consider the introduction of Flood Protection Certificates and examine the potential for building standards or other regulations.
- **Green infrastructure and sustainable drainage.** Sustainable Drainage Systems (SuDS) are starting to be more widely installed, but there is evidence to suggest it is not yet common place for these to be 'green' systems that have a host of benefits. To help with this the Planning Guidance and Defra's non-statutory standards for SuDS should be updated to encourage multi-functional SuDS with clear policy on who should maintain and adopt SuDS by default. The automatic right to connect new development to the existing sewage network should be made conditional on national SuDS standards being met or by water company agreement. The Government should also consider the need of a national retrofit strategy and approach to help guide local authorities when creating local plans, and introduce targets for increasing the amount of greenspace in urban areas.
- **Sustainable transport.** Given new evidence that many recently constructed housing developments are encouraging car-dependent lifestyles, the planning process must change to increase the importance of sustainable travel, including walking, cycling, and the use of public transport and electric vehicles. The need to encourage a shift to lower emission, healthier and more inclusive modes of travel should be a primary consideration from the beginning of the process, including the choice of location, housing layout, housing densities and accompanying infrastructure, such as public transport hubs and cycle paths. Local authorities must consider where best to locate new homes to minimise the need to travel to work and amenities such as shops and schools.

3.1 Purpose of this chapter

This chapter sets out how UK homes and neighbourhoods can be well-adapted to flood risk, and how the spaces around our homes can help contribute to long-term emission reductions and resilience to climate change.

Where possible the chapter considers the costs and benefits of these measures and identifies those which are low-regret. Our analysis looks at property level flood resilience and resistance, green infrastructure, and sustainable transport.

3.2 Property level flood resilience and resistance

There are an increasing number of homes expected to be at high flood risk in the coming decades, not all of which will be possible to protect with community defences.

The CCRA found that an estimated 1.8 million people are living in areas of the UK at significant (1% annual chance) risk of river, surface water or coastal flooding. The population living in such areas is projected to rise to 2.5 million by the 2080s under a 2C scenario and 3.5 million under a 4C scenario.[191]

The Environment Agency's Long Term Investment Scenarios show that it will not be cost-effective to build community flood alleviation schemes to protect all of these properties. Making properties more resilient and resistant to flooding can be a cost-effective way to manage flood risk when community-scale defences are not affordable, and can also help to reduce residual risk if defences fail.

In general, it is recognised that the most effective measure to speed up property reinstatement after a flood is to reduce the likelihood of water entering a property and to use property-level resilience measures, such as water-resilient fittings and materials wherever feasible. Property level flood resilience and resistance (PFR) can be defined as:[192,193,194]

- Flood resilience measures - which aim to minimise impact of flooding and facilitate repair, drying & cleaning and subsequent reoccupation. They can be implemented incrementally;
- Flood resistance measures - which aim to prevent water entering the building and damaging it in the first place. For a shallow flooding event, smaller properties can be protected for as little as £800,[195] while recovering from a flood without resistance measures could cost on average as much as £45,000.[196]

The greatest benefit of resistance and resilience measures will be felt by households that are at highest risk of flooding.

However, particularly for low-cost measures many other households could benefit (for example properties which are not currently at risk but projected to be in the future).

Updated research for the Committee has identified a number of low-regret adaptation options to protect both existing and new homes from flood damage in the Aire catchment in Yorkshire and Humber.[197] The assessment evaluated the costs of measures against the benefit of avoiding flooding or minimising impacts. It was then expanded to also include avoided costs of evacuation and mental health benefits as a dedicated sensitivity scenario (Box 3.1).It is difficult to generalise the results and to say with certainty if these measures are cost-effective beyond the Aire catchment. Climate risks are context-specific, especially flooding where the risk and severity of the impact depend upon where a property is located.

[191] Sayers et al. (2015) *Climate Change Risk Assessment 2017: Projections of future flood risk in the UK.* Assuming no population growth and continuing current levels of adaptation.
[192] See: http://www.aviva.co.uk/home/home-advice/extreme-weather-advice/article/getting-back-normal-after-flood/
[193] ABI. *A guide to resistant and resilient repair after a flood.*
[194] NFF (2014) *Ready for flooding –Before, during and after.*
[195] Wood PLC et al. (2019) Updating an assessment of the costs and benefits of low-regret climate change adaptation options in the residential buildings sector.
[196] See: https://www.building.co.uk/news/average-cost-of-repairing-flood-hit-home-as-high-as-30k/5067762.article
[197] Wood PLC et al. (2019) *Updating an assessment of the costs and benefits of low-regret climate change adaptation options in the residential buildings sector*.

However, the assessment provides an indication of potential low-regret measures. Other projects, such as a flood demonstration project in Carlisle, have been used to showcase how resilience products can be installed.[198]

Box 3.1. Cost-effective adaptation measures for property-level flood protection

Updated research for the CCC presented the costs and benefits of a range of adaptation measures:

- The installation of a **flood resistance package** was found to be 'low-regret' (cost-effective and easily installed) in all types of residential dwellings and all stages, including new build, repair and discretionary retrofit, when potential flooding is greater than 1% Annual Exceedance Probability (AEP). These measures include airbrick covers, door-guards, repointing external walls up to a height of one metre, main sewer non-return vales, drainage bungs and toilet pan seals:
    - While it is less costly for households to install measures as part of a repair following a flood, the benefits are less as they would have failed to avoid the damages of the flood. If these options are fitted as a discretionary retrofit measure before flooding occurs, rather than as part of the repair work (e.g. after a flood), they save more damages from flooding.
    - There are some properties, where although it is cost-effective to implement resistance measures, they may be unsuitable (for example in older houses where measures will never be fully effective).
- In new builds the research found a number of zero cost **flood resilience measures** that can be incorporated at the new build stage for properties at greater than 1% AEP flood risk. These include installing a chemical damp-proof course, moving the washing machine to the first floor, raising the service meters, wall-mounting the boiler and raising the oven. Installation of a new floor with treated timber joists during discretionary retrofits is the only measure which is cost-effective for existing homes.

Overall, the inclusion of wider benefits associated with reduced evacuation costs and intangible human health impacts has produced an expanded list of low-regret adaptation measures compared with previous analysis done for the CCC in 2011. Additional measures include:

- Installation of dense screed in new build properties and on repair.
- Moving washing machine and oven above flood level on repair in the case of deep floods.

The period of evacuation time is strongly associated with health impacts. A Flood Re and UWE report suggests that stress and mental health issues are related to length of evacuation. Therefore, implementation of flood resilience and resistance measures can help in reducing time for repair and recovery after flooding and positively affect mental health.[199]

- Flood resistance measures in general are assumed to result in zero displacement.
- There are no studies of resilience measures which quantify the increased speed of reoccupation, however anecdotal evidence suggest that successful full-scale resilience adoption allows reoccupation of an affected property within 24 hours.

Source: Wood PLC et al. for the CCC (2019) *Updating an assessment of the costs and benefits of low-regret climate change adaptation options in the residential buildings sector.*

[198] See: http://edition.pagesuite-professional.co.uk/html5/reader/production/default.aspx?pubname=&edid=a56b3613-b7cb-4bc7-9141-48e0b04d3712

[199] Flood Re (2018) *Evidence review for property flood resilience phase 2 report.*

Property level measures are being installed in some homes post-flood, however the amount of homes projected to be cost effective for property level measures is increasing faster than the projected uptake.

In England, the Flood Defence Grant in Aid scheme has installed measures in around 4,000 properties up to 2018.[200] Around 6,000 home and business owners also benefitted from a scheme following storms in 2013/14 to help protect their property against future flooding, and a further 17,600 properties were eligible to receive recovery grants in areas impacted by 2015/16 storms. According to Defra, two thirds of those eligible applied for grants, 95% of which were approved.

In Scotland it is estimated that 40,000 properties at risk could potentially benefit from property level protection measures. However, while some of the local authorities offer funded or subsidised scheme and some residents installed products independently with help from the Scottish Flood Forum, the uptake is low.[201]

In our 2017 progress report we found that the commitment in the current six-year investment plan in England would result in around 500 properties being fitted with PFR measures per year between 2015 and 2021. At this rate, PFR would be fitted to around 12,000 properties by 2039, when Flood Re will be withdrawn. More than 217,000 properties would be cost-effective to protect by this time.

Flood Re is developing a strategy to incentivise PFR, however, there are no targets for PFR in properties, nor are there any plans in place for how PFR will be incentivised once Flood Re has been withdrawn.

Flood Re was set up to aid the transition towards risk-reflective pricing by 2039. It is an industry funded re-insurance scheme that aims to make flood insurance available to those who face significant flood risk. Flood Re has been operating for less than 2.5 years and currently subsidises around 150,000 insurance policies:

- In 2018 Flood Re published a report to assess how the scheme might play a more direct role in incentivising households and insurers to implement property-level resilience measures. This concluded that incentivising and rewarding homeowner action will be more effective than penalising a lack of action. Flood Re have committed to undertake further work to understand specifically how communicating messages about PFR could be most effective, including through the fire service, insurers, Government and local flood groups.[202]
- Flood Re's transition plan also stated 'We will use our database of high flood risk properties and work with others to identify where we believe that spending would be the most effective in cutting the cost of flooding to households and insurers.' The plan committed to work with the Government, the devolved administrations, the Environment Agency, local authorities, and the Committee.

[200] Discussion with Defra (2019).
[201] See:
https://www.webarchive.org.uk/wayback/archive/20180516031016/http://www.gov.scot/Topics/Environment/Water/Flooding/resources/research/PLP-Evidence
[202] Flood Re (2018) *Incentivising household action on flooding and options for using incentives to increase the take up of flood resilience and resistance measures.*

- Flood Re now holds data on more than 100,000 households in the UK considered by insurance companies to be at the greatest flood risk. The process of releasing data to inform and help target new policies in high risk areas has not yet begun.

Neither the transition to risk-reflective pricing nor the steps towards removing Flood Re were mentioned in the second National Adaptation Programme (NAP), which outlines the UK Government's adaptation actions for the period 2018 - 2023. The removal of Flood Re in 2039 will be a significant event and the NAP has no targets or actions for managing the transition between now and 2023. Despite this, Defra are leading a number of initiatives to improve the evidence base of PFR and an industry led roundtable is aiming to develop action and policy for property flood level solutions.

In Scotland a Property Flood Resilience Delivery Group (PFRDG) is due to be set up in 2019. The aim of the group will be to mainstream PFR and help property owners take action to make their properties more resilient against the impacts of flooding.[203] The new Scottish Climate Change Adaptation Plan is also due for publication later in 2019. It is expected that this will make reference to actions to incentivise greater uptake of PFR measures.

Many insurers do not allow improvements to be made when flooded properties are reinstated, even if paid for by policy holders.

As part of the support information for a recovery scheme following the 2015/6 floods in 2016, the Government published a handbook to help practitioners both select and give better advice to households on low cost flood resilient measures.[204]

Insurance brokers who were interviewed in a Biba study included within the Property Flood Resilience Action Plan (Bonfield Plan) found that: [205]

- Internal resilience measures were seen in a positive light by just under half. However, installing them was not a common occurrence.
- Insurers do not recognise any standards for resilience measures.
- One-third of the brokers said they would not pay insurance claims if spent on flood resilient or resistant repairs, even if they were cost-neutral.
- Over half of the brokers said that they would not allow for improvements to be made to a flooded property if they required additional cost, even if this cost were met by the policy holder.
- The same survey also suggested that fitting resilience and resistance measures does not generally lead to lower insurance premiums.

Other barriers to wider uptake of PFR include lack of specialist installers and compliance and verification of installed measures. Property owners also lack motivation and information in order to implement risk reducing measures.

Evidence from a Social Market Foundation report (commissioned by Flood Re) and existing schemes suggest that important barriers to growth in uptake include a number of factors:[206,207]

[203] Flood Resilience Properties Advisory Group (2018) *Framework for delivery property flood resilience in Scotland*.
[204] Defra (2016) *Practitioners' Handbook for low cost repairable or resilient reinstatement for surveyors and local authorities*.
[205] Defra (2016) *The property flood resilience action plan.*
[206] Social Market Foundation (2018) *Incentivising household action on flooding.*
[207] BRE, *A Future Flood Resilient Built Environment.*

- **Lack of motivation:** Subsidised insurance schemes like Flood Re have largely removed the financial incentives for high risk households to take action to prevent flooding. Households need to be motivated to act. This means householders recognising that they are at risk of flooding (either now or in the future) and taking responsibility for protecting their property.
- **Lack of familiarity and access to information**: Households need to access information about various products on the market, and then be able to assess cost and benefits.
- **Costs and behavioural biases to taking action:** Some measures, in particular resilience or (recoverable) measures can be expensive. There are also some behavioural biases that could restrict the likelihood of action. For example owners could be reluctant to implement risk reducing measures which they perceive to demonstrate to the wider public (and potential home-buyers) that their properties are at risk, and equally buyers may be put off by resilience measures which make a property appear to be flood prone.
- **Lack of professional skills and knowledge:** There is a lack of specialist capacity amongst installers and surveyors, alongside a lack of independent verification of this capacity to build consumer confidence. Surveyors also have an important part to play in assurance to insurers that measures have been property installed.

Planning rules for new homes do not include provisions for PFR.

New homes built after 1st January 2009 are excluded from Flood Re. This ought to incentivise the location of new development away from flood risk areas and/or the installation of PFR, so that homes are insurable at reasonable cost.

The Building Research Establishment (BRE) conducted a survey for the Adaptation Committee of building professionals including architects, developers and consultants.[208] They found that the application of flood resilience measures in building design and construction was limited.

A report by the Royal Institute of British Architects (RIBA) found that statutory guidance, building standards and approved construction techniques for new flood resilience properties are lacking.[209]

Uptake of property level flood protection measures needs to be significantly increased. This can be achieved by providing homeowners with better information on costs and benefits of measures. The insurance industry must be fully engaged in property level protection. Resilience surveys and Flood Protection Certificates should be introduced.

The Committee's 2017 progress report and a report by the Social Market Foundation highlighted a number of ways to incentivise uptake from householders and insurance:[210]

- **Increasing understanding of risk and help available:** For example through pilot studies of how flood risk can be best communicated. A survey among 531 people living in areas at flood risk found that most were not aware of Government schemes (such as £5,000 grants for homes and businesses flooded in 2013 floods) to protect their properties, and few had taken up any scheme.[211]
- **Increasing ownership of the issue:** It is important that the approach to managing flood risk at a property level becomes normal practice so that homeowners and landlords can take a

[208] BRE (2017) for the CCC. *Resilience of new developments to high temperatures and flooding.*
[209] RIBA (2018) *The value of flood resilient architectural design*.
[210] Social Market Foundation (2018) *Incentivising household action on flooding.*
[211] Ipsos Mori (2015) for Defra. *Affordability and Availability of Flood Insurance*.

more precautionary approach, especially when refreshing or upgrading their property. Flood Re have suggested that at risk households could have a resilience survey that results in the issue of a Flood Performance Certificate. Working with surveyors and estate agents, this could then be available when properties are sold, rented or built.[212] BRE have developed a Property Flood Resilience database (PFR-d) tool for surveyors of PFR.[213] Surveyors must be independent of product manufacturers or suppliers. To gain access to the tool surveyors' must complete a certification scheme to test competence and independence. Once installers have installed PFR into a property surveyors can calculates a 'PFR-score', similar to an Energy Performance Certificate. If measures are certified and/or tested, the property will achieve a higher 'PFR-score'. The tool could then be used by other bodies (e.g. insurers to make decisions about insurance premiums). There is also potential to expand to wider resilience measures.

- **Increasing understanding of potential options and their benefits** by continuing the sharing of knowledge and best practices locally. For example, the Environment Agency's research and development team have recently started work to assess behaviours and map gaps and issues to PFR uptake. This includes proposing pilots to test methods of increasing uptake.[214] Resilience surveys and improved communication on available finance (e.g. government grants) can support homeowners and landlords in decision making.
- **Finance and reducing costs:** Introducing rigorous independent standards and certification of products should help to drive up skills and increase consumer confidence. This will widen uptake and reduce costs of measures. Alongside this there is a role for government grant schemes to be extended or reformed to include properties at high risk of flooding, for example like the Homeowner Flood Protection Grant Scheme in Northern Ireland. Property Flood Resilience schemes can be advanced by Flood Risk Management Authorities (such as county councils or the Environment Agency) for support through Flood Defence Grant in Aid or the Local Levy. Local Councils also have discretionary powers to fund grants, loans or other payments for home improvements, this can include funding for PFR.[215]
- **Insurance and finance industry playing a key role**: with Flood Re being used to initially target at risk households:
  - Flood Re have found that "building back better" when renovating (either after a flood or at another stage of renovations) would potentially have broad benefits and help to change social attitudes towards the acceptability of flood resilience measures in homes. For example, this could stimulate demand for products, develop trade skills, and encourage innovation in industry.[216]
  - The insurance industry has a role to play in achieving this. Insurance companies should insist on PFR after a flood claim, especially when measures are cost effective and cheaper than other alternatives. In order for them to do this PFR measures should be independently certified and tested.

[212] Flood Re (2018) *Incentivising household action on flooding and options for using incentives to increase the take up of flood resilience and resistance measures.*
[213] See: https://bregroup.com/expertise/resilience/flood-resilience/resilience-projects-and-publications/
[214] Discussion with Environment Agency (2019).
[215] Discussion with Defra (2019).
[216] Flood Re (2018) *Incentivising household action on flooding and options for using incentives to increase the take up of flood resilience and resistance measures.*

– Lenders should take a stronger role in encouraging PFR, for example through green finance mechanisms such as loans to complete work or linking installation of measures to overall property value.

These measures should increase the number of households voluntarily taking up relevant measures.

Better installation, enforcement and compliance in relation to PFR measures is essential. This can partly be achieved by a Certification Scheme and a new Code of practice due to be introduced in 2019.

Defra have committed in the National Adaption Programme to support the industry-led Property Flood Resilience Roundtable, including supporting an industry-owned voluntary Code of Practice to promote consumer and business confidence in measures to reduce the impact of flooding on buildings, and on those who live and work in them.[217]

There is a need for an independent Certification Scheme for surveyors, supported by training and an open standard for installers. The Code of Practice suggest a single surveyor has overall responsibility for the delivery of PFR measures within a property.

Building regulations and standards must be introduced for PFR in new and existing homes that are at high risk of flooding.

As a first step towards regulating property level protection it is important that the skills and knowledge required to install measures are improved, alongside a better understanding of the effectiveness of measures. Given the scale of the financial, emotional and behavioural/psychological barriers involved in homeowners or landlords installing PFR, it is likely that stronger incentives, including mandatory approaches, may be needed. This is particularly true if the adoption of resilience and resistance measures is to play a significant part in ensuring that, by 2039, a market for household flood insurance exists that is both risk reflective and affordable.[218]

Building regulations (or other standards) can ensure that measures are undertaken on a mandatory basis whilst properties are being reinstated post-flooding and during renovation, and also that (at a minimum) low and negligible cost resistance and resilience measures are rolled out to all new properties. Regulations should be linked to planning policy and guidance.

This would help to support a change in social norms, for example if all new properties were required to have raised electrical points, then it would no longer be seen as a signal of flood risk, rather the 'new norm'.

Recommendation: Defra should develop a long-term strategy to manage flood risks in each part of the country (as first recommended in 2015), so that as Flood Re is withdrawn properties can remain insurable at reasonable costs. This should include:

- Continuing to support the industry round table in communicating risk and possible adaptation actions to households and communities that are expected to remain or become at high flood risk by the 2030s. The Flood Re database should be used to initially target those at risk.
- Pilot schemes to test and increase understanding of potential PFR options and their benefits to homeowners and landlords.

[217] See: https://www.cila.co.uk/cila/download-link/sig-downloads/property/331-2017-pfr-end-of-year-report/file
[218] Social Market Foundation (2018) *Incentivising household action on flooding.*

- The introduction of resilience surveys and Flood Protection Certificates which can be used by homeowners, insurance companies and lenders. The UK Government should work with BRE to further develop and widen the use of the Property Flood Resilience database tool.
- Detail of how the new Code of Practice will ensure skills are improved and better compliance and enforcement of installing measures.
- Plans to work with the insurance industry to ensure they have the evidence needed in order to confidently make informed judgements about which resilience and resistance measures installed in properties lead to reduced risk. Insurers should insist that resilience and resistance measures be implemented during post-flood repairs as a condition of continuing insurance cover.

(Owner: Defra, Environment Agency, Insurance companies. Timing: by 2020).

Recommendation: MHCLG and the devolved governments, should examine the potential for regulations on flood protection approaches for both refurbishment and new builds of homes.

(Owner: Defra, MHCLG, Scottish Government, Welsh Government, Northern Ireland Executive. Timing: by 2021).

3.3 Greenspace and sustainable drainage

Greenspace in residential areas has a significant role to play in climate adaptation, and also provides a host of wider benefits.

Ensuring that housing developments have adequate areas of greenspace is an important adaptation measure for two reasons; reducing flood risk through improving drainage and reducing surface water flood risk, and reducing heat risks by providing shading and reducing the Urban Heat Island effect.

Greenspace is often also referred to as a 'green infrastructure', when it is considered in an urban setting. Examples of green infrastructure include trees, hedges, green roofs, walls, grassed areas, permeable paving, rain gardens, and swales. The latter examples can be used as sustainable drainage systems, as they help to reduce the speed and total flow of rainwater into sewers and thereby reduce the risk of surface water flooding.

Alongside acting as an adaptation measure, green infrastructure can bring a host of wider benefits to people and wildlife:[219]

- Maintaining and improving freshwater quality and supply
- Supporting biodiversity
- Providing amenity value to people
- Health benefits
- Providing spaces for walking and cycling.[220]

[219] Maksimovic, C; Mijic, A; Suter, I; Van Reeuwijk, M (2017) *Blue-green solutions. A systems approach to sustainable, resilient and cost-effective urban development.*
[220] Birmingham is one city that has made extensive use of the ecosystem approach and a range of practical tools to help gain full benefit from a strategic approach to green infrastructure. See: neat.ecosystemsknowledge.net/birmingham2.html

There are examples where full benefits have been calculated at local and city levels across the UK:[221]

- The Natural Capital Account for London's Public Green Space highlight the significant benefit of protecting and investing in London's Green Infrastructure. The account shows London's green spaces provide services valued at £5 billion per year including £950 million per year in avoided health costs.[222]
- A study of 11 UK cities valued the cooling effects of green space over 100 years as around £11 billion, with the total value associated with living green space estimated to be just over £130 billion in the UK.[223]

The proportion of urban area that is made up of greenspace is declining in England.

The total proportion of urban greenspace in England declined between 2001 and 2018 from 63% to 55% of urban area. Though there had been no change between 2011 and 2016, the area declined by a further 1% between 2016 and 2018.[224] Statistics are not available for the devolved administrations; monitoring of urban greenspace would be a useful action to include in their future national adaptation programmes.

As well as concerns over the decline in amount of urban greenspace, access to green space is not equal across the population. People living in the most deprived areas are less likely to live in the greenest areas, and will therefore have less opportunities to gain the health benefits of greenspace compared with people living in less deprived areas.[225]

Sustainable Drainage Systems are starting to be more widely installed in new developments in England, but it is unclear how far 'green' SuDS with multiple benefits are being favoured over 'grey' SuDS.

SuDs can be classified as 'grey' (for example underground pipes or tanks), or 'green' (for example green space, swales, green roofs). Grey SuDS do not have the same multiple benefits as green SuDS and are not adaptable to a changing climate, and so priority to green SuDS should be given wherever possible. This does not appear to be happening at present, at least in England, and new developments are adding pressure to existing drainage networks:

- A survey by CIWEM found little confidence among practitioners that green SuDS are being built in the majority of major new developments. For example, around 30% of the 500 respondents said that SuDS (of any type) are not used in all major developments, as current guidance requires, and a further 28% did not know whether this was the case.[226] In many cases the SuDS being built were below-ground retention systems.
- MHCLG's review of planning policy and its application of SuDS in 2018 found that 87% of a sample of approved planning applications in England explicitly featured SuDS. The review also found that most local plans contained policies, in line with national requirements that

[221] Elements of landscaping, including green infrastructure, can be costed through reference to Spon's. Spon's (2018) *External Works and Landscape Price Book, 2018.*
[222] Greater London Authority (2017) *Natural capital accounts for public green space in London.*
[223] Eftec for ONS (2018) *UK natural capital: ecosystem accounts for urban areas.* The 11 city regions included in the analysis are: Cardiff, Edinburgh, Glasgow, Greater Manchester, Liverpool, London, Sheffield and the city regions of the North East, West Midlands, West of England and West Yorkshire.
[224] ADAS (2019) for the CCC. *Research to provide updated indicators of climate change risk and adaptation action in England.*
[225] PHE (2014) *Local action on health inequalities: Improving access to green spaces.*
[226] CIWEM (2016) *A place for SuDS?*

SuDS should be prioritised in areas at risk of flooding, with about 83% of plans stating that they should be provided in all major new developments.[227] However, it made no distinction whether the SuDS being installed were green or grey.

The barriers to uptake of SuDS in England, including green SuDS, are well known:

- **There is a lack of compulsory, enforceable national standards for SuDS required in new or existing developments:**
  - Different national and local organisational structures is a challenge to the delivery of successful SuDS.[228]
  - Non-statutory Technical Standards for SuDS only apply to developments of 10 or more houses, do not promote the benefits of green SuDS, and fail to provide clear guidance on responsibilities for adoption and maintenance of SuDS.
  - The Landscape Institute surveyed Lead Local Flood Authorities and found that those responsible for SuDS feel it is difficult to challenge 'grey' SuDS as they can't refuse them if they store a sufficient quantity of water. Refusal of permission for a grey SuDS scheme is unlikely to be supported by an inspector at appeal or inquiry due to the Non-Statutory Technical Standards only requiring water quantity to be addressed, which is easier to measure for a grey than a green SuDS scheme.[229]
- **There is confusion over adoption and maintenance:**
  - CIWEM's survey found that the greatest barrier to SuDS delivery was the lack of a single adopting body or clear route for adoption of SuDS in new developments and responsibilities around maintenance. Of the responders, 60% identified responsibilities for maintenance and adoption not being clearly defined as a significant barrier to the delivery of SuDS in new development.
  - A third of local planning authority respondents to the SuDS review were unsure of the extent to which SuDS were adopted as agreed. A reactive approach was taken by most, checking only following complaints or issues raised by third parties.
- **Knowledge and awareness gaps exist:**
  - The design standards of SuDS can vary locally, thus their overall impact in managing flood risk and making new developments adaptable to climate change is not known.
  - There is a lack of general knowledge on how to adequately manage and maintain SuDS with only 8% of responders to CIWEM's survey considering current guidance effective at driving installation of high quality and effective SuDS.[230,231] These factors are likely to result in green SuDS not being proposed due to the perceived impact on the viability of a development.[232]
  - The SuDS review found that 40% of Lead Local Flood Authorities (LLFAs) in England suggested that their time, expertise and resources were under pressure with regards to

[227] MHCLG (2018) *A review of the application and effectiveness of planning policy for Sustainable Drainage Systems (SuDS)*.
[228] E.g. in CIWEM's report, *A Place for SuDS,* 2017.
[229] Landscape Institute (2018) *Achieving sustainable drainage.*
[230] Peter Melville-Shreeve, Ana Arahuetes, Sarah Cotterill, Raziyeh Farmani, Virginia Stovin, Laura Grant and David Butler (in press) *State of SuDS Delivery in the UK*. Water and Environment Journal.
[231] Defra (2018) *A review of the application and effectiveness of planning policy for sustainable drainage systems.*
[232] CIWEM (2016) *A place for SuDS?*

assessing planning applications. Once completed Local Planning Authorities (LPAs) had no specific checking regimes in place to ensure that SuDS had been constructed as agreed due to a lack of resources.

– Whether and how SuDS are retrofitted into existing developments is not widely monitored. If the risk of surface water flooding is being managed through building and upsizing of traditional systems such as sewers and underground storage, unsustainable solutions are perpetuated as they are not adaptable to a changing climate.

- **Difficult to quantify benefits:**
  – The full benefits of green infrastructure are often not accounted for in housing developments. Those that are put in at the beginning of a design project are often 'value engineered' out to bring down costs, use the space to deliver a larger number of new homes or areas of green space in existing developments being built on. [233,234]
  – There is currently no easily accessible source of 'whole-life' cost information that allows simple comparison between the costs of green infrastructure solutions and traditional grey infrastructure solutions at a specific site level.[235] However, recent research by the Welsh Government has found that SuDS were more cost-effective to fit and maintain than traditional 'grey' drainage in a range of recent developments.[236] The report also found that the operational costs of landscape SuDS were always cheaper than conventional grey solutions. Landscape SuDS can reduce the costs of energy and maintenance - savings of which can be passed on to water bill payers.[237]

The devolved administrations have stronger policies than in England to encourage or enforce sustainable drainage in new developments, though it is likely that still more could be done to encourage green SuDS.

In Wales, from 7 January 2019 all new developments of more than one dwelling or where the construction area is 100m^2 or more will require SuDS. SuDS on new developments must be designed and built in accordance with the Statutory SuDS Standards published by the Welsh Ministers and SuDS Schemes must be approved by SuDS Approving Bodies (SABs) in every local authority before construction work begins.

In Scotland, the Water Environment (Controlled Activities) Regulations have required SuDS for new developments since 2006 (for those where surface water drains into the water environment in order to protect water quality), and SuDS are routinely installed in new developments. The Flood Risk Management (Scotland) Act 2009 places a duty on local authorities to map SuDS in their area, although there is no statutory timescale for delivery. National promotion of SuDS by the SuDS Working Party is on-going with contributions being made to good practice publications and guidance such as 'Sewers for Scotland'. The SUDS Working Party, as well as authorities with responsibilities for surface water, highlighted to the Scottish Government that there were issues with the effectiveness of SuDS implementation in Scotland. To address these

[233] BRE (2017) for the CCC. *Resilience of new developments to high temperatures and flooding.*
[234] Building with Nature (2018), https://www.theplanner.co.uk/opinion/setting-a-new-standard-for-green-infrastructure
[235] McLintock, M. (2018) *Maximising the benefits of green infrastructure in social housing. Scottish Natural Heritage Research Report No.1046.*
[236]Environmental Policy Consulting (2017) for the Welsh Government. *Final report: Analysis of evidence including costs and benefits of SuDS construction and adoption*.
[237] Environmental Policy Consulting for Welsh Government (2017) *Sustainable Drainage Systems on new developments.*

issues the Scottish Government set up a new working group with Scottish Government, Scottish Water and local authorities, looking at SuDS implementation. The working group is on-going and is concerned with the adequacy of the installation and subsequent on-going maintenance of SuDS installations.

In Northern Ireland, Planning Policy Statement 15 (PPS15) 'Planning and Flood Risk' sets out the Department of Environment's planning policies to minimise flood risk to people, property and the environment. The Water and Sewerage Services Act (2016) extends the powers of Northern Ireland Water to adopt sustainable drainage systems (as they define them) and to require construction of SuDS. Section 5 supports this by introducing restrictions on the right to connect new surface water sewers to the public network.

There have been a number of policy developments since the Committee's last adaptation report to Parliament in 2017 that could place more attention on green SuDS and green infrastructure in England, if translated into action.

As part of the 25 Year Environment Plan commitments:

- The Government changed the National Planning Policy Framework (NPPF) to further encourage SuDS in major new developments and helped to clarify maintenance arrangements by requiring a maintenance plan is in place. While this improvement has been welcomed by the Committee, it was disappointing not to see this clause extended to all developments, with use of smaller scale SuDS schemes for minor developments. The revised NPPF also specified that 'where possible' SuDS should provide multifunctional benefits. This should be the default.
- Recommendations are included for green infrastructure including increased tree planting and new standards for green infrastructure.
- The new National Adaptation Programme includes actions relating to SuDS from the 25 Year Environment Plan, however the focus is solely on SuDS in new build, and there is no mention of retrofit.

Defra and Environment Agency also published a Surface Water Management Action Plan in July 2018 which considers issues related to surface water to ensure that those responsible for managing risks are taking the appropriate actions.

Immediate action can be taken to improve uptake of green infrastructure in England, including green SuDS in existing and new developments.

1. The importance of **shaded spaces** in urban areas should be included in the National Planning Policy Framework's (NPPF) section on 'promoting healthy and safe communities', so that all local planning authorities have to demonstrate their provision of shaded spaces in the clearance process of their local plans. Natural England are leading the establishment of a national framework of green infrastructure standards due to be published in 2019. Once published, local authorities should assess green infrastructure provision against new standards. MHCLG should also incorporate them in national planning policy and guidance for new builds.

2. **Improving Planning Guidance and knowledge** in England to ensure that designs for SuDS and other greenspaces are included in the housing delivery process from the start:

- Planning Guidance should be updated to bring the parts of the NPPF dealing with green infrastructure together. This should include using the latest evidence to support SuDS including the full costs and benefits of green SuDS and practicality of installations.

- The Construction Industry Research and Information Association (CIRIA) SuDS Manual[238] aims to assist planning, design, construction, management and maintenance of good SuDS. It provides the evidence and technical guidance needed to deliver surface water attenuation in all types of development, as well as benefits to biodiversity, water quality and amenity.
- Other guidance and standards, such as Building with Nature Benchmark can help industry bodies address skills and knowledge gaps.

3. Government should consider systems approaches to value more effectively **the full benefits of green infrastructure** as well exploring any unintended consequences from poorly designed schemes.[239] This could include demonstrating the value of green infrastructure in terms of 'preventative spend' (e.g. health outcomes / flood prevention) to secure funding from a wider range of sources (e.g. NHS, local authorities, health & social care partnerships, water companies). Funding schemes that deliver a range of benefits, with funding pots that multiple partners can bid into together, and innovation in the green finance sector could help in this area.

4. Following updates to planning guidance there is an **urgent need for clear standards** for the quality of SuDS:

- The Non-Statutory Technical Standards should to be expanded to include water quality, biodiversity and amenity.
- 'Sewers for Adoption 8' (2019) includes (for the first time) guidance on SuDS components. Water companies are responsible for producing Drainage and Wastewater Management Plans and can set guidelines, along with Lead Local Flood Authorities detailing the specifications that SuDS should meet in order to be adopted. Water Companies use Sewers for Adoption to identify what they can, or can't, adopt as a sewer under the Water Act, developers should be building SuDS at least to these standards.

5. To avoid adding further pressure to existing drainage networks the Government should **remove the automatic right to connect** to sewers in new developments (as recommended previously by the CCC), and allow water companies to consult on all planning applications.

6. The Government should consider the need for **water company drainage and wastewater action plans** to be statutory, as suggested by the Surface Water Flooding Action Plan.[240] This would have implications for how water companies work with other drainage bodies. Points to consider include:

- Ofwat's guidance to water companies is clear that building and adopting SuDS will meet their duty of drainage requirements. There are a number of examples where local authorities and water companies have successfully worked together to retrofit SuDS (for example Hammersmith and Fulham Council and Thames Water's retrofitting social housing scheme, Box 3.2).
- Drainage on a wider, integrated scale requires more collaborative working. CIRIA have produced a wide range of guidance and frameworks for SUDS alongside the SuDS manual and are due to produce guidance on Integrated Water Management in 2018/19.[241]

[238] CIRIA (2016) *The SuDS Manual (C753).*
[239] Mare Lohmus et al. (2015) *Making green infrastructure healthier infrastructure.* Infection Ecology & Epidemiology Journal.
[240] Defra and Environment Agency (2018) *Surface water management action plan.*
[241] See: https://www.susdrain.org/resources/ciria-guidance.html

- A report by Business in the Community (BITC) looked at how SuDs could be rolled out across Greater Manchester. United Utilities charge a surface water flooding charge to businesses to encourage them to install SuDS to reduce water run-off.[242]

Box 3.2. Climate-proofing Social Housing Landscapes

A project led by Groundwork in partnership with Hammersmith and Fulham Council sought to demonstrate how retrofitting open spaces on housing estates can be a cost effective solution to improving London's resilience to climate change. It involved design and implementation of open space adaptation schemes on three housing estates, incorporating green roofs and integrated SDS. The project was funded in part by the borough, EU Life funding and the Greater London Authority.

Outcomes achieved included:

- 100% of rainfall on estates being diverted from drains – found to represent 1,286,815L diverted annually.
- Retrofits provided reported to have GHG savings of 6.2 tonnes/ year.
- Small contribution to local employment; development of new skills.
- Raised awareness of potential benefits of SuDS.
- Modelling by New Economics Foundation found benefit for every £1 invested in a range between £2.31 and £5.15, when taking into account broader social benefits.
- Monitoring and evaluation of data highly valued by third parties, e.g. Thames Water. Programme has led to funding of further green infrastructure work with boroughs.
- High confidence of a risk reduction at the local scale

Monitoring and evaluation was treated as a key aspect of the project. This has helped to communicate the benefits and influence the work of others. The project prioritised working with communities where past work had been done and existing relationships were established. Groundwork operating as lead agency may also have helped to circumvent potential reluctance among residents to engage with a Council.

Source: AECOM for the CCC (2018) *Adaptation actions in cities: what works?*

Recommendation: Policy is needed in England to address the outstanding barriers to deliver high quality, effective green SuDS in new development and retrofit:

- The Planning Guidance for England must be updated urgently to encourage multi-benefit SuDS in all developments, to bring together other aspects of planning related to green infrastructure and to help address skills and knowledge gaps.
- Defra should update the non-statutory standards using latest evidence on the full costs and benefits of SuDS. To promote water company adoption of SuDs Defra should consult with Water UK to ensure that standards are aligned to most up to date 'Sewers for Adoption'.
- The automatic right to connect new development to the existing sewerage network to be made conditional on national SuDS standards being met or by water company agreement.

[242] BITC (2018) *Water resilient cities.*

- A clear policy is required on who should maintain and adopt SuDS by default, unless agreed otherwise.
- Improved information on the implementation of green SuDS across the UK.

(Owner: Defra, MHCLG and local authorities. Timing: by 2020).

In the long-term the UK Government and devolved administrations should aim to increase urban greenspace as much as possible.

The Committee agree with the Environmental Audit Committee's findings in their 2018 heatwaves report. The Government's commitments to green towns and cities are not measurable or target driven and do not link green space to urban heat island reduction. Towns and cities must begin to include a percentage of green space to limit increase in the urban heat island. This is already being done in some major cities:

- The London Plan proposes a policy called the urban greening factors, which enables developers to quantify how much green space they should incorporate into their building plans. The London Environment Strategy proposes increase green coverage from to 50% in 2050.
- Bristol City council are planning to increase tree canopy from 15% to 30%, primarily for cooling shade.
- The Green Infrastructure Partnership exists to help disseminate good practice in the provision of green infrastructure in the UK.[243]

Recommendation: The UK Government and devolved administrations should take steps to monitor and reverse the decline in urban greenspace through clearer policy and more support for schemes that deliver multiple benefits:

- The UK Government should set a national target for increasing the area of urban greenspace, as part of the 25 Year Environment Plan (YEP) metrics. New standards for green infrastructure should be set in England (as actioned in the 25 YEP) and embedded within planning policy.
- The UK Government should assess the need for a national green infrastructure retrofit strategy to help guide local authorities and water companies in creating and including green infrastructure in drainage and local plans.
- Options for funding schemes tailored to multi-benefit green infrastructure schemes. This could include providing funding pots that multiple partners can bid into together.
- The devolved administrations should monitor changes in urban greenspace over time, and if declining should also take steps aligned with those suggested for England to reverse the decline.

(Owner: Defra, Devolved Governments. Timing: by 2021).

[243] www.gip-uk.org/#about

3.4 Sustainable Transport

3.4.1 Walking, cycling and public transport

New housing developments should be designed to facilitate sustainable travel. To reduce emissions from cars, it must be easy and enjoyable for people to switch to walking, cycling and using public transport. Electric vehicles should be used when car travel is essential. Transport is now the largest emitting sector of the UK economy, with emissions from car travel representing 15% of UK greenhouse gas emissions in 2017.[244]

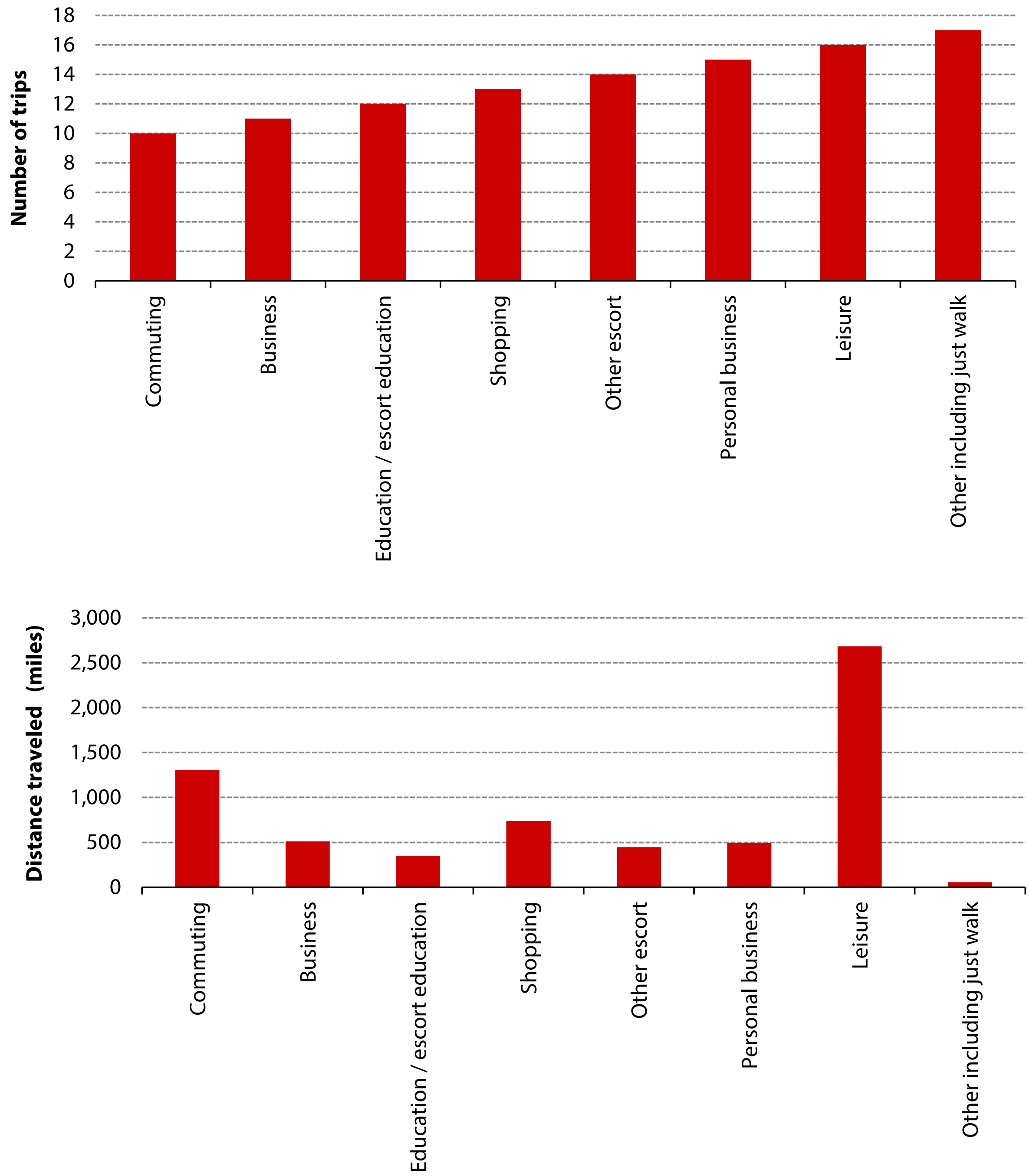
In order to reduce transport emissions, it is important to ensure that the location, layout, facilities and accompanying travel infrastructure for homes enable people to travel sustainably, whether by walking, cycling, public transport or driving in an electric vehicle.

From 2002 to 2017, on average across England, more trips were for shopping compared to any other trip purpose, although more miles were travelled for commuting purposes and to visit friends (Figure 3.1).[245] This emphasises the importance of locating shops and jobs near people's homes as far as possible accompanied by sustainable travel infrastructure, to reduce the need for car travel for these purposes.

In the current planning process, access to sustainable transport is not sufficiently prioritised, resulting in transport being considered in isolation to other key aspects of the development. This can lead to many new housing projects being designed around car use, located away from social hubs and lacking safe walking and cycling infrastructure.[246]

[244] Committee on Climate Change (2018) *Reducing UK emissions: 2018 Progress Report to Parliament.*
[245] Department for Transport (2018) *National Travel Survey: England 2017.* The National Travel Survey no longer covers the devolved administrations, and each devolved administration has different methods of collecting similar data which do not precisely align.
[246] Transport for New Homes (2018) *Project summary and recommendations July 2018.*

Figure 3.1. Average number of trips per person per year and average miles travelled per person per year in England (2017)



Source: DfT (2018) *National Travel Survey*.
Notes: Leisure includes visits to friends at home and elsewhere, entertainment, sport, holidays and day trips. Escort trips are used when the traveller has no purpose of his or her own to travel, other than to escort or accompany another person. Escort education includes trips taking a child to school.

Where possible, housing should be developed within existing urban areas. This provides easy access to amenities, reducing the need to travel.

Local authorities can use a series of spatial principles to assess the levels of traffic that a new housing development will create. New houses within and adjacent to urban areas tend to generate the least traffic:

- Creating new developments in large towns or redeveloping existing urban sites (brownfield land) make it easy for new residents to travel sustainably, as the homes are already sited in close proximity to education, shops, businesses and entertainment. These sites work best when not cut off from the town by major roads and roundabouts.
- Where this isn't possible, adding housing to smaller towns with good access to public transport or creating new villages where residents can easily access public transport is preferable.

Local authorities should prioritise locating housing in areas which minimise extra traffic.

However, many new areas of housing are being developed in locations which are remote from rail stations or located with good access to motorways only. This will generate large amounts of traffic:

- It is possible that the current planning system directs development preferentially to fields and meadows outside the town as this is often viewed as easier to develop.[247] In Trowbridge, Wiltshire, for example, houses are being built outside the town on a major road, whilst a large site in the town centre goes undeveloped.
- Whilst achieving sustainable development is a goal of the National Planning Policy Framework, pressures to deliver affordable housing have led to policies that require local authorities to maintain a five-year supply of potential land to build houses on and an emphasis on economic viability of these houses, both of which can lead to a focus on quantity of housing rather than quality.[248]
- Analysis by KPMG for Greener Journeys found that property developments in a regional centre, accompanied by public transport investment, had the largest positive economic impact on the area, when compared to those on the urban fringe, even if these were accompanied by public transport investment.[249]
- As well as increasing the need to travel for those living there, public services to low density urban developments are often higher cost due to the need to cover a wider area. These services include waste collection, school transport, police and emergency response.[250]

Recommendation: Sub-national transport bodies should play a role in coordinating regional housing plans and sharing good practice across local authorities.

(*Owner: Sub-national Transport Bodies. Timing: by 2021).*

[247] Transport for New Homes (2018) *Project summary and recommendations July 2018.*
[248] RTPI (2018) *Settlement patterns, urban form and sustainability: An evidence review.*
[249] KPMG for Greener Journeys (2018) *Sustainable transport: The key to unlocking the benefits of new housing.*
[250] RTPI (2018) *Settlement patterns, urban form and sustainability: An evidence review.*

Many new developments, particularly those built on large greenfield sites on the edges of towns, are designed for travel by car.

Car travel is likely to increase transport emissions in these areas in the near term. In 2017, the Department for Communities and Local Government (now the Ministry of Housing, Communities and Local Government) launched a new Housing Infrastructure Fund, consisting of up to £2.3 bn of government funding to fund infrastructure required to deliver 100,000 new homes. This was extended to £5.5 bn to unlock up to 650,000 new homes in total by Autumn Budget 2018. Whilst this funding can be used for a variety of new infrastructure projects, including new transport links, the guidance for applying for the funding does not mention the importance of ensuring that this transport is low emission and sustainable.[251]

A recent project by Transport for New Homes included visits to over 20 housing developments to assess how easy it was to access public transport or walk or cycle to local amenities.[252] Most of the new housing developments had plentiful car parking, but limited or no access to public transport, limited facilities and services, and a lack of safe pedestrian or cycling routes to town centres or the surrounding area. New developments across a variety of areas were advertised on the basis of easy access to major roads, in some cases, with the Government co-funding new roads with the developer.

Action must be taken to ensure that new developments encourage people to travel sustainably. To facilitate walking and cycling, new houses should be linked to towns where possible by suburban streets, rather than busy link roads.

The Department for Transport has set a target to double cycling trips by 2025 (from 2013 levels) in the Cycling and Walking Investment Strategy, and new developments should be planned with the necessary infrastructure to support this aim.[253] Public Health England has assessed that investment in active travel, including cycling infrastructure, can lead to numerous health gains, including improved cardiovascular outcomes.[254] Segregated cycle paths and bicycle parking can also help people feel safe when planning a journey by bicycle:

- New developments should include high-quality cycling infrastructure, including cycle parking near shops, facilities and connections to other transport modes. Segregated cycle paths can help people feel safe even when travelling on busy roads.
- Some roads connecting local centres to new estates do not have pavements, discouraging walking. Walking routes along dual carriageways, across large roundabouts, through underpasses or by streams or hedge-lines often connect new housing to towns, but are unattractive to use in the dark and can feel unsafe for those walking alone.
- Reducing motor traffic on roads appropriate for walking and cycling increases the likelihood people will choose to walk or cycle, due to improved perceptions of safety and ease of crossing.[255] New developments can benefit from a grid-like layout, ensuring that walkers and cyclists can travel easily from street to street but reducing the routes cars can use by the careful placement of plants, gates and bollards. When connecting new developments to

[251] Department for Communities and Local Government (2017) *An Introduction to the Housing Infrastructure Fund.*
[252] Transport for New Homes (2018) *Project summary and recommendations July 2018.*
[253] Department for Transport (2017) *Cycling and walking investment strategy.*
[254] Public Health England (2017) *Planning for Health: An evidence resource for planning and designing healthier places.*
[255] Aldred, R. and Croft, J. (2019) Evaluating active travel and health economic impacts of small streetscape schemes: An exploratory study in London. *Journal of Transport and Health,* 12, 86-96.

existing towns by cycle routes, it is important to ensure the route feels safe, by limiting through motor traffic and parked cars (which can limit visibility) using the same road.[256]

Recommendation: The Government should review the powers of planners and develop mechanisms to fund costs of building high quality walking, cycling and public transport infrastructure, even when outside the immediate housing site boundary.

(*Owner: MHCLG, DfT, devolved administrations. Timing: by 2020)*.

Developments must be serviced by public transport from the day people begin to move in.

Many new homes are not well connected to public transport and are located in places that may be difficult to service with buses:

- Transport for New Homes found from their research covering over a hundred urban extensions and green field estates that bus infrastructure was rarely given significant funding and only 1 new train station was delivered after many years of lobbying by a local authority.[257] Once travelling by car is established as a preferred mode of travel, it can be difficult to encourage people to change even with the provision of improved public transport infrastructure. When homes aren't connected to public transport and there are few local amenities, older people and teenagers struggle to access activities if they aren't able to drive or be given lifts.
- Public transport services are most cost effective when they can serve a number of residential areas along their routes. The placing of new housing in 'urban extensions' or 'garden villages' away from urban centres makes it harder to ensure adequate bus provision. Developing new housing in this way avoids large upfront infrastructure costs, so can initially seem less expensive. However, these residents will still require transport and other services and these costs should be factored in to the decision to develop. Small low density remote settlements can be prohibitively expensive to service with public transport.
- When there is insufficient certainty that new stations, bus infrastructure or cycle routes would be built, planners are prevented from relying on these modes of transport, resulting in increased road building to service the new development. In the case of local rail, this is often despite great enthusiasm from planners, Local Enterprise Partnerships and MPs.[258]

Transport planning must be integrated with local housing plans and be accompanied by clear coordination at a regional level. Discussions between local authorities, bus companies and developers should take place early to ensure sustainable travel is prioritised throughout the design process:

- Local plans must incorporate funded public transport networks and cycle networks to link new homes to sustainable transport possibilities. If new roads are built, the inclusion of bus priority lanes should be considered, as well as provision for cyclists and pedestrians. Some Councils have had success in using payments arising as part of legal agreements between the planning permission applicant and the local planning authority to ensure bus services are available at new developments from the day people move in. Across Devon, for example,

[256] Aldred, R. (2015) Adults' attitudes towards child cycling: a study on the impact of infrastructure. *European Journal of Transport and Infrastucture research,* 15, 92-115.
[257] Transport for New Homes (2018) *Project summary and recommendations July 2018.*
[258] Transport for New Homes (2018) *Project summary and recommendations July 2018.*

passenger numbers have increased by 40% since 2002 as a result, although have begun to level off in recent years.[259]

- The bus industry should be consulted as plans are being drawn up. Bus routes should be planned as new estates are being designed, ensuring that the roads are wide enough and buses can serve all areas of the estate.
- In areas where the demand for housing exceeds the amount of available land within or adjacent to existing urban areas, a series of linked small settlements could be located between two existing urban areas or between an urban area and another destination such as a university or science park. Linking small settlements in this way increases the likelihood that buses can service several different residential areas along a route, making them more commercially viable.
- Bus and other public transport routes should cohesively link housing to existing stations by public transport routes, enabling easy interchange. This should include integrated timetabling, information provision and smart ticketing.

Recommendation: MHCLG and DfT should explore the potential for new rail stations, and light rail, tram and bus (including bus rapid transit) routes to unlock areas for housing development whilst mitigating transport impacts.

(*Owner: MHCLG, DfT. Timing: by 2020).*

Recommendation: Local authorities must consult the bus industry at the Local Plan stage to ensure new housing areas can be serviced by commercially viable routes.

(*Owner: Local authorities. Timing: by 2020).*

When located near high capacity, frequent public transport, such as rail, light rail, trams or bus rapid transit, housing should be higher density, in order to make the best use of the infrastructure.

The National Planning Policy Framework suggests that minimum densities should be in place for areas well served by public transport but does not define what density should be used. Local authorities would benefit from the addition of density guidelines, to indicate what number of dwellings per hectare are appropriate for different types of transport infrastructure:

- The Royal Town Planning Institute (RTPI) recommends average levels of 50-100 dwellings per hectare (dph) for areas with good local bus services, rising to 100-200 dph for housing located around important public transport nodes.[260] In contrast, in England in 2016/17 the average density of new residential addresses was 32 addresses per hectare, although many of these are likely to be located away from public transport connections.[261]
- High density housing plans must still incorporate sustainable drainage and green space, ensuring where possible that the community design has wider benefits for water quality and diversity. The East Village development in Stratford, London has combined these considerations to ensure a large number of people can benefit from the excellent transport links to London Underground and National Rail lines. Green spaces are interlinked with

[259] Transport Committee (2018) *Oral Evidence: Health of the Bus Market. 12th November 2018.*
[260] RTPI (2018) *Settlement patterns, urban form and sustainability: An evidence review.*
[261] MHCLG (2018) *Land Use Change Statistics in England: 2016-17.*

medium rise but high density housing (147 dph).[262] Interspersing dense housing with green space also has positive impacts by making walking attractive.[263]

- Evidence suggests that existing changes to planning policy, encouraging higher densities in urban areas, may have already contributed to a modest fall in national driving (compared to the counterfactual), especially amongst young adults.[264]

Recommendation: For areas within walking distance of high quality public transport (such as local rail, trams and bus rapid transit), MHCLG and DfT should set minimum density guidelines to ensure local authorities concentrate housing in these areas wherever possible.

(*Owner: MHCLG, DfT. Timing: by 2020).*

Councils and local authorities around the UK must introduce innovative policies to deter people from driving into busy city centres, where there are more sustainable alternatives. Otherwise, extensive development on the periphery of towns is likely to exacerbate congestion, noise and air quality issues. Successful initiatives include workplace parking levies, congestion charges and pedestrianisation of urban centres (Box 3.3).

Box 3.3. Examples of measures to deter driving in busy city centres

Within the UK, cities have had success in charging car drivers to park or to travel within city centres. Nottingham has introduced a work place parking levy to generate funds for public transport improvements. This levy also explicitly encourages employers to consider the development potential of land currently used for parking in central areas, which could free up further land for housing. London has introduced a congestion charge to discourage driving in the city centre, whereas emissions based parking charges have been introduced in the City of London.

Internationally, the Norwegian Government has asked cities in Norway to estimate what kind of investment they require to enable them to thrive without growing traffic levels. Madrid plans to ban cars from 500 acres in the city centre, redesigning some of its busiest streets to encourage people to walk. Mexico City and Bogota have already implemented schemes which restrict the number of cars in the city on certain days of the week. Pontevedra in Spain introduced a ban on cars crossing the city and removed parking, resulting in reduced traffic fatalities. 75% of car journeys are now made on foot or by bike. Pontevedra has grown in size and supports a thriving small business sector.

Source: Marsden, G. et al. (2018*) All Change? The future of travel demand and the implications for policy and planning.*

If it is not possible to locate new housing developments near existing amenities, providing new schools, doctor's surgeries, shops and businesses within new developments can minimise the need for new residents to travel.

Whilst it might not be possible or practical for all journeys, a significant proportion of trips can either be eliminated or be short enough that walking or cycling is a practical choice. What is good for emissions is good for most other aspects of urban policy, by improving the economic and social well-being of cities:

[262] LSE London/LSE Cities report for the GLA (2018) *Residents' experience of high-density housing in London.*
[263] Brookfield, K. (2016) Residents' preferences for walkable neighbourhoods. *Journal of Urban Design,* 22, 44-58.
[264] Melia, S. et al. (2018) Is the urbanisation of young adults reducing their driving? *Transportation Research Part A: Policy and Practice*, 118, 444-456.

- Places of work, retail and community provision should all be integrated within walking distances in the residential area, without interruption by busy high-speed roads, large car parks or roundabouts. Even people who would not previously choose to walk have been found to change their behaviour and increase their number of walking trips when moving to homes with a wide variety of destinations within walking distance.[265]
- Local shops, schools and restaurants can generate a community feel and often feature on advertising literature for new houses. The inclusion of small scale, affordable and flexible premises for businesses in plans can encourage people to enter the area for leisure, ensuring new developments can support a good range of shops and community facilities, as well as providing employment near homes.
- Improving walkable access to recreational and non-recreational destinations can also lead to improved social outcomes among older adults.[266]

Recommendation: Government must strengthen the importance of sustainable transport plans that are integrated into the development throughout the design process, including the development of walking and cycling routes and early consultation with public transport providers.

(*Owner: MHCLG, DfT, devolved administrations. Timing: by 2020).*

3.4.2 Electric vehicle charging infrastructure for off-street parking

New homes should either have charge points installed or have accessible cabling to ensure easy installation at a later date.

In order to meet the Fifth Carbon Budget, the Committee has recommended that 60% of new car and van sales in 2030 are electric vehicles (EVs). Charging points must be installed in homes with off street parking or nearby for those without off street parking to enable vehicles to be charged overnight:

- The Government has indicated in its Road to Zero Strategy their intention that all new homes, where appropriate, should have a charge point available.[267] They plan to consult on introducing this as a requirement to new homes being built.
- In London, 20% of new homes with parking spaces must come with charging infrastructure already installed, with cabling for chargers installed in the remaining 80%.[268] Many other cities around the world have similar requirements, including Oslo, San Francisco and several cities in China.

Recent analysis for the Committee by Systra suggests that 27,000 new public charging points across the UK are needed to facilitate adoption of electric vehicles in urban areas.[269]

These could be installed on streets (including on new lamp posts) or outside shops or businesses developed in new residential areas to enable drivers to top up whilst they are doing other

[265] Giles-Corti, B. et al. (2013) The influence of urban design on neighbourhood walking following residential relocation: Longitudinal results from the RESIDE study. *Social Science and Medicine,* 77, 20-30.
[266] Public Health England (2018) *Planning for Health: An evidence resource for planning and designing healthier places.*
[267] Office for Low Emission Vehicles (2018) *Reducing emissions from road transport: Road to Zero Strategy.*
[268] ICCT (2018) *Electric vehicle capitals: Accelerating the global transition to electric drive.*
[269] SYSTRA for the Committee on Climate Change (2018) *Plugging the gap: An assessment of future demand for the UK's electric vehicle charging network.*

activities. In the Road to Zero strategy, the Government indicated that all new street lighting columns should include charging points in areas where there is significant on street parking.[270]

Recommendation: To encourage uptake of electric vehicles, the Government should immediately consult on regulations to include appropriate cabling ready for installation of electric vehicle chargers or electric vehicle chargers themselves in all new parking spaces for housing developments with off-street parking.

(*Owner: OLEV. Timing: by 2020).*

[270] Office for Low Emission Vehicles (2018) *Reducing emissions from road transport: Road to Zero Strategy.*

Chapter 4: Areas for progress in delivering better homes

Key messages

Addressing the multiple gaps and barriers to delivering high quality, sustainable housing set out in the previous chapters can be achieved through strategic forward planning, robust policies and effective implementation of those policies. Effective implementation will require a fundamental step-change in our approach to building homes:

- **Performance and compliance.** The vital first step is addressing building regulation compliance, and the performance gap between how homes are designed and how they perform when occupied. Tightening standards will have little effect otherwise. It is critical that stronger compliance and enforcement procedures, with greater levels of inspection and appropriate penalties, are in place, ensuring that new and existing buildings are safe, and deliver the energy and ventilation standards expected of them. 'As-built' performance should be formally integrated into the standards and enforcement framework. Closing the energy performance gap could deliver £70-£260 in annual bill savings per household, and around 2 $MtCO_2e$ in annual carbon savings by 2030.[271]
- **Skills gap.** The chopping and changing of Government policy has inhibited skills development in critical areas. Government must use the initiatives announced under the Construction Sector Deal to tackle the low-carbon skills gap, and develop a world-class construction sector which can realise the domestic and international industrial opportunities related to low-carbon building.
- **Building regulations.** The technology exists to deliver homes that are low-carbon, energy efficient and climate-resilient, with safe air quality and moisture levels. The costs are not prohibitive, and getting design right from the outset is vastly cheaper and more feasible than having to retrofit later. From 2025 at the latest, no new homes should be connected to the gas grid. They should instead be heated through low-carbon sources, have ultra-high levels of energy efficiency and, where possible, be timber framed. A statutory requirement for reducing overheating risks in new builds is urgently needed, alongside greater focus on ambitious water efficiency standards and property-level flood protection in areas at current or future high risk of flooding.
- **Retrofitting existing homes.** The 29 million existing homes across the UK must become low-carbon and resilient to a changing climate. This is a UK infrastructure priority and should be supported as such by HM Treasury. Homes must be made ready for low-carbon heating (heat pumps and heat networks). The uptake of energy efficiency measures such as loft and wall insulation must be increased. Upgrades or repairs to homes should include increasing the uptake of passive cooling measures (i.e. shading and ventilation), reducing indoor moisture, improving air quality and water efficiency, and, in homes at risk of flooding, installing property-level flood protection.
- **Finance and funding.** There are urgent funding needs which must be addressed now with the support of HM Treasury: low-carbon heating (currently only funded up to 2021), resources for local authorities and in particular building control. The UK Government must implement the Green Finance Taskforce recommendations around green mortgages, green loans and fiscal incentives to help finance upfront costs, as well as improving consumer access to data and advice. It should widen the scope of these measures to include resilience, for example by introducing house resilience surveys which assess water efficiency, flood risk and overheating.
- **Local authority action.** Local authorities can contribute through the services they deliver, their role as social landlords, and through their regulatory and strategy functions. However, climate change has been de-prioritised in the land-use planning system and funding for such measures

[271] Regulations and monitoring metrics are focussed substantially on the modelled performance of dwellings as designed, rather than their actual performance 'as-built'. There is a large body of evidence which points to a substantial gap between the two. This is the 'performance gap'.

Key messages

remains extremely limited. The regulatory and policy framework must incentivise and enable local and regional authorities to take action and be ambitious, through Government clarifying rights and obligations, and adequately funding local authorities. Clarity is needed on how far local and regional authorities are permitted to go in setting tighter new build standards. Planning frameworks and guidance should advise local authorities to take a strategic approach to planning for the creation and protection of green spaces and Sustainable Drainage Systems. Local authorities should consider how to shape demand for travel throughout the planning process, with the ultimate goal of reducing the need to travel, alongside making walking, cycling and the use of public transport straightforward and pleasurable.

4.1 Purpose of this chapter

This chapter sets out cross-cutting issues and recommendations for housing, building on the advice of previous chapters.

We consider four cross-cutting areas: addressing compliance issues and closing the 'performance gap'; building regulations; wider principles to guide the retrofit of existing homes; and local authority action to deliver low-carbon, resilient homes.

4.2 Addressing compliance issues and closing the 'performance gap'

New and existing homes often do not perform in line with the minimum standards of performance expected of them by law. Failure to perform in line with standards means locking in colder homes, higher bills and greater risk of flooding for generations. The consumer is cheated when stated building standards are not delivered. Consumers should not be paying the price for poor quality build.

These issues should be addressed as a matter of urgency. The Government has committed to building 1.5 million new homes in the UK by 2022 and evidence suggests that when house building rates increase, levels of homebuyers' satisfaction with quality falls.[272] Millions of existing homes must also be retrofitted if we are to meet legally binding carbon targets. As we prepare to build and retrofit more homes, we must do so to higher standards. This will require a fundamental step-change in our approach to building.

In the following sections we consider a range of drivers for buildings not performing as they should:

- Compliance issues: issues relating to the monitoring and enforcement of regulatory requirements.
- The 'performance gap': the gap between the performance of buildings as-designed and how they perform as-built, and the range of drivers which contribute to this, including challenges relating to knowledge and skills, measurement and householder behaviour.

Addressing these issues is a very significant challenge, requiring coordinated action across the industry, Government, enforcement bodies and also involving a role for householders.

[272] BEIS (2018) *Industrial strategy - Construction Sector Deal*; Analysis by the Chartered Institute of Building, published in All Party Parliamentary Group for Excellence in the Built Environment (2016), *More Homes, fewer complaints.*

Tightening standards will not be effective if they are left unresolved and bills and carbon emissions will not reduce as a result.

4.2.1 Compliance

Following the Grenfell Tower fire in June 2017, Dame Judith Hackitt was commissioned to review building standards and safety. The review was published in May 2018, and highlighted the systemic compliance issues in the current Building Standards regime. In her foreword to the Independent Review of Building Regulations and Fire Safety, Dame Judith Hackitt summarised the scale of the challenge: "it has become clear that the whole system of regulation, covering what is written down and the way in which it is enacted in practice, is not fit for purpose, leaving room for those who want to take shortcuts to do so."[273]

The Hackitt Review identified a range of issues with current building practice and the regulatory system:[274]

- **Ignorance** – regulations and guidance are not always read by those who need to, and when they do the guidance is often misunderstood and misinterpreted.
- **Indifference** – the primary motivation is to do things as quickly and cheaply as possible rather than to deliver quality homes which are safe for people to live in.
- **Lack of clarity on roles and responsibilities** – there is ambiguity over where responsibility lies, exacerbated by a level of fragmentation within the industry, and precluding robust ownership of accountability.
- **Inadequate regulatory oversight and enforcement tools** – the size or complexity of a project does not seem to inform the way in which it is overseen by the regulator. Where enforcement is necessary, it is often not pursued. Where it is pursued, the penalties are so small as to be an ineffective deterrent.

These issues must be addressed urgently.

We support the principles for resolution identified in the Hackitt review, in particular: an outcomes-based approach that sees buildings as a system; a clear model of risk ownership (with risk placed with those able to control it); transparent information and a clear audit trail; and effective oversight and sanctions underpinning the framework. 'As-built' performance should be formally integrated into the standards and enforcement framework. It is critical that stronger compliance and enforcement procedures, with greater levels of inspection and heavy penalties where appropriate, are in place, making sure that new and existing buildings are not only fire-safe, but also deliver the energy, ventilation and water economy standards expected of them.

Recommendation: Overhaul the compliance and enforcement framework so that it is outcomes-based (focussing on performance of homes once built), places risk with those able to control it, provides transparent information and a clear audit trail, with effective oversight and sanctions. Fund local authorities to enforce standards properly across the country.

(Owner: MHCLG, devolved administrations, HMT. Timing: by 2019).

[273] MHCLG (2017) *Independent Review of Building Regulations and Fire Safety: interim report.*
[274] MHCLG (2018) *Independent Review of Building Regulations and Fire Safety: final report.*

4.2.2 The 'performance gap'

A large body of evidence points to a substantial gap between the theoretical performance of buildings as measured at design stage, and the actual performance when built.

There is a lack of robust data, based on large sample sizes, to quantify the precise scale of the gap. Nevertheless there is a large body of evidence that points to it being substantial (Box 4.1). When a similar performance gap was uncovered in the automotive sector, this led to a widespread loss of trust in car manufacturers.[275]

Box 4.1. Evidence on the scale of the performance gap

A range of studies have examined the discrepancy between designed and 'as-built' heat loss performance in homes, providing evidence of a pattern of over-optimism in design estimates. Poorer than expected outcomes in terms of the building fabric thermal performance, airtightness and services contribute to this.

A study by Johnston et al. in 2015 examined 25 new build dwellings finding the measured Heat Loss Coefficient (a measure of heat flow through the building envelope) to be almost 1.5 times that predicted. Some studies find the performance gap on fabric heat loss can exceed 100%. The scale of the performance gap on fabric heat loss varies with build form and construction type, with larger performance gaps for mid-terrace houses relative to detached houses and masonry constructions relative to timber-frame builds.

Gupta et al. (2018) find a widespread airtightness gap in their UK sample of new build properties, but with a far less significant issue in Passivhaus properties than non-Passivhaus properties. Innovate UK's Building Performance Evaluation Programme found around a third of their sample did not meet airtightness expectations, but also noted that many of their sample did not aim to go beyond the minimum requirements of building regulations.

Innovate UK's Building Performance Evaluation Programme examined data from a subset of 76 homes where low-carbon design was a priority and suggested that carbon emissions from new homes are two to three times higher than design estimates (before adjusting for energy use from cooking and appliances not included in SAP). They found significant teething problems in the first year, but even in the second year found little correlation between the predicted emissions from SAP and actual emissions.

A study in London found that new homes built to a standard of 105 litres per person per day (l/p/d) actually tend to be using between 110-140 l/p/d, 5-25% more than expected. The water use performance gap is not well understood and needs to be investigated further.

Sources: Zero carbon hub (2010) *Carbon compliance for tomorrow's new homes - Topic 4, closing the gap between designed and built performance*; Gupta, R. and Kotopouleas, A. (2018) *Magnitude and extent of building fabric thermal performance gap in UK low energy housing. Applied Energy, 222, 673-686*; Johnston, D. Miles-Shenton, D. & Farmer, D. (2015) *Quantifying the domestic building fabric 'performance gap.' Building Services Engineering Research and Technology*, *36(5), 614–627;* Innovate UK (2016) *Building Performance Evaluation Programme: Findings from domestic projects, Making design match reality;* Policy Connect (2018) *Bricks and water*.

[275] Element Energy and ICCT (2015) *Quantifying the impact of real-world driving on total CO_2 emissions from UK cars and vans.*

The energy performance gap has very material impacts for bills and emissions.

Assuming a central estimate that new build homes lose 50% more heat than they should, closing the gap now could deliver £70-£260 in annual bill savings per household, and save around 2 $MtCO_2e$ in annual emissions by 2030.[276] In addition to delivering bill and carbon savings, closing the performance gap is critical in preparing the ground for tighter standards.[277]

The performance gap is created by a number of interacting problems, all of which need to be addressed. These present a major challenge to the construction industry.

In 2014 the Zero Carbon Hub conducted a comprehensive study on the energy performance gap and the factors that drive it. The study found a wide range of issues spanning the delivery process, and falling into three cross-cutting themes:[278]

- **Knowledge and skills:** a lack of integrated design between fabric, services and renewables; inadequate consideration of skills and competency at labour procurement; poor installation and commissioning of services; and concern over the consistency of some test methodologies and the interpretation of data.
- **Responsibility:** a lack of adequate energy performance-related quality assurance on site; a lack of robust energy performance-related verification; and a reliance on third-party information (e.g. by building control or warranty providers).
- **Communication:** as-built SAP calculations being produced without the inclusion of amendments to the design specification during the procurement or construction process, and a lack of clarity over the documentary evidence required for Part L and Part F compliance.

Whilst developed in relation to the energy performance gap, a number of these issues are also relevant to the performance gaps relating to ventilation and adaptation measures more broadly.

Behavioural factors can also have a significant impact on the performance gap. There is evidence of significant differences in energy consumption, ventilation performance and water use between homes built to the same specification.[279] A range of factors influence this, for instance how different people use domestic appliances and lighting, our use of hot water, when we open windows or use ventilation systems in our homes, and how much we shade our homes from the sun.

We have set out a range of steps that need to be taken to close this gap in previous reports including our 2016 report, Next steps for UK heat policy, and our 2018 Progress Report to Parliament.

[276] Based on modelling outputs from Currie & Brown and Aecom for the CCC (2019) *The costs and benefits of tighter standards for new buildings*. Assumes heat loss coefficients 1.5 times higher than those which would theoretically be achieved by building to the National House Building Council specification for new homes, with a gas boiler. Relationship between heat loss coefficients and space heat demand derived from SAP modelling. Split of stock archetypes for future build assumed to remain constant from present day.

[277] The introduction of low-carbon, low-temperature heating systems increases the importance of heating systems performing as intended to deliver affordable comfort. Where heat losses are higher than estimated this would require the heating system to be run at higher operating temperatures, incurring a material efficiency penalty. Closing the performance gap for current standards is also an important precursor to delivering homes with ultra-high thermal efficiency.

[278] Zero Carbon Hub (2014) *Closing the gap between design and as-built performance, Evidence review report.*

[279] For example, Zero Carbon Hub (2015) *Post occupancy evaluation, Rowner Research Project Phase two;* Waterwise (2018) *Advice on water efficient new homes for England.*

We build on these below, drawing also on recommendations from the Zero Carbon Hub's 2014 report, 'Closing the Gap between designed and as-built performance':

- **Monitoring metrics and certification** should be reformed to reflect real-world performance. For example, EPCs are not currently a good reflection of the expected running costs of a home (Box 4.2). An alternative framework should be based around more direct and objective metrics of performance, which provide a form of guarantee to householders - committing developers to the standard they advertise, and enabling consumer redress where these are not met. This should be expanded to include resilience measures such as property level flood protection where appropriate. In addition to shifting mind-sets and incentives in the design and construction process towards actual performance, this would provide reliable indicators of performance to grow the Green Finance market, and could empower consumers to choose homes which have been built to the highest standards.
- The **methodology underpinning building regulations**, currently the Standard Assessment Procedure, should be reviewed and revised. Action should be taken to put in place the Zero Carbon Hub recommended revisions to energy modelling practices, SAP processes and verification procedures, together with a strong regime to ensure that only suitably qualified persons carry out energy modelling and assessment.
- The chopping and changing of Government policy has inhibited **skills development** in critical areas.[280] Government must use the initiatives announced under the Construction Sector Deal to tackle the low-carbon skills gap, and develop a world-class construction sector which can realise the domestic and international industrial opportunities related to low-carbon building.
  - This will require a nationwide training programme to upskill the existing workforce, along with an increased focus on incentivising high 'as-built' performance.
  - The Government should also ensure the new Code for Practice for flood resilience is fully implemented to improve skills of property-level flood resilience and resistance measures.
  - The development of appropriate accreditations will help build consumer trust and drive demand for high-quality build. Uptake of relevant qualification and accreditation schemes can be supported by requiring them for developments on public land.
- Appropriate **guidance** can also play a role in disseminating best practice. In 2014 the Zero Carbon Hub recommended the development of an industry-owned and maintained set of best practice construction details covering major fabric junctions and systems in buildings. This should include ventilation systems.
- There should be a drive to **design buildings around the needs and preferences of the people that live in them**, and policy and regulation should support householders in using their homes effectively.
  - The concept of 'design for sustainable behaviour' works on the basis that if appropriate strategies are applied to the design of a product, the designer can positively influence the sustainable use of the product.[281] Examples could include having intuitive controls and standardised settings for thermostat and hot water temperatures in heating systems,

[280] Policies to support low-carbon measures have been weakened or withdrawn, including Zero Carbon Homes and the Code for Sustainable Homes.
[281] Delzendeh, E. et al. (2017) *The impact of occupants' behaviour on building energy analysis: A research view. Renewable and Sustainable Energy Reviews, 80, 1061-1071.*

and designing ventilation systems in ways that make them easier for occupants to use (e.g. having easily accessible filters, and alarm systems to make occupants aware of when filters need changing). In some cases, design approaches could remove the need for occupant intervention altogether.

– Policy and regulation should support householders in using their homes effectively. This includes helping people understand what strategies can be used to manage overheating risks (for example through shading and window opening at night), and how to operate heating and ventilation systems efficiently.

- Government and industry should undertake further research, based on large-scale studies, to robustly **quantify and benchmark the performance gap** for energy, ventilation and water and develop commercially viable methodologies for demonstrating performance. Industry could play a role in funding this, with the outputs preparing the ground for ongoing monitoring and improvement.

A number of comprehensive studies set out further details on the steps that are needed, including Zero Carbon Hub's 2014 report 'Closing the gap between designed and as-built performance', and the Building Performance Evaluation Programme's 2016 report on findings for domestic buildings, alongside a number of research studies on mechanical ventilation.[282]

Box 4.2. Reforming monitoring metrics and certification

Energy Performance Certificates (EPCs) are a widely used measure of the energy performance of buildings. They are required when selling or letting a property and are intended to provide information to householders on the performance of a home and to promote energy performance improvements in buildings. EPCs underpin a number of current government policies. They frame the current fuel poverty targets and Government aspirations for as many homes as possible to be EPC band C by 2035, and underpin the regulations around minimum energy efficiency standards (MEES) for the private rented sector. They are also beginning to play an increasing role in Green Finance markets.

EPCs are based on the Standard Assessment Procedure (SAP) methodology which quantifies a dwelling's performance in terms of energy use per unit floor area (kWh/m^2), a fuel cost-based energy efficiency rating (the EPC rating, in $£/kWh/m^2$) and emissions of CO_2 (the Environmental Impact (EI) rating, in CO_2/m^2). The EPC reports both the EPC rating and the EI rating on a scale from A (highest) to G (lowest).

Since the EPC rating is cost-based, it is more suited to issues around fuel poverty rather than energy efficiency improvements or emission savings. It is subject to fuel price variations over time and can lead to perverse incentives where emission saving measures involve a switch in fuels. For example, the nature of the metric means that a switch to heat pumps is disincentivised.[283]

There are also serious concerns over both the accuracy and reliability of EPCs. The SAP method is a normative calculation (e.g. assuming a standard occupancy) using expert knowledge on the main factors in determining home energy efficiency. Estimates are likely to be inaccurate where there are issues with assumptions (as has been the case with solid wall thermal transmittance assumptions), or

[282] Zero Carbon Hub (2014) *Closing the gap between design and as-built performance: End of term report*; Innovate UK (2016) *Building Performance Evaluation Programme: Findings from domestic projects, Making design match reality*; Gupta, R. Gregg, M. Sharpe, T. McGill, G. and Mawditt, I. (2017) *Characterising the actual performance of domestic mechanical ventilation and heat recovery systems. In: AIVC 2017, 6th TightVent Conference, 13-14 September 2017, University of Nottingham, UK.*
[283] Discussed in more detail in CCC (2016) *Next steps for UK heat policy.*

Box 4.2. Reforming monitoring metrics and certification

where what is constructed does not match what has assumed to have been constructed.[284] There are difficulties comparing assessments made at different times with changes in assumptions and a lack of transparency in the data.

There can be major discrepancies in the rating for an individual property when assessments are conducted by different assessors. Recent research has quantified some of the reliability issues faced by EPCs, particularly for existing homes:

- Mystery shopper research for DECC found the range of EPC ratings spanned at least two EPC bands for almost two-thirds of the dwellings analysed.
- CREDS (2018) estimated the error in EPC reliability to be equivalent to 10 EPC points on average (which is enough to move many properties into a different EPC band). They find the error to be larger for poorer performing properties with an estimated error on a dwelling at the E-F band boundary of about 24 points, and the error on a dwelling at the C-B band boundary of about 4 points.
- Concerns have also been raised around EPCs being less reliable for larger, older and rural (off-gas) homes.

Grounding estimates in real-world data, such as from smart meters, should be the basis for reform of monitoring metrics and certification.

Sources: CCC (2016) *Next steps for UK heat policy*; Centre for Research into Energy Demand Solutions (2018) *Energy Performance Certificates in buildings: consultation response;* DECC (2014) *Green Deal Assessment Mystery Shopping Research;* All Party Parliamentary Group for the Private Rented Sector (2016) *Improving the Energy Efficiency of Private Rented Housing;* Hamilton et al. (2016) *Valuing energy performance in home purchasing: an analysis of mortgage lending for sustainable buildings.*

A range of industry and Government initiatives are in train to try to address build quality issues, and improve 'as–built' performance and measurement.

These include the Government's Construction Sector Deal and Buildings Grand Challenge Mission (both of which include commitments to drive up quality); the commitment to consult on skills and training as part of the Future Framework for Heat in Buildings; Government's innovation competition for methods to measure the thermal performance of homes; BRE's Home Quality Mark (HQM);[285] the Design for Performance pilot being led by the Better Buildings Partnership;[286] and CIBSE's updated Health and Wellbeing guidance document.[287]

However many of these initiatives are still in initial stages, and further detail is needed on how the full range of challenges will be addressed. Government should ensure a clear and comprehensive set of initiatives is put in place to close the gap, building on best-practice approaches internationally (Box 4.3).

[284] Centre for Research into Energy Demand Solutions (2018) *Energy Performance Certificates in buildings: consultation response.*
[285] See: https://bregroup.com/products/home-quality-mark/
[286] See: http://www.betterbuildingspartnership.co.uk/node/360
[287] Discussion with CIBSE. This will provide a summary of guidance on design, construction and facilities management. For a range of environmental factors it will also provide recommended performance criteria (e.g. pollutant levels) which could be used as targets in new designs or to reference the performance of existing buildings.

Box 4.3. Examples of international good practice in build quality

Germany

The German construction market is more regulated than the UK one, with a higher rate of housebuilding. Builders must train for three years before becoming 'Master Craftsmen'. About 15% - 20% of family homes are pre-manufactured in factories (like HUF houses), which means there may be less chance of things going wrong on site.

Netherlands

Purchasers are able to withhold 5% of the price of a newly built house for six months to cover any snagging or build issues. The final amount due to the builder is then determined through an independent inspection.

France

Where a defect arises, the homeowner is not obliged to prove the fault and the builder is presumed to be responsible. Homeowners can bring legal action against the developer for up to 30 years if the property does not meet the specification in the sale contract. This compares with up to ten years in England and Wales.

Source: https://www.ippr.org/files/publications/pdf/German-model-homes-Dec16.pdf; https://www.dw.com/en/skilled-crafts-boom-stretches-capacities-in-germany/a-41902114; https://www.huf-haus.com/en-uk/; Vereniging Eigen Huis https://www.eigenhuis.nl/huis-kopen/nieuwbouw/oplevering#/; https://www.french-property.com/guides/france/purchase-real-estate/off-plan/guarantees/building/.

Recommendation: Reform monitoring metrics and certification to reflect real-world performance, rather than modelled data (e.g. SAP). Accurate performance testing and reporting must be made widespread, committing developers to the standards they advertise.

(Owner: BEIS, MHCLG, devolved administrations, industry. Timing: 2020-2025).

Recommendation: Review professional standards and skills across the building, heat and ventilation supply trades with a nationwide training programme to upskill the existing workforce, along with an increased focus on incentivising high ‘as-built’ performance. Ensure appropriate accreditation schemes are in place.

(Owner: BEIS, industry. Timing: 2019).

Recommendation: Undertake a large-scale study to provide robust quantification and benchmarking of the performance gap for energy, water and ventilation.

(Owner: BEIS, industry. Timing: 2019).

4.3 Building regulations

Building regulations set out the framework of standards for new build homes and for new work to existing properties. Standards must evolve to deliver homes which are low-carbon, affordable to run, comfortable to live in and better for our health.

4.3.1 Trajectory for tighter standards

Building and retrofitting homes to these high standards will require a fundamental step-change in our approach to building. The Government has already recognised the need for a drastic overhaul in building practices.[288] The trajectory for standards development must be carefully planned and staged to support high-quality delivery at scale.

As a first step, and as considered above, compliance issues must be addressed and the performance gap must be closed.

Alongside this there is a need for a focus on revising the regulatory framework to address issues and gaps, and ensure it is fit for purpose as we prepare for future uplifts to standards:

- **Methodologies underpinning standards.** The framework underpinning standards, the Standard Assessment Procedure, must be reviewed and revised to ensure it is fit for purpose in facilitating the delivery of ultra-energy efficient, low-carbon, well-adapted, moisture-safe, and well-ventilated homes which perform as designed. We have considered a range of issues with SAP that will need to be considered and addressed, including ensuring it accurately values the benefits of low-carbon technologies.
- **Requirements for standards to be met.** The provisions in the Town and Country Planning Act 1990 currently allow for circumstances where homes built now need only remain subject to the standards in place at the date planning permission was granted. In some cases this can be a number of years prior to when homes are actually built.[289] Changes to permitted development rights in England also mean that it is permissible to convert light industrial and commercial units to residential dwellings, without the need to ensure those properties meet the standards set out in Approved Documents L and F for new dwellings.[290] These loopholes mean new homes are still being built which do not meet the minimum standards for new dwellings set out in current regulations. The latest Government data shows that 12% of the homes built in 2018 were rated EPC C, whilst 7% were rated D or below.[291] These loopholes must be closed.
- **Ventilation.** Ventilation requirements must evolve to keep pace with improvements in energy efficiency and to deliver excellent levels of indoor air quality in homes. All ventilation systems should be designed, commissioned, and installed properly and householders supported to use them effectively.

[288] This is reflected in the Grand Challenge Mission to have the energy use of new buildings, and in the package of commitments set out in the Construction Sector Deal, including the Industrial Strategy Challenge Fund Transforming Construction Programme, and the package of work in train with the Construction Industry Training Board.

[289] Section 91 of the Town and Country Planning Act 1990 requires that development must begin within three years of the date planning permission is granted (unless an alternative timeframe is set by the relevant authority). After this time planning permission expires. However Section 56 of the Act provides a broad definition of what it means for development to have 'begun', allowing for circumstances where negligible work can be undertaken in the first three years following planning permission being granted, with substantive build happening up to years later. This means homes are being built now, to the standards that were in place a number of years ago.

[290] In October 2017, to help with the lack of homes in England, permitted development rights were extended, allowing owners to change light industrial and commercial units to residential dwellings without the need for planning permission. See: *The Town and Country Planning (General Permitted Development) (England) Order 2015*, Schedule 2, Part 3. The Raynsford Review of Planning has gathered examples which illustrate the impacts of this permitted development right, including the lower standards secured through building regulations on energy efficiency. For further discussion see: TCPA (2018) *Planning 2020 Raynsford Review of Planning in England, Final Report*.

[291] MHCLG (2018) *Live tables on Energy Performance of Buildings Certificates.*

- **Overheating.** A standard or regulations must be introduced to ensure overheating risk is managed from a thermal comfort and health perspective. Passive cooling strategies should be installed before consideration of active (mechanical) cooling.
- **Water efficiency.** Review new build regulation standards to allow local authorities to set more ambitious standards, especially in current and future water-stressed areas.
- **Property-level flood resilience and resistance**. Regulations should ensure that all new developments in flood risk areas demonstrate reduced exposure and vulnerability to flood damage as well as broader benefits to the resilience of the local area.
- **Electricity demand reduction and peak management.** Government should examine the potential role that could be played by the new-build standards framework in incentivising technologies to support demand reduction and peak management.
- **Whole-life carbon.** Policies should be developed to support a substantial increase in the use of wood in construction and mechanisms should be strengthened to drive whole-life carbon savings in new buildings, incorporating embodied emissions and carbon sequestration.
- **Electric vehicle charging infrastructure**. Government should consult on plans to include electric vehicle charging infrastructure requirements for parking spaces in new developments.

A framework must be in place by 2020 to signal the trajectory for future standards, and to support early movers. Clear forward trajectories for the evolution of standards should be set well in advance. This will encourage innovation, learning, and minimise costs to developers. A targeted package of measures should be developed to incentivise and support early movers:

- There is a role for a nationwide training programme to develop professional standards and skills, alongside the provision of guidance to support skill development and disseminate knowledge on best practice approaches.
- Fiscal incentives can be used to encourage the purchase of low-carbon and well-adapted homes. This could include rebalancing stamp duty or council tax to provide a discount for homes which are lower-carbon, more energy-efficient and better adapted. There is scope to do this in a revenue-neutral way where penalties are also levied for higher-carbon or less well-adapted homes.
- There is potential for incentives to be linked to current Government initiatives such as Help to Buy and Homes England. Homes England are responsible for increasing the number of new homes built in England and, amongst other things, work to increase the supply of public land. In return for the benefits associated with the permission to develop land, developers could be required to commit to delivering higher quality homes.
- Those procuring and purchasing buildings should have better access to information that allows them to consider the quality of design and built performance in purchasing decisions. Monitoring, ratings and accreditation procedures should be developed to assess the quality of built performance, empowering purchasers to choose contractors who demonstrate high performance. Performance metrics, including those on indoor air quality and water efficiency, as well as energy, should be required to be displayed more prominently when a house is sold or rented, and lenders could go further to support better consideration of energy and water costs in mortgage affordability calculations (e.g. through quoting running costs alongside mortgage offers).

- Green finance can facilitate access to capital, enabling consumers to respond to incentives. Government should implement the Green Finance Taskforce recommendations around green mortgages and green loans to encourage uptake and support financing of high-quality homes. The Government should also look to widen the scope of green finance, for example including water efficiency, flood and other resilience in digital green passports and EPC ratings.
- Enabling frameworks can support Local and Regional Authorities in driving up standards in their localities. Greater clarity is needed around the rights and obligations of local authorities with regard to standards. We consider these issues further in the next section.
- Additional support for small and medium-sized house builders is likely to be important to help minimise the additional costs they face, and support competition and high-quality build.[292]

Recommendation: Close loopholes allowing homes to be built which do not meet the current minimum standards for new dwellings. This includes provisions around the expiry of planning permission, and permitted development rights relating to change of use.

(Owner: MHCLG. Timing: 2019).

Recommendation: Implement tighter standards for new buildings to ensure they are designed for a changing climate, properly ventilated, moisture-safe, are future-proofed for low-carbon heating and deliver ultra-high levels of energy efficiency. The whole life-carbon and peak demand impacts of new homes should be minimised.

(Owner: MHCLG, devolved administrations. Timing: in force and forward trajectory set out by 2020).

Recommendation: Government should develop a targeted package of new measures to incentivise and support those developers and individuals who wish to take early action in building low-carbon and resilient homes.

(Owner: MHCLG, BEIS, HMT, devolved administrations. Timing: in force by 2020).

4.3.2 Preventing measures from being 'value-engineered out' of new homes and community design

Even when sustainability measures are included in designs for new homes, they do not always end up in the finished development.

The Adaptation Committee's 2017 Progress Report summarised evidence about the barriers to installing adaptation measures such as green sustainable urban drainage, passive cooling and property-level flood protection measures. A survey of housing industry professionals found that although these measures are often included in the design stage, lack of awareness and client demand for measures meant that even when issues were raised they were more often than not 'value-engineered out' of the build project as it progresses, in order to keep costs down. The survey also found that there are perceived costs associated with installing resilience measures in new builds, although highlighting that costs at build stage would be cheaper than at retrofit stage.

[292] Research by the Federation of Master Builders in 2017 found that consumers were twice as likely to be 'very satisfied' with the quality of their new home if it was built by a small and medium-sized (SME) house builder. For further information see: https://www.fmb.org.uk/about-the-fmb/newsroom/consumers-twice-as-likely-to-be-satisfied-with-homes-built-by-small-house-builders/.

The costs of building high-quality, low-carbon and resilient homes are not prohibitive.

Recent modelling suggests that the incremental costs of delivering homes in 2020 that meet ultra-high levels of energy efficiency, whilst incorporating low-carbon heating, are in the region of £1,300-£6,900 representing a 1.1-4.3% increment on build costs. For small developers in higher cost locations costs could be around 130% of base prices (£1,800-£9,100), representing a 1.4-5.7% increment on build costs.[293]

Research conducted for this report has found that low-regret adaptation measures to improve new homes for overheating and water efficiency would cost an additional £1,600-£2,600 for a semi-detached house.[294] However, there are a number of simple design and construction solutions for resilience which would have zero additional cost to builders, for example: ensuring windows provide natural cross ventilation, installing low-flow showers and taps, and raising electrics above floor level in homes at risk of flooding.

Viability impacts are an important consideration in the standard setting process. Local planning authorities could play a role in determining which adaptation measures must be implemented, reflecting local needs. There is evidence to suggest that policies such as energy standards generally represent modest costs as a proportion of development value, and would, at least in part, be passed back to land owners in reduced land value uplift with limited impacts on overall viability and the supply of new homes. A range of steps can also be taken to reduce viability risks associated with tightened standards (Box 4.4).

Box 4.4. Evidence relating to the impact of more ambitious new build standards on development viability

Concerns over more ambitious standards for new homes have historically focused on risks that the supply of housing could be impacted or that standards will exacerbate affordability issues for buyers.

The viability impacts associated with measures will vary with policy design and economic conditions amongst other things. They will also vary nationally, with greater impacts expected to be in areas with low land value/house prices. However it is notable that past impact assessments and viability studies examining the impact of more ambitious energy standards have generally found risks associated with these standards to be limited. The impact assessment for Zero Carbon Homes anticipated that 'additional costs of zero-carbon homes will be largely passed back to land owners in reduced land value uplift', estimating 'the potential to supress the supply of new homes by between 0.5-1.3%, on top of the 1.2% impact on supply caused by other policies' (such as the Section 106 agreements).[295]

Figure B4.4 illustrates the very significant land value growth seen in recent years. The Greater London Plan viability study found that policies such as energy standards 'represent modest costs as a proportion of development value and typically have limited impact on overall viability'.

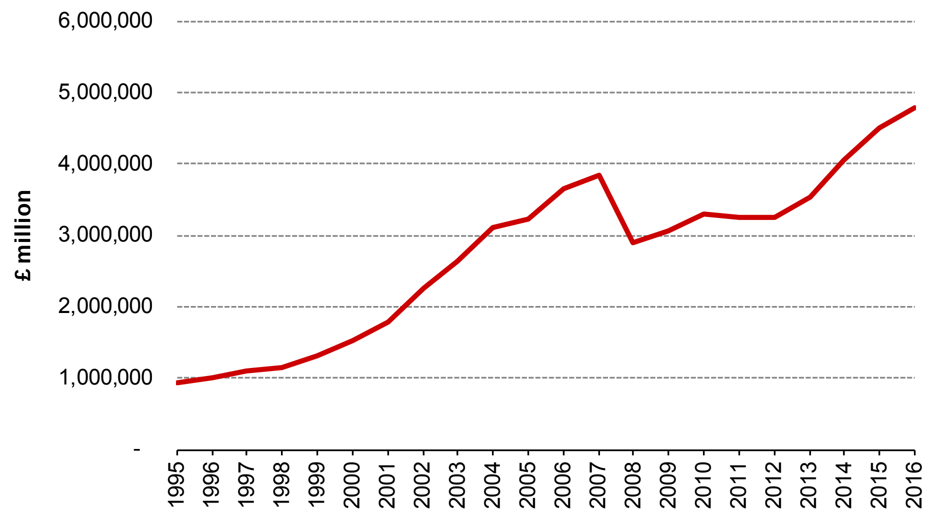
A range of steps can be taken to reduce viability risks, including actions to drive market demand for low-carbon, climate resilient homes, e.g. through fiscal incentives (such as stamp duty or council tax

[293] Currie & Brown and Aecom for the CCC (2019) *The costs and benefits of tighter standards for new buildings*. Range reflects difference between a small flat and a detached home.
[294] Low-regret measures include: high-thermal mass walls and floors, externals shutters, and a water efficiency package of 105 litres per person per day. Homes at risk of flooding could be improved with low-regret resilience and resistance measures for a further £700-1,500. Wood Plc et al. for the CCC (2019) *Updating an assessment of the costs and benefits of low-regret climate change adaptation options in the residential buildings sector.* David Langdon for the CCC (2011) *An assessment of the costs and benefits of low-regret climate change adaptation options in the residential buildings sector.*
[295] Communities and Local Government (2011) *Zero Carbon Homes Impact Assessment.*

Box 4.4. Evidence relating to the impact of more ambitious new build standards on development viability

rebalancing) and greater public awareness of the benefits. Costs to developers can also be minimised through a clear and robust policy framework set well in advance, and a targeted package of measures to incentivise and support early movers.

Figure B4.4. Changes in the value of land underlying buildings and structures (1995-2016)



Source: Office for National Statistics (2018) *Aggregate Land Values, 1995 to 2016.*
Notes: Representative of total value of land underlying buildings and structures

Source: Communities and Local Government (2011) *Zero Carbon Homes Impact Assessment*; Three Dragons, Turner & Townsend and Housing Futures Ltd on behalf of the Greater London Authority (2017) *London Plan Viability Study Technical Report*; Office for National Statistics (2018) *Aggregate Land Values 1995 to 2016;* discussions with Pat McAllister, Henley Business School, University of Reading (2019).

4.4 Wider principles to guide the retrofit of existing homes

Building regulations are a key lever for driving up standards in new homes, and play an important role in setting standards for new work to existing homes. However, the retrofit challenge requires a much broader package of policies and actions from developers and homeowners. Given the scale of the challenge, retrofit should be supported by HM Treasury and the Devolved Governments as a national infrastructure priority.

Here we review a range of the recommendations made in previous chapters, in the context of principles for policy development.

Four out of five homes that will be occupied by 2050 have already been built. These householders will generally face the greatest challenges in decarbonising, and adapting to the changing climate.

Unlike new builds, the impetus to, and responsibility for retrofitting existing homes comes largely from the individual householder or landlord. Decision making will be influenced by a range of factors, including cost, social norms and the inconvenience or 'hassle' associated with retrofitting.

A householder's willingness to take action depends on a number of issues, including:[296]

- Awareness of need.
- Availability of information on appropriate measures, their costs and benefits.
- Availability of funds to make the changes.
- Local, skilled installers willing to undertake work.
- Availability of technologies.

In our 2016 report Next steps for UK Heat Policy, we set out a number of principles to guide the development of effective policy.

We have updated these below, also incorporating adaptation needs:

- A stable framework and direction of travel, backed up by evolving standards for the performance of buildings.
- A joined-up approach to energy efficiency, low-carbon heat, ventilation and cooling that works across the building stock, and focuses on real-world performance.
- Simple, highly visible information and certification alongside installer training to ensure that low-carbon and adaptation options are understood by consumers and that installers are effective and trusted.
- A well-timed offer to households and SMEs that is aligned to 'trigger points', such as when a house is sold or renovated.
- Consistent price signals that clearly encourage affordable, low-carbon, and sustainable choices.

Alongside their relevance to new homes, these principles should remain guiding considerations for the development of policy to drive retrofits in existing homes.

A stable and clear policy framework set far in advance, can deliver long-term policy certainty, encourage innovation, reduce delivery costs and minimise risks associated with ambitious policies.

The need for a stable and clear policy framework relates to areas including:

- **A UK strategy for decarbonised heat**, including clear signals on the future use of the gas grid in the UK and a trajectory of energy efficiency standards covering owner occupied, social and private-rented homes.
- **A long-term strategy to manage flood risks** down to tolerable levels in each part of the country.
- **An action plan to develop a market for resilience measures** including research and development, innovation, support for early movers, and the development of resilience standards.

[296] London Climate Change Partnership (2008) *3 Regions Retrofitting.*

- **Action to assess and reduce the risks of overheating in existing homes**, prioritising passive cooling and behaviour change.
- **Per capita consumption targets for water** which can address future supply-demand deficits resulting from both 2 and 4 degree climate change scenarios.
- **A strategy for retrofitting green sustainable urban drainage** in existing developments to reduce risk of surface water flooding and bring wider benefits.
- **A strengthened approach to locate and design new housing developments around sustainable transport** to increase levels of walking, cycling and use of public transport.

Policy frameworks must also demonstrate a joined-up approach to energy efficiency, low-carbon heat, ventilation and cooling which focuses on real-world performance. 'Whole-house' approaches to retrofit can support efficient long-term investments, in place of piecemeal incremental change.

The Green Finance Taskforce (GFT) recommendation on Green Building Passports offers potential to bring together a number of data sources to provide a holistic and long-term view of renovation needs. Each building would have a digital passport, transferable between building owners, which sets out a customised retrofit roadmap for the building based on fabric and operational data. The intention is to capture EPC data digitally and augment it with other data over time. We support the recommendation that the platform should be expanded to cover issues such as indoor air quality, flooding and overheating.

Area based programmes, such as Local Heat and Energy Efficiency strategies in Scotland, can also play an important role in enabling holistic solutions and efficient implementation. Many of the barriers to action (e.g. disruption from changes, the need to find a trusted installer, financing constraints) are shared across types of measure, and improvements in one component of the building fabric can have important interactions with another (for instance the synergies between improved energy efficiency and low-carbon heat, and interactions between thermal efficiency, overheating and indoor air quality).

Simple, highly visible information and certification are needed alongside installer training.

Awareness of low-carbon heating, energy efficiency and adaptation options is generally low. A key policy focus must be improved information. Green Building Passports and a new Code of Practice for property-level flood protection can play a role.

We have already considered the critical role of installer training, and appropriate accreditation schemes to build consumer trust and help consumers select trusted and competent installers. There is also a need for expert advisors to be available to support households in planning and undertaking works.

Consistent price signals, with offers aligned to trigger points, are needed to drive uptake of measures.

In the area of energy efficiency, a survey by EEVS Insight and Bloomberg New Energy Finance finds that 21% of energy efficiency suppliers see policy uncertainty as their primary issue of concern.[297] Results from the Low Carbon and Renewable Energy Economy Survey run by the

[297] EEVS insight and Bloomberg New Energy Finance (2018) *Energy Efficiency trends Vol. 21*.

Office of National Statistics also show that full time employees working on 'energy efficient products' in the construction industry dropped from 67,000 in 2014 to 37,000 in 2016.[298]

While many energy efficiency improvements are already financially attractive, some other measures, including most low-carbon heat options, would not currently be attractive without public subsidy or incentives. Actions will be needed to provide consistent price signals in order to drive uptake, including:

- **Reviewing the balance of tax and regulatory costs across fuels** in order to improve alignment with implicit carbon prices and reflect the progressive decarbonisation of electricity.
- **An appropriate support framework for low-carbon heating** including financing for heat pumps, biomethane, and networked low-carbon heat.
- **Implementing the Green Finance Taskforce recommendations** to facilitate access to capital for low-carbon and resilience improvements.

Frameworks must create an attractive package for householders, aligned to 'trigger points' such as when a home is purchased, a boiler breaks down, or when other renovations are taking place.

Recommendation: Improve consumer access to data and advice by implementing the GFT proposal on Green Building Passports, improving EPCs and access to data underpinning EPCs and SAP, and identifying options to go further in particular to include resilience measures. Water efficiency, flood resilience and other resilience measures should be considered in digital 'green passports', and resilience surveys or Flood Protection Certificates developed alongside EPCs.

(Owner: BEIS, HMT, devolved administrations. Timing: 2019-2020).

Recommendation: Implement GFT recommendations around green mortgages and fiscal incentives to encourage uptake and support financing of upfront costs. To help drive the market for resilient products and services the Government should also look to widen the scope of green finance to include resilience.

(Owner: BEIS, HMT. Timing: 2019).

4.5 Local authority action to deliver low-carbon, resilient homes

Local and regional authorities are well placed to drive and influence emissions reductions, and adapt their localities to a changing climate, through the services they deliver, their role as social landlords, trusted community leaders and major employers, and their regulatory and strategy functions.

Local and regional authorities have a number of key levers in reducing emissions and adapting localities to a changing climate, including planning functions and enforcement. They are also uniquely placed to join up and support the chain of decision-makers (e.g. householders, social landlords, installers and suppliers).

With regard to reducing emissions, local and regional authorities have a critical role in decarbonising heating in buildings and in leading the reduction in emissions from transport:

- **Heat.** Supply and demand for heat is by nature more specific to local areas than electricity production and consumption, due to the relative difficulty in transporting heat over long

[298] Office for National Statistics (2018) *Low carbon and renewable energy economy final estimates.*

distances. Long-term national planning relies on regional spatial planning together with coordination, support, capacity-building and public engagement at a local level.

- **Energy efficiency.** Local authorities have an important role in ensuring new housing is energy-efficient. Under the planning system, local authorities can prepare Local Development Plans which identify sites for specific land uses (e.g. new housing) and set out the criteria for approving planning applications, including energy efficiency standards for new homes that exceed current building regulations.[299] The Scottish Government has consulted twice on a statutory requirement for Local Authorities to prepare Local Heat and Energy Efficiency Strategies (LHEES). These would set the strategy and a framework for reducing energy demand and decarbonising the heat supply of buildings in the area covered, across the timeframe of the Scottish Government's Energy Efficient Scotland programme. Approaches are being piloted across Scotland's local authorities at present. Across the UK, local authorities have a general duty to enforce building regulations, as well as duties to enforce Energy Performance Certificate (EPC) legislation.[300]
- **Transport.** Local authorities are responsible for local transport plans, and play a key role in applying for funding for new infrastructure for walking and cycling, defining transport requirements for those in new homes and influencing travel demand through parking charges and other levies to deter people from driving into busy town centres. In some cases, local authorities, local enterprise partnerships and local MPs have been able to lobby for new rail stations to be opened in areas of housing growth. Other local authorities have led initiatives to promote electric vehicle uptake.

Local and regional authorities have an equally critical role in climate adaptation. In England, local authorities are key partners in delivering many aspects of the National Adaptation Programme (NAP). Addressing climate change is a key component of delivering sustainable development and is a strategic priority in the NPPF.[301] Local authorities are well placed to understand the short and longer term risks faced by their communities, and to lead and facilitate action to address them:

- **Minimise flood and coastal erosion risk.** In line with the National Planning Policy Framework (NPPF), local authorities are advised to avoid inappropriate development in areas at risk of flooding and coastal change. Where such development is unavoidable, it should be delivered in a way which does not increase the risk of flooding elsewhere. The NPPF also requires local authorities to prioritise the use of sustainable drainage systems (SuDS) in developments (see Chapter 3).
- **Retain and enhance green infrastructure.** The NPPF advises local authorities to take a strategic approach to planning for the creation and protection of green spaces. This can include measures such as green roofs, targeted urban tree planting, and constructed wetlands. Such measures can help to keep urban areas cool in summer and manage storm water in periods of heavy rainfall.
- **Address overheating risk.** Local planning policies can reinforce the need for new developments to be planned and designed (e.g. orientation, shading, window design and

[299] In Scotland, Local Development Plans are also required to include a greenhouse gas policy that seeks to achieve emissions reduction through the use of low and zero-carbon generating technologies. See The Town and Country Planning (Scotland) Act, 1997, section 3F.
[300] EPCs, which provide an assessment of the energy efficiency of a home, are mandatory on re-letting or a sale of a property, and compliance is carried out by local authority trading standard departments.
[301] DCLG (2014) *Climate Change Planning Practice Guidance.*

ventilation) to manage internal temperatures. The NPPF now includes a requirement for local plans to consider overheating risks.

- **Deliver resilient infrastructure.** Local Planning Authorities (LPAs) are responsible for ensuring that new infrastructure is designed and appropriately located to take current and future climate change risks into account.

The devolution of powers and budgets to core city regions in England has changed the way that services can be funded and needs prioritised by the local government sector. There are 10 core city regions across the UK and six 'metro mayors' for combined authorities. They offer opportunities for local leadership on climate change as part of policies that promote regional growth and investment in housing and transport, and in some cases also public health and social care.[302]

Local and regional authorities have played a valuable role in driving improvements (Box 4.5).

Box 4.5. Examples of local and regional authorities driving improvements

Better Homes Yorkshire: Better Homes Yorkshire is a joint programme managed by the West Yorkshire Combined Authority and Leeds City Region Enterprise Partnership. It aims to help residents (owners, tenants and landlords) in the participating ten local authority areas to take advantage of Government funding options to make energy efficiency improvements to their homes.

Greater London Authority's London Plan: A zero-carbon target for major residential developments has been in place for London since October 2016, and is planned to apply to major non-residential development from 2019. The new draft Plan also includes requirements for planners to ensure buildings are designed to adapt to a changing climate, through making efficient use of water, and reducing impacts from natural hazards like flooding and heatwaves.

Climate Ready Clyde: Climate Ready Clyde is a place-based adaptation initiative, set up by Adaptation Scotland in 2012. The partnership includes 13 funding institutions: the University of Strathclyde, Scottish EPA, Transport Scotland, Strathclyde Partnership for Transport, Scotia Gas Networks, NHS Greater Glasgow and Clyde, University of Glasgow and six unitary authorities. The partnership has produced a regional climate change risk assessment building on the method used for the UK CCRA, which considered risks to the housing stock in the region. This assessment will feed into a regional adaptation strategy and action plan.

Greater Manchester: Greater Manchester plans to locate new housing in and around existing town and regional centres, easily served by public transport with key local facilities within walking and cycling distance. Developers will also be encouraged to provide space for car clubs and charging points for electric vehicles.

Source: For further information of Better Homes Yorkshire see: https://www.betterhomesyorkshire.co.uk/; for the London Plan see: https://www.london.gov.uk/what-we-do/planning/london-plan; the Greater London Authority had also planned to require the operational energy use of new development to be reported after completion, although this requirement has recently been removed following consultation; AECOM for the CCC (2018) *Adaptation actions in cities: what works?*; Transport for Greater Manchester (2017) *Greater Manchester: Transport Strategy 2040: Our Vision*.

[302] The ten core city regions are: Birmingham, Bristol, Cardiff, Glasgow, Leeds, Liverpool, Newcastle, Nottingham and Sheffield. The six metro mayors elected are for: Cambridgeshire and Peterborough; Greater Manchester; Liverpool City Region; Sheffield City Region, Tees Valley; West Midlands; and the West of England.

These examples illustrate the considerable ambition of some local authorities, but many struggle to assemble capacity and resources at the scale necessary to make material impacts.[303]

Local authority funding remains extremely limited. There is also evidence that climate change has been de-prioritised in the land-use planning system.

In 2012, we recommended a clear statutory duty and/or additional funding to ensure local authorities have stronger incentives to act. However, there is still no clear statutory requirement for local authorities to take action on climate change and funding remains extremely limited. There have been a number of recent changes to planning frameworks for local authorities:

- Where local authorities are pushing ahead with low-carbon programmes (such as low-carbon heat networks) and adaptation, this is non-statutory. The same is true of the UK's 39 Local Enterprise Partnerships (LEPs). The indicators which LEPs are monitored against are in terms of outputs such as new homes and jobs created, rather than low-carbon growth, efficiency savings or resilience, meaning that any focus on the opportunities for low-carbon growth (as seen in Leeds) and adaptation is effectively voluntary. Revisions to England's NPPF in 2018 have clarified and improved some aspects of planning for transport, flood management and overheating, but have removed the requirement for active support of energy efficiency improvements to existing buildings, and have failed to clarify how far local and regional authorities are permitted to go in setting tighter standards for new build homes.
- There is evidence that **climate change adaptation has been de-prioritised** in the land-use planning system. The resilience projects that are undertaken are focussed on flood risk management to address immediate issues. A published study by the Town & Country Planning Association (TCPA) concluded that local authorities are not using planning policy, as they are required to by law, to make progress on climate change mitigation or adaptation, and that for most local authorities there continues to be a focus on flood risk management with little attention paid to other aspects of adaptation.[304]
- The **central government funding** that was in place to engage and support local authorities on climate change adaptation in England has come to an end. This has resulted in the closure of the Environment Agency's Climate Ready Support Service, the Local Government Association's 'Climate Local' initiative, Climate UK, and more than half of Climate UK's regional climate change partnerships in England. Scotland and Northern Ireland still maintain an adaptation research and advice function through SNIFFER and Adaptation Scotland. Appropriate funding is also required to discharge responsibilities around enforcement of building regulations and wider government policies (for example EPC certificate requirements). A recent report by the National Audit Office found a 49% reduction in government funding for local authorities between 2011 and 2018, with a 48% reduction in spending on building control between 2011 and 2017.[305]
- Greener Journeys, a submission of evidence to the Health and Bus Market Inquiry, suggest that local authorities do not have the funding and structures required to develop integrated strategies for transport, employment and housing.[306] Fragmented competitions for funding,

[303] Webb et al. (2016) *Sustainable Urban Energy Policy: heat and the city.*
[304] TCPA's assessment of 64 Local Plans published since England's NPPF was introduced in 2012 highlighted a "large-scale failure" to implement the requirements of national planning policy, and specifically the policy requirements underpinned by the 2008 Climate Change Act.
[305] National Audit Office (2018) *Financial sustainability of local authorities 2018.*
[306] Greener Journeys (2018) *Written evidence in submission to the Health of the Bus Market Inquiry.*

run across a variety of government departments, have provided only short term funding and little long-term certainty, with a significant proportion of council resource being devoted to the application process.

- The decision to leave the European Union will impact local authorities' access to **EU funding sources** and networks, such as the European Investment Bank[307] and European Structural and Investment Funds (ESIF). The last Government committed to maintain funding to ESIF projects signed before the UK leaves the EU. It is not yet clear what domestic measures, if any, will replace ESIF in the longer-term.

Our 2017 Adaptation Committee Progress Report concluded that the current and future outlook for local government funding remains extremely challenging.

The regulatory and policy framework must incentivise and enable local and regional authorities to take action and be ambitious.

The local planning and development system should support the transition to a low-carbon future in a changing climate, and be capable of dealing with the complex interrelationships between people and their environments. Local authorities should be ambitious with local action or, at a minimum, facilitate those who wish to be. The policy and regulatory framework should support this, including enabling action across authority boundaries (such as public transport, cycling networks or low-carbon district heating systems) where necessary. For example:

1. Public bodies have a duty to co-operate on planning issues, particularly those that relate to the strategic priorities for Local Plans as set out in the NPPF. Local authorities should exercise this duty as part of their plan making function, and apply it to address climate change risks that cross administrative boundaries. In the absence of sufficient integration there is a risk that responses to climate change will be event-led and piecemeal, with opportunities missed to reduce emissions and adapt effectively at low cost.
2. There is significant potential for Local and Regional Authorities to drive up the quality of our homes. There are a number of authorities who are taking the lead (for example the Greater London Authority and its Zero Carbon Plan), and many more who would like to play a stronger role. To do this, Government urgently needs to clarify how far Local and Regional Authorities are permitted to go in setting more ambitious standards for new build homes.[308]
3. There is a potential role for the development of a building standards framework, similar to the Energy Step Code in British Columbia (Box 4.6). This could allow Local Government to play a leadership role in energy and water efficiency whilst providing some degree of standardisation to minimise administrative costs for developers.
4. Local authorities must be given appropriate support, funding and frameworks to take action and enforce regulations. Local authorities should have access to the technical expertise, guidance and practical tools they need to fully exercise their responsibilities. The Hackitt

[307] In April 2018 the European Investment Bank agreed a €1.1 billion investment in energy and the environment
[308] Following the publication of a Written Ministerial Statement in March 2015 (see: https://www.gov.uk/government/speeches/planning-update-march-2015), there has been uncertainty over whether local authorities are permitted to set energy performance standards which exceed the equivalent of Code for Sustainable Homes Level 4. In its summary response to the draft revised National Planning Policy Framework consultation the Government stated that 'local authorities are not restricted in their ability to require energy efficiency standards above Building Regulations'. See MHCLG (2018*) Government response to the draft revised National Planning Policy Framework consultation*. However a more formal statement explicitly clarifying the ability of local authorities to set standards which exceed the equivalent of Code for Sustainable Homes Level 4 is needed in order to provide local authorities with the confidence to act.

review identified the need for more rigorous enforcement power and more serious penalties, including powers to require changes to work that fail to meeting Building Regulations.

Box 4.6. British Columbia Energy Step Code

In Canada, British Columbia has a goal for all new buildings to be net-zero energy ready by 2032. In 2017 it introduced the British Columbia (BC) Energy Step Code, a voluntary provincial standard that paves the way for this progress. The BC Energy Step Code provides an incremental and consistent approach to achieving more energy-efficient buildings. It establishes a series of measurable, performance-based energy-efficiency requirements for construction that builders can choose to build to and communities may voluntarily choose to adopt in bylaws and policies when ready. The first step is the base BC Building Code and the highest represents a net-zero energy ready standard.

The Code does not specify how to construct a building, but identifies an energy efficiency target that must be met and lets the builder decide how to meet it. This supports consumer choice, empowers builders to pursue innovative, creative, cost-effective solutions, and allows them to incorporate leading-edge technologies as they become available.

The Code provides a consistent approach that allows the market to gradually build capacity and skills and reduce costs over time. The policy has benefitted from industry support, as a result of the clarity it has provided around defined standards, communicated well in advance. It is expected to further BC's role as a green building and construction leader.

Source: British Columbia (2017) *BC Energy Step Code: A Best Practice Guide for Local Governments*; https://www2.gov.bc.ca/gov/content/industry/construction-industry/building-codes-standards/energy-efficiency/energy-step-code

Recommendation: MHCLG must clarify the rights and obligations of local and regional authorities in relation to climate change mitigation and adaptation. This includes clear statutory duties, and clarification of how far local and regional authorities are permitted to go in setting tighter new build standards.

(Owner: MHCLG. Timing: 2019).

Recommendation: Fund local and regional authorities adequately to drive and influence emissions reductions and adapt their localities to a changing climate, and to discharge their responsibilities in relation to the enforcement of building regulations and wider Government policy.

(Owner: HMT. Timing: 2019 spending review).

Glossary

Climate change adaptation: The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects.

Climate change mitigation: A human intervention to reduce the sources or enhance the sinks of greenhouse gases.

Energy Performance Certificate: The Energy Performance Certificate provides details on the energy performance of the property and what householders can do to improve it. This includes an estimate of energy costs (using the Standard Assessment Procedure) and a measure of carbon efficiency. An Energy Performance Certificate is required for UK properties when constructed, sold or let.

ECO: Energy company obligation. A Government energy efficiency scheme in Great Britain to help reduce carbon emissions and tackle fuel poverty.

Flexibility: Modifying generation and/or consumption patterns in reaction to an external signal (such as a change in price) to provide a service within the energy system.

Heat pump: High efficiency electric heating which uses a vapour compression cycle (also used in fridges) to upgrade ambient heat. This process means that it can typically produce three units of heat (or more) for every unit of electricity used, with very low overall carbon emissions.

Heat network: Also known as district heating, it is the practice of piping hot water between buildings for space heating and hot water ('central heating for cities').

Household: One person living alone, or a group of people (not necessarily related) living at the same address who share cooking facilities and share a living room, sitting room or dining area.

Low-carbon heat: This covers efficient non-fossil-fuel based heating such as electric heat pumps, geothermal heat, biomass boilers and low-carbon gas such as hydrogen and biomethane. It also typically refers to the use of district heating systems in heat dense areas (e.g. cities) to distribute low-carbon heat.

Low-regret adaptation measure: An adaptation measure that is cost-effective to implement today; where the benefits are less sensitive to precise projections of the future climate; and where there are co-benefits or no difficult trade-offs with other policy objectives.

Peak demand: Peak demand is the maximum amount of energy required at any one moment in a year, typically around 17.30 on a winter weekday evening.[309]

Property: An individual dwelling (e.g. house, flat, studio, either owned or rented).

Property-level flood resilience and resistance: Measures to homes that reduce the impact of flood water on the building. These include measures that stop water entering properties (e.g. door guards), and materials that allow a building to be restored more quickly such as waterproof plaster or placing sockets higher up on walls.

SAP (Standard Assessment Procedure): The methodology used by the Government to assess and compare the energy and environmental performance of dwellings. It is the basis for establishing compliance with Building Regulations, and for Energy Performance Certificates.

SuDS: Sustainable Drainage Systems. SuDS aim to alleviate surface water flooding by storing or re-using surface water at source, by decreasing flow rates to watercourses and by improving water quality.

[309] See: http://fes.nationalgrid.com/media/1264/ev-myth-buster-v032.pdf

Glossary

Urban heat island: A man-made area that is significantly warmer than the surrounding countryside. Heat islands exist because the land surface in towns and cities, which is made of materials like tarmac and stone, absorbs and stores heat. This is coupled with concentrated energy use and less air flow than in rural areas, creating a heating effect that is especially pronounced at night.

Vulnerable person: Someone who is susceptible to and unable to cope with adverse impacts of climate change, including climate variability and extremes.

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SUSTAINABLE ENERGY ASSOCIATION

Social Housing: Leading the Way to Net Zero

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Foreword by Lord Best

Lord Best, President of the Sustainable Energy Association

"

As everyone knows, it is imperative that carbon emissions must be dramatically reduced. And it is clear that a big part in this must be played by those building and managing the nation's homes.

But most new homes are built by the volume house-builders who have shown considerable reluctance to achieve the highest standards. And much of the rented sector is owned by private landlords for whom there has been little incentive to invest in energy efficiency.

This means that the nation must turn to the social housing sector to set high standards and to take positive action to cut carbon emissions. It is the housing associations who can and should take the lead in moving toward net zero carbon emissions from housing.

The UK is taking the issue of climate change seriously and has now legislated a net-zero emissions target by 2050. The energy we use in our buildings is key to the achievement of this target. Our homes contribute 22% of the UK's emissions, so more needs to be done to stop our buildings from contributing to global warming.

The social housing sector has a strong record of providing good quality, energy efficient homes for its tenants and is at the forefront of standards in the wider housing industry.

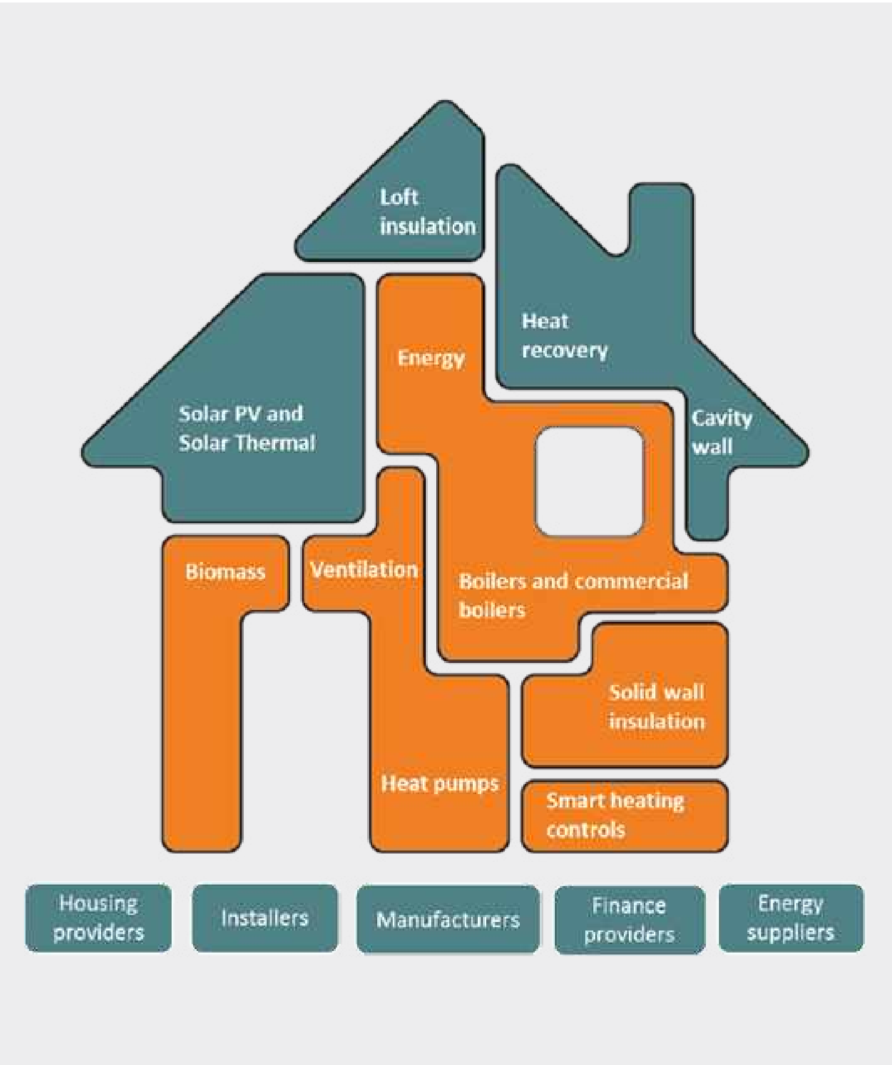
In developing this report, the Sustainable Energy Association brought together experts from social housing and the built environment in a round table discussion. The discussion, which focused on how the social housing sector can achieve the net-zero target, was both positive and encouraging, whilst acknowledging the challenges that need to be overcome and the change that is required.

This report includes detailed analysis of how net-zero could be achieved and industry insight into what actions will be needed to realise it. The analysis demonstrates that business as usual will not deliver the target and that significant change is required. The report builds on the round table discussion to make practical recommendations to government and industry on how social housing can stop its contribution to the UK's carbon emissions.

The important upcoming reviews of Building Regulations and standards in the social housing sector present an opportunity to ensure that homes achieve net-zero emissions whilst being affordable and comfortable to live in. If appropriate policy and frameworks are implemented, the UK's social housing can lead the way to net-zero.

With sincere thanks to all at the Sustainable Energy Association for their perceptive analysis and hard work, I commend this timely contribution to the wider debate.

About the Sustainable Energy Association



The Sustainable Energy Association (SEA) is a member-based industry body. We draw on our wide-ranging membership from manufacturers of energy saving technologies and heating systems to housing associations with an interest in sustainable energy. SEA member's manufacture, distribute, install, retail or regulate a range of technologies, they also own and manage homes and supply energy.

In a world of finite resources, the Sustainable Energy Association exists to help create living and working spaces fit for future generations. Our work seeks to align the interests of business, politicians and consumers to make this a reality. We are industry leaders in energy in buildings. We are technology agnostic and provide objective, evidence-based policy positions which help shape how we think about, generate and use energy. We are constructive, collaborative and committed to achieving our vision, by ensuring that buildings are energy efficient, low carbon and warm.

Acknowledgements

The Sustainable Energy Association would like to thank the following stakeholders for attending our social housing roundtable held on 2nd July 2019 in the House of Lords; Aster Group UK, Broadland Housing Group, Catalyst Housing Limited, Clarion Housing Group, Committee on Climate Change, Daikin UK, the Department for Business, Energy and Industrial Strategy, EDF Energy, Hastoe Housing Association, Incommunities, Irwell Valley Homes, Kingspan Insulation, Knauf Insulation, Mitsubishi Electric, Natural Building Technologies, Newlon Housing Trust, NIBE Energy Systems, Octavia Housing, Onward Housing, Optivo, Recticel Insulation, Showersave, South Yorkshire Housing Association, Sovereign Housing Association, The Guinness Partnership, The Riverside Group Ltd and Vaillant Group. Thanks also to other SEA members and stakeholders who have contributed to the development of this report.

Table of contents

Executive Summary

The Climate Change Act of 2008 required the UK to reduce its emissions[1] by at least 80% of 1990 levels by 2050. With homes accounting for around 22% of UK emissions, the UK Government outlined its commitment to reducing emissions from buildings in the Clean Growth Strategy.

In May 2019, the Committee on Climate Change in its report Net-Zero: The UK's contribution to stopping global warming recommended that the UK should set and vigorously pursue an ambitious target to reduce greenhouse gas emissions (GHGs) to 'net-zero' by 2050, ending the UK's contribution to global warming within 30 years.[2] This target was subsequently adopted by the UK Government and came into force on 27th June 2019.

Social housing makes up just over 17% of homes across the UK and yet only contributes 10% of the residential sector's carbon emissions[3], showing the good foundations that have been laid in mitigating carbon emissions in this sector. However, to meet the net-zero carbon target, we must largely eliminate emissions from all homes which means that business as usual is not enough.

The aim of this report is to contribute to the discussion on how social housing can continue to lead the way in reducing emissions in the residential sector and help to meet the Government's 2050 target of net-zero.

The analysis carried out shows that given current trends, emissions from the social housing sector will continue to fall modestly up to 2050. However, this fall will not be anywhere near substantial enough to meet the original 80% reduction target, let alone the newly adopted target of net-zero. To even get close to reaching this target, policies to significantly improve energy efficiency and promote low carbon heating technology deployment need to be implemented urgently. Before the adoption of net-zero, some experts had already stated that the residential sector would need to reduce its emissions by over 80% to allow for a lack of emissions reduction potential in other sectors.[4] So even to achieve an 80% reduction, complete decarbonisation of heat was probably required. With the adoption of the net-zero target this is certainly now essential.[5]

This report evidences that only a combination of deep retrofit of existing social housing, raising the standards of all new builds and encouraging rapid market growth of low carbon heating systems such as heat pumps can be successful in achieving an 80% reduction in carbon emissions by 2050. To reach further emission reductions in line with the net-zero scenario, this combination of changes will need to be extended by implementing far higher standards for new builds and creating an even faster uptake of low carbon heating. The social housing sector is keen to take on the challenge of net-zero, recognising the benefits it can bring and the important role the sector can play. However, this will require significant changes from house builders and social housing providers alongside targeted support from government and propositions from industry to enable social landlords to carry out the combination of measures required.

SEA conclusions and recommendations:

KEY CONCLUSIONS

1. Conducting business as usual in social housing will not acheive net-zero carbon by 2050

2. Only a combination of deep retrofit of existing social housing, implementing far higher standards of all new builds and encouraging rapid market growth of low carbon heating systems can be successful in achieving the net-zero target.

3. Action is required now if we are to achieve net-zero. Recommended actions are summarised opposite

KEY RECOMMENDATIONS

1. REGULATION & STANDARDS

Legislate the EPC Band C target; raising all homes to EPC Band C wherever 'practical, cost-effective and affordable' by 2035 and starting with social housing by 2030. Energy efficiency is the first essential step in creating homes with a low energy demand.

Introduce a new improved 'Decent Homes Standard' for social housing. This is required to reflect the new net-zero target.

Set a clear deadline on the use fossil fuel heating systems in social housing. There needs to be a phase out of fossil fuel heating in existing social housing properties, starting from today. To help achieve this, a clear signal should be sent to industry by the introduction of a deadline.

Implement the 'Future Homes Standard' as soon as possible. This is essential to meet the carbon emissions target and will mandate the end of installation of fossil fuel heating in new build social housing.

2. FUNDING

Provide specific Central Government funding for upgrading energy efficiency in social housing. The Grenfell tragedy has resulted in increased spending on fire safety and budget cuts has meant that money allocated for home renovations including energy efficiency and heating system upgrades has been reduced. In line with the BEIS Select Committee recommendations, energy efficiency should have increased funding from Central Government to mitigate this.

Introduce a 'warm rent' option for social housing providers which addresses the issue of split incentives within the sector and recognises the long-term benefits of energy efficient housing whilst not compromising the affordability of the home for the occupants overall.

Ensure that environmental and social obligations placed on energy bills are not disproportionally placed on certain fuels, particularly where those fuels are lower carbon, as this conflicts with the achievement of net-zero.

3. QUALITY

Increase monitoring of new build homes and those procured through Section 106 to ensure the performance gap between the design and as-built performance of a home is closed. To achieve this, there should be improved access to redress for properties that do not meet the design standards when they are built.

Introduction

THE NEED TO DECARBONISE HOUSING

The growing importance of tackling global warming through reducing greenhouse gas emissions (GHG) is highlighted by the Intergovernmental Panel on Climate Change's (IPCC) report on the Impacts of Global Warming of 1.5ºC.[6] The IPCC warn that "limiting global warming to 1.5ºC would require rapid, far-reaching and unprecedented changes in all aspects of society", but this should be coupled with ensuring that society becomes more "sustainable and equitable". The Committee on Climate Change (CCC) is the independent body which under the Climate Change Act has specific statutory duties that include advising the Government on carbon targets and climate change risks. The Committee published a report, 'UK Homes: Fit for the Future?' which highlighted that "emissions reductions from the UK's 29 million homes have stalled, while energy use in homes – which accounts for 14% of total UK emissions – increased between 2016 and 2017". [7]

The UK Government had set targets to reduce emissions by at least 80% from 1990 levels by 2050. In May 2019, the Committee on Climate Change in its report, *Net-zero: 'The UK's contribution to stopping global warming'* recommended that the UK should set and vigorously pursue an ambitious target to reduce greenhouse gas emissions (GHGs) to 'net-zero' by 2050, ending the UK's contribution to global warming within 30 years.[8] On 12 June 2019 the Government laid the draft Climate Change Act 2008 (2050 Target Amendment) Order 2019[9] to amend the Climate Change Act 2008 by introducing a target for at least a 100% reduction of greenhouse gas emissions (compared to 1990 levels) in the UK by 2050 - known as the net-zero target. The draft instrument was debated and approved by the House of Commons and the House of Lords and the Order came into force on 27th June 2019.[10]

In the Clean Growth Strategy, the Government outlined its commitment to emissions reductions. This included raising all fuel poor homes and private rented sector homes to EPC Band C by 2030. For the social housing sector, the Government committed to consult on how these properties can meet similar levels over the same period.[11]

Improving the energy performance of the property can not only provide financial benefits to the occupant, but can also reduce the need for expensive retrofit later on and so create long-term savings for social housing providers. Additionally, there is evidence to suggest that higher EPC ratings lead to reduced void days, lower rent arrears and reduced spend on repairs. Rent arrears are on average half a month higher in Band F properties compared to other Bands. Additional benefits for the provider include reduced time spent seeking rent payments and lower legal costs.

Whilst this report focuses on social housing, it is also important to consider the wider housing stock in this context; the Government has set out an aspiration for all homes to reach EPC Band C by 2035. This aspiration has since been referred to as a target and this has been reiterated in subsequent publications including in the Transforming Heating: Overview of Current Evidence.[12] The SEA recommends that this target be enshrined in law to drive action across the whole housing stock and ensure that any future Government would retain this commitment and a legacy would be achieved. This is likely to also have positive consequences for the social housing stock. As installers are upskilled, costs fall through economies of scale and housing across the country becomes more affordable due to improved thermal performance.

With a programme of house building underway, new homes are also an important market. They can add to our current stock of poorly insulated homes heated with high carbon fossil fuels or they can provide an opportunity to deliver high quality, well insulated homes with low carbon heating systems. They can also support the development of the supply chain for the technologies and skills required to bring all homes to these standards. With many social housing providers currently undertaking building programmes, the sector has an important role to play in the new build market.[13]

There was recognition of the importance of ensuring that the emissions from new homes are minimised in March 2019 with the Government's announcement of the 'Future Homes Standard', which will future-proof homes with low carbon heating and deliver world leading energy efficiency standards from 2025.

This report sets out proposals for the energy performance trajectory for the social housing sector and analyses what is required to meet the net-zero target.

STARTING WITH SOCIAL HOUSING

The residential sector currently accounts for 22% of the UK's emissions, representing a large potential for emissions reduction, which mainly come from heating, lighting, cooking, and running appliances.[14] Social housing has been a forerunner in reducing emissions, and on average it is the most energy efficient part of the housing stock.[15] Currently, social housing constitutes 17% of the total housing stock, but only contributes 10% of the emissions from the sector.

The Energy Performance Certificate (EPC) rating of a home is dependent on a Standard Assessment Procedure (SAP) score, which is calculated by the energy consumption of a dwelling at a defined level of comfort and service provision (based on standardised assumptions for occupancy and behaviour). SAP is the Government's method for assessing and comparing the energy and environmental performance between buildings and is used to underpin many government initiatives.

In 2017, social housing stock had an average SAP rating of 68, which was higher than private rented and owner occupier sectors which had an average SAP rating of 61.[16] This is partly due to greater uptake of wall insulation and also the dwelling composition. There is a higher proportion of flats in the social rented sector in contrast to other tenures and flats also tend to have less exposed surface area through which heat can be lost compared to detached or semi-detached houses.

Over recent years, the average SAP ratings across all tenures have increased, however between 2016 and 2017, there was no change in average EPC ratings, inferring a hiatus in activity. In 2017, over half (52%) of dwellings in the social housing sector were in Bands A-C as shown opposite. Despite the average EPC rating of social housing properties being higher than private and owner occupier tenure properties, there is still a significant proportion in need of retrofitting.

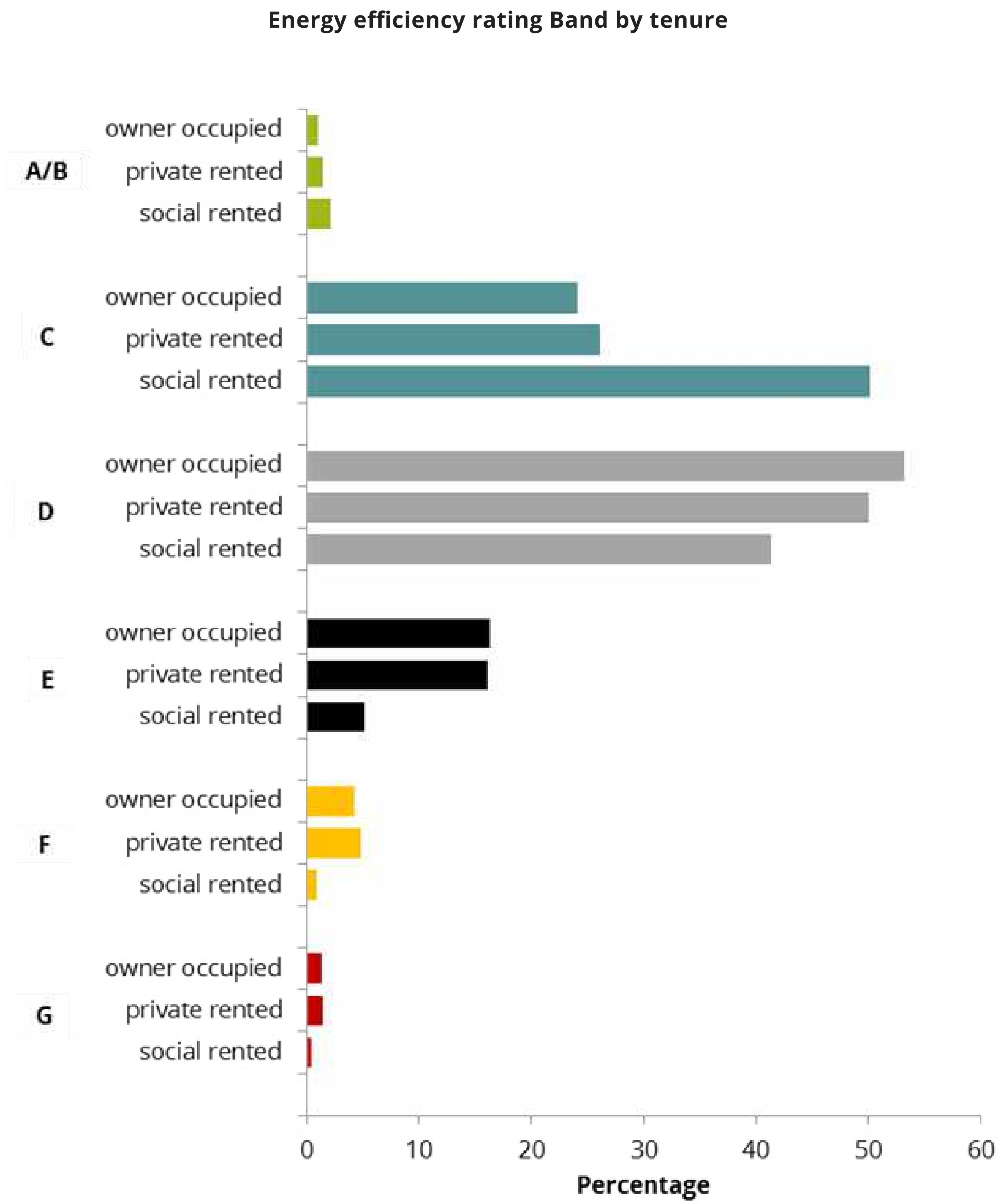


Figure 1 - Energy efficiency rating Bands, by tenure, 2017. Source: English Housing Survey [17]

For the Government's legally binding net-zero target to be met, significant reductions in carbon emissions are needed across all sectors. For the residential sector this will mainly require the heating demand of properties to be reduced through energy efficiency improvements as well as the shift to heating methods with lower carbon intensities and greater efficiencies. Despite leading the way so far, social housing will need to continue to reduce energy demand and lower emissions over the coming years. It is particularly poignant as reducing the energy bills of those living in social housing, through these improvements, will have the additional benefit of reducing their risk of living in fuel poverty.

The characteristics of the UK housing stock present a barrier to decarbonisation. The UK has a relatively slow turnover of houses compared to other European countries; it is estimated that at least 80% of the current housing stock will still be in place by 2050.[18] This means that a significant proportion of the old, energy inefficient homes that exist today are likely to remain in 2050 if nothing is done to improve them. Therefore, it is essential that emissions from these existing homes are reduced through retrofit measures. However, retrofitting of the existing stock has stalled.

It is significantly easier and cheaper to ensure that new buildings are built with high levels of energy efficiency and low carbon heating than it is to retrofit existing stock. We would expect standards to be higher from new builds but over a quarter of new builds are being built EPC Band C or below.[19] The SEA's report *'Halving Energy Use of New Homes'* [20] seeks to address the challenges faced in the new build sector and makes recommendations as to how we can ensure that the homes we build today are fit for future generations.

Number of New Dwelling Energy Performance Certificates lodged on the Register in England by Energy Efficiency Rating (all tenures)

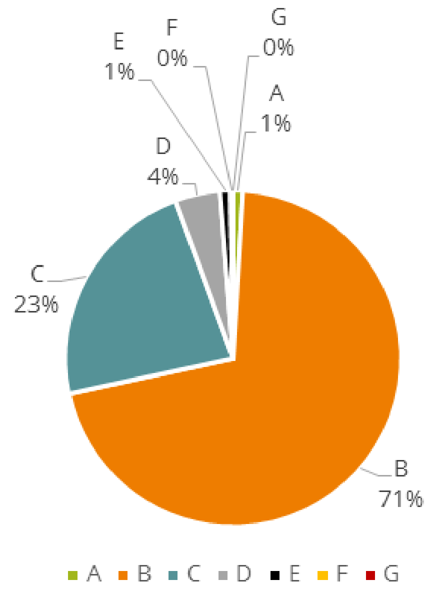


Figure 2 - Number of New Dwelling Energy Performance Certificates lodged on the Register in England by Energy Efficiency Rating. Source: MHCLG (2019) EPCs for all new domestic properties (including new build dwellings, conversions and change of use)[21]

ANALYSIS IN THIS REPORT

Energy Performance Certificates (EPCs) must be issued for all houses available to buy or rent in the UK. They provide information on the heating and lighting costs of a property and give a rating or 'Band' for energy efficiency from A (very efficient) to G (inefficient).[22] As the features of the UK housing stock adjust over time, this will be reflected by changes in the EPC Bands. Although the use of EPCs[i] is not an exact indicator of the energy consumption and emissions coming from the housing stock, they can be used to provide a strong indication of these values. The analysis in this report therefore models the movement in EPC Bands up to 2050 across the different scenarios.

The SEA recognises that the EPC Band might not accurately reflect the actual performance of every home as there can be a performance gap between the designed and built performance of homes, but for the purpose of this analysis EPC Bands are considered the most appropriate proxy for energy efficiency.

The report projects the emissions from the social housing sector up to 2050. The considered emissions are those from energy consumption in the house, such as heating and other electrical use. Other emissions, such as embodied carbon and those associated with manufacture of the products used, are beyond the scope of the analysis. The relative costs of technologies will be important in determining the uptake of low carbon technologies. However, this analysis focusses on the emissions of the social housing sector to illustrate the types of changes that will be necessary to achieve the net-zero target.

The total emissions are then compared to a 2050 target of 3.58 $MtCO_2e$, which would represent an illustrative 80% reduction in residential emissions from 1990 levels with social housing maintaining its current proportional contribution (10%) towards the total emissions. In addition, following the Government's adoption of the 'net-zero' target[23], a further target of 2.1 $MtCO_2e$ was developed for the social housing sector as another comparator for emission reductions achieved.[ii]

Several scenarios are then considered. The Business as Usual (BAU) scenario assumes a constant housing stock total and improvements to the energy efficiency and carbon emissions from social housing based on the extrapolation of existing trends. Additionally, scenarios for a widespread retrofit of the housing stock to EPC Band C, higher new build standards being introduced, and a mass market for low carbon heat (heat pumps have been used as an example of a low carbon heating system) are considered individually and in a combination scenario.

[i]Energy Performance Certificates contain information on potential energy costs and carbon dioxide emissions. For the purpose of this report the cost element has been used as this aligns with government analysis.

[ii]The target was calculated based on an 80% reduction in residential emissions by end users from the 1990 level (as set in the Climate Change Act of 2008) of 171.4 $MtCO_2e$ to 34.3 $MtCO_2e$ by 2050. Social housing accounted for 10.45% of residential emissions in 2016 (Energy Performance of Dwellings) and so maintaining this proportion in 2050 results in social housing emissions at the target level of 3.58 $MtCO_2e$. The same process has been followed for the net-zero target with a reduction on 1990 levels consistent with the CCC's 'Further Ambition' scenario for residential buildings used. This assumes that there will also be negative emissions elsewhere in the economy.

A Further Ambition scenario has also been considered going beyond the combination scenario to study how a net-zero target could be reached. The changes required for this Further Ambition scenario include the same retrofit programme and new build rate as the combination scenario, with even higher standards in terms of space heating requirements for new builds, in line with the 'world-leading' levels of energy efficiency set out in the Future Homes Standard, as well as a deeper transition to low carbon heating. Figure 3 illustrates (left to right) the current position, business as usual 2050 projection, the target average emissions required from a social rented property in 2050 to meet the 80% reduction target and the requirement to meet the net-zero target.

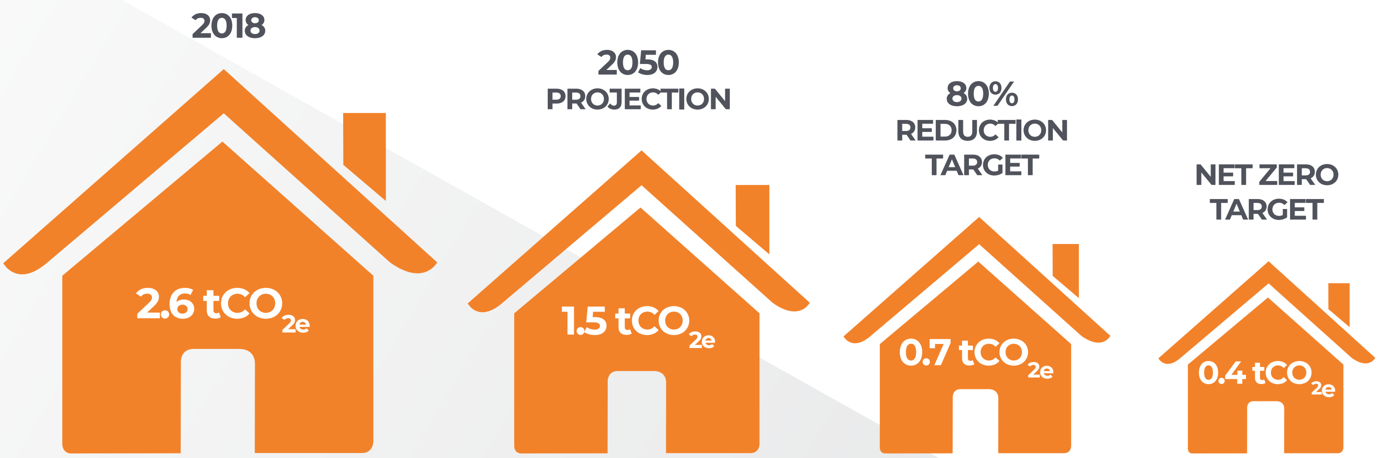


Figure 3 - Average emissions per household, 2018 level, 2050 projection under the business as usual scenario level, 80% reduction and the Net Zero target by 2050 level.

Table 1 provides a summary of the analysis conducted under the different scenarios considered: Business as Usual (BAU), EPC Band C retrofit, tightening of new build standards, a mass market for low carbon heat, a combination of these and the Future Ambition scenario which considers how the net-zero target can be achieved.

TABLE 1: SUMMARY OF PROJECTIONS BY SCENARIO

Scenario	Projected 2050 Consumption (TWh)	Projected 2050 Emissions ($MtCO_2e$)	Difference Compared to 80% Reduction Target	Difference Compared to Net Zero Target ($MtCO_2e$)	Percentage Decrease of Emissions from 2016 to 2050
Business as Usual	53.79	7.45	+3.87	+5.3	43%
EPC Band C 2030 Retrofit	47.07	6.24	+2.66	+4.09	52%
New Build	50.05	6.77	+3.19	+4.62	48%
Mass Low Carbon Heat Market	35.68	3.77	+0.19	+1.62	71%
Combination	31.54	3.19	-0.39	+1.04	75%
Further Ambition	24.45	1.72	-1.86	-0.43	87%
80% Reduction on 1990 Levels Target	N/A	3.58	N/A	N/A	72%

For an 80% reduction to be met, the average social housing property would need to achieve emissions of 0.716 tCO_2e per year from heating and other electrical consumption. Under the BAU scenario, households by 2050 would emit 1.49 tCO_2e and consume 10,758 kWh of energy on average per year, far above an 80% reduction.

The combination of the three scenarios, reaching a total of 3.19 $MtCO_2e$ across the whole stock, achieves the 80% reduction from 1990 emissions levels by 2050. This combination would see the average social housing property consuming 6,308 kWh and emitting 0.64 tCO_2e per year. However, reducing emissions to this level is unlikely to be enough to dampen the effects of climate change sufficiently and this has now been formally recognised with the adoption of a new legally binding target of net-zero by 2050. The combination scenario outcome is still above the net-zero target and only the Further Ambition scenario achieves the reduction necessary for net-zero. Under Further Ambition, emissions reach 1.78 $MtCO_2e$ by 2050, meaning the average social housing property would be consuming 4,891 kWh and emitting 0.36 tCO_2e per year.

The modelling suggests that a range of approaches will be needed, meaning that there is no silver bullet for large-scale carbon emission reductions in the residential sector. Without the widespread combination of increased energy efficiency, higher standards for new builds and the mass market deployment of low carbon heating, emissions are unlikely to fall sufficiently. Additionally, without the "unprecedented" interventions required as suggested by the IPCC and recommended by the CCC, the carbon emissions from heating our homes will continue to remain a barrier to achieving the net-zero target.

Analysis of Scenarios

BUSINESS AS USUAL SCENARIO

The BAU scenario is the baseline position for our analysis, which extrapolates previous trends up to 2050. We assume that the social housing stock will remain constant at 5 million homes and the proportion of property types (terraced, semi-detached, detached, bungalows and flats) contributing to this will also remain the same. The EPC ratings for these homes shifts over time, largely because of new builds, demolitions and retrofit measures taking place. For each property, the type of property, EPC Band, energy consumption by fuel, and underlying electricity demand were considered to calculate how heating and electricity consumption would change up to 2050 for the social housing sector. Other emissions that households may contribute, such as travel and waste, were not considered as part of the analysis.

Figure 4 shows the proportion of properties by EPC Band in the social housing sector by 2050 under BAU arrangements. The percentage of houses in Band A remains extremely low in 2050 at 0.22%. This can be explained by a very small number of highly rated new build properties being added to the stock combined with a minimal amount of homes being retrofitted to this standard. There are no houses at bands F and G by 2050. This is due to an assumption that on an annual basis, demolition of the most inefficient and likely older homes takes place. Our analysis assumes that, on average, just over 8,000 demolitions occur each year and these are targeted at the least efficient stock.[iii]

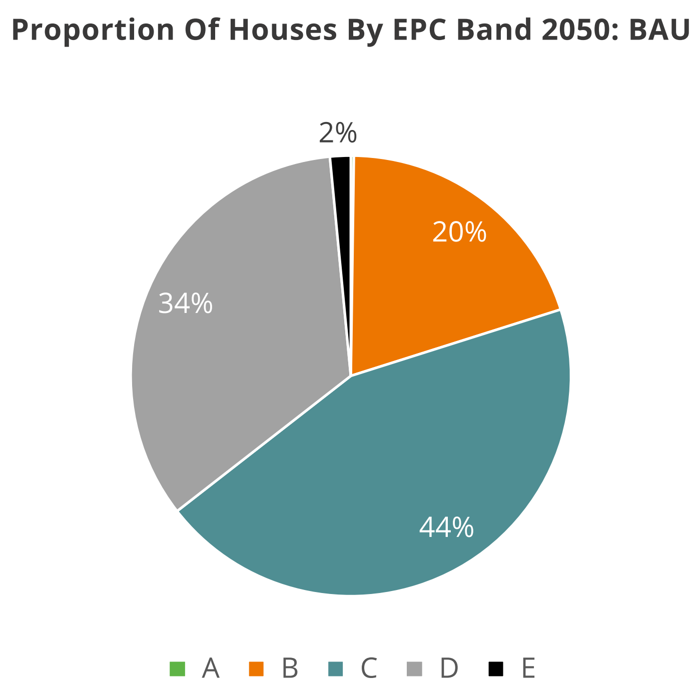


Figure 4 - 2050 proportions of social houses by EPC Band under the business as usual scenario

[iii] See assumptions tables

Over time, the EPCs of the social housing stock improve as the heating requirements for each property fall and there is a slight move to more efficient heating methods. The majority of homes continue to be heated using natural gas systems with a relatively low uptake of renewable heating solutions.

Under the BAU scenario, total energy consumption falls slowly from 60.79 TWh in 2018 to 53.79 TWh in 2050, as shown in Figure 5. For the average household this represents 10,758 kWh of energy consumption by 2050. It is important to note that whilst this equates to a 12% reduction in energy demand, it is not sufficient to meet the carbon targets. Moreover, this limited demand reduction could risk achieving the UK's fuel poverty ambitions.

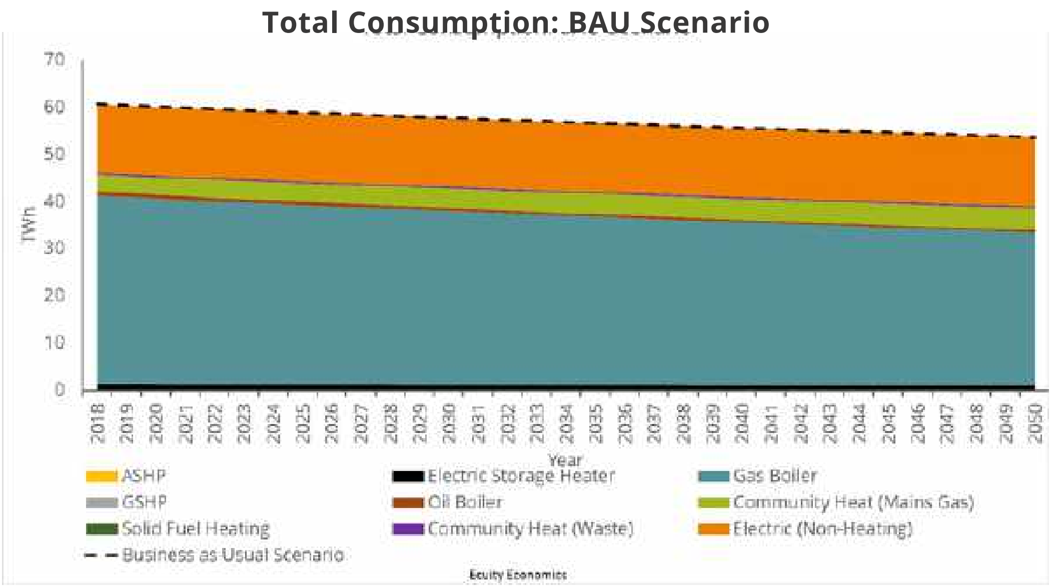


Figure 5 - Total consumption (TWh) projection based on the business as usual scenario

The second quarter of 2018 saw the total share of renewables within electricity generation reach 28.1%.[24] This was an increase of 22.2% points compared to the equivalent 2010 value. It is expected that the share of renewable generation will continue to increase up to 2050. This means that the carbon intensity of electricity is projected to continue to fall, as shown in Figure 6.

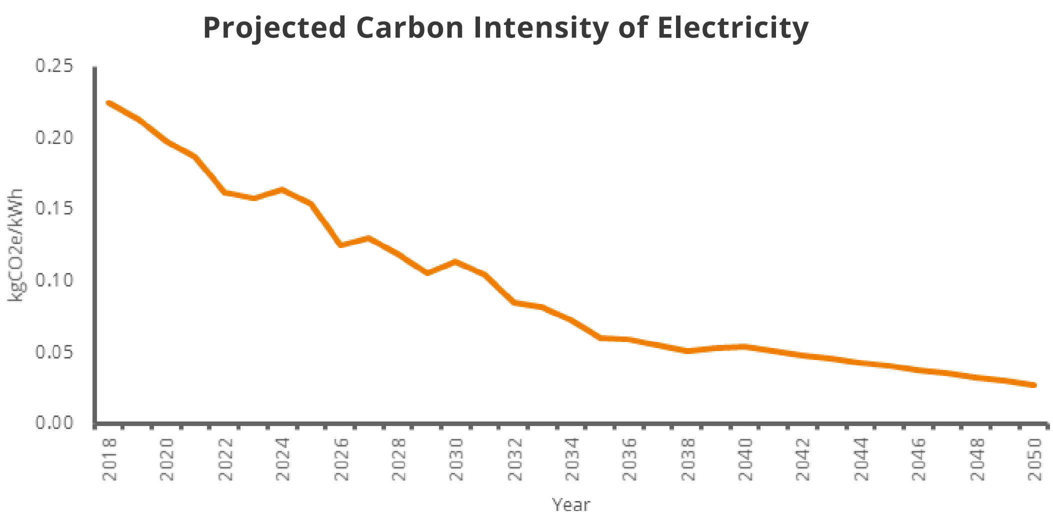


Figure 6 - Projected carbon intensity (kgCO_2e/kWh) of electricity. Source: BEIS, 2018[25]

This falling carbon intensity of electricity (shown above in Figure 6), the reduced consumption (shown in Figure 5) and a move away from high carbon fossil fuel heating systems results in a reduction in total emissions from 11.95 $MtCO_2e$ in 2018 to 7.45 $MtCO_2e$ in 2050 (black dashed line in Figure 7), which is the equivalent of 1.49 tCO_2e per household. This sits significantly above both the 80% emissions reduction of 3.58 $MtCO_2e$, and the net-zero target as shown below.

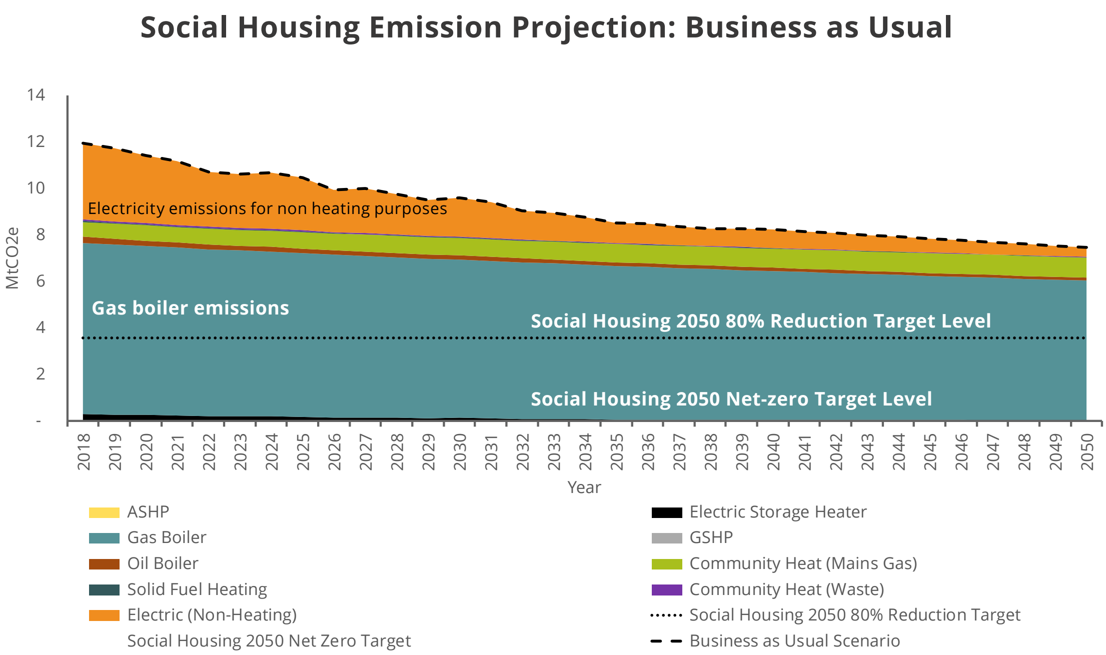


Figure 7 - Total emissions ($MtCO_2e$) from social housing projection based on the business as usual scenario.

Figure 7 shows that if the current trends continue to 2050, then emission reductions from the social housing sector are very unlikely to meet the 80% emission reduction threshold and indicates far-reaching changes are required. The progress made as part of this BAU scenario is hindered by limited volumes and poor quality of retrofitting, low new build standards and built-out rates, and minimal adoption of more efficient low carbon heating methods. The following scenarios will consider the effect on emissions from the social housing sector, if these adjustments were to happen in isolation and combination.

PROPERTY CHARACTERISTICS:

SEMI-DETACHED AND TERRACED HOUSING ASSOCIATION HOMES

(50 PROPERTIES)

TECHNOLOGIES USED:

PARTY WALL INSULATION ✓

LOCATION: BOSTON, LINCOLNSHIRE

KNAUF INSULATION
it's time to save energy

THE PROJECT

Boston Mayflower, a housing association in Lincolnshire, wanted to improve the energy efficiency of around 50 of its semi-detached and terraced homes. As well as lowering energy bills, it was important that any works could be carried out with minimal disruption to residents.

Boston Mayflower decided to use Knauf Insulation's Supafil® Party Wall insulation, a Glass Mineral Blowing Wool insulation, designed specifically for use in separating party walls. Supafil® Party Wall is non-combustible, with a Euroclass A1 Reaction to Fire Classification. It offers excellent thermal and acoustic performance, and is manufactured with up to 80% recycled content.

SPECIFICATION

Field tests have proven that heat is lost when party cavity walls are uninsulated. This is due to a phenomenon known as party-wall thermal bypass, which occurs when cold air enters the uninsulated cavity at exposed edges. The cavity creates a chimney effect and the cold air rises as it is warmed by heat conducted through the eaves of the party wall from the adjoining homes. It then escapes from the cavity to the external environment.

Knauf Insulation's Supafil® Party Wall insulation has been independently proven to eliminate the air movement that causes party-wall bypass without compromising on acoustic performance. The insulation is manufactured with a blue colour, for easy on-site identification and to promote compliance with robust details - a means of satisfying the sound insulation requirements of the building regulations.

BENEFITS

The energy efficiency of 50 homes has been improved, reducing their carbon footprint.

Residents are benefitting from reduced energy bills and warmer, more comfortable environments. Boston Mayflower has therefore improved the quality of its housing stock.

"When we heard about the benefits of Supafil® Party Wall insulation and how it reduced heat loss between two properties, we knew that it would be a great fit for our homes and would allow our current and future tenants to live comfortably in a warm house with lower bills." ***Paul Benton, Property Investment Manager, Boston Mayflower.***

BAND C 2030 RETROFIT SCENARIO

Key Input:	Key Output:
All social homes are EPC Band C by 2030 following an extensive retrofit programme.	Emissions fall considerably, but not enough to reach the original 80% reduction target or the net-zero target.

This scenario considers an extensive retrofit of the existing housing stock. The modelling projected a rate of retrofitting across the stock to bring all social homes up to Band C by 2030. This is aligned with the Government's commitment to bring as many fuel poor households up to Band C by 2030.[26] The SEA is supportive of this objective and also of the target to extend this to ensure that all homes, wherever practical, cost-effective and affordable, are raised to EPC Band C by 2035.[27] The SEA recommends this target be adopted as a firm commitment and enshrined in law. This would help to tackle carbon emissions from the residential sector as well as raising the levels of energy efficiency in the housing stock making homes warmer and more affordable to live in. Whilst having obvious significant benefits for those in fuel poverty, making all social housing more efficient and affordable can increase resident's disposable income whilst making homes warmer and healthier. The social housing sector is likely to be able to implement a retrofit programme faster than the private rented and owner occupier sectors. Considering this, there is evidence to suggest that the social housing stock could be retrofitted within 10 -11 years and within the 2030 target if action is taken now.[28] There is also evidence that every £1 spent on improving energy efficiency provides £3.20 in returns via gross domestic product (GDP) increases across the country[29], making energy efficiency improvements a sensible and cost-effective approach to tackling carbon emissions from buildings.

The Fuel Poverty Strategy was first published in 2015 under the Coalition Government, recognising the importance of alleviating the health and wellbeing issues that arise from living in energy inefficient homes. The Strategy is being consulted on during 2019 and the adoption of a sustainability principle is proposed. This would ensure that policies contributing to the fuel poverty target are complementary to other Government priorities such as the Clean Growth Strategy and the Industrial Strategy. The SEA fully supports the inclusion of this principle in the Fuel Poverty Strategy. The net-zero target will not be achieved unless government strategies (and departments) are aligned and contribute to meeting our legally binding carbon targets.

Combined with clear policy and targets, financial support is likely to play a key role in improving the housing stock of the fuel poor. The new iteration of the Energy Company Obligation, which will run until 2022, targets fuel poor and vulnerable households. The scheme aims to improve the thermal efficiency and encourage the uptake of new heating systems to increase the overall performance of the housing stock.

There is a substantial evidence base suggesting a 'performance gap' between the measured energy requirements in the certification of the EPCs and the actual performance of a property. Here it is important that regulation works to close the gap and the social housing sector better understands the real performance of their stock.

Asset modelling may be needed to understand the specific issues that social housing providers face based on the characteristics of their stock. This could help to identify which homes can be improved to EPC Band C and what needs to be done to do so cost-effectively. There is a need to ensure that incremental improvements do not lead to higher costs. Taking a holistic and long-term approach to retrofit may help to ensure cost-effective improvements are made. This means providers may seek to achieve higher standards earlier to avoid the need to re-visit properties at a later date. However, this requires clear long-term targets and policy frameworks to be in place to allow the sector to plan improvements.

To help tackle some of the most poorly performing socially rented homes, there have been calls for additional targets to be set, reaching 2050 or beyond. The rationale behind this is social housing providers often have longer term asset management budgets to upgrade properties and own them for a long period of time. This means that it may be more beneficial to providers in the long term to aim for higher targets to ensure that their properties are future-proofed. This could reduce costs by mitigating any need for retrofit in the future and could lower maintenance costs ahead of standards being introduced.

As noted above, this scenario assumes that a strong commitment is made to improving all social housing stock to EPC Band C by 2030. In Scotland, there are proposals for all social housing properties to meet EPC Band B by 2032 with a minimum standard that no social housing should fall below EPC D from 2025. Whilst there is recognition that setting more ambitious targets might be challenging to achieve, there is support for a longer-term target given that 2030 is just over 10 years away which equates to a single boiler replacement cycle (average 12-year lifetime).

The inputs to the EPC Band C retrofit model are the same as the BAU scenario, including the number of homes, tenure type, energy consumption by fuel and underlying electricity demand but retrofitting to EPC Band C by 2030 is included. Figures 7 and 8 show the projected consumption and emissions respectively for the BAU scenario.

Total Consumption: EPC Band C Scenario

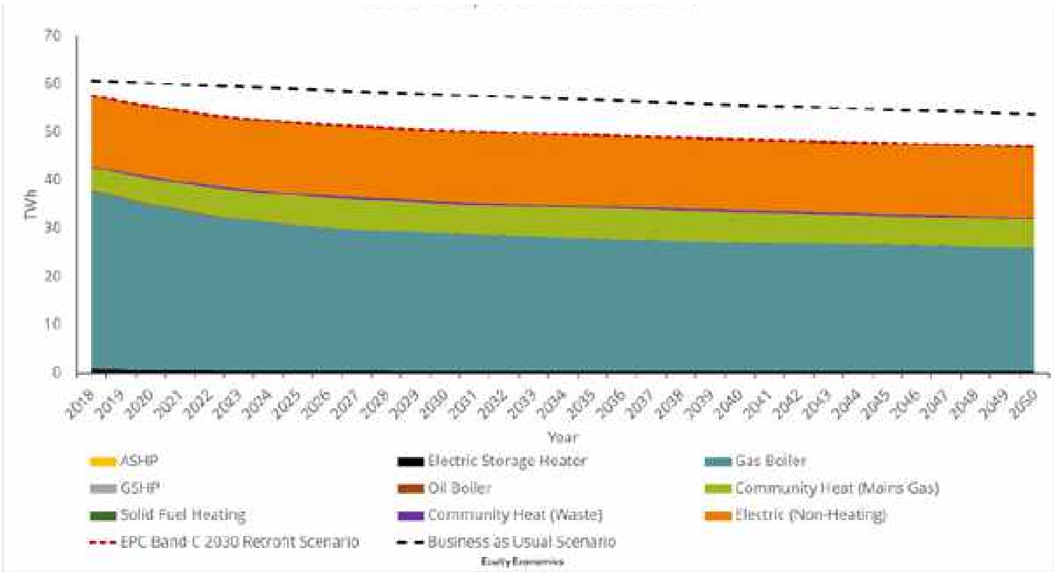


Figure 8 - Total consumption (TWh) projection based on the EPC Band C 2030 retrofit scenario

Social Housing Emission Projection: EPC Band C Retrofit Scenario

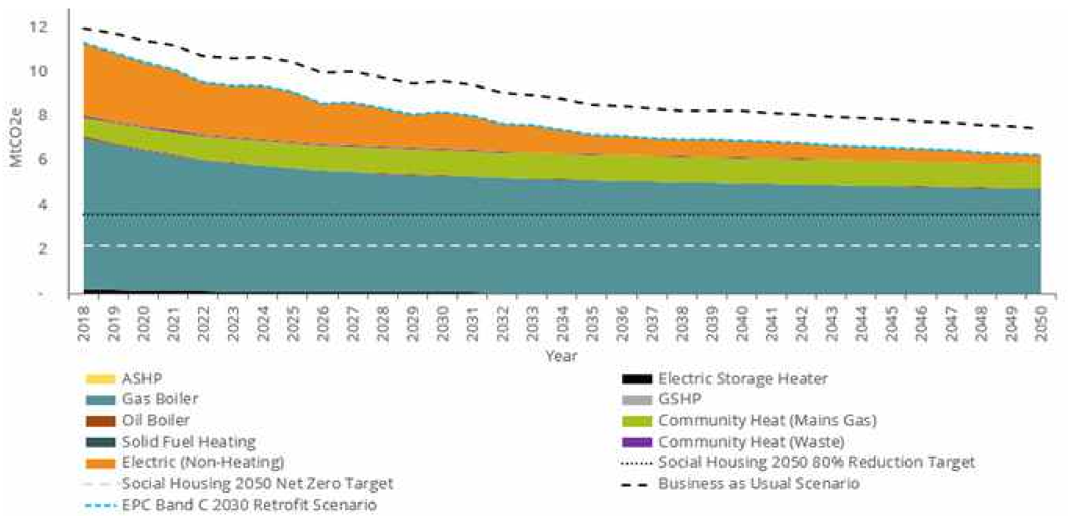


Figure 9 - Total emissions ($MtCO_2e$) from social housing projection based on the EPC Band C 2030 retrofit scenario

As can be seen in Figures 8 and 9, consumption under this scenario falls to 47.07 TWh and emissions to 6.24 $MtCO_2e$ respectively by 2050, a slight decrease on the BAU scenario. This represents an average annual consumption of 9,404 kWh and average emissions 1.25 tCO_2e per household.

Whilst there is a reduction in carbon emissions compared to the BAU scenario, this is not significant enough to meet either the 80% reduction threshold or the net-zero target. This is largely because the dominant heating method in Bands A, B and C properties is assumed to be a gas boiler, with a smaller proportion utilising community heating systems and electric heating. It is important to note that our analysis assumes there are no oil boilers in these Bands. This is because the Government has committed to phasing out 'high carbon fossil fuel heating' throughout the 2020s.[30] The analysis shows that even with these retrofit improvements and the subsequent elimination of more carbon intensive oil and solid fuels, the dominance of gas in heating up to 2050 could present a significant barrier to emission reduction within the EPC Band C Retrofit scenario. This is because this scenario assumes a relatively low uptake of low carbon heating system in line with current deployment rates.

Whilst it is currently unclear as to which decarbonisation pathway the UK will follow e.g. electrification, hydrogen, or a combination of the approaches, it is important that the housing stock is prepared for the transition to lower carbon heating solutions. From this analysis, it is obvious that further work is needed over and above achieving EPC Band C by 2030 if we are to meet our decarbonisation goals. In the subsequent section, we analyse the impact of widespread uptake of low carbon heat.

This analysis suggests that if a retrofit scenario was to be implemented then retrofit programmes will need to be more ambitious and aim for higher thermal efficiency ratings and/or low carbon heat deployment. Whilst we have not modelled the impact of retrofitting homes to Passivhaus standard, we have evidence to demonstrate that improving a property to this standard delivers significant carbon savings, improves thermal comfort and reduces energy bills for tenants.

TECHNOLOGIES USED:

HEAT RECOVERY	✓
AIR SOURCE HEAT PUMP	
SOLID WALL INSULATION	✓
MONITORING EQUIPMENT	✓

LOCATION: HOLBORN, LONDON.

OCTAVIA HOUSING

THE PROJECT

100 Princedale Road, London is a Victorian house in a Conservation Area. It was certified as Passivhaus standard in February 2011 and the tenant family moved into the house one month later.

The house was compared to one typical home on the same street and another which met the Decent Homes Plus standard for its final energy demand, emissions, energy bills and capital investment and payback, thermal comfort, indoor air quality and water usage.

SPECIFICATION

The house was retrofitted to have extremely high levels of energy efficiency at 63 kWh/m2a for final energy demand, a reduction of 83% compared to a typical home, and 46% less than a similar home retrofitted to Decent Homes Plus standard. This was achieved by upgrading the building's roof, walls and floors insulation and improving cold bridge resolution. New external windows and doors were also fitted to improve energy efficiency.

Solar thermal technology was installed to supply the majority of the hot water, combined with a Mechanical Ventilation with Heat Recovery system in combination with a small exhaust air heat pump system. This met all space heating requirements of the building.

BENEFITS

The house that was retrofitted to Passivhaus standard was kept at a steady temperature of between 19.3°C and 24.9°C for 95% of the year, yielding higher thermal comfort without overheating

A 70% reduction in carbon emissions for the Passivhaus home compared to the typical scheme, an annual saving of 5.5 tonnes of CO_2.

Energy bills for the year for the home improved to Passivhaus level were just £773, a saving of 62% compared to a typical home on the same street.

MASS MARKET FOR LOW CARBON HEAT SCENARIO

Key Input:

- Oil boilers and solid fuel heating to be phased out by 2026,
- Gas boiler usage to fall by 60% by 2050,
- No 'inefficient' electric heating by 2050.

Key Output:

Emissions fall considerably, but not enough to reach the original 80% reduction target or the net-zero target.

In this scenario, fossil fuel heating systems are replaced over time with low carbon solutions. For the social housing stock to get close to reaching the 80% emissions reduction by 2050, the analysis suggests that heating systems will need to become more efficient and there is a need to switch to a less carbon intensive fuel than natural gas. As recommended by the Committee on Climate Change, the Government recently agreed to mandate the end of fossil fuel heating in new builds by 2025 as part of the Future Homes Standard.[31] It is not yet clear if the Future Homes Standard will ban new gas connections. If new gas grid connections are allowed, then natural gas will need to be decarbonised over time at a significant cost. If there is widespread electrification of heat, this will require upgrades to the grid. It is important to note that this falls beyond the purpose of the analysis and outside the scope of the model. Off grid, where fossil fuels such as oil and LPG are currently used, these too will need to be decarbonised or replaced if the targets are to be met.

A conversion of the gas grid to hydrogen and a widespread use of biogas are options being suggested for the future of the gas grid, although currently both technologies require further research before it is known if they can become commercially viable, with questions over feedstocks and other potential uses of these fuels e.g. for transport, being raised. [32]

The analysis conducted in this scenario therefore focusses on the established technology of heat pumps (as an illustrative example of a low carbon heat source). Heat pumps are more efficient than the current mainstream heating methods, meaning that the consumption requirements will be lowered. Despite this, social housing providers are still installing gas boilers in the main, largely due to upfront cost considerations and are likely to do so until policy is introduced that provides a clear signal for the need to shift towards the installation of low carbon heat. For this we recommend the setting of a deadline for the end of fossil fuel heating systems in new and existing social housing properties. This would help provide stability and a clear trajectory for heat in social housing.

As a well-known mature technology with high uptake in many parts of Europe and with demand for low carbon solutions on the rise, installing heat pumps is an action which social landlords could take now. The SEA is technology agnostic, does not advocate the use of one technology over another and recognises that a range of solutions will be needed across the whole housing stock to meet carbon emission targets. For some properties, it may be more suitable to install bioenergy or other low carbon forms of heating, however for the purposes of this analysis we have not modelled this level of detail. Heat pumps have therefore been used as a proxy for low carbon heat for illustrative purposes in this report.

To ensure that low carbon technologies are deployed at scale, it will be necessary to grow the skills of the workforce over the next few years. The Government has committed to consulting on skills and training in a low carbon economy in 2019 and this is something that the SEA believes will be essential for meeting the needs of social housing providers and consumers more widely in the future. Clear direction is required from government to encourage installers to invest their time and money in training and certification for low carbon technologies. Installers will only be prepared to make the investment if there is clear policy to stimulate market growth. The lack of market growth has discouraged installers in the past and led to significant decreases in registrations with the Microgeneration Certification Scheme (MCS), which certifies microgeneration technologies used to produce electricity and heat from renewable sources. The cost and effort involved in renewable certification is significantly higher than for fossil fuels and given the difference in the market sizes, it is not surprising that many fossil fuel installers see little incentive to transition to renewables. The target of net-zero should be seen as an opportunity to set clear policy to encourage low carbon solutions and stimulate market growth.

For the reasons explained above, this scenario considers a mass market developing for heat pumps which can be used as a proxy for many low carbon technologies. For this to happen, we have projected a phasing out of inefficient electric heating, gas boiler usage to fall 60% by 2050, and oil boilers and solid fuel heating to be phased out by 2026. The gap left from the removal of these methods of heating is taken up by heat pumps, with an even split between air source heat pumps (ASHP) and ground source heat pumps (GSHP).[iv]

As can be seen in Figures 10 and 11 respectively, this scenario projects consumption to fall to 35.68 TWh and emissions to be 3.77 $MtCO_2e$ by 2050, the equivalent of 7136 kWh and 0.75 tCO_2e per household. Although this scenario sees significant emission reductions, the total emissions in 2050 are marginally above the 80% emission reduction threshold. This means that switching to low carbon heating in isolation, even at this aggressive rate, would not yield enough of a reduction by 2050.

Total Consumption: Low Carbon Heat Deployment Scenario

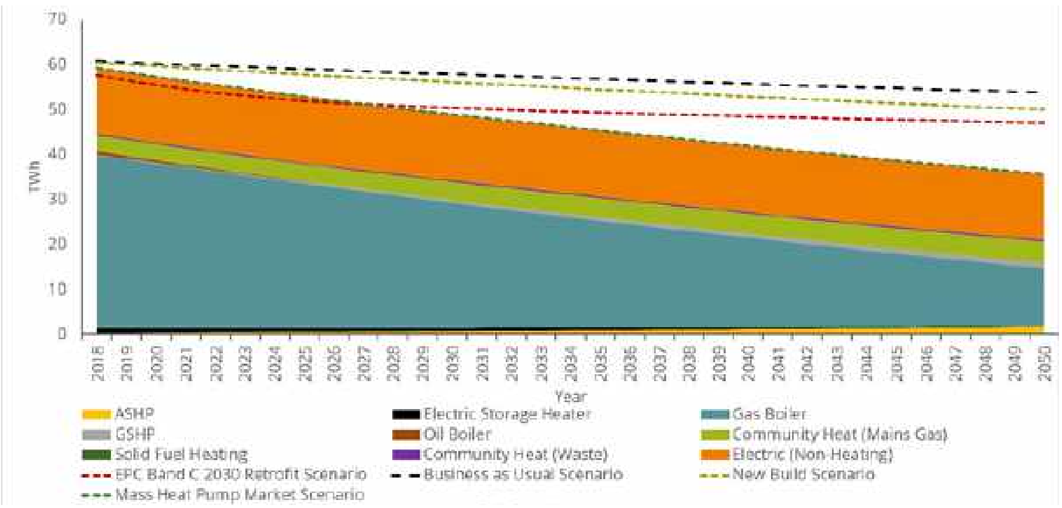


Figure 10 - Total consumption (TWh) projection based on the mass heat pump market scenario

[iv] This is an arbitrary split to highlight the emission reduction that low carbon heat can give.

Total Consumption: BAU Scenario

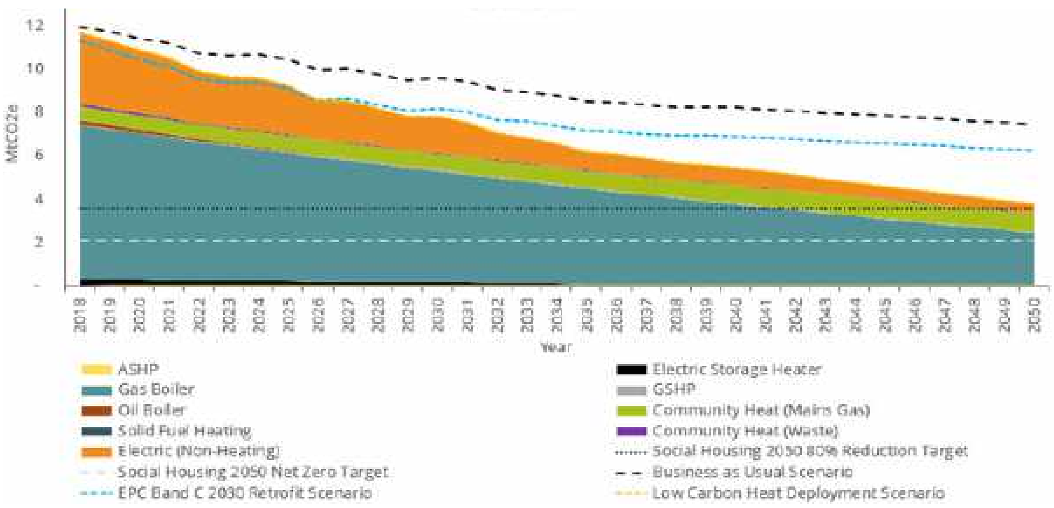


Figure 11 - Total emissions (MtCO$_2$e) from social housing projection based on the mass market for heat pumps scenario

it is unrealistic to expect uniform uptake of low carbon solutions (specifically heat pumps) across the entire housing stock given the varied property characteristics and the presence of hard to treat properties. It is important to recognise that a variety of low carbon heating solutions are available, including biomass, direct electric heating, fuel cells, hybrids and potentially hydrogen boilers, and the type of retrofitting that will take place will depend on the property itself.

LOCATION: SOUTH GLOUCESTERSHIRE

TECHNOLOGIES USED:

AIR SOURCE HEAT PUMP ✓

THE PROJECT

In 2016 Merlin Housing launched a programme to upgrade its housing stock, including 50 2 and 3-bed bungalows and semi-detached properties in South Gloucestershire. In this project, 50 off-gas grid properties were switched from electric storage heating or oil-fired systems to Daikin air source heat pumps to yield energy bill savings and improve the thermal comfort of the homes

SPECIFICATION

Depending on the size of the properties, 5kW or 7kW Daikin Altherma Monobloc systems (air source heat pumps) were installed as a new heating source along with 200-litre Daikin hot water cylinders. As the heat pumps are low temperature units, the systems have optional back-up heaters which raise domestic hot water to the required temperature, and can supplement heat pumps at times of extreme heating demand

BENEFITS

Heating bills for Merlin's tenants, who are often over the age of 55, were forecast to fall by three-quarters, from £80 per week to just £20.

At the time, the rates of the Renewable Heat Incentive policy meant that Merlin Housing could recuperate much of the costs of installation over 7 years subsequent to the retrofit.

"We're getting feedback on the tenants' costs and it's pointing to exceptional savings in some cases. The Daikin Altherma Monobloc will certainly help to alleviate the risk of fuel poverty for these people...the tenants seem very pleased with the new systems, which they are finding very simple to use" ***Tim Grimshaw, Special Projects Surveyor (Merlin Housing)***

NEW BUILD SCENARIO

Key Input:

- Increase in the number of social homes built each year to 50,000 from 34,500
- Build these homes to a space heating requirement of 40 kWh/m^2/year instead of the current 54 kWh/m^2/year.

Key Output:

Emissions fall, but not enough to reach the original 80% reduction target or the net-zero target.

The scenarios assessed in previous sections focus on the existing housing stock. Whilst these properties make up the greatest proportion of homes in the social housing sector, it is anticipated that the number of new social homes will increase over time. If we continue to build at current standards, these homes will cause emissions from buildings to rise, and homes will require retrofitting in the future to achieve the emissions reduction target. It is therefore vital that new builds strive to achieve the highest standards and do not increase emissions on top of the current housing stock.

This section considers the effect of increasing the rate at which homes are built, the heating systems installed and the thermal performance achieved. Here we assume the number of social sector new builds per year increases from 34,500 in the baseline to 50,000. This baseline reflects the average number of socially rented homes per year from 2012 – 2017 (34,500)[33] and increases to 50,000 in line with the Government's aim to tackle the housing shortage in England whilst providing more properties of every tenure type, including social housing, by 2030. The modelling assumes homes are built to at least EPC Band C, with proportions also being built to Bands A and B.

Social housing providers often procure homes through Section 106, which means they have limited control on the standard of the home which is built by a private developer. This means that most new property additions to the sector are built at current building regulations.

The current space heating regulations for new builds in the UK is 54.26 kWh/m^2/year.[34] The Government has committed to consulting on the standard of new build homes under the Building Regulations Part L review. Below we have modelled a slight reduction in space heating demand to 40 kWh/m2/year[35] but maintaining current heating solutions i.e. majority of homes heated with gas boilers.

Under this scenario energy consumption falls to 50.05 TWh and emissions fall to 6.77 $MtCO_2e$ by 2050 (as shown by Figures 12 and 13 respectively), which is significantly higher than both the 80% emissions reduction threshold and the net-zero target by 2050. This is linked to a large proportion of the emissions in 2050 coming from gas boilers under this new build scenario. This scenario is unambitious and contributes very little in terms of emissions reduction. There is therefore a need to further improve the thermal performance of new homes whilst reducing fossil fuel usage and/or combine carbon reduction scenarios to meet the target.

Total Consumption: New Build Scenario

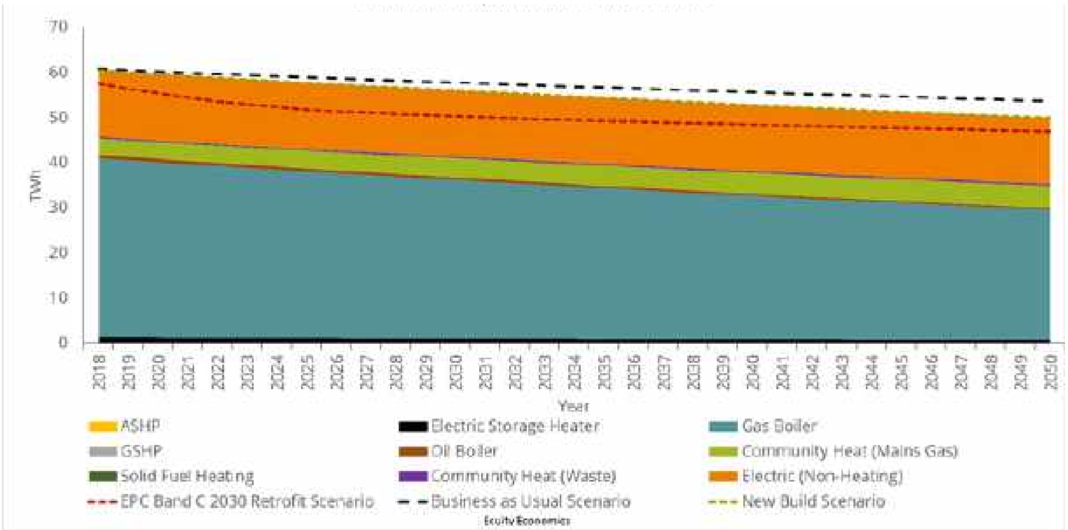


Figure 12 - Total consumption (TWh) projection based on the new build scenario

Social Housing Emission Projection: New Build Scenario

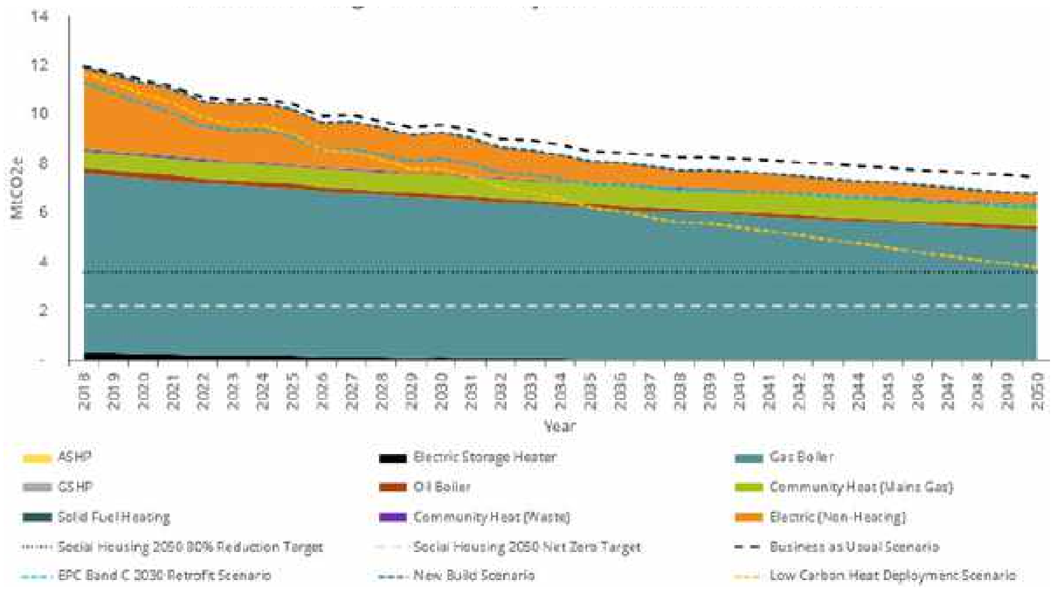


Figure 13 - Total emissions ($MtCO_2e$) from social housing projection based on the new build scenario

Whilst we see an urgent need for strong regulation to play a role in driving down emissions from new housing, there are numerous case studies of social housing providers choosing to build new homes to a standard which goes beyond the minimum building regulations without regulatory intervention. For example, there are multiple Passivhaus standard developments in the social housing sector. It is clear from the above scenario that small improvements in thermal performance in the new build sector will not be sufficient. As such, we have modelled a combination scenario which seeks to understand whether a mixture of the above scenarios will achieve the net-zero target.

PROPERTY CHARACTERISTICS:

WIMBISH PASSIVHAUS SCHEME. 14 HOMES FOR RENT - UK'S FIRST RURAL SOCIAL HOUSING PASSIVHAUS SCHEME

TECHNOLOGIES USED:

HEAT RECOVERY	✓
SOLID WALL INSULATION	✓
MONITORING EQUIPMENT	✓

LOCATION: BOSTON, LINCOLNSHIRE

Hastoe Group

THE PROJECT

Hastoe housing association's development at Wimbish, Essex, was the UK's first rural social housing Passivhaus scheme.

Since completion in 2011, Hastoe has worked with the University of East Anglia to monitor the performance of the homes and ensure they are still making the energy and fuel bills savings intended when they were completed.

SPECIFICATION

The construction of a Passivhaus requires incredibly low air tightness requirement of 0.6 air changes per hour (Building Regulations requires 5 air changes per hour). Mechanical ventilation and heat recovery (MVHR) is needed to change air in the property and keep heat within the homes.

The dwelling forms have been kept deliberately simple to avoid thermal bridging risks, and porches, meter boxes and brise soleil are all independently supported to avoid penetrating the insulation overcoat. East west orientation of the blocks facilitates passive solar gains, with careful attention to shading to avoid summer overheating.

Learnings from this first Wimbish scheme helped Hastoe to complete a second Passivhaus scheme in the village in 2016, as well as 100 more across Rural England. The knowledge from this evaluation - that Passivhaus really works over a sustained period - gives us confidence to build more in other villages across the country.

BENEFITS

At the latest assessment in 2018, the Wimbish Passivhaus homes were still recording exceptional performance of around £130 per year for houses and £62 per year for flats. That compares to an average annual UK gas bill of £676 per year. The exceptionally high energy efficiency standard cuts fuel poverty for social housing tenants, keeping more money in their pockets. It also substantially reduces overall carbon emissions.

One resident of Wimbish said: "We have been very comfortable and have enjoyed a constant pleasant temperature. The brise soleil has done its job beautifully, as have the exterior window blinds. It is a pleasure to have such large windows and triple glazing is most effective both in terms of temperature and noise levels." "Utility bills are much lower, even water bills have been reduced. Gas is very low"

COMBINATION SCENARIO

Key Input:

- EPC Band C by 2030 for all social homes from a retrofit programme
- Increase in new build numbers to 50,000 from 34,500
- Improvement in the space heating requirement in new builds at 40 kWh/m2/year instead of 54 kWh/m^2/year
- Oil boilers and solid fuel heating to be phased out by 2026
- Gas boiler usage to fall by 60% by 2050
- No 'inefficient' electric heating by 2050

Key Output:

Emissions fall enough to reach the original 80% reduction target, but not enough to reach the net-zero target level.

The Combination scenario represents a mixture of the scenarios modelled previously - it runs all the carbon reduction strategies for these scenarios simultaneously. As noted above, it is likely that a combination of energy efficiency and low carbon measures is needed for existing buildings given the diversity of the building stock. Moreover, none of the single scenarios detailed above are able to achieve the 80% reduction threshold in isolation, let alone the net-zero target.

The consumption and emissions levels for this scenario are illustrated in Figures 14 and 15 respectively. Consumption levels fall to 31.54 TWh and emissions are lowered to 3.19 $MtCO_2e$ by 2050, which falls below the 3.58 $MtCO_2e$ threshold which denotes an 80% emission reduction. Per property, consumption has reduced to 6,308 kWh and emissions to 0.64 tCO_2e each year.

This means that a combination of scenarios; retrofitting, moderately raising the standard of new builds and mass deployment of low carbon heating options can successfully reduce carbon emissions from the social housing sector significantly. However, emissions under this scenario still do not fall sufficiently to reach the net-zero target level, meaning that further measures will need to be introduced in social housing if the legally binding target is to be achieved.

Total Consumption: Combination of the Scenarios

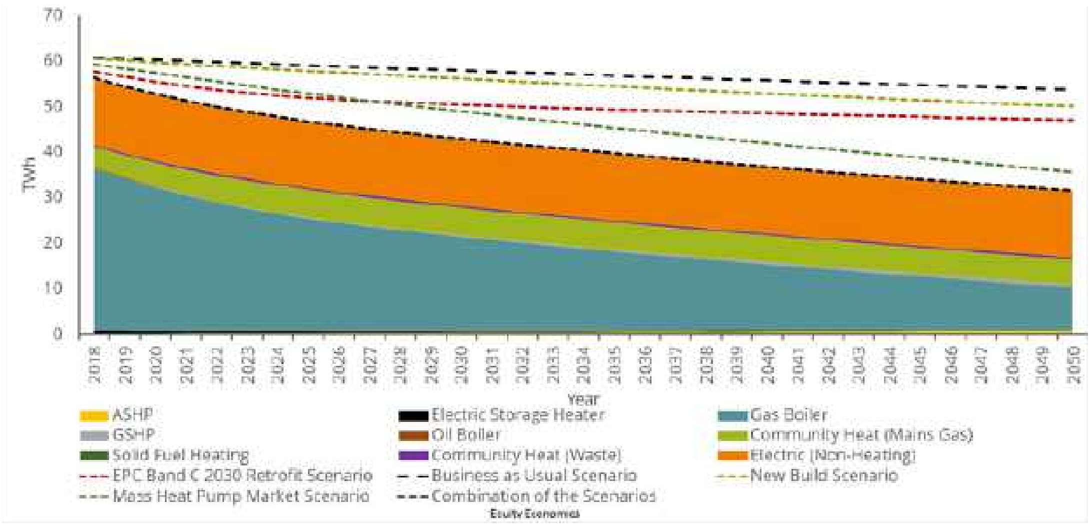


Figure 14 - Total consumption (TWh) projection based on the combination of scenarios

Social Housing Emission Projection: Combination of Scenarios

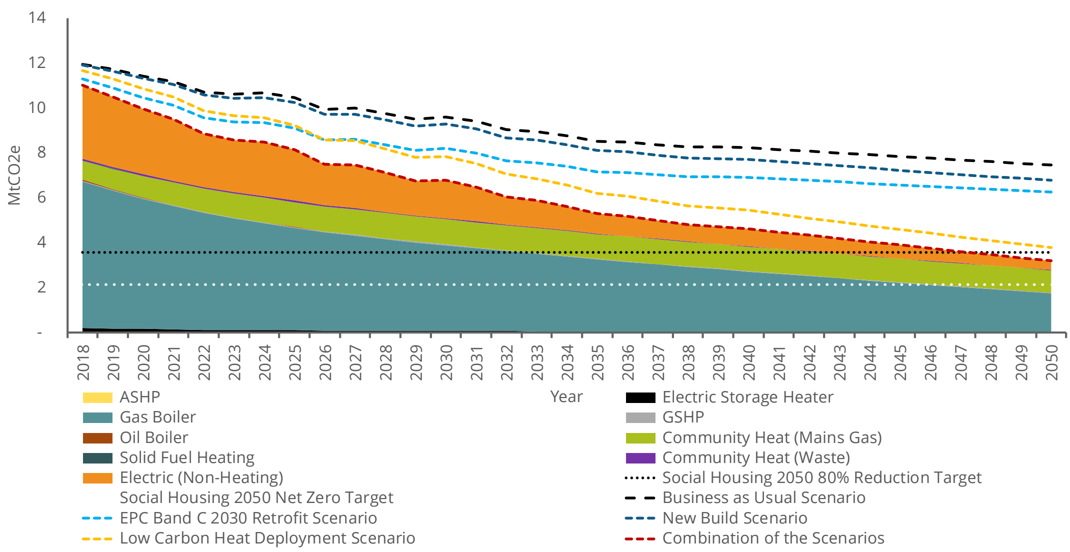


Figure 15 - Total emissions ($MtCO_2e$) from social housing projection based on the combination of scenarios

Figures 16 and 17 show the proportions of houses by EPC Band and heating method in 2050 under this combination scenario. Under this scenario, it is assumed that just over 1 in every 2 homes would have a low carbon heat source (for illustrative purposes a heat pump has been used) and nearly a quarter would be EPC Band A. As the proportion of houses in Bands A, B and C increases, the proportion of homes with communal heating also increases, reaching just under 16% by 2050. The Clean Growth Strategy highlighted that heat networks are likely to play an increasingly important role in heating buildings, and in each pathway modelled within the Strategy there was an assumed 17% proportion of heating in buildings assigned to heat networks by 2050.[36] Therefore, the modelling in this report reflects a similar projection.

Proportions Of Houses By EPC Band 2050: Combination of Scenarios

Figure 16 - 2050 proportions of houses in each EPC Band for the combination of scenarios

2050 Heating Method Proportions Combination of Scenarios

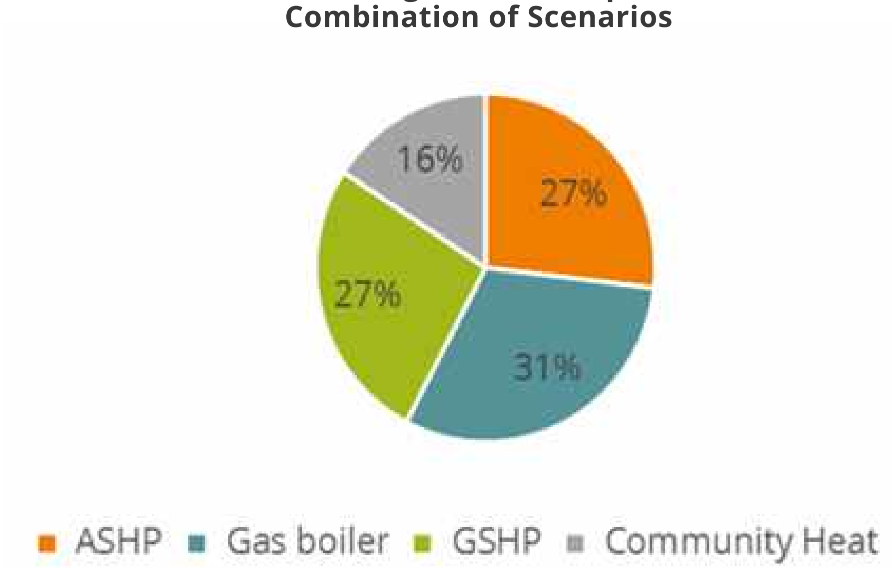


Figure 17 - 2050 heating method proportions under the combination of scenarios

As noted above, this combination scenario will not achieve the net-zero target. Our modelling suggests that net-zero is unlikely to be achieved without unprecedented changes over and above the scenarios we have projected. In addition to the changes to fuel mixes, there is also a need to consider storage and smart technologies to reduce demand at peak times. Whilst our modelling has not attempted to forecast the uptake of smart solutions, demand response and storage, these are likely to play an increasingly important role as we see increased deployment of electric heating.

FURTHER AMBITION SCENARIO

Key Input:

- EPC Band C by 2030 for all social homes from a retrofit programme,
- Increase in new build numbers to 50,000 from 34,500,
- Improvement in the space heating requirement in new builds in line with the Future Homes Standard at 15 kWh/m2/year instead of 54 kWh/m2/year
- Oil boilers and solid fuel heating to be phased out by 2026,
- Gas boiler usage to fall by 92.5% by 2050,
- No 'inefficient' electric heating by 2050.

Key Output:

Emissions fall Net-zero sufficiently in thjs sector to allow net-zero by 2050 overall

The Further Ambition scenario reflects a pathway where emissions reach a level in line with the illustrative net-zero target. As previously proposed, a multifaceted approach will be needed targeting existing and new homes from both a thermal performance and heat perspective.

The CCC have recommended that a space heating demand of 15 – 20 kWh/m2/year should be considered for new homes[37] which would put the UK at the forefront of international building standards in line with the Future Homes Standard. Our new build standard above demonstrates that a moderate improvement in energy efficiency will not be sufficient and that we must go further in terms of demand reduction. The building regulations review in 2019 offers a unique opportunity to drive up performance and mitigate the need to retrofit homes at a significant cost in the 2020s and 2030s.

For this to happen, new builds must be built to the Future Homes Standard, providing "world-leading" levels of energy efficiency as soon as possible. To reflect this, the analysis uses an annual space heating demand of 15 kWh/m2/year (the lower end of the range recommended by the CCC). Building new homes to this tighter space heating requirement, whilst ambitious, is achievable with many projects across the country achieving and exceeding this level of air tightness.

In addition, the Future Homes Standard will ensure that no fossil fuel heating systems are installed in new builds. The accelerated transition to low carbon heating is reflected in the Further Ambition scenario through a quicker move to low carbon heating methods such that, in addition to the combination of scenarios, gas boilers reduce by a further 32.5% points, with these houses switching to air source heat pumps.

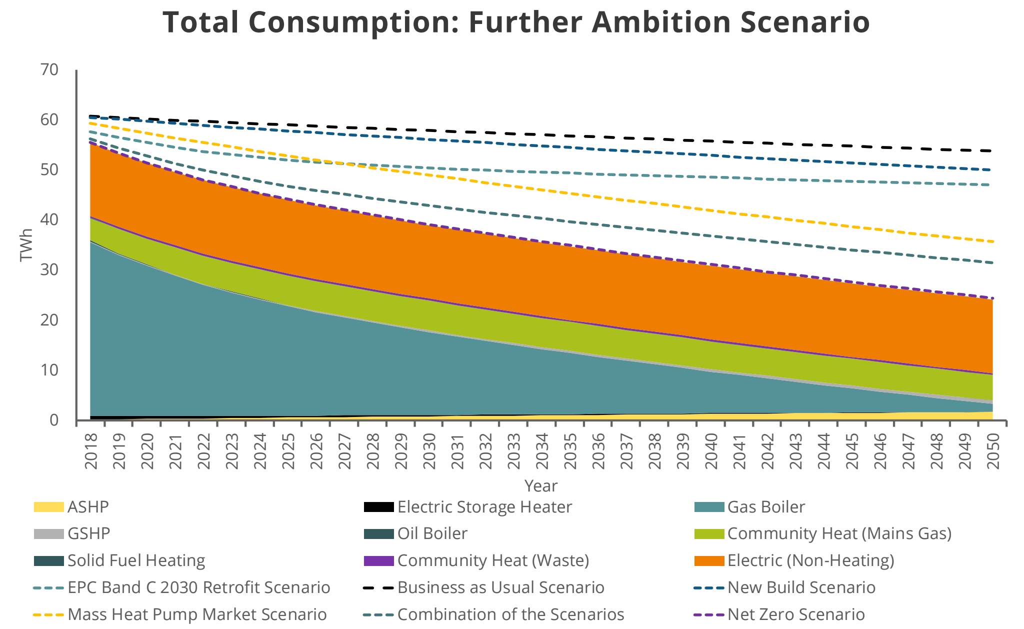


Figure 18: Total consumption (TWh) projection based on the net-zero scenario

Figure 18 shows the sharp reduction in consumption under this Further Ambition scenario. Here total consumption is 24.45 TWh in 2050. This translates to a fall in emissions to just below the net-zero target for the social housing sector (see Figure 19).

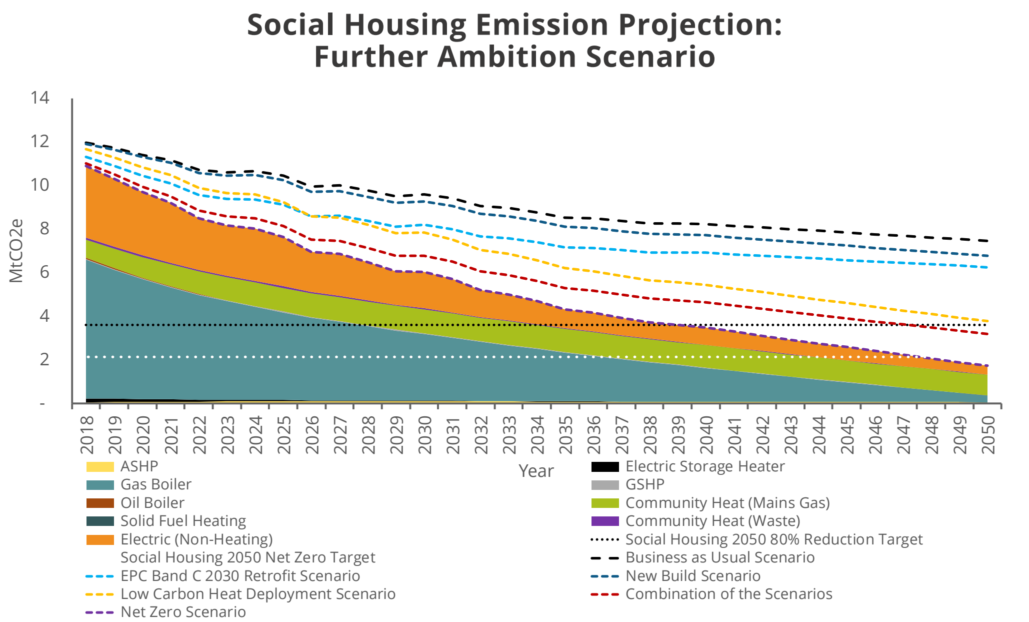


Figure 19: Total emissions ($MtCO_2e$) from social housing projection based on the net-zero scenario

The emissions in this scenario fall to 1.72 $MtCO_2e$, which is below the net-zero target of 1.79 $MtCO_2e$. The modelling carried out for this report emphasises the scale of the change which is needed to achieve emission reduction in the social housing sector. This includes the predominant heating fuel needing to shift away from natural gas to low carbon alternatives, as shown in Figure 20. Note that ASHP, GSHP are proxies for low carbon heating solutions and community heating is technology agnostic so can incorporate a multitude of low carbon technologies.

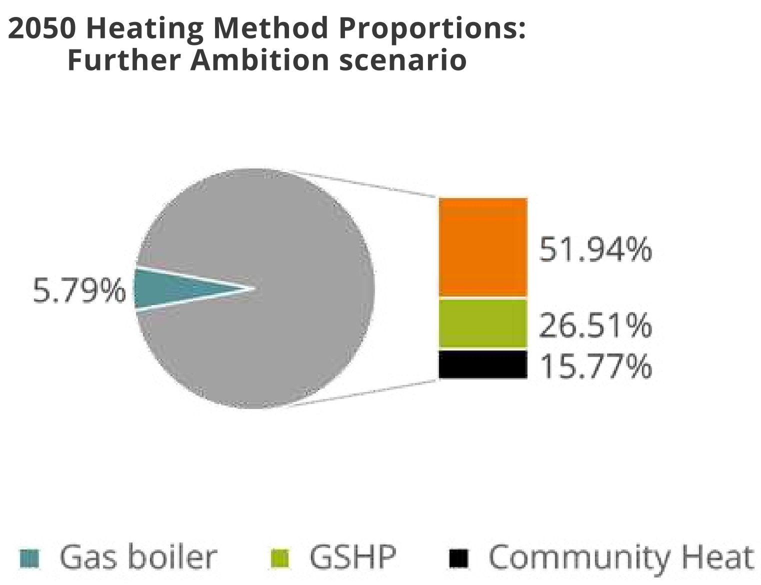


Figure 20: 2050 heating method proportions under the Further Ambition scenario

Widespread adjustments are needed, with tight standards for energy requirements in new builds (to a space heating of 15 kWh/m2/year), a programme of retrofit across the current stock, an almost complete shift to low carbon heating methods, as well as an increase in the development of new build homes. This array of changes needs to happen in combination and the time to implement these is now. Any further delays will only add to the already very difficult challenge of decarbonising the social housing sector.

LOCATION: WEST BERKSHIRE

TECHNOLOGIES USED:

SMART CONTROLS ✓
AIR SOURCE HEAT PUMP ✓
HEAT EMITTERS ✓

THE PROJECT

Sovereign is one of the largest housing associations in the country, providing quality, affordable homes, within strong and sustainable communities, for people priced out of the housing market. Modernising its homes and making best use of technology to help residents heat their homes for less is one way Sovereign is meeting its commitment to long-term investment and creating great places for residents to live.

As a result, the association recently carried out an Air Source Heat Pump trial that is producing some impressive early results to build on in the future.

21,000 of Sovereign's 58,000 homes are off gas, so it's a strong supporter of the affordable warmth that heat pump systems can provide for these homes.

It has already installed over 800 such systems but wanted to further develop this innovative approach. So, it decided to carry out a detailed trial using Mitsubishi Electric Ecodan Air Source Heat Pumps, combined with smart control and remote access so that performance could be measured and monitored more effectively.

SPECIFICATION

The trial involved replacing old storage heater systems in six 1970s one-bed and two-bed bungalows for older people in a small village in West Berkshire.

Supported with funding from the domestic Renewable Heat Incentive, the study focused on carbon reduction, energy efficiency and looking at real world performance and operation of the systems. The aim was to provide insight to inform the association's financial modelling requirements for future off gas project planning.

The association's long-term vision is to use a balanced technology approach, which focuses on gas and electric heating rather than solid fuel or oil. For off gas grid houses, bungalows and maisonettes, the preference is to fit ASHP systems.

The aim is to provide residents with energy-efficient homes that are more affordable to run, warmer and have less impact on the environment by reducing carbon emissions. This project's results so far suggest this is one way to achieve that.

BENEFITS

Early results have been impressive with the following headline figures after the first eight months:

- better energy performance – the RdSAP and EPC figures have gone from 52 (Band E) to 71 (Band C)
- lower fuel bills – bills are now around 57% lower than previous levels, making the homes far more affordable for residents
- warmer homes – residents' own warmth ratings have significantly increased: from 1/5 to 5 out of 5

Micky Cummins, Sovereign's Commercial Director said, one of the residents told us, "It's absolutely amazing, 10 out of 10".

Achieving Net-Zero

THE ANALYSIS CARRIED OUT SHOWS THE SCALE OF THE CHALLENGE IN MEETING NET-ZERO.

The social housing sector exists to provide housing to people of low incomes or those with particular needs. As such, they have a long-term interest in the affordability and sustainability of their stock and the well-being of their tenants. They regularly invest in the maintenance of their existing properties and the acquisition of new homes to meet demand. Despite this commitment and many in the sector initiating innovative projects to drive up the performance of their stock, there is unlikely to be a universal shift without the right market signals in place. Thus far we have discussed the technology mix and performance requirements which could help the sector meet the net-zero target. In this section, we outline the policies which will enable this transition. Without sufficient long-term and ambitious sector specific targets alongside stable policy and financial support mechanisms, we do not foresee the sector delivering the required emissions reduction by 2050. This section considers how prepared the sector is, and what changes are required from both the Government and providers to achieve net-zero.

A HOLISTIC APPROACH

If the UK is to achieve net-zero by 2050, widespread deployment of energy efficiency measures and low carbon heating in the UK's buildings is essential and the social housing sector will be key to the success of any strategy.

The BEIS Select Committee's Energy Efficiency: Building towards net zero report, published in summer 2019, commented that although 'the Government wants the social housing sector to be a "flag bearer" for energy efficiency standards', it has so far 'failed to set out a delivery mechanism for the sector'.[38] There is growing consensus among stakeholders that more needs to be done by government more quickly, and there is an appetite for a market framework that delivers energy efficiency and low carbon heating across all sectors. The availability of funding alone will not be sufficient to drive largescale change but similarly regulations without financial support will risk quality. The Government must consider how the whole suite of support mechanisms, nudges and regulation work together to drive improved thermal performance and the uptake of low carbon heat.

Ensuring that there are robust and ambitious frameworks in place across the whole housing market as well as clear targets for the social housing sector will encourage economies of scale and allow providers to plan renovations and investments over the long-term. The chopping and changing of policy such as the Zero Carbon Homes policy has not been helpful for this industry and it is important that this is avoided in future. Stability is key for investment in the housing industry if it is to contribute to meeting the net-zero target.

Existing market frameworks encourage social housing to be affordable, a crucial aspect of this sector which is essential to uphold. However, more importance should be placed on the quality of the asset itself, particularly its energy performance, and the value of this should be better reflected in the property's price.

The analysis conducted in this report has shown that if the current trend of gradually reducing emissions from the social housing stock continues, (Business as Usual Scenario) then by 2050 emissions will not even reach an 80% reduction compared to 1990 levels let alone the net-zero target legislated in 2019. **The Further Ambition scenario reflects a pathway where emissions reach a level in line with the net-zero target**. This requires a holistic approach which means;

- retrofitting existing homes to EPC Band C by 2030,
- raising standards of new builds to the Future Homes Standard providing "world leading" levels of energy efficiency at space heating demand of 15 kWh/m2/year and without fossil fuel heating systems, and
- accelerating the development of the low carbon heat market for existing homes with gas boilers market share reducing further.

For the average household to meet the requirements in energy consumption and emissions for the target level, it would mean consumption per household of 4,833 kWh and emissions of 0.344 tCO_2e. For the illustrative net-zero target to be met, our analysis suggests that around 75% of social housing will have a low carbon heating system, such as a heat pump, with the rest mainly served through heat networks and a minor share of gas boilers (6%) still being used. In addition, just over a quarter of homes would need to be EPC Band A and none should be below Band C.[V]

A key challenge as we transition to low carbon heating is how to ensure that installers are equipped to support the transition. The transition is likely to involve (re)training and may also require important changes to standards, assessment and enforcement to ensure all installations are carried out in alignment with a clear framework. Training our heating installers will provide them with the skills and knowledge to install and service a mix of heating systems, thereby positioning them within a much larger market. The Government has committed to a consultation on skills and training in 2019.

REGULATION AND STANDARDS

SETTING CLEAR LONG-TERM TARGETS

The Government has expressed its desire for the social housing sector to be a "flag bearer" for energy efficiency standards and our research confirms that the sector is willing to act as such however, a clear trajectory and policy framework for the sector is required if net-zero is to be achieved.

Our analysis shows that retrofitting existing homes to at least EPC Band C is essential if net-zero is to be achieved. The existing EPC Band C target should therefore be legislated to ensure it is delivered and not disregarded by any subequent governments.

The Further Ambition scenario models an accelerated transition to low carbon heating methods, such that, in addition to the higher new build standards and increased retrofit rates to EPC Band C, gas boilers reduce by a further 32.5% as homes switch to heat pumps.

The mass market growth of low carbon solutions and recognising their importance in decarbonisation is key. A range of low carbon solutions must be available as the most suitable solution will be dependent on the characteristics of the home, occupant and location. However, setting clear longer-term targets beyond 2030 should be considered to drive greater uptake of low carbon heat. There needs to be a phase out of fossil fuel heating in existing social housing properties, starting from today. To help achieve this, a clear signal should be sent to industry by the introduction of a deadline. This will allow housing providers to better plan works and reduce the risk of unintended consequences which could be associated with taking a shorter-term approach. Setting a deadline and outlining a roadmap for the decarbonisation of heat in social housing, including an end date for the use of fossil fuel heating in existing homes and implementing the Future Homes Standard to ensure no new builds are installed with fossil fuel heating would be helpful.

GOING BEYOND THE DECENT HOMES STANDARD

The Decent Homes Standard of 2006[39] set a new standard for social housing including requiring effective insulation and efficient heating. It also required key building components to be in a suitable state (do not need replacing or a major repair) including external walls, central heating boilers and storage heaters. Homes with a Standard Assessment Procedure (SAP) (using the 2005 framework) of less than 35 were deemed unsuitable for human habitation. The introduction of this standard did lead to improvements in social housing stock performance. However, many social housing providers feel that a new standard, which sets higher ambition than the Decent Homes Standard and is more representative of modern climate change targets would be helpful for the sector and its tenants.

In March 2019, the Homes Fit for Human Habitation Act[40] came into force having been successfully taken through the Commons by Karen Buck, MP and through the Lords by SEA President Lord Best. The Act aims to ensure that rented houses and flats are 'fit for human habitation', which means that they are safe, healthy and free from things that could cause serious harm. If they are not, then tenants can take their landlords to court to get them to carry out repairs or pay compensation. New tenancies must comply with the requirements of the Act now and those in existence must comply by March 2020.

The Act adds to the requirements of the risk-based housing health and safety rating system (HHSRS), which was implemented as part of the Housing Act 2004. Under the HHSRS, a decent home is free of category 1 hazards, and the existence of such hazards should be a trigger for remedial action. However, it is important to note that HHSRS is a risk assessment procedure and does not set a standard.

An adapted and updated Decent Homes Standard should be introduced, which more accurately reflects the challenges in the industry today and the net-zero target. This would help to ensure that homes are highly energy efficient and have low carbon heating systems, provided sufficient funding is also in place. This standard should be aligned with the Future Homes Standard to ensure that homes are future-proofed.

BUILDING REGULATIONS

The 2019 Building Regulations review presents a substantial opportunity to drive a step change in the performance of our building stock. As highlighted by the analysis, moderate improvements in thermal efficiency will not be sufficient to meet the net-zero target. The Further ambition scenario requires new builds be built to the Future Homes Standard, providing "world leading" levels of energy efficiency at space heating demand of 15 kWh/m2/year and without fossil fuel heating systems. The SEA believes that the social housing sector can and should lead the way by ensuring that any new builds are highly energy efficient and have low carbon heating systems installed as standard. **This is in line with the Committee on Climate Change's recommendations[41] and the 'Future Homes Standard,' which will mandate the end of fossil fuel heating in all new build properties. The SEA believes this should be implemented in the upcoming iteration of Building Regulations.**

In order to meet the net-zero target by 2050, and the Government's Grand Challenge Mission to halve the energy use of new builds by 2030, there needs to be deep increases in energy efficiency in new build social housing properties.

Without the regulations to mandate that these minimum standards are met, we will continue to see a piecemeal approach to higher standard developments which will inevitably mean that the net-zero target is not achieved. Regulation is a key step to reach net-zero in social housing, and it is important that social homes built by social housing developers as well as those bought from other sectors in Section 106 are monitored. New build homes need to be specified to higher standards and also built to those standards. **Closing the performance gap should be considered a priority to ensure that homes actually perform to their specified standard** if net-zero is to be achieved in practice as well as in theory.

FINANCIAL MECHANISMS

ACCESS TO FINANCE

Social landlords have control over whole estates, access to capital and approach investment in terms of coordinated stock upgrades. Social housing providers recognise and understand the need to improve the energy performance standard of their stock, however there is often limited resource to do so. The social housing sector is under pressure to build new homes, and to upgrade their existing homes but they operate within a rent-setting regime and have limited financial resources. There are currently limited public funding options for improving the energy performance of social housing and providers are often faced with competing priorities for budget allocation. This includes building maintenance issues and fire safety particularly following the Grenfell tragedy. There is therefore concern that the investment required to upgrade stock could leave some social housing providers in breach of their financial regulations.

For this reason, it is important that the Government provides specific funding for energy efficiency upgrades to address funding issues in the sector. There must be sufficient resource for social housing providers to improve the quality of their homes without compromising their affordability or safety. A dedicated fund for improving the energy efficiency of social housing, in line with all properties in this sector reaching EPC Band C by 2030, would support achievement of net-zero in the sector.

There are restrictions in place on how much social housing providers can increase their rents meaning that budgets are currently constrained. However, they have long term asset management budgets to upgrade properties.[42] Social housing providers have highlighted that changes to funding in the past have led to a reduction in investment in retrofit of existing properties. This can also impact resources with fewer members of staff able to focus entirely on retrofit work.[43] If a motivated sustainability or energy manager is lost, this can often hamper projects and slow progress.

There is evidence that every £1 spent on keeping homes warm can save the NHS 42p in health costs[44] therefore social housing providers would be contributing to societal benefits by undertaking this work and this should be acknowledged. This is something government should recognise in its policy making.

Widespread schemes to improve the energy efficiency and heating systems in social housing properties need support and long term commitment from government to raising standards. There have been several trials of Passivhaus (see case studies throughout this report) in the social housing sector which demonstrate the sector's willingness and ability to carry out largescale improvements. However, in most cases previous trials have not been deemed cost-effective and therefore the Passivhaus standard was not rolled out more widely. To overcome this barrier, funding from central government for low carbon solutions and measures that improve a property's energy performance, would be helpful.

It has been highlighted in recent government research[45] that some larger social housing providers have dedicated energy efficiency budgets, resulting in these improvements falling into a different category to routine maintenance operations (which are more focussed on aspects such as new kitchens and bathrooms). Having different budgets can be beneficial as energy efficiency upgrades, including installation of a new heating system, can be carried out more quickly and systematically by targeting the worst performing (lower EPC) buildings first. However, there can sometimes be challenges with gaining access to the property when there are multiple upgrades happening at different times, for example energy efficiency upgrades being carried out separately to bathroom and kitchen upgrades. There is a need to ensure a joined-up approach between these different departments to improve efficiencies.

For some smaller housing associations, smaller budgets mean that the focus is on emergency repairs and short-term essential maintenance. It is important to also ensure that funding aligns with retrofit cycles and the practicalities of carrying out the work such as weather conditions. Only around half of social landlords have internal budgets available to carry out insulation retrofit works and those without internal funding streams tend to carry out works based on the availability of funding rather than in a structured way to meet a target EPC rating.[46] It would be useful to provide a framework, as well as dedicated funding, that allows associations to plan and budget for a longer-term approach to improving the energy performance of their properties.

The proposals on energy efficiency within the recent Green Finance Strategy[47] were welcomed by the social housing sector, particularly the funding for innovation and whole house retrofit. However, there is scope to take the Strategy much further and introduce a range of packages that are attractive to landlords and tenants in the social housing sector. This includes considering the introduction of 'warm rent' where slightly more rent is charged for more efficient properties.

RENT CALCULATIONS AND ENERGY COSTS

Market barriers, specifically split incentives, impede energy efficiency renovations across the building stock. This is particularly apparent in the social rented sector because those who benefit from improvements (the tenants) do not pay for the renovation. **We recommend that an assessment of the range of solutions to address split incentives** is undertaken to recognise the long-term benefits of energy efficient housing whilst not compromising the affordability of the home for the occupants overall. Below we outline some of the options available.

Some housing associations already **take into account energy efficiency when setting rent structures for new acquisitions and new build properties.** For example, a point system has been used by Almond Housing Association to calculate the rental value which takes into consideration the benefits associated with new developments or major refurbishment where the average energy efficiency rating over all properties is 80 or above.[48] However, the impact of energy efficiency in this overarching rental calculation is likely to be minimum and is not applicable to existing homes and cannot be increased as a result of renovation works. However, in the Netherlands, through a bill approved in March 2011, the rental price evaluation system incorporates energy performance. This is used to determine the rental price for houses and apartments in the social housing sector and offers landlords the opportunity to increase the rent if the score on the EPC improves (ensuring that the benefit outweighs the rental price increase), thus incorporating energy efficiency in the evaluation criteria.

It is important to note that under the current social housing regulation an increase in rents or a separate energy efficiency related charge is not permissible. To overcome this, Energiesprong has introduced energy performance guarantees with tenants paying a fixed monthly/annual energy service plan charge which entitles them to a defined annual energy allowance. This results in an additional yet secured cash flow for the housing provider.[49] The approach means that industry takes the responsibility for the long term performance of the refurbishment which allows the provider to **offer tenants an energy service plan, giving them an energy allowance for a fixed monthly fee.**

Government should however consider introducing the ability for landlords to provide a 'warm rent' tenancy, where slightly more rent is charged for more efficient properties thus reflecting the value, driving demand and raising awareness of improved performance. The extra cost associated with a 'warm rent' service charge is remediated by the tenant through lower energy bills as a result of increased property efficiency. This is similar to the above Energiesprong model, however the energy performance impacts the rental value and can be applied to any home. This addresses the issue of split incentives within the sector and recognises the long-term benefits of energy efficient housing whilst not compromising the affordability of the home for the occupants overall.

Rents can also be used to drive energy efficient behaviour. Holistic rent arrangements which include heating costs could be adopted. These are typically used in Western or Northern countries (e.g. Germany and Sweden) but can be found in student or professional lettings in the UK. A consequence of this approach is that the consumer has little incentive to conserve energy as they are not responsible for paying the bills.[50] Monitoring energy use in these circumstances can help to overcome user-related split incentives. A gross warm rent model with direct feedback can allow landlords and tenants to agree on a set of comfort conditions (e.g. indoor temperatures). If the tenant consumes less than the agreed energy usage, they receive compensation but if they exceed the threshold, they pay the additional energy costs. This could encourage energy efficient behaviour.

Important to consider in the transition to low carbon heating is the relative levies and charges placed on electricity bills compared to gas. By 2050, gas is considered to be a more carbon-rich source of energy than electricity if the decarbonisation trends in electricity continue. The charges placed on electricity include environmental and social obligations and this results in electricity bills being more expensive than their gas counterparts. Therefore, low carbon heat sources, such as electric heat pumps, may be more expensive than gas which could act to disincentivise low carbon heating and risks the achievement of net-zero. As recommended by the CCC, **a review of electricity and fossil fuel bills should be carried out to mitigate this risk.**

PROCUREMENT AND DISPOSAL

Current procurement frameworks for social housing include Section 106 of the land use planning system, where private sector housebuilders are required to assign a certain proportion of their new builds for affordable and social housing. Section 106 homes can fall into 3 sections;

1. Social Rent – usually based on 25% of average earnings,
2. Intermediate Housing – which often takes the form of shared ownership lease,
3. Affordable Rent – which is a rent equal to 80% of open market rent.

A high proportion of new social housing is gained through Section 106, with our research indicating that this can be as high as 50%[vi] of a social housing provider's new homes annually. Section 106 provides a good opportunity to procure homes for the social housing market, and these are often mixed with privately rented and owner-occupied homes which creates a diverse community to live in, as recommended by the Decent Homes Standard.

However, there are some concerns about this procurement framework. Firstly, as land is reaching its limits, more and more associations are competing in a very competitive private market for land. This means that social housing providers are regularly outbid by private developers. This then increases the price of the property when built and/or reduces the quality of the home to try to limit costs.

Secondly, there are some concerns about the quality of the homes procured through Section 106 as social housing providers themselves are not responsible for their design or build and have little control on the final as-built quality of the property. Sometimes the concerns over the quality of properties procured through section 106 are so great that social housing providers feel they are unable to use this route to market. To overcome this, **there needs to be higher standards and regulation placed upon private sector housebuilders to ensure they deliver higher quality homes**. The SEA's report, Halving Energy Use of New Homes[51] includes recommendation for raising standards.

In addition, there are concerns surrounding the performance gap of buildings in the UK more generally. The difference between estimated and actual energy usage needs to be closed by focusing on the outcome when new homes are built, not on their initial specification. We recommend that the Energy Performance Certificate (EPC) should reflect the buildings actual performance, to ensure that what is specified is actually installed and any cost-saving changes to building design are reflected in the EPC. Furthermore**, there is a need to ensure better inspection of works to ensure performance post build.**

To assist in closing the performance gap, all new properties should come with detailed information about the products installed, guarantees and maintenance information. The rollout of smart meters which will record the energy use of homes is likely to be helpful in reducing the performance gap, and the Government's smart meter programme should be encouraged in the social housing sector. A property inspection should be carried out after completion to ensure compliance with the energy performance promised at the outset, and monitoring homes procured through Section 106 will help to raise the standard of new builds across the UK. The testing of homes procured by social housing in this way would not only ensure that homes purpose built for social housing are of a high quality but also help to ensure that the performance gap is closed across private sector homes through knowledge spill over.

[vi] This statistic was provided by social housing providers at the SEA hosted roundtable on 2 July 2019.

✓

Social housing providers have indicated that disposal of their stock that is not able to reach EPC Band C cost-effectively, affordably or technically is important to relieve funds for other works and to ensure that tenants are not exposed to unnecessarily high energy costs. However, it is crucial that social housing properties unable to reach EPC Band C are not simply passed onto the private sector with no incentive for the property to be improved. A holistic energy efficiency policy framework is needed to ensure that properties do not fall through the gaps. This type of disposal is undesirable because it allows poorly performing homes to continue to be inhabited, having consequences for occupant's health and finances. It is acknowledged that some exemptions may be needed if it is not possible to improve a property, however there should be a requirement to demonstrate that all practical and cost-effective measures have been completed. In our modelling, we have assumed that demolitions occur for the worst performing properties, but sales are proportional across the social housing stock.

Conclusions and recommendations:

KEY CONCLUSIONS

Conducting business as usual in social housing will not acheive net-zero carbon by 2050

Only a combination of deep retrofit of existing social housing, implementing far higher standards of all new builds and encouraging rapid market growth of low carbon heating systems can be successful in achieving the net-zero target.

Action is required now if we are to achieve net-zero. Recommended actions are sumarised below:

1. REGULATION & STANDARDS

Legislate the EPC Band C target; raising all homes to EPC Band C wherever 'practical, cost-effective and affordable' by 2035 and starting with social housing by 2030. Energy efficiency is the first essential step in creating homes with a low energy demand.

Introduce a new improved 'Decent Homes Standard' for social housing. This is required to reflect the new net-zero target.

Set a clear deadline on the use fossil fuel heating systems in social housing. There needs to be a phase out of fossil fuel heating in existing social housing properties, starting from today. To help achieve this, a clear signal should be sent to industry by the introduction of a deadline.

Implement the 'Future Homes Standard' as soon as possible. This is essential to meet the carbon emissions target and will mandate the end of installation of fossil fuel heating in new build social housing.

2. FUNDING

Provide specific Central Government funding for upgrading energy efficiency in social housing. The Grenfell tradegy and budget cuts have resulted in increased spending on fire safety, and money allcoated for home renovations including energy efficiency and heating system upgrades has been reduced. In line with the BEIS Select Committee recommendations, energy efficiency should have increased funding from Central Government to mitigate this.

Introduce a 'warm rent' option for social housing providers which addresses the issue of split incentives within the sector and recognises the long-term benefits of energy efficient housing whilst not compromising the affordability of the home for the occupants overall.

Ensure that environmental and social obligations placed on energy bills are not disproportionaly placed on certain fuels, particularly where those fuels are lower carbon, as this conflicts with the achievement of net-zero

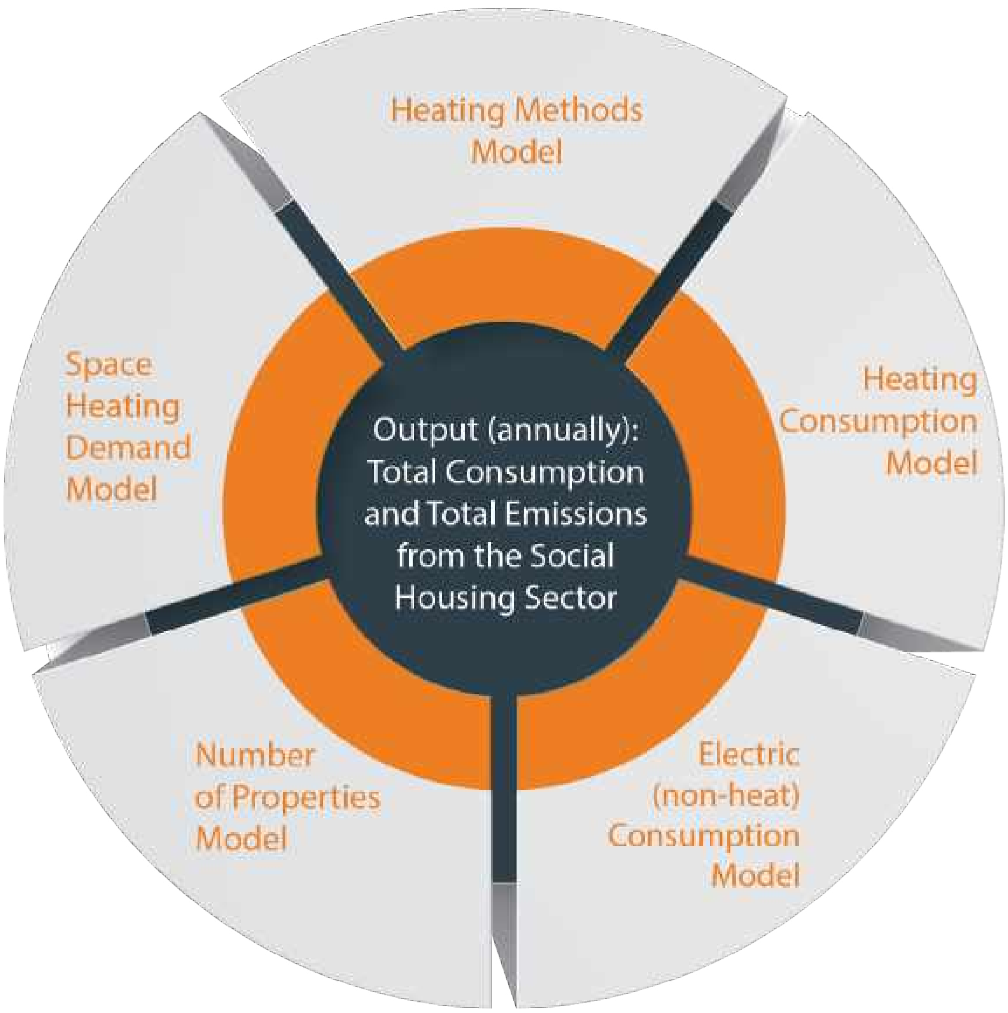
3. QUALITY

Increase monitoring of new build homes and those procured through Section 106 to ensure the performance gap between the design and as-built performance of a home is closed. To achieve this, there should be improved access to redress for properties that do not meet the design standards when they are built.

ANNEX

METHODOLOGY AND DATA ASSUMPTIONS

The graphic below provides an overview of the structure for the modelling used in this report.



EXPLANATION OF EACH MODEL

NUMBER OF PROPERTIES MODEL

Number of Properties Model: this model assumes a stationary total social housing stock of 5 million homes up to 2050. Within these homes there is an ongoing improvement in the EPC Bands of the properties, which is a result of standards of new builds, demolitions and improvements from retrofit.

SPACE HEATING DEMAND MODEL

Space Heating Demand Model: this model is used to adjust the heating requirements for properties which are affected by new build regulations. It represents the fact that over time, as more new build properties are built, the average space heating demand of the housing stock will fall. This is then fed into the Heating Consumption Model as a multiplier for each property type at the applicable Bands.

HEATING METHODS MODEL

Heating Methods Model: this model uses the output from the Number of Properties Model for each year in combination with the proportion of heating methods for each EPC Band to calculate the number of different heating methods by property type and EPC Band yearly. This therefore reflects the shift in heating methods which is likely to occur from the improvement of the housing stock across the time-frame.

HEATING CONSUMPTION MODEL

Heating Consumption Model: this model uses a baseline heating demand across the various fuel and property types. This is then adjusted for the efficiency of the different heating methods that proportionally make up each fuel type and multiplied to calculate the consumption of energy through each of the different heating methods and number of properties in each year.

ELECTRIC (NON-HEAT) CONSUMPTION MODEL

Electric (non-heat) Consumption Model: this model considers the extra electrical consumption that occurs for uses such as lighting, cooking and other appliances across homes. It is simply multiplied by the number of houses to work out the total consumption, which remains constant each year.

OUTPUT

Output: this is where the consumption values from the various models are aggregated and multiplied by the suitable carbon intensities to work out the overall emissions for each year.

MODEL PARAMETERS	VALUE	COMMENT	SOURCE
NUMBER OF PROPERTIES MODEL			
Number of properties	5,000,000	Stays constant across all years.	Live tables on Dwelling Stock, Northern Ireland Housing Market
New Builds	34,500 (per year)	Stays constant across all years. Increases to 50,000 under new build scenario. Average value between 2012-2017 based on data across the countries of the UK and scaled proportionally for any missing points.	NI, SCO, WAL, ENG
Demolitions	8,179 (per year)	Demolitions assumed to take place on lowest EPC Bands each year. Average value between 2012-2017 based on data across the countries of the UK and scaled proportionally for any missing points.	SCO, Social Housing Sales: Demolitions of Social Housing Stock for England
Retrofit	A +1.25, B -26.75, C 280.125, D -91.75, E -116, F -34.5, G -12.375 (number of homes per year)		EPC Open Data

<table>
<tr><td>New Build EPC Band Proportions</td><td>A 1.1%,
B 86%,
C 12.9%</td><td>Calculations based on data and then assumption no social housing new builds below Band C</td><td>Live tables on energy performance of buildings</td></tr>
<tr><td>Number of houses per property type</td><td>Terrace 1,374,714,
Semi-detached 814,438,
Detached 27,291,
Bungalow 501,268,
Flat 2,282,288</td><td>Proportion of property types in England social housing stock scaled up to a UK level (5 million)</td><td>Stock profile</td></tr>
<tr><td>Starting housing profile</td><td><table>
<tr><th colspan="6">Year 0 Houses by Property Type and EPC Band</th></tr>
<tr><th></th><th>Bungalow</th><th>Terrace</th><th>Semi-detached</th><th>Detached</th><th>Flat</th></tr>
<tr><td></td><td>197</td><td>83</td><td>62</td><td>0</td><td>1022</td></tr>
<tr><td></td><td>2441</td><td>6859</td><td>2831</td><td>249</td><td>89226</td></tr>
<tr><td></td><td>160392</td><td>570665</td><td>290433</td><td>7955</td><td>1444132</td></tr>
<tr><td></td><td>301302</td><td>682874</td><td>424118</td><td>13783</td><td>639183</td></tr>
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<tr><td></td><td>2286</td><td>8343</td><td>6917</td><td>1239</td><td>13314</td></tr>
<tr><td></td><td>1349</td><td>6716</td><td>4666</td><td>530</td><td>5738</td></tr>
</table></td><td>Based on data from EPC certificate database and adjusted for social dwellings EPC Bands % from</td><td>EPC Open Data,
Energy Performance - Dwellings</td></tr>
<tr><td colspan="4">SPACE HEATING DEMAND MODEL</td></tr>
<tr><td>Starting space heating demand</td><td><table>
<tr><th>Year 0</th><th>Bungalow</th><th>Terrace</th><th>Semi-det</th><th>Detached</th><th>Flat</th></tr>
<tr><td>A</td><td>145</td><td>98</td><td>101</td><td>130</td><td>171</td></tr>
<tr><td>B</td><td>147</td><td>107</td><td>108</td><td>140</td><td>114</td></tr>
<tr><td>C</td><td>142</td><td>117</td><td>124</td><td>152</td><td>134</td></tr>
</table>
(kWh/m^{2})</td><td>Ecuity calculations</td><td>Ecuity calculations</td></tr>
<tr><td>New build space heating demand</td><td>54.26 (kWh/m^{2})</td><td>Value taken from NHBC building regulations</td><td>NHBC</td></tr>
</table>

HEATING METHODS MODEL

Heating Method Proportions per EPC Band

Heating Method Proportions per Band	A	B	C	D	E	F	G	Overall
ASHP	0.00%	0.58%	0.40%	0.17%	0.53%	0.24%	0.00%	0.40%
Electric storage heater	1.85%	7.58%	8.22%	9.89%	21.79%	49.72%	51.30%	10.38%
Gas boiler	87.86%	56.53%	78.44%	87.72%	74.77%	41.22%	35.06%	80.78%
Gas heat pump absorption	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
GSHP	0.00%	0.00%	0.06%	0.01%	0.03%	0.00%	0.00%	0.03%
Hybrid heat pump gas boiler	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Micro-CHPs (inc Fuel Cells)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Oil boilers	0.00%	0.11%	0.04%	0.10%	0.35%	1.68%	1.95%	0.11%
Hydrogen	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Community Heat (Mains Gas)	6.12%	26%	9.11%	1.73%	0.95%	0.64%	0.00%	6.29%
Bio-LPG	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Solid Fuel Heating	0.00%	0.00%	0.01%	0.20%	1.60%	6.50%	11.69%	0.38%
Community Heat (Waste)	4.07%	9.56%	3.72%	0.40%	0.00%	0.00%	0.00%	1.35%

Ecuity calculations.

EPC Open Data

HEATING CONSUMPTION MODEL

Efficiency of Heating Methods

Efficiency of Heating Methods	
ASHP	170%
Electric storage heater	100%
Gas boiler	92%
Gas heat pump absorption	143%
GSHP	230%
Hybrid heat pump gas boiler	120%
Micro-CHPs (inc Fuel Cells)	75%
Oil boilers	80%
Hydrogen	90%
Community Heat (Mains Gas)	80%
Bio-LPG	85%
Solid Fuel Heating	65%
Community Heat (Waste)	100%

Values taken from various sources

SAP,

Rehva,

Cibse,

Pure Energy Centre,

Senedd

Gas consumption by Band and Property Type

Gas Consumption by Band and Property Type (kWh)	Bungalow	Terrace	Semi-detached	Detached	Flat
A	7442	7252	7445	11304	8707
B	7521	7911	7996	12340	5804
C	7204	8665	9191	13634	6802
D	9025	10172	11029	14497	8525
E	11004	11961	13143	17604	10702
F	12112	12809	14889	24593	13150
G	9421	10643	12591	19588	11065

Values taken from NEED EPC analysis, weighted for social housing

NEED

Electricity (heating) Consumption by Band and Property Type

Electricity (Heating) Consumption by Band and Property Type (kWh)	Bungalow	Terrace	Semi-detached	Detached	Flat
A	0	386	506	4383	0
B	0	386	506	1975	0
C	0	386	506	1790	0
D	0	594	819	1420	152
E	426	1009	1540	2068	758
F	1854	1631	2174	3550	1474
G	4038	2668	3634	5309	2135

Assumed to come from oil boilers. These values are calculated using a combination of proportions from Need, EPC Band heating fuel types and ECUK data for the domestic sector by fuel type

NEED,

EPC Open Data,

UK Energy Consumption

<table>
<tr><td>Petroleum Consumption by Band and Property Type</td><td><table><tr><th colspan="6">Petroleum Consumption by Band and Property Type (kWh)</th></tr><tr><th></th><th>Bungalow</th><th>Terrace</th><th>Semi-detached</th><th>Detached</th><th>Flat</th></tr><tr><td>A</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr><tr><td>B</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr><tr><td>C</td><td>52</td><td>62</td><td>66</td><td>98</td><td>49</td></tr><tr><td>D</td><td>217</td><td>244</td><td>265</td><td>348</td><td>205</td></tr><tr><td>E</td><td>898</td><td>976</td><td>1072</td><td>1436</td><td>873</td></tr><tr><td>F</td><td>3487</td><td>3688</td><td>4287</td><td>7081</td><td>3786</td></tr><tr><td>G</td><td>1401</td><td>1583</td><td>1873</td><td>2914</td><td>1646</td></tr></table></td><td>Assumed to come from oil boilers. These values are calculated using a combination of proportions from Need, EPC Band heating fuel types and ECUK data for the domestic sector by fuel type</td><td>NEED,
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<tr><td>Solid Fuel Consumption by Band and Property Type</td><td><table><tr><th colspan="6">Solid Fuel Consumption by Band and Property Type (kWh)</th></tr><tr><th></th><th>Bungalow</th><th>Terrace</th><th>Semi-detached</th><th>Detached</th><th>Flat</th></tr><tr><td>A</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr><tr><td>B</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr><tr><td>C</td><td>6</td><td>7</td><td>8</td><td>12</td><td>6</td></tr><tr><td>D</td><td>21</td><td>23</td><td>25</td><td>33</td><td>20</td></tr><tr><td>E</td><td>199</td><td>216</td><td>236</td><td>318</td><td>193</td></tr><tr><td>F</td><td>648</td><td>685</td><td>796</td><td>1315</td><td>703</td></tr><tr><td>G</td><td>497</td><td>562</td><td>665</td><td>1034</td><td>584</td></tr></table></td><td>Assumed to come from oil boilers. These values are calculated using a combination of proportions from Need, EPC Band heating fuel types and ECUK data for the domestic sector by fuel type</td><td>NEED,
EPC Open Data,
ECUK</td></tr>
<tr><th colspan="4">ELECTRIC (NON-HEAT) CONSUMPTION MODEL</th></tr>
<tr><td>Underlying Household Electricity Consumption</td><td>2933.4 (kWh)</td><td>Value calculated from ECUK data using the sum of electric consumption for cooking, lighting and appliances (3.02) divided by the number of households (3.03)</td><td>ECUK</td></tr>
<tr><th colspan="4">OUTPUT</th></tr>
<tr><td>Projected Emission Intensity</td><td>Gas 0.184, Electric (varies), Fuel oil 0.268, Bio-LPG 0.37, Solid Fuels 0.362
(KgCO_2e/kWh)</td><td>Emission intensities calculated for values of grid average for the domestic sector.</td><td>Data tables 1-19</td></tr>
<tr><td>2050 Target 80% Reduction in Social Housing Emissions from 1990 levels</td><td>3.6
(MtCO_2e)</td><td>Residential emissions by end user were extracted. Adjusted for the proportion of emissions from social housing.</td><td>UK GHG by end user,
Energy Performance - Dwellings</td></tr>
</table>

ASSUMPTION	RATIONALE
No new builds coming in below Band C	Although new builds in 2018 have had some below Band C, it is assumed that social housing has a higher standard to allow for calculation simplification
Proportion of new builds going into the different Bands remaining constant across time	Future trends in this are extremely hard to predict
Future trends in this are extremely hard to predict	This is based on historic data and although this may change, it could be an increase or decrease. An increase is probably more likely, but to allow simpler calculations the model assumes a constant value
Stock of acquisitions and sales similar in terms of characteristics (no effect on the Bands or across property types) compared to the previous year	This allows the total stock to remain constant without adjustments to the proportions of property types
Demolitions to reduce the stock of the lowest Bands	Some higher Bands are likely demolished, but this is a minority and allows far easier calculations
Constant movement between Bands from retrofit	Constant movement between Bands from retrofit
EPC proportions per property type have been calculated from data for England and Wales, it is assumed this proportion is constant across the whole of the UK	Allows scaling up to UK level, a safe assumption as Scottish and Northern Irish housing will not differ hugely
All social housing retrofits were included on the EPC register between 2008-2016	This allows a number to be placed on the number of retrofits per year
Retrofit has the same proportional effect across all property types	Breaking down the data into smaller samples would have made the findings less reliable to calculate at this level
No petroleum and solid fuel consumption for Bands A and B in social housing	This allows for the phasing out of these fuels across the time-frame
Constant underlying electricity use is the same for all households and matches the national average	This allows for a quick calculation to be made on electric consumption across properties for purposes other than heating

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March 2021

The Role Of Data In Delivering Net Zero Social Housing Retrofit

HOUSING INNOVATION PROGRAMME

CATAPULT Connected Places

Executive Summary

Registered Social Landlords (RSLs) are seen by many policymakers as a potential 'vanguard' for net zero housing retrofit[4]. With a concentrated ownership of homes, capacity to manage large-scale capital projects, and sense of mission, they are seen as being the most likely catalyst for expanded demand.

Furthermore, it is hoped that this new demand could start a virtuous cycle of falling costs, investment in R&D, and real progress towards Net Zero. However, progress by RSLs since that ambition was widely articulated in 2009 has been limited, and surveys of their current plans suggest that whatever constraints have applied over the last decade are still in place.

This report is part of a series of evidence based reports and follows on from our report published in January 2020, Retrofit: Towards A Sector-Wide Roadmap. In our latest research, through a data discovery we investigate the key constraints for RSL's in scaling up net zero housing retrofit and to investigate a key hypothesis identified in the sector wide roadmap, that data is a binding constraint in scaling net zero retrofit.

Presenting the findings from this work, we describe opportunities in the use of data to catalyse growth in deep retrofit for net-zero housing. We also detail three key opportunities for data to support net zero retrofit including:

- Supporting greater ambition: using data to support better measurement of net zero targets (referred to as the 'SAP Hack')
- Believing in the business case: the role of data and standards in evidencing and sharing data on which retrofit technologies actually work
- Improving market visibility and supplier confidence: through use of open data for housing stock and the use of open contract data standards to remove opacity of demand and improve prospecting for deep housing retrofit for potential financiers and suppliers

These opportunities are presented alongside an exploration of the wider constraints to deep retrofit at scale in social housing, insights into the retrofit decision making process and insights into the retrofit data ecosystem.

Contents Page

The Opportunity

Deep Retrofit at Scale, in social housing alone could involve investment in the region of £104bn[2] between now and 2050. An investment of £65bn between now and 2035 has **the potential to create over 40,000 new jobs every year**[3], contributing to economic recovery post-COVID and the government's levelling up agenda. It would also support ambitions for the UK to be a world leader for green technology and finance[4].

Yet, despite the economic opportunity, Deep Retrofit at Scale (DRaS) is not happening. To date, retrofit has been conducted in piecemeal approaches designed to bring the worst performing buildings to intermediate standards (such as Minimum Energy Efficiency Standards). This has led to high volumes of cavity wall and loft insulations with harder to treat properties that require more comprehensive treatments neglected. An impact of this is that the solutions that achieve net zero properties are still poorly understood and the supply chains to deliver them are undeveloped. A good example of this is the 27% of the UK's housing stock with solid walls, where annual installations of solid-wall insulation are currently at less than 15%[1] of the rate required to bring us to net zero. Installations of low-carbon heating lag even further behind, at just 1.5%[2] the required rate.

Growth of uptake of deep retrofit requires:

Through our research we have identified the following four key factors that are fundamental to the uptake of deep retrofit:

1. Government incentives / mandates
2. Understanding the impacts of combinations of technological solutions across different housing types and trust in their long-term suitability
3. Sufficient trusted suppliers who have the technical skills to evaluate and carry out whole-house retrofit
4. Availability of financing models that incorporate the long-term energy savings of whole-house retrofit

Data as a Binding Constraint to Market Growth

There are several barriers currently preventing deep retrofit at scale:

- Lack of demand from householders and landlords;
- Lack of clear and consistent government policy;
- High costs of retrofit;
- Insufficient capability and capacity throughout the supply chain;
- Lack of financing.

These five barriers interact and reinforce each other. Lack of demand means limited market pull for innovative solutions, keeping volumes low and prices high. Government policy could instantly create demand, but there is uncertainty that solutions exist and can be delivered. Better financing could increase take-up, and drive down costs, but there is no clear market pull.

When analysing the demand and supply side as a catalyst for greater investment in deep retrofit, we looked at their needs, and found:

- **On the demand side,** 'confidence that solutions can be delivered', 'information and knowledge', 'a good business case to invest' and 'an offer tailored to their needs' point to **insufficient data about the impacts of deep retrofit solutions and how they apply to existing properties** acting as a constraint on growth.
- **On the supply-side,** 'a sustainable market' and 'information and evidence' highlight **a need for greater visibility to suppliers of the current housing stock and buyers' appetite** for business to enable growth.

The Purpose of This Discovery

The aim of this project was to inform a potential program of work investing in data infrastructure to catalyze growth in deep retrofit.

The key aims for the project were to:

1. **Solve the right problems** - across all parts of the public/private/social sphere, well-capitalised R&D programs have a history of prioritising the cutting-edge solutions which engineers want to build over the tools which customers actually need.

2. **Make use of what already exists** - to maximize the impact for the size of this project, we want to combine and build upon what already exists, whether it is public sector datasets and APIs, existing data standards, private companies solving RSLs' modelling challenges, or coalitions through which parties already cooperate.

The research was approached through a combination of user research with retrofit decision-makers within RSLs, and a desk-based analysis of the existing data landscape.

This document sets out what we learned about the binding constraints on investment in Deep Retrofit by RSLs, and the recommendation for data-focused initiatives to undo those constraints.

Research Objectives

The objectives of this research can be summarised in the following six points:

1. **Understand what Retrofit means to the user** (Single Measures vs Deep Retrofit) and **how it fits in their organisational strategy**

2. **Map key steps and decisions** users need to take for retrofit to happen (as well as who needs to be involved in those decisions)

3. **Identify what data is required to inform each decision**, what data is currently being used and gaps between what is available

4. **Identify current data barriers** in collecting, maintaining, finding, accessing, trusting, and using data

5. **Identify other barriers** that currently prevent retrofit decisions from being made (financial and non-financial)

6. **Game changers:** Identify key restrictions to retrofit at scale and explore the role data can play innovating in the sector

User Research Methodology - Approach

A combination of **semi-structured interviews, journey mapping, and a prioritisation exercise was used** to gather the best possible insights.

The interviews allowed for more in-depth, qualitatively sensitive information to be shared by the respondents. Whilst the journey mapping gave respondents a chance to describe key processes in visual form, triggering important conversations, and identifying key pain points in the user experience. Finally, the prioritisation exercise asked the respondents to decide which concepts are most important or high priority for them.

Stakeholders

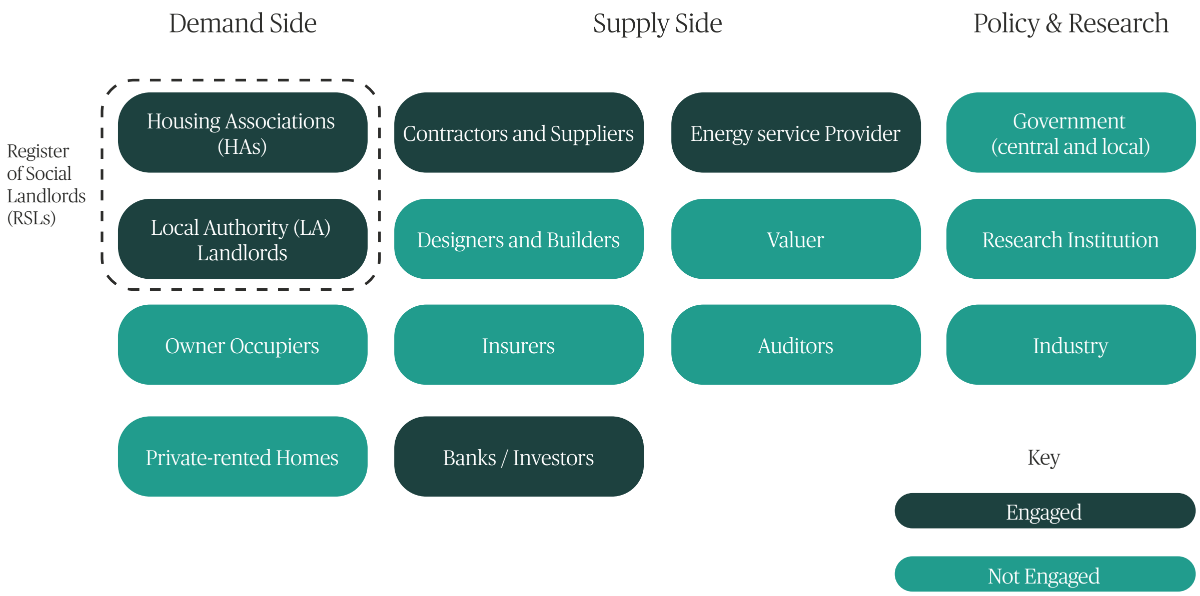
The diagram below shows the stakeholders, including those that we both did and did not engage with on the demand and supply side. In total, we spoke to **8 housing associations, 3 suppliers, 2 intermediaries, and 1 mortgage lender.** However our focus was primarily on the needs of users from the demand side, to ensure we could gain sufficient enough depth of insight, within a relatively short time frame.

What does Retrofit mean for Housing Associations and Local Authorities?

- Housing Associations and Local Authorities are more and more aware of the "climate emergency" and keen to reduce carbon emissions and see Retrofit as one important step to progress in that direction.

How are RSLs developing a strategy around Retrofit?

- Retrofit is starting to become part of RSLs strategy but they are at different points in their journey with most still in a pilot phase, implementing small projects and gathering learnings from them.
- RSLs are currently focused on Energy Performance Certificates (EPC targets), which poorly align with net zero targets, and they are also unclear about Government expectations on when/how to reach Net Zero.



RSL decision-making insights

The research showed that there are two different moments / processes where RSLs have an opportunity to reflect on Retrofit and make specific decisions on it.

A) annual strategy work, and

B) decisions to launch specific retrofit programmes.

The table below shows the key decisions made at each moment and the decision makers behind them:

Moment		Key Decisions	Decision Makers

A	Annual Strategy Work	• What is the scale of RSLs ambition for retrofit (to 2030 / 2050)
		• What does the RSL want to achieve in the near-term (1-3 years)
		• What are the current guiding policies? (e.g. whole house plans vs piecemeal)
		  • Are RSLs limited by grant finances or will they develop project financing?
		  • Are RSLs working with what technologies and suppliers alrready exsist or will RSLs trt to deliver the markets development?
		  • Are RSLs working alone, or building a strategic partnership with others?
			Sustainability manager
			Executive board

B	Decisions to Launch Specific Retrofit Programmes	• Which properties should be prioritised? • Which Interventions should be applied? • Which Financial mechanisms are available to fund the initiative? • How can we make the case to invest in retrofit? • What are the up-front costs of the interventions? • What are the long-term benefits of retrofit, in terms of tenant comfort, maintenance programme, energy efficiency? • What mechanisms can we use to split the cost of interventions ? • What contractors are available to deliver the specific interventions? • Which contractors have a good track record at performing these interventions?	Sustainability manager Property manager Renovations manager Technology and innovation Finance director Sustainability procurement Maintenance

A) Annual Strategy Work

Housing Associations and Local Authorities are more and more aware of the "climate emergency" and keen to reduce carbon emissions. Retrofit is starting to become part of their strategy but are still at different points in their journey. We've grouped them in three different types of strategies:

Piecemeal strategy w/ no programme for full retrofit - 4/8	Piecemeal strategy w/ scoping for full retrofit strategy - 3/8	programme includes deep retrofit - 1/8
• No whole-house approach, focussed on cavity wall and loft insulation • **Retrofit part of wider asset management** strategy / divided between different teams	• Retrofit happens in 'fits and bursts'; ideal is fabric first, then heating source • New corporate strategy to 'tackle climate emergency' • Planning 30 year strategy but whole-house still not possible currently	• Energiesprong approach for hard-to-treat homes part of current strategy

Key Insights:

- RSLs are aware of Deep Retrofit but still on a pilot phase, implementing small projects and gathering learnings from it.
- RSLs are currently focused on EPC targets, which don't align with net zero targets. RSLs are also unclear about Government expectations on when/how to reach Net Zero.

The Social Housing Retrofit Journey:

Through our research we have mapped the journey for delivering retrofit programmes and key decisions / pain-points along the journey. At a high level this flows from:

1. Selection of properties and interventions
2. Financing and budget allocation
3. Preparing a business case / project finance
4. Contracting and project implementation

Step	Key decision
1	Which Properties should be prioritised? Which interventions should be applied?
2	Which financial mechanisms are available to fund the initiative? How can we make the case to invest in retrofit
3	What are the up-front costs of the interventions? What are the long-term benefits of retrofit, in terms of tenant comfort, maintenance programme, energy efficiency? What mechanisms can we use to split the costs of the interventions?
4	Which contractors are available to deliver the specific interventions? Which contractors have a good track record at performing these interventions?

1. Selection of Properties:

Currently most RSLs use a mix of a proactive and reactive approach to select and prioritise properties that require retrofitting. The proactive approach means RSLs use the housing stock data they have available to identify and prioritise which properties benefit the most from Retrofit. The main data point / method used here to prioritise properties is the SAP rating. But even in cases where there is a clear strategy and approach to proactively prioritise properties, retrofit strategies are often superseded by immediate, reactive asset management requirements generated by customer complaints and requests.

3 Preparing a Business Case / Project Finance

4 Contracting and project implementation

Decision makers
Sustainability manager Property asset manager Renovations manager Technology and innovations
Finance Director
Sustainability Maintenance Technology and Innovation
Sustainability Procurement Maintenance

2. Selection of Interventions:

There are different reasons that make it hard for RSLs to select Retrofit interventions. The most relevant being:

- The lack of trusted data on real-world performance of retrofit interventions which has led RSLs to conduct their own pilot experiments to collect data on this and
- The fear to implement specific technologies that will become more efficient in the future.

This makes RSLs feel there is no urgency to jump today and see a benefit in waiting in the expectation that technology will get cheaper.

3. Building a Business Case

RSLs struggle to put together an attractive business case to invest in Retrofit. Retrofit costs are still too high whilst the benefits are most often captured by tenants and indirect benefits are not always easy to quantify (e.g. reduction of future rent arrears and the potential increase in the value of the property).

4. Contracting and Implementing

RSLs have mentioned constraints in terms of the supply of contractors available, saying the market is not matured yet with skills gaps and constraints in terms of the supply available at scale.

Data Insights

Alongside considering the user journey, this discovery has also identified what data exists for understanding housing retrofit and highlights some of the problems and limitations with these data. We explored how users make use of the existing data, the strategies currently employed to resolve the gaps and what this leaves behind. When there is reference to 'users', it is social landlords that are being referred to.

Through a combination of desktop research to map different data sources available and a series of research interviews with asset managers and sustainability managers, we have captured the following insights.

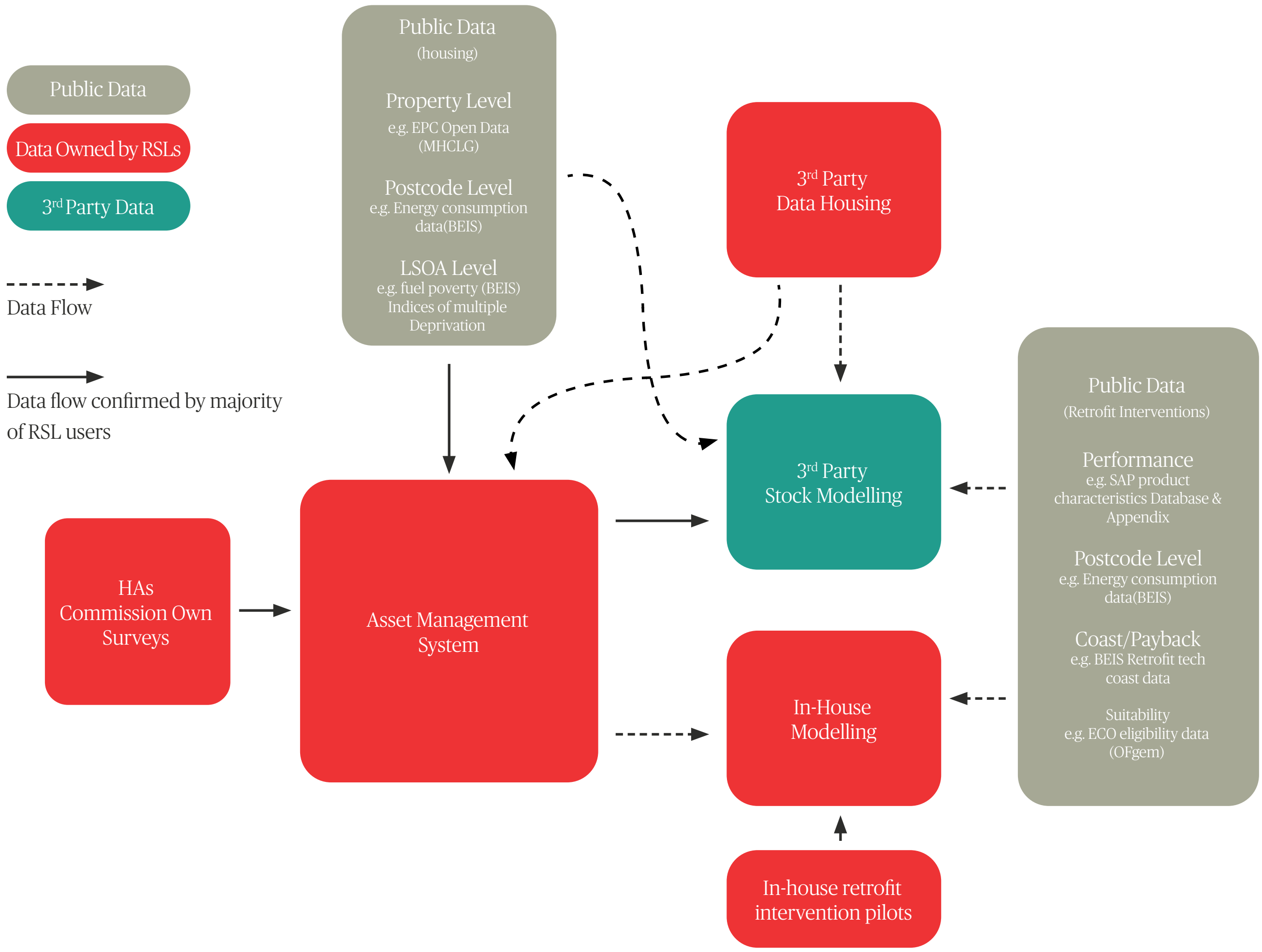
Two key types of data

The key data that are required for a housing association to develop a housing retrofit strategy are data on housing stock and retrofit technology interventions.

Though there is a great deal of overlap between these types of data, and models and data platforms that attempt to bring them all together, this summary will address each separately, as the strategies employed by housing associations for acquiring these data are quite different.

- For data on housing stock, a user needs to know the current state of their properties, in terms of physical characteristics, condition etc. and the energy technology currently installed in the property. They may also want to know the profile of the household occupying the property and their energy consumption behaviour.
- For data on retrofit technology interventions, a user needs to know what measures are appropriate for a given property, and the effect that these measures will have on the energy efficiency of the property. This clearly requires measured energy consumption data (rather than modelled) related to a combination of property and technology data.

In the image below you can find a data ecosystem map that shows how the data flows between the databases used by social landlords to develop their retrofit strategy. This aims to summarise the data that are available and utilised by housing associations.



Key Data Insights

1. Housing Stock Data

- User research sessions showed that the collection of EPCs is the primary strategy employed by housing associations to understand their housing stock.
- The data that are publicly available through the EPC open register are not as comprehensive as the data collected during the generation of the certificate.
- Most housing associations listed current understanding of housing stock data as a relatively low concern in comparison to other barriers for achieving growth in the retrofit market, such as information on retrofit technology performance, clarity of government targets relating to achieving net zero carbon emissions, and the cost of retrofit programmes.
- It was noted that the rdSAP (Reduced Data SAP) framework may not be capturing sufficient information about the physical characteristics of properties to understand the suitability of retrofit interventions. For example, the information captured does not provide confirmation that there is sufficient physical space available to install exterior wall insulation.
- Missing entirely from the rdSAP framework is data on the energy consumption behaviour of the occupants of the property or an evaluation of the condition of the property through a framework such as the Decent Homes or Housing Health and Safety Rating System (HHSRS) frameworks. There is limited public access to these data at a property level.

2. Data on retrofit technology interventions

- The impacts of retrofit technologies on housing energy efficiency are poorly understood and that this represents a serious barrier to scaling retrofit. This was particularly cited for when technologies were installed in combination, as is required for 'deep' whole-house retrofit intervention strategies.
- rdSAP is a key source of information about the impact of different technologies on properties. These data are housed in the Product Characteristic Database (PCDB) , with limited public access to the information underlying the assumptions about each technology.
- The key publicly available source of information on the performance of housing energy technologies is the National Energy Efficiency Data-Framework (NEED) managed by BEIS, However, it contains information about a relatively small subset of the retrofit technologies generally considered for deep retrofit strategies.
- Publicly available data on whole-house retrofit interventions are relatively sparse - it is often in the form of case studies lacking a standardised data structure that is required for analysis.
- RSLs are conducting their own pilot projects to analyse the impacts of deep retrofit solutions on their properties. This suggests that housing associations do not consider the available data sufficient to confidently plan deep retrofit strategies.

Summary of data landscape insights

What data is required in the context of Housing Retrofit?

- Social Housing Providers need access to two types of data in order to create successful deep retrofit programmes:
  - data on housing stock (current energy efficiency, build type, physical characteristics).
  - data on impact of retrofit technologies on energy efficiency of properties.

What is the primary source of information used by RSLs?

- EPCs are the primary source of information used by RSLs for understanding their stock.
- Access to all of the data generated by a Domestic Energy Assessor in generating an EPC is not uniformly given by accreditation schemes and the data available on the public database is incomplete. Though the majority of housing associations have reported strategies to mitigate this issue, changes to MHCLG's policy on sharing this data would improve public access to the key data on domestic properties.

What are the challenges RSLs face with the current data sources in use?

- Given the high reliance on EPCs for informing the retrofit strategies of housing associations, a lot rests on their being adequate for the task. One user research participant expressed doubts that they captured sufficient physical information to plan suitable interventions to properties. This possibility should be evaluated and mitigated.
- Publicly accessible data on retrofit interventions, particularly for whole-house measures, is inadequate. Housing associations are almost uniformly conducting whole-house pilot experiments to resolve this data gap. A collaborative approach to the collection and use of the data generated would offer a valuable source of evidence for planning retrofit programmes.
- Currently available public data sources on the impacts of technologies (such as NEED) are impressive in scale, but lack a wide range of retrofit technologies.

Key Constraints in delivering Net Zero for Social Housing

We sought to identify what constraints whose weakening or removal would really move the system as a whole and catalyse a dramatic increase in Deep Retrofit at Scale (DRaS).

Our user research set out to answer this, focussing specifically on what the constraints to demand from RSLs. We wanted to understand how RSLs decide what retrofit projects to launch, and what barriers they face to undertaking more, larger, and deeper retrofit projects. We were particularly interested in barriers relating to data accessibility, reliability, and comparability.

We conducted interviews with staff responsible for developing retrofit plans, asking about the ambition of existing retrofit programmes, the steps through which they took a plan to approval and execution, where the pain points are in that process, and how they currently use data.

We consistently found that the binding constraints are:

- Ambition - RSLs do not have concrete plans to make the necessary investments to take Deep Retrofit to scale in the absence of government mandate or funding.
- Confidence in the Business Case - RSLs were unconvinced by the existing business case for Deep Retrofit, and particularly by assessments of technology risk.
- Availability of Finance - deep retrofit at scale is a major capital works programme and RSLs considered that they lacked means to finance it, despite most being aware that 'alternative finance' approaches existed.

The interaction of these three constraints is critical. The novelty of the technical approach and the scale of the investment required naturally creates anxiety which is reflected in the high bar set for the business case. External pressure which could potentially overcome this is absent.

1: Ambition

Investment of tens of billions in new technology to meet a new policy goal requires board-level commitment across the sector, and ambitious targets. Our research found that beyond the use of EPC ratings, this was not in place but gave some indicators as to how we might use existing data resources to change that. This is primarily a question of regulation, funding, and leadership - not data. However, given the primacy of this issue it is worth asking how better data could help catalyse those.

Findings:

- All RSL's we spoke to are engaged in retrofitting to meet the EPC C 2030 target, but most have no concrete plans for Deep Retrofit at Scale (DRaS).
- None were engaged in deep retrofit at scale.
- Only 1/8 had incorporated deep retrofit into their plans, but at pilot scale.
- 3/8 had ambitions to move to deep retrofit, but had not made concrete plans and acknowledged that in practice they were **struggling to move away from reactive and piecemeal installations**.

This is not due to a lack of awareness of the need or possibility of deep retrofit. They know that existing plans are inadequate, and are assuming that more ambitious plans will be developed in due course.

The focus on the EPC C 2030 target matters because this target is insufficient to achieve net zero, and is displacing Net Zero focussed plans and action. Achieving this target will reduce CO2 emissions from social housing by less than 25% of what is required if Net Zero by 2050 is to be achieved10. This is in part due to low ambition (EPC C not A), and in part that the orientation of SAP scores (of which EPC bands are a simplified expression) towards affordability rather than emissions fails to reward investment in energy generation and storage, or of moving from gas to electricity in a decarbonising grid11. The activity which this target does encourage is the traditional piecemeal measures which RSLs are already comfortable procuring - largely cavity wall insulation and loft insulation. This is a missed opportunity to integrate more ambitious works into each disruptive retrofit activity.

Government targets, existing and anticipated, were the determining factor in what type of retrofit is being implemented, and at what scale. The ambition determining which properties were targeted and how was, for 8/8, achieving the target of 100% of properties at EPC C by 2030. This is a classic SMART target, with the requirement to conduct surveys and report on findings creating a high degree of accountability for boards and executives in RSLs.

Some local authorities and devolved governments have begun setting carbon-focussed targets - running ahead of Westminster. For example, Nottingham's push for Net Zero by 2028, Leeds 2030 Zero Carbon Roadmap, South Cambridgeshire Zero Carbon Strategy and Bristol's One City Climate Strategy.

These pioneers' action plans recognise the key role which addressing the energy efficiency of housing stock will play. For example, Nottingham's action plan notes that homes are responsible for 25% of the City's CO2 emissions, that "current housing stock is a key challenge", and that a local RSL owns 20% of them.

However, existing data does not enable LAs to set and monitor targets for individual RSLs, and track performance against them. They need to be able to measure an RSL's current performance in CO2 emissions per m2 (crucially with a correction for SAP's current estimation of the carbon cost of electricity use). They also need to be able to track changes in performance on the same measure (e.g. "average CO2/m2 for the provider's homes in Nottingham has dropped X% over the last twelve months, in line with commitments". By contrast, LAs can do exactly this for SAP-based targets because the SAP data standard and register allows comparable data to be held and analysed on the performance of RSLs and other key actors against a target if it is calibrated in SAP ratings.

Opportunities for Better Data to Help Remove this Constraint

The quickest and cheapest approach, although not without limitations, is to link the per-property CO2/m2 estimates already available (although not foregrounded) in the SAP register to data on RSL's portfolios and display in a digital tool. We explore the potential of this 'SAP Hack'. A more comprehensive approach - transcending the limitations of SAP - would involve building out a new standard, surveying approaches, workforce, and supporting tools. This is being pursued in the Optimised Retrofit programme in Wales.

3: Availability of Finance

Even with a stronger business case, financing for deep retrofit programmes is far short of what is required. Our research suggested widespread awareness of potential solutions but little willingness to be the first to experiment with alternative innovative finance solutions.

Findings:

- The potential financial costs of deep retrofit programmes for RSLs are far beyond the budgets they currently have to allocate. All RSLs we spoke to currently rely almost exclusively on government grants to carry out even single measure interventions.
- 6/8 specifically acknowledged the need to develop sustainable models that would remove the need for government funding therefore RSLs recognise the need to move beyond government funding to carry out deep retrofit programmes. Moreover, RLSs are aware of the potential of project financing mechanisms but are not currently testing them.
- Cost sharing mechanisms with tenants would break the "Split Incentive"18 issue and provide financing for retrofit projects. However, these are viewed with nervousness at Executive level due to their potential to harm relationships with tenants. None of the organisations we interviewed had concrete plans to use alternative finance mechanisms.

Opportunities for Better Data to Help Remove this Constraint

This is not, fundamentally, a data infrastructure issue however financing does typically bring very high demands for data quality and there are likely to be needs for data infrastructure work in this space which will become clearer as preferred financing routes are articulated.

Our recommended next step would be further analysis of innovative finance solutions as being explored through a separate piece of work by CPC 'Innovative financing's potential to drive sustainability in the built environment sector". This should be followed by identifying a potential pilot and showcasing to help build confidence in the social housing sector in exploring alternative models.
the limitations of SAP - would involve building out a new standard, surveying approaches, workforce, and supporting tools. This is being pursued in the Optimised Retrofit programme in Wales.

4: Trust and Transparency Across the Demand/ Supply Divide

RSLs view supply for deep retrofit as immature while suppliers need to see evidence of enduring demand in order to expand. The market is fragmented and opaque.

Findings:

- RSLs do not see their established supply chains as capable of delivering Deep Retrofit. 6/8 claimed they do not currently procure from any contractors who they believe would be capable of delivering a deep retrofit programme and that they would not know where to procure these services from.
- Suppliers are said to lack confidence to invest in Deep Retrofit due to uncertainty about current and future demand.
- The PAS2035 certification scheme and Trustmark are viewed positively by sustainability managers, but provide limited information to a commercial buyer. Their Data Warehouse22 covers all ECO3-funded work, and currently contains more information than is made available to market participants (e.g. event-level contracting history of registered suppliers, linked to specific buildings). They have an active program to explore ways to make this more useful to landlords and tenants through digital tools, and channel partnerships, and are welcome to suggestions as to how they could better meet the needs of both RSLs and Energy Services providers.

Opportunities for Better Data to Help Remove this Constraint

In other public sector markets for innovative goods and services, open contracting data has been an effective tool for bringing transparency to a market. The key challenge is not the standard or the portal, but making it easy and attractive for buyers to share their data. Procurement frameworks have achieved this in some markets - offering access to more sellers and competition as well as faster procurement.

5: Housing Stock Data

Frustrations with the data available for planning retrofit were common for sustainability managers, but were described as secondary to other constraints noted above.

Findings:

RSLs have access to modelling tools, but have varying levels of information about their housing stock which they can input into their models. 5/8 RSLs reported use of the Parity Projects Portfolio20 product, which enables access to open data on housing stock (e.g. EPC open register) and provides modelling tools for planning retrofit programmes. Interviewees estimated that they held current EPCs on between 50% and 100% of their properties. All were confident that their plans for surveying would meet their needs for stock data, but defined those needs primarily in terms of holding in-date EPCs. However, holding EPCs is not the same as having comprehensive stock data.

As a result, the process of understanding what the path to Net Zero could be for a portfolio is slow and uncertain, and so is identifying pockets of stock for a large-scale Deep Retrofit project. In addition, public data on stock characteristics ((e.g. EPC open register) does not come linked to data on what stock is owned by which RSL (if any) and so its value as a prospecting tool for DRaS promoters (identifying pockets of viable stock from outside the RSL) is limited

Fundamentally, this comes back to ambition - technical solutions exist for capturing and managing this data, and RSLs investing in large-scale surveying, but they are focussing on meeting the EPC C 2030 target and not on DRaS. DRaS represents, with its requirement for 'Big Up Front Design', a step-change in the detail and reliability of data required centrally.

Culture, processes, and tools in many RSLs have evolved to meet a far simpler information challenge and organisational capacity to provision data suitable for an ideal DRaS process is an issue for many RSLs. In particular, resourcing of data governance and data management appear to be key constraints, which complicates delivering impact from standards-based solutions.

Possibilities for Better Data to Help Remove this Constraint

Typical solutions to this type of problem either tackle the problem head-on (with investment in skills, systems, and audit), or work around it by finding ways to limit the reliance on up-front accuracy. The Optimised Retrofit programme[17] in Wales is taking the first approach - developing new standards, tools, and workforce for its surveying programme as well as for ongoing sensor-based data capture and data management.

The Optimised Retrofit approach is ambitious, but relying on both its success, and its rapid adoption around the UK (despite the presence of conflicting targets, standards, and accreditations) is high risk. We recommend work in parallel to consider how to help RSLs and Energy Services providers work around the limitations of the existing system.

DRaS is still in its infancy in the UK. A detailed and reliable picture of suppliers' data needs will only emerge from deep and ongoing involvement in the first projects, and is likely to evolve over time - not least in reaction to new contractual or technical means for working around data gaps.

Conclusion and next steps

This research, by focusing on understanding the particular needs of retrofit decision makers in social housing has identified a number of insights, into some of the key constraints for delivering net zero housing retrofit including:

- **Ambition:** there are limited incentives or targets to focus on net zero and a lack of tools that enable that focus to deliver net zero in practice. There is a focus on delivering short term incremental improvements focused around particular measures and short term EPC band C targets rather than comprehensive, outcome focused multi-year net zero strategies.
- **Belief in the business case:** a lack of coordinated, standardised evidence to prove what retrofit technologies actually work combined with hesitance not to move ahead of potential regulations that might mandate particular technologies, is constraining investment in deep retrofit.
- **Availability of Finance:** Even with a stronger business case, financing for deep retrofit programmes is far short of what is required. Our research suggested widespread awareness of potential solutions but little willingness to be the first to experiment with alternative innovative finance solutions.
- **Trust and Transparency Across the Demand / Supply Divide:** RSLs view supply for deep retrofit as immature while supply need to see evidence of enduring demand in order to expand. The market is fragmented and opaque.
- **Housing stock data:** Frustrations with the data available for planning retrofit were common for sustainability managers with an overreliance on EPC data rather than what is needed to support deep net zero retrofit, but were described as secondary to other constraints noted above.

We have also identified, the role of data in supporting delivery of net zero, including a number of opportunities that data provides in addressing some of the key market constraints in net zero housing retrofit:

- **Supporting greater ambition:** using data to support development and measurement of net zero strategies and targets (the 'SAP Hack').
- **Believing in the business case:** the role of data and standards in evidencing what retrofit technologies actually work.
- **Availability of Finance:** The exploration, piloting and showcasing of innovative finance solutions as being explored in CPC's parallel work on innovative finance could help build confidence in the social housing sector in exploring alternative models. Financing typically brings very high demands for data quality and there are likely to be needs for data infrastructure work in this space which will become clearer as preferred financing routes are articulated.
- **Improving market visibility and supplier confidence**: through use of open data for housing stock and the use of open contract data standards to remove opacity of demand and improve prospecting for deep housing retrofit.

As a next step we invite all interested individuals and groups to comment on the insights and opportunities identified and get in touch if you would like to explore these opportunities further. Connected Places Catapult will continue to flesh out the opportunities ideas to bring them to a stage where we can work with a core active group and seek the necessary funding to progress and help the community to come together to find practical ways to deliver.

Acknowledgements

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Cosy Homes Oxfordshire
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TrustMark
HACT

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Disclaimer

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HOUSING
INNOVATION
PROGRAMME

Hackney

Living in Hackney Scrutiny Commission 8th November 2021 Item 5 – Minutes of the Previous Meeting	Item No 5

Outline
The draft minutes of the previous meeting on 26th October 2021 have been delayed and will be provided at the next LiH meeting.

Living in Hackney Scrutiny Commission 8th November 2021 Item 6 – Living in Hackney Scrutiny Commission Work Programme 2021/22	Item No 6

OUTLINE

The work programme for the Living in Hackney Scrutiny Commission 2021-22 is attached. Please note this a working document.

ACTION

The Commission is asked for any comments or amendments on the work programme for the municipal year 2021-2022.

Living in Hackney Scrutiny Commission: Work Plan June 2021 – April 2022

Each agenda will include an updated version of this Scrutiny Commission work programme

All meeting guests will be virtual until further notice.

Dates	Proposed Item	Directorate and lead officer contact	Description, Comment and Purpose of item
22nd June 2021 Papers deadline: Thurs 8th June 2021	Trust and Confidence and Inclusive Policing	**Metropolitan Police Service** DCS Marcus Barnett, CE BCU Commander Commander Jane Conners **Mayor's Office for Police and Crime (MOPAC)** Natasha Plummer, Head of Engagement **Independent Officer for**	This meeting will be a discussion with Metropolitan Police Service (Head Quarters & Borough Commander for Hackney), Mayor's Office for Policing and Crime and the Independent Office for Police Conduct about building trust and confidence and inclusive policing. Further questions were sent to the IOPC, MPS and MOPAC for a response in advance of this meeting. This discussion will cover: Independent Office for Police Conduct (IOPC) 1. MPS complaints system 2. Culture Change 3. Youth Engagement. Mayor's Office for Policing and Crime (MOPAC) 1. Representation of Hackney's diverse community in the MPS and MOPAC community engagement structures 2. Trust and confidence 3. Accessibility and transparency of MPS data. Metropolitan Police Service 1. MPS Complaint system

Dates	Proposed Item	Directorate and lead officer contact	Description, Comment and Purpose of item
		Police Conduct (IOPC) Sal Naseem, Regional Director London	2. Accountability of officers 3. No set targets for the successful outcome rates for stop and search 4. Reducing disproportionality 5. Representation of Hackney's diverse community in the MPS and MOPAC community engagement structures.
14th July 2021 Papers deadline: Mon 5th July 2021	Play Infrastructure	David Padfield Interim Director of Housing	Play infrastructure and design principles for play infrastructure. The Council's policy on play infrastructure for estates and provisions across the borough. The design principles for play infrastructure for developments and estate regenerations.
	Play Infrastructure and Planning	Aled Richards Strategic Director Sustainability and Public Realm	Planning - Child Friendly Borough Information about the consultation/feedback and work towards a child friendly borough linked to the Local Plan.

Dates	Proposed Item	Directorate and lead officer contact	Description, Comment and Purpose of item
26th October 2021 Papers deadline: Fri 15th Oct 2021	**Energy Strategy and Energy Systems**	Procurement Service Energy and Carbon Management Planning Services Resident Liaison Group	Energy Strategy – overview of the strategy, its objectives and energy systems needed to meet net zero carbon targets. This discussion will cover: **Planning Team** 1. Information about how the Council's planning policies support Hackney Council's commitment to achieve the net zero carbon targets and requirements of COP 26 for all future developments in the borough. 2. Information about the planning powers to ensure buildings and developments in the borough are as green as possible in relation to how they are built and that the materials used meet the ambitions of the council in relation to climate change and net zero carbon emissions. 3. Information about planning's role in ensuring developers in the borough are informed and engaged with the Council's net zero carbon targets. **Energy Team** 1. An overview of the Council's Energy Strategy 2. The Council's roadmap and planned work to achieve net zero carbon for all council emissions and its properties? 3. Information about the new energy systems being considered and the cost implications associated with the new energy technology systems? 4. Information about how the Council's Energy Strategy and objectives align with the Council's fuel poverty strategy 5. Information about planned engagement with the public about the Energy strategy objectives and ambitions to tackle climate change? A look at buildings and how they are built. A look at the process and

Dates	Proposed Item	Directorate and lead officer contact	Description, Comment and Purpose of item
			how the council can ensure all the buildings built in the borough are environmentally friendly. Look at the carbon footprint from construction and the built environment.
8th November 2021 Papers deadline: Wed 27th October 2021	**Climate Change and Buildings**	**Service Areas** Strategic Property Housing Services Inclusive Economy, Corporate Policy and New Homes	Climate change and buildings **-** council's work to meet its net zero carbon target in relation to building maintenance, developments and retrofit of buildings in the borough to ensure they are as green as possible. This will include looking at housing and corporate council buildings. Looking at the retrofit of buildings, materials used and any proposed energy efficient insulation work towards achieving net zero carbon. To consider if the materials used or available are recyclable and/or carbon neutral. This session will cover 1. Council Housing - Retrofitting council homes to achieve net zero carbon target 2. Private Sector housing - what the private sector need to do to achieve the net zero carbon target 3. New Homes Delivery - how new build home and regeneration developments will achieve / deliver the net zero carbon target 4. Council Strategic Property - How the council's maintenance programme aims to retro fit and deliver net zero carbon for all non-residential council property.

Dates	Proposed Item	Directorate and lead officer contact	Description, Comment and Purpose of item
13th December 2021 Papers deadline: Wed 1st December 2021	**Electric Charging Infrastructure**	**Service Areas** Streetscene Procurement Hackney Light and Power	Development of electric charging infrastructure and the plans to encourage the shift to electric car use in the borough. A review of the electric charging costs and how cheap communal electric charging points can be provided to encourage shift to electric cars. The Commission will look at: • The development of electric charging infrastructure in the borough • The Council's work with the community and partners (e.g. RSLs) to encourage the shift to electric car use in the borough. • Pricing and charging. Includes looking at the geographical location of electric charging bays and the number of bays across the borough. Work with housing associations and other partners The Council's role in helping to reduce the costs associated with running an electric car and making the shift?

Dates	Proposed Item	Directorate and lead officer contact	Description, Comment and Purpose of item
17th January 2022 Papers deadline: Wed 5th January 2022	**Fire Safety**	Housing Services	Fire safety of buildings - to look at the arrangements in place covering fires safety products fitted; the checks on the products used to ensure they are of the highest fire standard grade available (quality over price).
	Private Sector Housing – temporary accommodation and the licensing scheme	Inclusive Economy, Corporate Policy and New Homes	Private sector housing licensing scheme - exploring an extension to the scheme across the borough.
24th February 2022 Papers deadline: Mon 14th February 2022	**Housing Needs for Young People Leaving Care**	Benefits and Housing Needs Inclusive Economy, Corporate Policy and New Homes	Joint piece with Children and Young People Scrutiny Commission to look at the housing options for young people leaving care. Includes looking at council's housing strategy and objectives for housing young people leaving care.

Dates	Proposed Item	Directorate and lead officer contact	Description, Comment and Purpose of item
7th March 2022 Papers deadline: Wed 23rd February 2022	**Leisure Services and Facilities**	Leisure, Parks and Green Spaces	1. An overview of leisure facilities and services in the borough open to the public 2. Cost and access to leisure services A look at the difference in prices across facilities and why Information about the concessions available and how this is promoted to local residents (how do people find out and how does the council let them know about the leisure offer).

To note