



HOMES FIT FOR THE FUTURE

RETROFIT TOWARDS A SECTOR-WIDE ROADMAP 2020

EXECUTIVE SUMMARY

Places that are economically successful, great places to live and ready for a changing world need homes that are fit for the future. Homes that are low carbon, adaptable, resilient to climate change and desirable. 80% of the homes we will be inhabiting in 2050 already exist, which means our stock is already old and inefficient. If we do not upgrade our stock, we will not be able to achieve net-zero carbon emissions by 2050. What's more, we'll also face constantly rising health and social care costs, fail to meet the needs of our future population, and our economic performance will suffer.

We know that technically it is possible to deep retrofit homes to the required standard. We also know that it is not happening fast enough, and that we also understand the barriers. So, breaking those barriers is what's most essential to delivering deep retrofit in volume, at speed and cost-effectively.

A deep retrofit programme is worth pursuing. Upgrading the entire UK housing stock to be fit for the future will avoid £35bn p.a. in costs, grow the low carbon economy and open up a large deep retrofit export market.

As part of their Housing Innovation Week, Connected Places Catapult brought together 40 organisations to explore the changes required to unlock the UK retrofit market. The goal? To create a shared vision and roadmap to transform our current housing stock.

Participants tackled two questions:

- What needs to be true for housing owners to invest in deep retrofit?
- What changes are needed by suppliers to help them develop and deliver solutions?

The key needs and challenges identified are:

Buyers' Needs	Sellers' Challenges
Confidence that solutions can be delivered	A sustainable market
Information and knowledge	Information and evidence
Policy and regulation drivers	Policy and regulation drivers
A good business case to invest	Providing guaranteed performance
An offer tailored to their needs	Better supply chain skills

From these, the group then defined four core actions that would help bridge the gap between buyers and sellers:

- Development of a deeper understanding of the existing housing stock to find the best solutions
- Creation of replicable, integrated interventions – the 'retrofit kit'
- Explore mass customisation of standard solutions to fit our diverse housing stock
- Creation of a finance platform to create standardised contracts and to match projects and funders

This report is the first step on the journey to a shared vision and roadmap. Connected Places Catapult invites comment on the key needs and challenges and the four action ideas. At the same time, we will support further development of these actions so they can seek funding. We will also work with partners to help Government and funding agencies see that transforming the UK housing stock into homes fit for the future is essential, technically deliverable, and can be a practical reality.

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1 INTRODUCTION

1.1 Homes Fit for the Future

Getting housing right is essential to building places that are economically successful, great places to live, resilient and adaptable to change. Across the world cities are struggling to deliver housing in the face of population growth, demographic shifts, climate change and resource limits.

At Connected Places Catapult we believe that we need Homes Fit for the Future. Homes that meet higher energy efficiency standards, are resilient to climate change, desirable and adaptable to changing use. Some of these will of course be new properties – but with 27m pre-existing homes, it is vital that we explore and deploy refurbishment if we are to meet future needs quickly and efficiently.

We believe that a collaborative approach, with the right insights, interventions and innovations, can collectively develop and implement solutions to our housing challenges. This report builds on research undertaken throughout 2019. We brought together thought leaders from across the housing ecosystem to share their insights, challenges and ambitions for housing, focusing on Deep Housing Retrofit.

Through workshops, interviews, roundtables and extensive research we have built on a wealth of great work already undertaken and provided additional insights to move this agenda along; In so doing we hope to support both the demand and supply side of this developing market, and in turn, encourage delivery of Homes Fit for the Future.

1.2 Deep Housing Retrofit

The UK has very ambitious targets for cutting greenhouse gas emissions. Net-zero by 2050.¹ Our homes use approximately 30% of the UK's energy² and are responsible for 18% of carbon emissions.³ They play a vital role in decarbonisation.

Unfortunately, our housing stock is old and in poor condition. 80% of the homes we will use in 2050 already exist.⁴ Over three-quarters of UK homes were built before 1980⁵, before the introduction of standards for insulation and energy performance. Less than one-third have an energy efficiency considered acceptable by today's standards⁶, and almost none have an energy efficiency that meets our future needs.

Given an ageing population, increasing numbers of people living with chronic health conditions, changing structures of families and patterns of work, it is also a concern that few homes meet the Lifetime Homes Standard⁷. Energy efficiency is rightly the immediate focus of deep housing retrofit given the net-zero carbon objectives and the impact of the climate crisis. Fortunately, we can implement many of the changes required to make homes adaptable and flexible at the same time as we are improving energy efficiency.

We can't rely on building new energy-efficient homes, as the turnover rate is too low. Nor can we rely on decarbonising the grid as the energy demand, particularly for heat, is too high. It is also risky to focus on intermediate targets, such as mandating higher EPC ratings. Carbon emissions from our homes must reach net-zero, and focusing on EPC ratings creates two problems:

- Firstly, because they are theoretical and do not represent actual performance, it's possible to meet the target and yet still emit too much carbon.
- Secondly, meeting an intermediate target only encourages short-term investments that will not ultimately deliver net-zero, and so must be expensively replaced again later.

We need to radically improve the energy efficiency of our existing housing stock by minimising energy demand, and decarbonising the remainder.

'Deep retrofit' is the sensible approach. A whole-house strategy that takes a property from its current state to near net-zero energy demand. It is sensible, but it is just not happening. In this report we have looked at what needs to change to enable us to roll-out deep retrofit in volume, at speed and cost-effectively. We have identified key changes required by both buyers and sellers to open up the market, and identified a number of projects that could begin to bridge the gap between them.

¹ <https://www.gov.uk/government/news/uk-becomes-first-major-economy-to-pass-net-zero-emissions-law>

² <https://www.gov.uk/government/statistics/energy-consumption-in-the-uk>

³ <https://www.gov.uk/government/collections/provisional-uk-greenhouse-gas-emissions-national-statistics>

⁴ <https://www.theiet.org/media/1675/retrofit.pdf>

⁵ https://www.designingbuildings.co.uk/wiki/English_housing_stock_age

⁶ https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/36395/2072202.pdf

⁷ <http://www.lifetimehomes.org.uk/pages/revise-design-criteria.html>

2 THE NATION'S CASE FOR CHANGE

To reach government targets of net-zero carbon emissions by 2050⁸, the UK needs to radically cut emissions from our homes. The current generally inefficient housing stock has several key impacts on the economy, environment and society:

Carbon emissions

The UK residential sector contributes 18% of the UK's greenhouse gas emissions.⁹ The vast majority – over 82% – of domestic energy consumption is for space and water heating¹⁰, driven in part by inefficient heating systems and insulation. The majority of the housing stock was built before national building regulations came into force, and over two-thirds built before regulations required insulation.¹¹

Energy demand

Housing accounts for nearly one-third of the UK's total energy demands, and two-thirds of that is gas. Whilst we are successfully decarbonising the electricity grid, we cannot simply replace fossil fuel heating with electric heating. There will not be the capacity in the foreseeable future. Transport is another third of primary energy consumption¹²; almost entirely in fossil fuels. Electrification of transport is another major objective throwing even more pressure on a zero-carbon electricity grid. To achieve net-zero we must drastically cut the energy demand of homes, particularly for space and water heating. Reducing the domestic energy demand will also help alleviate some of the UK's vulnerability to international volatility in fossil fuel prices¹³ – the price of energy also being a key determinant of fuel poverty.

⁸ <https://www.gov.uk/government/news/uk-becomes-first-major-economy-to-pass-net-zero-emissions-law>

⁹ <https://www.gov.uk/government/statistics/provisional-uk-greenhouse-gas-emissions-national-statistics-2018>

¹⁰ https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/386858/Estimates_of_heat_use.pdf

¹¹ https://www.designingbuildings.co.uk/wiki/English_housing_stock_age

¹² https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/820843/Energy_Consumption_in_the_UK_ECUK_MASTER_COPY.pdf

¹³ <https://www.theccc.org.uk/wp-content/uploads/2017/03/Energy-Prices-and-Bills-Committee-on-Climate-Change-March-2017.pdf>

Air quality

Domestic gas use also contributes to air pollution. For example, it contributed an estimated 33% of central London's nitrogen oxides in 2010¹⁴, which can cause respiratory problems and exacerbate heart and lung conditions.

Cold-related deaths and illnesses

An estimated 9,700 winter deaths are directly related to living in a cold home, with the majority (6,900) linked to the coldest 25% of homes in the UK.¹⁵ The elderly are the most affected and, as the UK ages, this will become increasingly prevalent – by 2030, one in five people will be 65 or older.¹⁶ Cold homes also contribute to respiratory illnesses and circulatory problems, as well as mental health issues such as stress, anxiety and depression in adults and children.¹⁷ The burden on the NHS is significant, with costs of £848m per year attributed to excessively cold homes alone¹⁸ (and more when factoring for cold-related issues such as excess moisture and mould), whilst beyond health and well-being the wider societal costs also impact on educational attainment and economic productivity.¹⁹

Fuel poverty

10% of excess winter deaths are directly attributable to fuel poverty²⁰, and there were 50,100 excess winter deaths in England and Wales in 2018²¹. In England alone there are an estimated 2.53 million households in fuel poverty, approximately 11% of households.²²

¹⁴ <https://www.ippr.org/files/publications/pdf/lethal-and-illegal-solving-londons-air-pollution-crisis-Nov2016.pdf>

¹⁵ <https://www.nea.org.uk/wp-content/uploads/2018/02/E3G-NEA-Cold-homes-and-excess-winter-deaths.pdf>

¹⁶ https://www.ageuk.org.uk/globalassets/age-uk/documents/reports-and-publications/older_life_uk_factsheet.pdf

¹⁷ https://england.shelter.org.uk/_data/assets/pdf_file/0016/39202/Chance_of_a_Lifetime.pdf

¹⁸ <https://www.bre.co.uk/filelibrary/pdf/87741-Cost-of-Poor-Housing-Briefing-Paper-v3.pdf>

¹⁹ https://fingertips.phe.org.uk/documents/Fuel_poverty_health_inequalities.pdf

²⁰ Hills J. Getting the measure of fuel poverty: Final Report of the Fuel Poverty Review. London: 2012.

²¹ <https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/bulletins/excesswintermortalityinenglandandwales/2017to2018provisionaland2016to2017final>

²² https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/829006/Annual_Fuel_Poverty_Statistics_Report_2019__2017_data_.pdf

3 THE HISTORY OF UK RETROFIT

3.1 Retrofit Progress

It has been clear for many years that making the existing housing stock more energy efficient will bring benefits. It would tackle a significant source of carbon emissions and improve health and social outcomes. Domestic energy efficiency is also a vital part of addressing the energy trilemma of how to deliver a secure and sufficient supply of energy that is both low-carbon and affordable?

The Climate Change Act 2008 set a carbon emissions reduction target of 80% by 2050.²³ And with housing contributing 18% of the U.K.'s greenhouse gas emissions²⁴, a dramatic reduction in this area was essential. Given the difficulties of reducing emissions in the rest of the U.K.'s inventory, the Committee on Climate Change argued that the carbon emissions target for housing should be zero.²⁵ In 2019 the UK Government set a 2050 goal of net-zero carbon emissions²⁶, which puts even more pressure on domestic emissions.

We cannot substitute fossil-fuel heating with electrical heating, as that would dramatically increase electricity demand when we are busy decarbonising the supply. All of which means that the only practical route to achieving the net-zero objective is a dramatic improvement in the energy efficiency of existing homes.

There has been a great deal of work over the last 10 to 15 years on improving energy efficiency. Academic studies, individual projects and large-scale demonstrators, long-term whole-house performance studies and innovation projects focused on specific materials and components. There have also been experiments on different housing types both in the UK and internationally.

Several major reports like “Scaling up Retrofit 2050” by the IET²⁷, “UK Housing – Fit for the Future”²⁸ by the Committee on Climate Change²⁸, “Regeneration and Retrofit” by UKGBC²⁹, “Reinventing Retrofit” by the Green Alliance³⁰ and “Homes Fit for the Future – Project Position Paper” by Connected Places Catapult³¹ summarise the common findings. We know that we can deliver deep retrofits that cut emissions, but we are not adopting the solutions at the necessary scale and speed.

3.2 Remaining Barriers to Retrofit

The main barriers which persist in the UK to large-scale retrofitting of the existing stock are:

- Lack of demand
 - Retrofit for energy efficiency is not an attractive enough proposition for buyers
 - Buyers are not confident that the promised benefits will be delivered and worry about the risks of relatively new and untried approaches.
- Lack of clear and consistent Government policy
 - Government is not providing policy and guidance that demands deep retrofit as part of the journey to net-zero
 - The history of policies such as the Code for Sustainable Homes³² and the Green Deal³³ makes both buyers and suppliers nervous about the commitment of the UK Government.
- High costs of retrofit and the lack of capability and capacity throughout the supply chain
 - Current costs of deep retrofit to meet 2050 targets are greater than the break-even point for social and private landlords
 - Buyers lack the knowledge, skills and capability to specify and procure deep retrofit
 - There is a skills gap in the construction sector. Too few people who can design and deliver successful retrofits
 - The diversity of housing stock presents a challenge to reaching economies of scale. The 28 million homes in the UK³⁴ are of a wide variety of types, ages and sizes, adding to the complexity of delivering scalable retrofit solutions.

²⁹ <https://www.theiet.org/media/1675/retrofit.pdf>

²⁸ <https://www.theccc.org.uk/wp-content/uploads/2019/02/UK-housing-Fit-for-the-future-CCC-2019.pdf>

²⁹ <https://www.ukgbc.org/wp-content/uploads/2017/09/08498-Regen-Retrofit-Report-WEB-Spreads.pdf>

³⁰ https://www.green-alliance.org.uk/reinventing_retrofit.php

³¹ <https://s3-eu-west-1.amazonaws.com/media.fc.catapult/wp-content/uploads/2019/09/30174155/Homes-for-the-future-Project-position-paper.pdf>

³² https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/5976/code_for_sustainable_homes_techguide.pdf

³³ <https://www.gov.uk/green-deal-energy-saving-measures>

³⁴ <https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/families/bulletins/familiesandhouseholds/2019>

²³ <http://www.legislation.gov.uk/ukpga/2008/27/contents>

²⁴ <https://www.gov.uk/government/collections/provisional-uk-greenhouse-gas-emissions-national-statistics>

²⁵ <https://www.theccc.org.uk/wp-content/uploads/2019/05/Net-Zero-The-UKs-contribution-to-stopping-global-warming.pdf>

²⁶ <https://www.gov.uk/government/news/uk-becomes-first-major-economy-to-pass-net-zero-emissions-law>

- Lack of financing
 - At current prices, deep retrofit provides an unattractive investment offer when compared with investment in other green technologies, such as wind-farms that are less risky and more established
 - Low-cost financing is not available in the UK to stimulate the market.
- Future Energy Supplies
 - Power systems need to become an integral part of a scalable retrofit programme to transform not only the fabric and performance of the internal workings of all homes, but also their ability to reduce their demand on the grid and produce a supply of energy independently.

These five areas of impediment interact and reinforce each other. Lack of demand means no 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. The barriers lock together to create a formidable obstruction to delivering deep retrofits at speed, in volume and cost-effectively. Nonetheless, everyone agrees that the problem of domestic carbon emissions must be solved. Therefore, we need to find approaches that can break the logjam.

4 THE VALUE OF DEEP RETROFIT

Successfully upgrading our existing housing stock to be fit for the future will bring significant benefits – environmentally, socially and economically. We will gain from additional economic activity and avoided costs, including:

4.1 Carbon savings

Housing is responsible for 18% of UK carbon emissions,³⁵ with 82% of that coming from space and water heating.³⁶ Eliminating all carbon emissions from domestic heating would save approximately 46Mt CO₂ p.a.³⁷ Using the UK Government model for carbon prices in the Emissions Trading Scheme, this has a value of £640m p.a. today, rising to £2bn p.a. in 2035.³⁸

4.2 Fuel savings

Consumers spent £34bn³⁹ on domestic power and fuel in 2018. Increasing the energy efficiency of homes to cut space and water heating requirements could save almost £15bn p.a. in direct consumer costs.

4.3 Health costs

Poor quality housing has health consequences beyond energy efficiency. The direct cost to the NHS due to cold, damp, falls and other problems is £1.4bn p.a.⁴⁰ Vulnerable people have their lives cut short by cold, overheating and poor air quality. Cold homes cause 9,700 deaths each winter, overheating kills 2,000 people every year⁴¹ and poor air quality causes about 30,000 early deaths each year.⁴² Fixing the biggest problems with our housing stock could generate 175,000 additional Quality Adjusted Life Years (QALYs) over 5 years. The National Institute for Health and Care Excellence (NICE) estimates that each QALY is worth £20,000 to the UK,⁴³ so the value of those avoided early deaths totals £3.5bn.

The Building Research Establishment (BRE) has estimated that the total cost to society of poor housing in England alone – which includes the direct costs to the NHS, loss of earning potential and educational opportunities – is £18.6bn p.a.⁴⁴

4.4 Value of avoiding climate change

It is known that climate change incurs additional costs. The UK faces threats of flooding, extreme heat and coastal erosion, as well as disruption to the global economic system. These are difficult to quantify, but a recent study estimates that 1.5°C warming would not have a material effect on global GDP, but 2.0°C warming would reduce global GDP growth by 2%⁴⁵. That is a significant amount and shows that the costs of climate change are high. Making our housing stock fit for the future will help the UK avoid these economic impacts.

4.5 Productivity gains

With 2.26 million jobs⁴⁶ and very low productivity in the construction industry, retrofit solutions represent a wider opportunity to the sector and UK economy. The gap between construction and other more productive sectors in the UK is one which deep retrofit can make steps towards tackling. Digitisation, innovative solutions and new product development will support jobs and increase productivity now and into the future.

4.6 Additional economic activity

Transforming the 27 million homes in the UK to be fit for the future is a task that will require huge investment and create thousands of jobs. However, although this is a big shift in resources to this part of the economy, it does not necessarily imply additional growth.⁴⁷ The bigger opportunity is in exporting low-carbon goods and services to other markets. It is estimated that the low carbon economy in the UK could grow to 13% of total output by 2050⁴⁸ with £60bn to £170bn additional exports by 2030⁴⁹. The global market for low carbon upgrades to buildings from 2020-2050 is estimated to be \$6.2tn⁵⁰. That would lead to lifetime operational savings of \$9.7tn.

³⁵ <https://www.gov.uk/government/collections/provisional-uk-greenhouse-gas-emissions-national-statistics>

³⁶ https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/386858/Estimates_of_heat_use.pdf

³⁷ <https://www.gov.uk/government/collections/provisional-uk-greenhouse-gas-emissions-national-statistics>

³⁸ https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/794188/2018-short-term-traded-carbon-values-for-modelling-purposes.pdf

³⁹ https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/812298/table_261.xls

⁴⁰ <https://www.bre.co.uk/filelibrary/pdf/87741-Cost-of-Poor-Housing-Briefing-Paper-v3.pdf>

⁴¹ <https://www.theccc.org.uk/2017/08/08/hidden-problem-overheating/>

⁴² <https://www.gov.uk/government/news/public-health-england-publishes-air-pollution-evidence-review>

⁴³ <https://www.nice.org.uk/Media/Default/guidance/LGB10-Briefing-20150126.pdf>

⁴⁴ <https://www.bre.co.uk/news/New-BRE-Trust-report-shows-poor-quality-homes-in-England-cost-the-NHS-14bn-per-year-and-wider-society-186bn-1161.html>

⁴⁵ <https://royalsocietypublishing.org/doi/10.1098/rsta.2016.0460>

⁴⁶ <https://www.nomisweb.co.uk/>

⁴⁷ <https://www.theccc.org.uk/wp-content/uploads/2019/05/Net-Zero-The-UKs-contribution-to-stopping-global-warming.pdf>

⁴⁸ <https://www.theccc.org.uk/wp-content/uploads/2017/03/ED10039-CCC-UK-Bus-Opportunities-Draft-Final-Report-V7.pdf>

⁴⁹ https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/700496/clean-growth-strategy-correction-april-2018.pdf

⁵⁰ <https://www.drawdown.org/solutions/buildings-and-cities>

In summary, upgrading the whole of the UK existing housing stock to 'homes fit for the future' will avoid costs of at least £35bn p.a. Improving the energy efficiency of homes is also essential for delivering the UK target of net-zero by 2050. That will contribute to reducing the impacts of climate change on the UK economy. Delivering deep retrofit to our existing housing stock is a major contribution to growth in the UK low-carbon economy. This opens up a large export market with opportunities for clean growth in the UK economy.



5 THE UNMET MARKET NEEDS

Meeting the government's target for carbon emissions to reach net-zero by 2050 requires that the existing housing stock is upgraded to very high levels of energy efficiency – specifically that there are no carbon emissions from space and water heating. But whilst the necessary retrofits are technically feasible, a complex of barriers are impeding delivery of these retrofits at scale, and at speed and cost effectively.

As part of the Housing Innovation Week in September 2019, Connected Places Catapult collaborated with the Institution for Engineering and Technology and Innovate UK to bring together 40 organisations to explore the changes required to unlock the UK retrofit market.

The participants covered a broad range of stakeholders including:

- Housing Associations
- Private Estate Owners
- Developers
- Retrofit Specialists
- Foundation/Non-profit
- Central Government
- Local Government
- Academia
- SME/Start-ups

After reviewing the drivers for retrofit and current capabilities, the group focused on this key question:

“What needs to be true for housing owners to invest in deep retrofit?”

The goal was to identify what changes needed to happen to overcome the already identified barriers.

The next question to be tackled was:

“If these are the needs of housing owners, what changes do suppliers need to help them develop and deliver solutions?”

These simple questions sparked a lively debate that quickly converged into some core issues. The top five ‘needs’ for buyers and sellers were:

Buyers’ Needs	Sellers’ Challenges
Confidence that solutions can be delivered	A sustainable market
Information and knowledge	Information and evidence
Policy and regulation drivers	Policy and regulation drivers
A good business case to invest	Providing guaranteed performance
An offer tailored to their needs	Better supply chain skills

Following this, a group discussion unpacked these needs and challenges to paint a revealing picture of what needs to change.

5.1 Buyers’ Needs

5.1.1 Confidence

Buyers need to feel confidence in the solutions on offer and the people providing those solutions. Whilst they understand there is risk involved in any new approach, they need to know the risks are quantifiable and acceptable.

Buyers need to know there is a solution for their specific property and that the solution will work as advertised. They need to feel sure they won’t have problems with new suppliers providing new solutions or be left to deal with unexpected consequences.

A big concern is that by being an early adopter they may be trapped into an investment that is not future-proofed against the need to do the work all over again when policy or technology changes.

5.1.2 A good business case

A particular problem for commercial landlords is the need for a strong business case. They may recognise the need to upgrade their stock to preserve its value into the future, but any specific investment needs to show that it is a better use of the organisation’s money than other investment options.

Buyers are not seeing business cases that fit their strategic objectives and demonstrate worthwhile payback. In many cases the benefits of improving the performance of the home is seen elsewhere – for example, in reduced costs for health and social care. They would like to see those who benefit contributing to funding and delivery.

5.1.3 Information and knowledge

Buyers struggle to find reliable information on deep retrofit. They are unsure what the options are and what the impact of those choices might be.

They need trusted and independent sources of information and advice that should be supported by reliable and independent evidence of performance and value.

They need access to a knowledgeable and skilful supply chain that can guide them through the options, explain the impact, help them develop a strategy, and then deliver the retrofit on the ground. It is a noisy and confusing world – buyers simply don't currently know where to look for information or who to trust.

5.1.4 Policy and regulation

Many landlords feel they can barely cope with current legal requirements. So, unless upgrading the housing stock is mandated, it will never make it to the top of the agenda. They need clear government policy and supporting regulation.

There is also a fear they are being pulled in different directions by different government policies. A concern is that there is no clear integrated housing policy that everyone understands and can use in their decision-making.

5.1.5 A better offer

Buyers felt that what was offered by suppliers was not tailored to their needs. Vendors need to do a much better job of showing how solutions they offer fit the buyers' needs and how they will assist the buyer to achieve their strategic objectives. Vendors need to work to make retrofit fast and hassle-free so that it is easy for buyers to act.

There also needs to be a strong consumer offer to householders so that the value of deep retrofit is clear. That will enable them to decide either to invest themselves, or to pressure their landlords.

5.2 Sellers' Challenges

5.2.1 Information and evidence

Sellers need better information on the existing housing stock to guide innovation and the development of solutions. How many homes of which typology? What is the current actual performance?

They would be helped by independent evidence of performance in use for different systems and subsystems. This would go together with impartial advice on the best approach for any given project.

Most suppliers also want independent validation of their claims. They know that buyers are made nervous by new suppliers or new solutions, but they lack a way to give buyers the confidence they need.

A strong theme that emerged was that the entire sector would be helped by more information and knowledge sharing. It would help everyone to deliver to this emerging market. So whilst there can always be intellectual property concerns, in this complex area where multiple players need to come together to create integrated solutions, suppliers need to work better together nonetheless.

5.2.2 Market

A critical need for suppliers is to have confidence in the market. They need to know the market exists and is sustainable so that they can innovate and invest. The history of policy interventions in home retrofit has painfully illustrated that markets can vanish in an instant if there is a change in approach by Government. For this reason, they prefer markets that can be sustained without subsidy in the long term.

5.2.3 Policy and regulation

Suppliers recognise the ability of governments to make markets. Strong policy and regulation, sustained over a long period of time, would help create the market confidence they are looking for.

The UK Government should demand energy efficiency in the UK housing stock. They need to provide carrots and sticks, incentives and legal requirements, for both buyers and sellers.

5.2.4 Guaranteed performance

Suppliers want to offer a guarantee of performance. They want to ensure complete solutions for every building type, and pathways to net-zero for every property. They want to assure customers of the performance and benefits promised. Large-scale retrofit requires mass customisation and bespoke integrated solutions. Suppliers will need to work in new and complex supply chains and to have confidence they can trust the partners they are working with.

5.2.5 Skills

A skilled workforce will be critical for delivering deep retrofit at scale, at speed and cost effectively. Retrofits will need to be right first time, every time. That means new designs, new materials and new methods of construction, all delivered by a workforce with new skills. Suppliers need accredited training so they can provide guaranteed performance to their customers.

In summary, buyers and sellers have some unique needs, as well as many shared ones. Both see the risks, and both need confidence in the other to be able to scale up retrofits. Both lack critical information and are looking for independent and reliable advice and evidence. Supportive Government policy and regulation would help both overcome the barriers to creating homes fit for the future.

The workshop provided good evidence of what needs to change to overcome the well-known barriers. Now we need to identify projects and activities that can start to bridge the gap between buyers and the sellers.

6 ENABLING THE MARKET: FOUNDATIONS FOR A ROADMAP

In this section we consider four interesting ideas for projects or initiatives that could help both buyers and sellers. A wide range of ideas were explored, and the experts in the room felt – and confirmed in follow-up interviews and roundtables – that these four projects had the best chance of success, and as such were the ones they wanted to work on. These ideas are practical examples of ways to bridge the gap between the needs of buyers and the capabilities of sellers, and illustrate how deep retrofit could start to become commercially and technically viable, and an attractive consumer proposition.

These suggestions provide a valuable opportunity to explore how we might develop these ideas and help them take a tangible form. Each example is a ‘what if?’, aiming to stimulate discussion on how retrofit stakeholders can collectively leverage technology and innovation to deliver the shared goal of a high-quality, cost-effective, thriving retrofit market.

6.1 A National Housing Stock Database – enabling a deeper understanding of the existing housing stock

Value proposition: a national database and classification system enabling existing data to be linked into housing modelling tools allowing different retrofit strategies to be assessed.

This report focusses on the national housing supply, but such a tool could be expanded to include all buildings in the UK, including government and commercial buildings, creating far-reaching opportunities.

A better understanding of the existing UK housing stock for buyers and sellers, with an agreed classification system based on national data, would allow a property to be quickly and accurately assigned by type and condition. Building modelling would allow the effect of different retrofit strategies to be assessed, ensuring a good retrofit strategy – including an estimate of costs and impact – for any property. This housing model would help suppliers decide where to focus innovation to develop new components and solutions.

To be effective it would need to be based on actual building performance. A number of important datasets already exist, and this idea links existing information with building models and aims to fill in any data gaps. It offers a route to providing some of the key information needed for better decision-making by buyers and sellers.

6.1.1 Impacts of a National Housing Stock Database

The main impact would be in the efficiency and productivity of the retrofit process. It would also help accelerate the rate at which houses can be retrofitted, and the quality to which retrofits perform. Digital tools such as Building Information Modelling save the equivalent of 2-3% of the whole-life costs of construction projects, potentially generating £430 million p.a in benefits to the UK economy⁵¹, and we would expect similar benefits in retrofits. Industry impacts we would expect include:

- **Efficiency and productivity gains in the retrofit industry:** the diversity of UK housing stock means retrofit solutions must be customised to individual properties. This inefficient manual process is costly and time consuming. A structural database coupled with models would cut the time from design to delivery, provide optimal design for performance and reduce the risk of complications and remedial work.
- **Innovation:** a common evidence base would show which solutions work under which circumstances, allowing innovators to create novel solutions. As evidence on performance in use gathers, we would learn the fastest and most cost-effective routes to cutting carbon emissions from our existing housing stock.

Indoor environmental and performance sensors on retrofitted homes would constantly build the evidence base, allowing continuous improvement in retrofit design and practice and providing confidence to buyers and sellers. It opens an opportunity for data mining and machine learning to further improve efficiency and productivity, supporting digital transformation in the construction industry.

Monitoring of actual performance in use is also a key part of the next idea – the ‘retrofit kit’ – and shows how the different ideas support each other in transforming our housing systems.

- **Spillovers:** If we linked the data with building passports and property portals, new services in property rental and purchase markets could offer insights into a property’s history, potential upgradeability and expected future comfort and costs. This would allow owners to monetise the benefits of retrofit, incentivising short-term investment.

⁵¹ <https://www.pwc.co.uk/industries/capital-projects-infrastructure/insights/quantifying-benefits-of-bim.html>

6.2 Replicable, integrated interventions – the ‘Retrofit Kit’

Value proposition: a menu of components, based on standard interfaces and connections, that are reliable, predictable and flexible and which could be used to construct a solution for any property.

Reproducibility is critical to delivering retrofits quickly and correctly first time. Right now, a deep retrofit project involves sourcing components and materials from different suppliers and integrating them into a workable solution. There is relatively little information about how the different parts work together. Each project is unique, and therefore expensive and slow.

With standard interfaces and connections supported by rigorous testing we could develop a kit of parts that would work together reliably and predictably and be flexible enough to cover a wide range of building situations. This ‘menu of components’ could be used to define workable solutions, backed by good evidence, for any specific property and would by extension therefore enable mass customisation.

6.2.1 Impacts of a ‘retrofit kit’

The main impact would be improvements in speed, cost and reliability of retrofit, leading to increased carbon savings. Increased speed and reliability will bolster consumer confidence in retrofit solutions, helping to drive demand. Whilst current solutions (‘deep retrofit’) are effective, there remains a cost/performance gap which needs to be closed.

6.2.2 Development of an integrated ‘kit’ approach to replace piecemeal retrofit

- **Disincentivise legacy piecemeal retrofit**

The current approach of piecemeal retrofit typically yields less than 50% reduction in energy demand. It will not deliver the carbon savings required. Wherever possible it should be replaced with an integrated whole house retrofit.

- **Scale core ‘deep’ retrofit kits**

Current deep retrofit solutions enclose the home in a thermal envelope and use fully renewable energy. These solutions have been shown to deliver between 67% and 100% of the gas and electricity demand. These need to be further developed so they can be delivered quickly, cost effectively and with guaranteed performance.

- **Advanced retrofit innovation**

As well as scaling up kits based on existing technology we need innovation to expand the range of homes that can be quickly treated, and new components for integration; including improved insulation, better heat pumps and integrated energy ‘pods’. We also need to explore tighter integration between deep retrofit and changes to the energy supply system, including wider use of heat networks and secondary heat source.

All of this could be certified through a scheme approved and recognised by the industry.

This would be instrumental in creating trusted investments for encouraging finance,

detailed further in 6.4.

6.3 Mass customisation

Value proposition: modern methods of construction that combine mass factory production with adaptation of standard kits, ‘pop-up’ factories and local supply chains.

The UK has a wide range of building types and configurations. What’s more, as buildings age they are progressively adapted, modified and repaired; drifting from their original layout and specification.

Solutions that can be rapidly designed and manufactured for such a diversity of homes need to combine factory-like modern methods of construction and mass customisation. Adapting standard kits of parts to the needs of a specific building.

Such approaches are already widely used in other industries, and we can learn a lot from how they can deliver an individualised product using mass production techniques. It implies a complete rethinking of the construction process. A move away from the artisanal and traditional methods of construction to one which takes advantage of factory production, without attempting ‘one-size-fits-all’ conformity. Customisation would allow retrofit projects to respect the local vernacular, producing buildings with the right look and feel to fit in with their surroundings. As techniques develop, smaller ‘pop-up’ factories could be developed to service local regeneration projects. Taking advantage of locally available construction materials and building local supply chain skills.⁵²⁶¹

6.3.1 Impacts of mass customisation

The primary impacts of this idea are efficiency, productivity, local supply chains, creation of a skills base and reduced cost per unit. Fostering local hubs of retrofit expertise and taking advantage of modern methods of construction such as ‘flying’ and ‘pop-up’ factories, where manufacturing is performed off-site in local temporary factory units, will improve economics and take up. Flying factories in general construction have been found to reduce installation times by 65%, costs by 44%, and quality defects by 75%. They also cut waste, reduce transport and associated air emissions and reduce commercial risk.

Mass customisation also allows retrofitted homes to blend in with their surroundings, less likely to be seen as ‘odd’ and therefore more attractive to the typical householder.

Modern methods of construction should enable cost per unit to decrease over time, subject to ‘learning curves’ as seen in the solar panel and fuel cell industries. The learning curve theory assumes that with every doubling of production, the unit price falls at a consistent rate (dependent on a number of factors). If cost per unit reaches the break-even point for social landlords (£35,000 in some discussions), then roll-outs of 5,000 homes per local area could generate £175 million in revenues, with a proportion going to the local supply chain.

⁵² <https://www.skanska.co.uk/about-skanska/innovation-and-digital-engineering/innovation/flying-factories/>

Mass customisation then, combined with modern manufacturing methods, would allow the 'kits' in the previous section to be rapidly and cost-effectively adapted to a much wider range of properties. This will help drive costs down to the point where they are commercially viable for larger landlords. It should be particularly attractive in the social housing sector; which accounts for 17% of the UK stock.

6.3.2 Strategy for mass customisation

Targeting strategy

Mass customisation would be easiest to develop and have the greatest impact if targeted at relatively large numbers of similar properties in an area. Social landlords are the obvious target. Areas of focus could be identified by looking at environmental, economic and social indicators, weighed to strategy priorities, for example:

- **Number of homes with worst performing EPC ratings**

EPC ratings do not reflect actual carbon emissions, but they are still a useful and available proxy. 'D' and 'E'-rated homes (based on Leeds EPC ratings data) emit on average 5.1 tonnes of carbon per year, compared to 3 tonnes for 'C' ratings and 0.6 tonnes for 'A' ratings.⁵³ The retrofit roll-out need not be limited to homes with 'D' and 'E' ratings, but those figures could simply guide which local authorities to prioritise.

- **Suitability of homes for core retrofit kits**

Homes already suitable for the core retrofit kits described in 6.2.2 will be an easier challenge for mass customisation.

- **Excess Winter Mortality Rates**

Excess winter deaths measure the impact of cold homes on vulnerable people. Carmarthenshire, Wales, has over 40% more deaths in winter than other seasons.⁵⁴ Deep retrofit tackles fuel poverty and reduces the costs to health and social care.

- **Gross disposable household income per head**

Along with household energy requirements and energy prices, disposable household income indicates areas at risk of fuel poverty.

As an example, selecting the top ten local authorities in England and Wales based on a rough assessment in line with these criteria and improving the homes to 'beyond A' rating could save up to 9.1 million tonnes of carbon – nearly 14% of UK housing emissions, despite being just over 7% of UK housing stock.

⁵³ [https://epc.opendatacommunities.org/ Data set for Leeds](https://epc.opendatacommunities.org/Data set for Leeds)

⁵⁴ <https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/datasets/excesswintermortalityinenglandandwalesreferencetables>

6.4 A platform for retrofit finance

Value proposition: a platform that brings together housing and finance providers, offering standardised risk assessment tools, business models and contracts, and accessible finance package.

There is no shortage of money looking for long-term low-risk investment but, to-date, retrofit projects have not been able to access it. In the UK, renewable energy projects have been able to draw on international finance because the projects are large, well understood, with clear risks and yields. However, retrofit projects do not have the same characteristics.

Retrofit finance, which can be understood as a subset of green finance, involves both the commitment of the financial services sector to ensure more environmental factors form part of financial decision making, alongside an understanding of financing green products and services that support and develop innovation. The BEIS Green Finance Strategy released in July 2019, outlined a range of reform and policy that will underpin green finance in the UK in the near future. Financial instruments created for the retrofit market require standardised contracts and other tools such as measurement and verification of projects. Digitisation of these processes will result in productivity gains.

On a larger scale, the global green bond market, which exceeded USD\$200 billion issuance last year,⁵⁵ presents opportunities for retrofit financing. The growth of Economic, Social and Governance Exchange Traded Funds are similarly indicative of the global market's readiness to securitise green and social assets⁵⁶.

On the smaller-to-medium-scale, donation, debt and equity crowdfunding is growing in the UK as a viable option for retrofit financing. Debt crowdfunding, where investors receive their money back with interest, also known as Peer-to-Peer lending, allows the constraints of traditional banks to be bypassed⁵⁷, although the cost of debt is higher than residential mortgages. In the UK, crowdfunding is expected to reach £76.3 million in 2020, with an annual growth rate of 6.9%.⁵⁸ Even banking institutions have started providing crowdfunding platforms for residents to fund renewable energy products, signalling the wider acceptance by the UK's market of such capital raising tools.⁵⁹

There is an opportunity to create a platform that brings together housing providers and finance providers. For larger housing providers we need risk assessment and business modelling tools. For individual homeowners we need a range of standardised and accessible finance packages targeted at improving the energy efficiency of their home. Financers of retrofit need standardisation, certification and a large and steady flow of opportunity.

⁵⁵ <https://www.climatebonds.net/2019/10/green-bond-issuance-tops-200bn-milestone-new-global-record-green-finance-latest-climate>

⁵⁶ https://www.climatebonds.net/files/reports/cbi_gbm_final_032019_web.pdf

⁵⁷ <https://www.ukcfa.org.uk/what-is-crowdfunding/>

⁵⁸ <https://www.statista.com/outlook/335/156/crowdfunding/united-kingdom>

⁵⁹ <https://www.triodoscrowdfunding.co.uk/>

6.4.1 Impacts of a platform for retrofit finance

The main impacts of this idea would be an improved understanding of the business case for social landlords, improved access to finance for retrofitting firms and an investable proposition for international finance.

As the green products and services sector continues to grow across the house-building industry, green products may become more appropriate, and considered by fund managers to be packaged into more traditional and conservative investor portfolios, particularly when considering scaled or larger housing projects⁶⁰. While more research is required, new analysis has shown that certified commercial buildings are more commonly resilient to market-wide shocks which means investment portfolios could have a lower systemic risk attached. As this becomes more widely demonstrated for retrofit projects into the future, it will be a key in presenting a more attractive investment offer.

6.4.2 Strategy for a platform for retrofit finance

Developing an online platform which digitises services and processes for financing retrofit, could include the following:

- **Business Case Development and Financial Tools**

Templates and calculators for return on investment ratios, payback period, net present value, measurement and verification models and other financial instruments and contracts could be developed and supported. Information and the steps to be undertaken for bond issuance could also be provided.

- **Standards and certification recognition**

As detailed in the retrofit kits and mass customisation, any recognised standardisation or certification scheme could be implemented and tracked.

- **Crowdfunding**

Peer-to-Peer lending and other crowdfunding could be facilitated through the platform, allowing social landlords and other housing associations to promote their project and raise investment.

- **Sharing digital statements**

The above three elements could be facilitated by the digitisation of these documents outlined as well as other financial documents. Those statements historically provided to traditional lenders in person, could be scanned and shared with service providers online.

⁶⁰ <https://www.mandg.co.uk/-/media/Literature/UK/Institutional%20insights/MG-RE-Magnify-Green-Buildings-certification.pdf>

7 MOVING FORWARD

The objective is to create a shared vision and roadmap that all stakeholders can get behind. A clear narrative that points to the end goal, identifies what needs to happen to create homes fit for the future, and shows possible routes to success. Different participants will choose different pathways and different areas of focus, but a clear vision and roadmap will help us all navigate our way through a complex and confusing landscape.

This report is just the first few tentative steps on that journey. We have taken the best of the work already done and worked with many stakeholders to see where we need to focus and who needs to be involved. We now need to work with many more individuals and groups to refine the map of the landscape and jointly identify and deliver the best ways forward.

As a next step we invite all interested individuals and groups to comment on these ideas. Can you contribute examples, projects or evidence that would help develop the roadmap?

Connected Places Catapult will continue to flesh out the four initial ideas to bring them to a stage where we can identify a core active group and seek the necessary funding to progress.

For each idea we will work with the teams that created them to strengthen and deepen the story – to develop elevator pitches, blog pieces, white papers, or whatever is appropriate to explore and test the idea – and help the community come together to find practical ways to deliver.

We will be working with all our partners to demonstrate to government and funding agencies such as UKRI that transforming the UK housing stock into homes fit for the future is essential, technically deliverable, and that we can see what needs to be done to make it a practical – and profitable – reality.

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8 APPENDICES

8.1 Methodology

8.1.1 Workshops

A workshop took place at Connected Places Catapult in Clerkenwell on Wednesday 25th September 2019. The workshop was designed by Connected Places Catapult's Insight and Design Team with support from retrofit experts. The findings of the workshop have been shared within this report in Section 5, 'The Unmet Market Needs', and Section 6, 'Enabling the market: foundations for a roadmap'. The event was attended by 44 organisations, from across:

- Housing Associations
- Private Estate Owners
- Developers
- Retrofit Specialists
- Foundation/Non Profit
- Central Government
- Local Government
- Academia
- SME/Start-Ups

On 26th February 2019 over 120 people attended a workshop titled "Homes fit for the future – accelerating the deep retrofit market" at the Urban Innovation Centre in Clerkenwell to debate how we can upgrade our housing stock to tackle the challenge of climate change and meet the future needs of our citizens. A joint event organised by the Future Cities Catapult (Connected Places Catapult's former incarnation prior to merging with Transport Systems Catapult), Innovate UK and The Institution of Engineering and Technology (the IET). It took as its starting point a report published in November 2018 by the IET and Nottingham Trent University – "Scaling Up Retrofit 2020".

8.1.2 Interviews

Interviews with stakeholders and actors across the housing sector took place over the period June 2019 to December 2019.

8.1.3 Roundtables

A series of roundtable discussions were held throughout October 2019 to further develop the four ideas and to carry out early market testing on the strength of the ideas. The first of these roundtables took place on October 15th, and participants included stakeholders from Bow-Tie Construction, Pupil, QBOT, and BEIS Clean Growth Unit. The second roundtable took place on October 16th, and participants included stakeholders from IPPR and the Construction Products Association. The final roundtable took place on October 17th, with stakeholders from Innovate UK, UK GBC, and Turner & Townsend.

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BEIS	PRP
Bow Tie Construction	Pupil
BRE	Q-Bot
C40 Cities	Resideo
Catalyst	SD Foundation
Chair of Good Homes Alliance	South Yorkshire Housing Association
Construction Projects Association	Sustainable Energy Association Telemental
Department for Business, Energy & Industrial Strategy	The Institute of Engineering and Technology
Energy Systems Catapult	The Guinness Partnership
Energiesprong	The Retrofit Academy CIC
Facilitating the Future	Turner & Townsend
Flagship Group	UK Centre for Moisture in Buildings,
Gapogroup	University College London
GLA	UK Green Building Centre
Green Alliance	Ventive
Grosvenor	Waterstons
Hyde Housing Association Ltd	Welsh School of Architecture

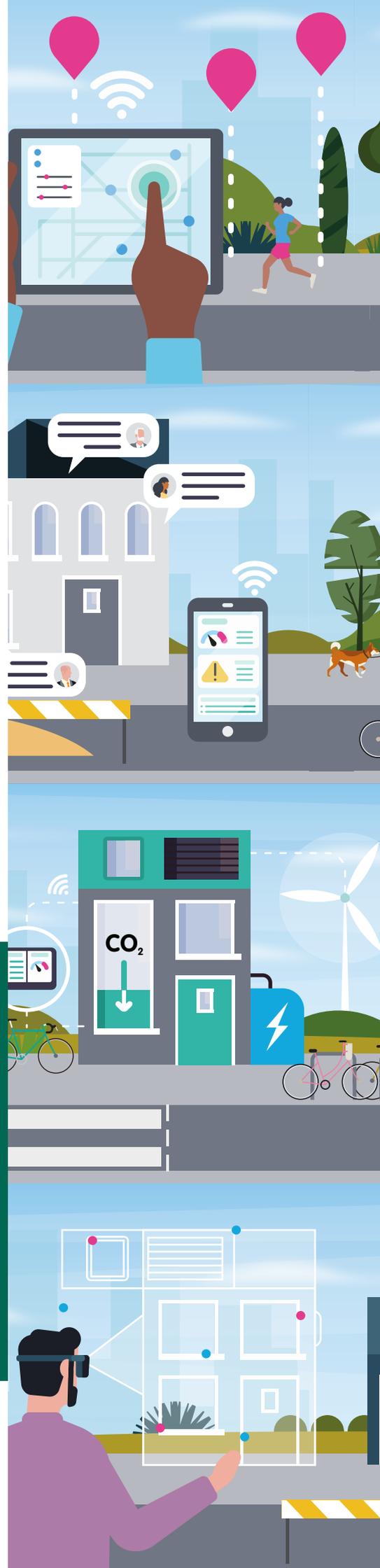
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DISCLAIMER

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