



HM Government

Heat and Buildings Strategy

Presented to Parliament by the Secretary of State for Business, Energy and Industrial Strategy by Command of Her Majesty

October 2021



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Chapter 1: Setting the scene

1.1. Ministerial foreword



In 2019 the UK became the first major economy to pass laws to reduce its greenhouse gas emissions to net zero by 2050.¹ In April 2021, we enshrined an ambitious target to reduce emissions by 78% by 2035 on 1990 levels into UK law. We must intensify our efforts and eliminate virtually all emissions arising from heating, cooling and energy use in our buildings. The UK has already shown that environmental action can go hand-in-hand with economic success, having grown our economy by more than three-quarters while cutting emissions by over 40 per cent since 1990. The sixth carbon budget is another indication of this government's dedication to Britain's green industrial revolution, positioning the UK as a global leader in the green technologies of the future.²

Decarbonising energy used in buildings is a key part of our [Clean Growth Strategy](#)³ and underpins the Prime Minister's [Ten Point Plan](#)⁴ for a Green Industrial Revolution to “*build back better and build back greener*”. This means improving our buildings' fabric efficiency, changing the way we heat and cool our buildings and improving the performance of energy-related

¹ For the purposes of this publication, we will focus on the UK's trajectory towards net zero total greenhouse gas emissions across all four administrations by 2050, henceforth referred to as 'Net Zero'.

² We have set a series of targets to reduce greenhouse gas emissions through legally-binding 'carbon budgets'. The sixth carbon budget covers the period 2033-2037.

³ BEIS (2017), 'Clean Growth Strategy' (<https://www.gov.uk/government/publications/clean-growth-strategy>).

⁴ BEIS (2020), 'The ten point plan for a green industrial revolution' (<https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution>).

products⁵. It will involve large-scale transformation and wide-ranging change to energy systems and markets, including the development of UK-based, green industrial capability and capacity. It is a challenging undertaking that has no single solution and will require a combination of leading-edge technologies and innovative consumer options. However, it also presents enormous opportunity.

The Confederation of British Industry, Climate Change Committee, National Infrastructure Commission, and International Energy Agency, and many others, have highlighted the importance of decarbonising buildings as part of a post-COVID economic response. We agree, decarbonising buildings will help the economy grow, create new green jobs and deliver greener, smarter, healthier homes and workplaces with lower bills. Delivering energy performance improvements and low-carbon heating systems will create new jobs in all parts of the UK – offering enormous potential to support our ‘levelling up’ agenda. The transition to low-carbon buildings could add £6 billion GVA (gross value added) and support 175,000 skilled, green jobs by 2030. It will create new markets and supply chains for innovative products fit for a Net Zero future, and as these markets grow, the UK may have greater export opportunities in sectors where we have particular knowledge, experience or expertise.

In driving this change, we are focusing support on the households and businesses that need it most. For example, in England we are delivering policies such as the Home Upgrade Grant and the Social Housing Decarbonisation Fund. These grants and funds are not only vital for meeting our Net Zero target, but also represent a key part of our strategy for tackling fuel poverty. We also announce the new £450 million Boiler Upgrade Scheme to support households who want to make the switch to low-carbon heat pumps with £5,000 grants.

Our ambition is to phase out the installation of natural gas boilers beyond 2035. Much like the move to electric vehicles, the move to low-carbon heating will be a gradual transition from niche product to mainstream consumer option. No-one will be forced to remove their existing boilers. Heat pumps are already a predominant technology in some other countries, and have high levels of customer satisfaction; however, work needs to be done to build UK supply chains and drive down costs. Meanwhile we will continue to invest in hydrogen heating through the neighbourhood and village trials, and the plan for the town pilot. This will allow us to take strategic decisions on the role of hydrogen in heating by 2026.

Across our diverse buildings landscape, we all have a role to play. The changes needed will be different depending on the type of building, building owner or occupier, and wider energy system considerations. An NHS hospital requires different solutions than a rented terraced home, and our policy package reflects this – tailoring our approach to different types of buildings and their occupants. This is the common-sense approach – putting consumers at the heart of our action to transform our buildings.

This strategy brings together the government’s work on energy efficiency and clean heat. It ensures that we have a consistent and coherent approach across different markets, buildings and occupancy types, and that we have robust plans which offer a credible pathway to achieving carbon budgets and lay the foundations for Net Zero buildings in the UK by 2050.

Rt Hon Kwasi Kwarteng MP

Secretary of State for Business, Energy and Industrial Strategy

⁵ Energy-related products are products which directly consume energy (such as washing machines, lighting and heating appliances) or indirectly impact energy consumption during use (such as taps and non-electric showers).

1.2. Our Heat and Buildings Strategy – at a glance

The strategy sets out the vision for a greener future, which creates hundreds of thousands of green, skilled jobs, drives the levelling up agenda and generates opportunities for the growth of British businesses. The transition to high-efficiency low-carbon buildings can and must take account of individual, local and regional circumstances. Interventions need to be tailored to the people and markets they serve. The strategy outlines a transition that focuses on reducing bills and improving comfort through energy efficiency, and building the markets required to transition to low-carbon heat and reducing costs, while testing the viability of hydrogen for heating. This will provide a huge opportunity for levelling up – supporting 240,000 skilled, green jobs by 2035, concentrated on areas of the UK where investment is needed most. This section sets out:

- *the rationale behind our approach*
- *the principles and phasing of the policy package that delivers them*
- *key commitments for action*



To meet Net Zero virtually all heat in buildings will need to be decarbonised.

The benefits of more efficient, low-carbon buildings for consumers are clear: smarter, better performing buildings, reduced energy bills and healthier, more comfortable environments. Additionally, studies indicate that more energy efficient properties typically have a higher value than less efficient ones. Evidence from a study commissioned by BEIS indicated that properties with an EPC C rating were worth around 5% more than those currently at EPC D rating, after controlling for other factors such as property size and archetype. The 2020s will be key to delivering a step change in reducing emissions from buildings and establishing the foundations of a pathway to Net Zero. This means improving the efficiency and flexibility of our buildings, and developing the UK supply chains and technology options needed to save carbon throughout the decade and put us on a cost-effective pathway to Net Zero.



The buildings transition presents huge opportunities for jobs, growth and levelling up.

Decarbonising buildings can provide a major economic stimulus, creating new highly-skilled jobs, products, markets, and supply chains in the UK, fit for a Net Zero future. As building improvements are labour-intensive, upgrading our homes and workplaces could rapidly create new opportunities and support over 240,000 low-carbon jobs by 2035 across the sector (from manufacture to installation and modelling to project management) as part of a green recovery, while also reducing energy bills and delivering better, greener, and healthier homes and workplaces.⁶ As the global market for low-carbon heat, smart products, and energy efficiency grows, UK businesses can make use of export opportunities in sectors where we have developed particular knowledge, experience and expertise. We are working to ensure that these opportunities are available across the UK, especially where they can help level up certain areas.

⁶ As stated in the Energy White Paper and Ten Point Plan, based on BEIS analysis of the Energy Innovation Needs Assessment, Vivid Economics et al. (2019) (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/845654/energy-innovation-needs-assessment-building-fabric.pdf).



Fairness and affordability are at the heart of our approach. Investing in energy efficiency will bring down bills for millions of households and businesses – with Government support for low income households to pay for improvements.

Meanwhile we are acting to reduce the costs of low-carbon heat – with the ambition of working with industry to reduce the costs of heat pumps by at least 25-50% by 2025 and towards parity with boilers by 2030, and supporting consumers who switch early with £5,000 Boiler Upgrade Scheme grants. Alongside action to remove distortions in energy prices, heat pumps should be no more expensive to buy and run than existing boilers and we are investing in innovation to make them smaller, easier to install and beautiful in design.



Ultimately, Net Zero will mean gradually, but completely, moving away from burning fossil fuels for heating. Which is why we are setting the ambition of phasing out the installation of new natural gas boilers from 2035. The future is likely to see a mix of low-carbon technologies used for heating: electrification of

heat for buildings using hydronic (air-to-water or ground-to-water) heat pumps, heat networks and potentially switching the natural gas in the grid to low-carbon hydrogen. While there is work to be done to identify the best solutions for different buildings and regions, there are also areas where the solution is clear and we can take decisive, ‘no-regrets’ action now. No or low-regrets’ means actions that are cost-effective now and will continue to prove beneficial in future. For example, installing energy efficiency measures reduce consumer bills now, while making buildings warmer and comfier, but have the added benefit of making future installations of low-carbon heating more cost-effective. For example, hydronic heat pumps will be a key technology for new buildings and buildings not connected to the gas grid, and heat networks will be a key technology in areas of high-density heat demand and where there are large low-carbon heat sources. Consultations published alongside this strategy propose how regulations can encourage the transition in these segments



We will take major strategic decisions on the role of Hydrogen for heat by 2026. The infrastructural and regulatory implications that will come with mass

adoption of different low-carbon heat sources – such as new electricity generation capacity and network reinforcement and additional hydrogen production plants – will be transformational. Strategic decisions will be required to enable a co-ordinated, efficient, effective and affordable mass decarbonisation by 2050. These decisions will need to be informed by a comprehensive programme of research, development, planning and innovation over the coming years. In particular, we will explore the potential to use hydrogen for heating buildings in the next few years to inform a strategic decision on the role of hydrogen in decarbonising heat in 2026. Along our journey to Net Zero, we will need to take co-ordinated decisions across all levels – national, regional, local and individual – to ensure we deploy the most suitable low-carbon heat source for that area or building.



We need to act now to develop the market and bring down costs for energy efficient low-carbon heat. Heat pumps and Heat Networks are proven scalable options for decarbonising heat and will play substantial roles in any Net Zero scenario, so we need to build the market for them now. A UK market with the

capacity and capability to deploy at least 600,000 hydronic heat pump systems per year by 2028 can keep us on track to get to Net Zero and set us up for further growth if required. This means ramping up UK-based supply chain and deployment from approximately 35,000 heat pumps a year⁷, to potentially being able to replace around 1.7 million fossil fuel boilers per year

⁷ BSRIA (2020), ‘Heat pumps market analysis’ (<https://www.bsria.com/uk/>).

by the mid-2030s.⁸ We are also working on and investing £338 million over 2022/23 to 2024/25 into a broader Heat Network Transformation Programme to scale up low-carbon heat network deployment and to enable local areas to deploy heat network zoning, which will create a step-change in low-carbon heat network market growth.



The journey to Net Zero buildings starts with better energy performance.

Increased awareness of energy use and the need for greater efficiency is the first stepping-stone to enabling consumer decisions to improve building energy performance and use smarter, more efficient products and systems. Improving energy efficiency by adopting a fabric-first approach is key in ensuring the transition to low-carbon heating is cost-effective and resilient. 'Fabric-first' means focusing on installing measures that upgrade the building fabric (e.g. walls/lofts) itself before making changes to the heating system. We are committed to supporting businesses and households to upgrade as many buildings as possible to higher levels of energy efficiency and flexibility, in a way that will ensure long-term compatibility with low-carbon heating systems.



We need to take a co-ordinated system-wide approach to decarbonise cost-effectively.

To deliver Net Zero in a way that delivers value to consumers, we need to consider the measures needed to decarbonise heat alongside the decarbonisation action needed in other sectors. This includes the generation, distribution and storage of energy (such as electricity and hydrogen), and the associated investment and reinforcement of infrastructure required. We will need to consider this at a national and local level. To minimise generation demand and thereby reduce costs, we need to create a smart and flexible energy system, and ensure buildings use energy in a smart and flexible way.

Our policy approach

We have developed a set of five core principles to guide action in the 2020s and longer-term transformation to Net Zero.

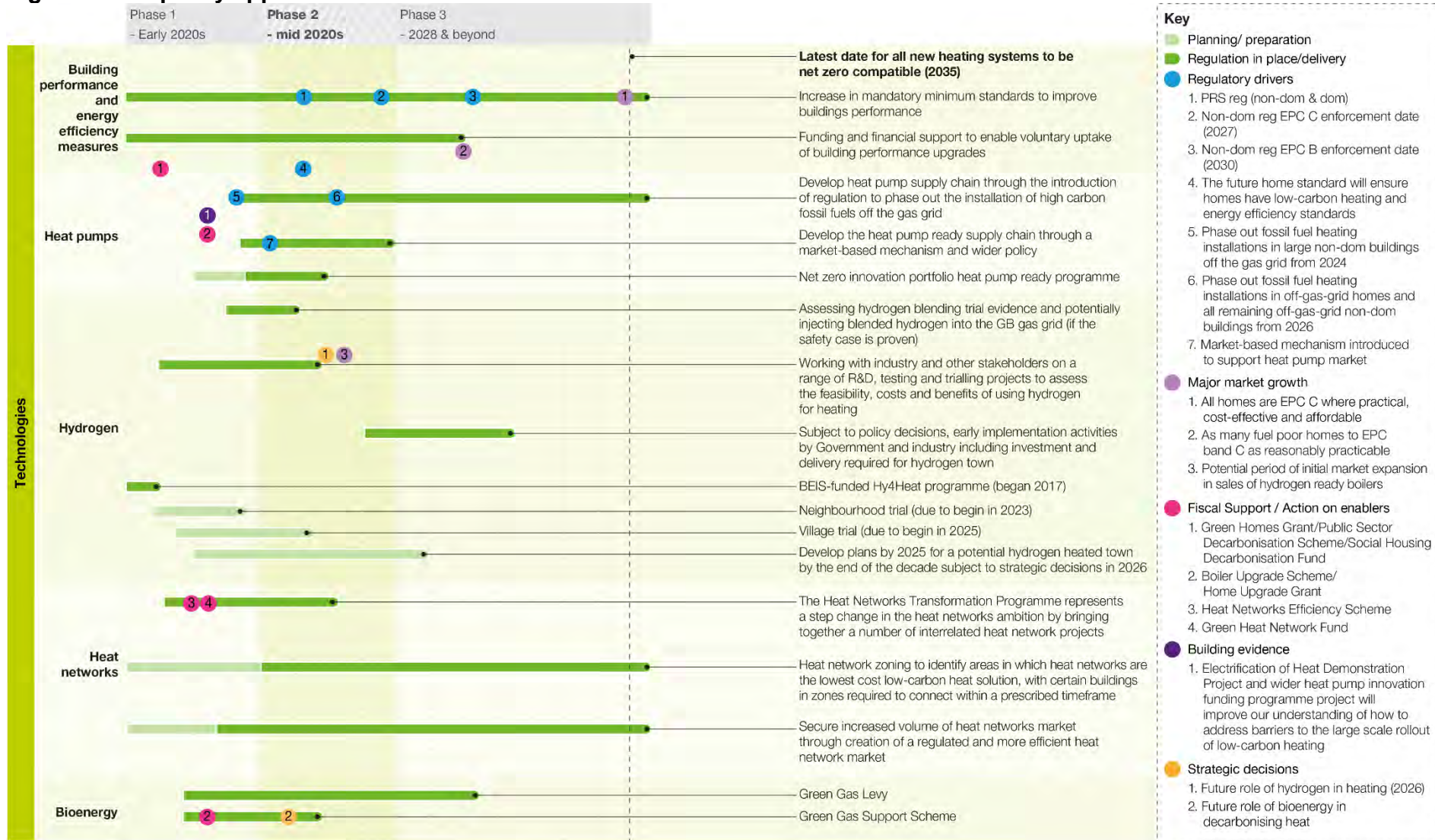
1. **We need to take a whole-buildings and whole-system approach to minimise costs of decarbonisation** - We will consider the heating system in the context of what is most appropriate for the whole building, as well as considering local and regional suitability and how best to manage system-level impacts (this is explored in Chapter 3). This will also deliver UK jobs across a variety of specialisms.
2. **Innovation is essential to driving down costs, improving options and informing future decisions** - We will ensure that regional, local and national decisions can be informed by the latest data and research and we will continue to work with industry to refine processes and technologies to deliver value for money and value for the UK economy (this is explored in Chapter 4).
3. **In parallel, we need to accelerate 'no- and low-regrets' action now** - Prioritising action to: improve buildings with low energy performance and high-carbon emissions, futureproof new-builds to avoid the need for later retrofitting, adopt a fabric-first approach to improve building thermal efficiency, increase the performance of products and appliances, ensuring climate change resilience by mitigating risks of overheating and poor air quality, build the market by developing our technical expertise, growing

⁸ BSRIA (2020), 'Domestic Boilers (World Market for Heating Boilers 2020/R2019)' (https://www.bsria.com/uk/product/nEjGED/domestic_boilers_world_market_for_heating_boilers_2020r2019_8a707622/).

the workforce, and expanding the UK's manufacturing capacity and capability. This includes building the market to install at least 600,000 hydronic heat pumps per year by 2028, which we know will be needed in all paths to Net Zero (this is explored in Chapter 5).

4. **We will balance certainty and flexibility to provide both stability for investment and an enabling environment for different approaches to be taken to address different buildings** - We will provide long-term signals to investment by setting requirements and embedding flexibility in how they are achieved, so businesses and the public can prepare to decarbonise in a way that suits them and maximise the opportunities this presents, including investing in training in greener skills (this is explored in Chapter 5).
5. **Government will target support to enable action for those in most need** - We will make sure that our policies support those who are hardest hit by COVID-19, such as small businesses and the fuel poor. We will also use taxpayer money efficiently to transform public sector buildings and improve the support and protection available for consumers (this is explored in Chapter 6).

Figure 1: Our policy approach



What we will do – key commitments

Upgrading our building stock will require a comprehensive package of measures to be implemented in the next decade. This strategy outlines how we plan to:

Deliver the [Ten Point Plan](#)⁹ ambition to develop the markets and consumer choices required to achieve Net Zero heating:

- 1. Signalling our intention to phase out the installation of new natural gas boilers from 2035:** Given the lifetime of a natural gas boiler is around 15 years, in order to reach Net Zero in a cost-effective consumer-friendly way, we aim to phase out the installation of new natural gas boilers beyond 2035, once costs of low-carbon alternatives have come down. No-one will be forced to remove their existing boilers. Instead, we will grow the market for heat pumps through incentivising early adopters through Boiler Upgrade Scheme grants, proposing introduction of a market-based regulation on manufacturers¹⁰ similar to that which has been successful in growing the market for electric vehicles, and phasing out the installation of the dirtiest and most expensive fossil fuel systems and deployment in new buildings. This would be in line with the natural replacement cycle, including any hydrogen ready boiler in any areas not converting to hydrogen, to ensure all heating systems used in 2050 are compatible with Net Zero.
- 2. Setting a clear ambition for industry to reduce the costs of installing a heat pump by at least 25-50% by 2025 and to ensure heat pumps are no more expensive to buy and run than gas boilers by 2030:** We understand that capital costs can act as a barrier and that investment to refine technologies, supply and installation requires clear signals and market certainty. Therefore, working with industry, we are setting out our ambition to see significant cost reductions. We know that industry is ready to back these ambitions in response to the package of measures in this strategy and accompanying publications.
- 3. Improving heat pump appeal by continuing to invest in research and innovation:** Together with industry we must continue to innovate to reduce the barriers to installation, making heat pumps beautifully designed, smaller, and easier to install and use. We are investing in new innovation opportunities - as part of the Net Zero Innovation Portfolio - aimed at advancing heat electrification to support the decarbonisation of homes. The £60 million Net Zero Innovation Portfolio (NZIP) 'Heat Pump Ready' Programme will support the development of innovation across the heat pump sector, including to improve the consumer experience in installing and using a heat pump. This will build on our previous Energy Innovation Programme activities, such as the Electrification of Heat Demonstration Project and Green Home Finance Innovation Programme.
- 4. Ensuring affordability by providing financial support to meet capital costs:** Our ambition is to ensure that the costs of decarbonising heat and buildings falls fairly across society. Consumers who choose to switch to a heat pump will be supported in making the transition to a heat pump. We have published our government response on

⁹ BEIS (2020), 'The ten point plan for a green industrial revolution' (<https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution>).

¹⁰ BEIS (2021), 'Market-based mechanism for low carbon heat' (<https://www.gov.uk/government/consultations/market-based-mechanism-for-low-carbon-heat>).

a clean heat grant¹¹, called the Boiler Upgrade Scheme, to support deployment of low-carbon heat in existing buildings. This will provide households with £5,000 grants when they switch to an air source heat pump or £6,000 when they switch to a ground source one.

5. **Rebalancing energy prices to ensure that heat pumps are no more expensive to buy and run than gas boilers:** Clean, cheap electricity is an everyday essential. We have seen the impact of overreliance on gas pushing up prices for hardworking people but our plan to expand our domestic renewables will push down electricity wholesale prices. However, current pricing of electricity and gas does not incentivise consumers to make green choices, such as switching from gas boilers to electric heat pumps. We want to reduce electricity costs so when the current gas spike subsides we will look at options to shift or rebalance energy levies (such as the Renewables Obligation and Feed-in-Tariffs) and obligations (such as the Energy Company Obligation) away from electricity to gas over this decade. This will include looking at options to expand carbon pricing and remove costs from electricity bills while ensuring that we continue to limit any impact on bills overall. We know that in the long run, green products are more efficient and cheaper, and we are putting fairness and affordability at the heart of our approach. We will launch a Fairness and Affordability Call for Evidence on these options for energy levies and obligations to help rebalance electricity and gas prices and to support green choices, with a view to taking decisions in 2022.
6. **Significantly growing the supply chain for heat pumps to 2028:** We will go from installing around 35,000 hydronic heat pumps a year¹² to a minimum market capacity of 600,000 per year by 2028. This will be supported by the introduction of a market-based mechanism to establish the incentives for industry to take the lead in transforming the consumer market in low-carbon heating, which we are consulting on alongside this Strategy.¹³ In all future heat scenarios - including if hydrogen is proven to be feasible and preferable to use in heating some buildings - 600,000 hydronic heat pump installations per year is the minimum number that will be required by 2028 to be on track to deliver Net Zero. Hydronic heat pump systems will be the key technology for many properties in the future, including: properties that are not connected to the gas grid, new-builds requiring low-carbon heating, and existing buildings where consumers ultimately opt to switch to heat pumps in preference to other low-carbon heating options. To ensure we can build the UK low-carbon heat market sustainably towards the 1.7 million heating systems per year needed by 2035, further policy would be required to phase out installation of new fossil fuel heating. We could grow the heat pump market and transition consumers in stages, while continuing to follow natural replacement cycles to work with the grain of consumer behaviour.
7. **Ensuring all new buildings in England are ready for Net Zero from 2025¹⁴:** We are bringing in the Future Homes Standard and have consulted on the Future Buildings Standard for new-builds in England. Government's ambition is to build 300,000 new

¹¹ BEIS (2021), 'Government response: Future support for low carbon heat' (<https://www.gov.uk/government/consultations/future-support-for-low-carbon-heat>).

¹² BSRIA (2020), 'Heat pumps market analysis' (<https://www.bsria.com/uk/>).

¹³ BEIS (2021), 'Market-based mechanism for low carbon heat' (<https://www.gov.uk/government/consultations/market-based-mechanism-for-low-carbon-heat>).

¹⁴ New buildings consented from 2024 for Scotland and 2025 for Wales.

homes a year by the mid-2020s.¹⁵ We anticipate at least a third of our 2028 heat pump target to be installed in new build domestic properties annually. To enable this, we will introduce new standards through legislation (such as Building Regulations) to ensure new homes and buildings will be fitted with low-carbon heating and high levels of energy efficiency, so that new buildings do not have to be retrofitted in the future. We will also consult on ending new connections to the gas grid.

8. **We intend to start by phasing out the installation of fossil fuel heating systems in properties not connected to the gas grid:** Alongside this strategy, we are consulting on ending the installation of high-carbon fossil fuels to heat homes that are not connected to the gas grid in England from 2026 and non-domestic buildings not connected to the gas grid from 2024. Households will not be forced to remove their existing boilers, instead we will be taking an approach that goes with the grain of markets and consumer behaviour to minimise costs and disruption. We are keen to hear views on this approach, and in particular whether there are sectors or building types with specific needs that should be taken into account, for example, heritage buildings or those occupied by voluntary sector organisations.
9. **Growing UK-manufactured technology and capabilities:** We want manufacturers to scale-up UK production to help meet UK demand and we are aiming for a 30-fold increase in heat pumps manufactured and sold within the UK by the end of the decade. This ensures the UK gets the full economic benefit of investment including benefits to businesses and customers, through reduced costs and emissions from supply chains and shipping. Growing UK manufacture and supply of heat pumps to over 300,000 units a year by 2028 could increase the rate of installation, grow opportunities for exports, and create more than 10,000 manufacturing-related UK jobs. Recent investments into low-carbon technology manufacture and supply are welcome early steps in this direction.
10. **Ensuring the electricity system can accommodate increased electricity demand and heat pumps can be quickly and affordably connected to the network:** We will work with Ofgem, distribution network operators, and other local actors on the approach to planning the network in Great Britain and delivering smart, secure, cost-effective solutions. We will also consider carefully the role of flexibility within buildings, including the potential for storage and hybrid technologies in combination with flexible tariffs.

Deliver the [Ten Point Plan](#)¹⁶ commitment to develop hydrogen for heating through:

11. **Developing hydrogen for heating buildings by thoroughly assessing the feasibility, safety, consumer experience and other costs and benefits, by the middle of the decade:** We will work in partnership with industry and other key stakeholders to test and evaluate the potential of hydrogen as an option for heating our homes and workplaces.

¹⁵ HM Treasury (2017), 'Building the homes the country needs' (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/661430/Building_the_homes_the_country_needs.pdf). This figure includes both new-build and change of use.

¹⁶ BEIS (2020), 'The ten point plan for a green industrial revolution' (<https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution>).

12. **Establishing large-scale trials of hydrogen for heating:** We will support industry to conduct first-of-a-kind 100% hydrogen heating trials, including a neighbourhood trial by 2023 and a village scale trial by 2025. We will also develop plans by 2025 for a possible hydrogen town that can be converted before the end of the decade. Earlier this year BEIS and Ofgem wrote to the gas distribution network operators inviting them to develop proposals for a village trial.¹⁷ We also published a [consultation on facilitating a grid conversion hydrogen heating trial](#)¹⁸ in August 2021.
13. **Enabling blending of hydrogen in the gas grid:** As stated in [UK hydrogen strategy](#)¹⁹, we are engaging with industry and regulators to develop the safety case, technical and cost-effectiveness assessments of blending up to 20% hydrogen (by volume) into the existing gas network. This has the potential to deliver up to 7% emissions reductions from the grid, whilst supporting the development of the UK Hydrogen Economy. We aim to provide an indicative assessment of the value for money case for blending by autumn 2022, with a final policy decision likely to take place in 2023.
14. **Consulting on hydrogen-ready boilers:** soon, we aim to consult on the case for enabling, or requiring, new natural gas boilers to be easily convertible to use hydrogen ('hydrogen-ready') by 2026, in line with our timelines to take broader strategic decisions about the role of hydrogen in heating buildings. This would mean that new boilers would be fit for the future, minimising later disruption and costs to consumers. We will also use this consultation to test proposals on the future of broader boiler and heating system efficiency and explore the best ways to reduce carbon emissions from gas heating systems over the next decade.
15. **Developing the evidence base necessary to take strategic decisions on the role of hydrogen for heating buildings in 2026:** Local trials and planning work, together with the results of our wider research and development and testing programme, will inform and enable strategic decisions about the role of hydrogen for heating in delivering Net Zero, and the actions that will be required to support this. We anticipate that conclusions from our ongoing research will be available in the mid-2020s and we intend to take strategic decisions on the role of hydrogen in heating buildings in 2026.

Deliver the Ten Point Plan²⁰ commitment to Greener Buildings through:

16. **Improving the performance of existing homes:** Continue to drive improvements to poorer performing homes throughout the 2020s, in line with the commitment we made in our [Clean Growth Strategy](#)²¹ for as many homes as possible to achieve EPC band C by 2035 where cost-effective, practical and affordable, and our commitment to reduce fuel poverty by ensuring as many fuel poor homes in England, as reasonably practicable, achieve a minimum energy efficiency rating of band C by the end of

¹⁷ Ofgem (2021), 'Hydrogen Consumer Trial - Open Letter to GDNs' (<https://www.ofgem.gov.uk/publications/hydrogen-consumer-trial-open-letter-gdns>).

¹⁸ BEIS (2021), 'Hydrogen for heat: facilitating a grid conversion hydrogen heating trial' (<https://www.gov.uk/government/consultations/hydrogen-for-heat-facilitating-a-grid-conversion-hydrogen-heating-trial>).

¹⁹ BEIS (2021), 'UK hydrogen strategy' (<https://www.gov.uk/government/publications/uk-hydrogen-strategy>).

²⁰ BEIS (2020), 'The ten point plan for a green industrial revolution' (<https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution>).

²¹ BEIS (2017), 'Clean Growth Strategy' (<https://www.gov.uk/government/publications/clean-growth-strategy>).

2030^{22, 23} We have also consulted on driving energy efficiency improvements in the private-rented sector and aim to publish a response before the end of the year.²⁴

17. **Supporting social housing, low income and fuel poor households:** We will continue to ensure financial support is targeted to those who need it most, supporting the most vulnerable in society in switching to low-carbon heating and improving the energy efficiency of their homes. We are boosting funding for the Social Housing Decarbonisation Fund (investing a further £800 million over 2022/23 to 2024/25) and Home Upgrade Grant (investing a further £950 million over 2022/23 to 2024/25), which aim to improve the energy performance of low income households' homes, support low-carbon heat installations, help to reduce fuel poverty and build the green retrofitting sector to benefit all homeowners.
18. **Leading through the public sector:** We aim to reduce direct emissions from public sector buildings by 75% against a 2017 baseline by the end of carbon budget 6. We will encourage public sector organisations to monitor and report their energy use, develop and deploy plans to decarbonise, including by applying for government funding, and to lead by example to build demand and encourage other sectors to decarbonise. We have already made available over £1 billion through the Public Sector Decarbonisation Scheme²⁵ which will provide critical support and drive whole-building interventions that deliver energy efficiency and low-carbon heating at the same time. We are investing a £1425 million into this scheme over 2022/23 to 2024/25.
19. **Setting long-term direction and clear signals:** We will build on our 2020 consultation on improving the energy performance of privately rented homes²⁶ using minimum standards to ensure the UK housing stock is on track to meet EPC band C by 2035 where practical, cost-effective and affordable. Our approach to raising minimum standards will work with the grain of the market, using natural trigger points to help minimise disruption to consumers. We will consider different segments of our building stock individually, helping to ensure we take a tailored pathway to improving our homes, workplaces and public spaces. There is no one-size-fits-all solution to heat decarbonisation, and our approach to regulation demonstrates this. For example, the Decent Homes Standard review will consider how the standard can work to support better energy efficiency and the decarbonisation of social homes, and we are also exploring opportunities to improve the energy performance of owner-occupier homes. We are considering how we can kick start the green finance market and have consulted on introducing mandatory disclosure requirements for mortgage lenders on the energy performance of homes on which they lend, and on setting voluntary improvement targets to be met by 2030. In addition, we will consider the case for

²² In accordance with our 'Fuel Poverty Energy Efficiency Rating Methodology' (2014) (https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/332236/fpeer_methodology.pdf).

²³ As stated in their 2021 policy programme (<https://www.gov.scot/publications/scottish-government-and-scottish-green-party-shared-policy-programme/>), Scottish Government are seeking to upgrade the majority of homes in Scotland to at least EPC Band C by 2033, where feasible and cost-effective.

²⁴ BEIS (2020), 'Improving the energy performance of privately rented homes' (<https://www.gov.uk/government/consultations/improving-the-energy-performance-of-privately-rented-homes>).

²⁵ BEIS (2020), 'Public Sector Decarbonisation Scheme' (<https://www.gov.uk/government/publications/public-sector-decarbonisation-scheme-psds>).

²⁶ BEIS (2020), 'Improving the energy performance of privately rented homes' (<https://www.gov.uk/government/consultations/improving-the-energy-performance-of-privately-rented-homes>).

setting a date to ensure that all homes meet a Net Zero minimum energy performance standard before 2050, where cost-effective, practical and affordable.

20. **Significantly reducing energy consumption of commercial, and industrial buildings by 2030:** This will deliver significant emissions reductions and deliver cost savings for businesses by: setting privately-rented commercial buildings a minimum efficiency standard of EPC band B by 2030 in England and Wales, introducing a new and innovative performance-based energy rating for large commercial and industrial buildings, over 1,000m² which use more energy than all other commercial and industrial buildings, while only accounting for about 7% of the stock²⁷ and can deliver significant energy and emission reductions, consulting on regulating the owner-occupier sector later this year
21. **Launch a new world-class policy framework for energy-related products:** We will continue to pursue and explore policies that increase use of energy efficient, smart and sustainable products and maximise their associated benefits, following our departure from the EU. We plan to launch our new Energy Related Products Policy Framework which will be published in due course and include illustrative proposals on a range of products including cookers, boilers (including consideration of hybrids), showers, taps and heat emitters. The introduction of this new framework will reduce consumer bills, reduce energy consumption, and reduce emissions by ensuring that when consumers invest in new products, they are buying products that have been made to high efficiency standards.
22. **Considering how to ensure flexible demand and supply (including through smart technologies and energy storage) is taken into account across the full range of energy performance, fuel poverty and heat policies, including regulation and subsidy schemes:** We will build on existing work to consider how to recognise technologies in the Standard Assessment Procedure (SAP) methodology, so that buildings are decarbonised in a way that works for the consumer and the wider energy system.
23. **Developing a workforce pipeline with the skills to meet the requirements of Net Zero transition:** Government is working closely with industry to ensure that installers have up-to-date, high-quality training and that they are not undercut by installers who offer cheaper, low-quality installations. This involves developing new core competencies and agreed training criteria for installing low-carbon heating systems and ensuring energy efficiency improvements are delivered to high standards, using quality and certification schemes, and specification standards.

²⁷ BEIS internal analysis of BEIS (2016), 'Building Energy Efficiency Survey' (<https://www.gov.uk/government/publications/building-energy-efficiency-survey-bees>). Private buildings only. Excluding energy used for manufacturing and refining.

Deliver further critical carbon savings and Energy White Paper²⁸ commitments through:

24. **Accelerating growth of the low-carbon heat network market through a series of complementary measures:** We will continue to provide funding through the Green Heat Network Fund and Heat Networks Investment Project to support current market growth, and develop the heat network zoning approach in England.²⁹ This is part of a broader Heat Network Transformation Programme, in which we are investing £338 million (over 2022/23 to 2024/25). We will develop regulations to drive decarbonisation and deliver better consumer protections, all as part of a comprehensive transformation programme for heat networks.
25. **Increasing the proportion of biomethane in the gas grid in Great Britain:** We will deliver the Green Gas Support Scheme (GGSS) to support the injection of biomethane from anaerobic digestion (expected to deliver 2.8TWh of renewable heat per year in 2030/31). In the long term, we will explore the development of commercial-scale gasification and a potential biomethane support scheme to replace the GGSS after 2025.

1.3. Background

This Heat and Buildings Strategy aims to set out the immediate actions and long-term signals required to reduce emissions from buildings to near zero (between 0 and 2 MtCO₂e) by 2050.

This section:

- *sets the context for decarbonising buildings*
- *introduces other key aims to be progressed in parallel when decarbonising buildings*

In 2019, the UK government set out a target to achieve net zero greenhouse gas emissions across the whole UK by 2050.³⁰ This commitment, enshrined in the Climate Change Act (2008), means that we have 30 years to completely decarbonise the economy. But this presents substantial opportunities for the UK: to grow skills, build diverse job markets, level up across the country, reduce bills by improving efficiency, tackle fuel poverty, have warmer and better buildings, and ensure our energy system is secure and fit for the future. We will take a phased and targeted approach to ensure a gradual transition to Net Zero.

²⁸ BEIS (2020), 'Energy white paper: Powering our net zero future' (<https://www.gov.uk/government/publications/energy-white-paper-powering-our-net-zero-future>).

²⁹ Scotland uses district heating zones to identify priority areas to implement energy efficiency measures and enable coordinated action to develop and deliver long-term district heating plans (<https://www.gov.scot/publications/analysis-responses-consultation-heat-energy-efficiency-strategies-regulation-district-heating/>). This activity is regulated by Heat Networks (Scotland) Act 2021 (<https://www.legislation.gov.uk/asp/2021/9/contents/enacted>).

³⁰ In this strategy we refer to this target as 'Net Zero'. We have measured emission reduction by comparing all greenhouse gases to their equivalent tonnage of carbon dioxide. MtCO₂e = mega tonnes of carbon dioxide equivalent.

To ensure continued progress, we have set a series of targets to reduce near- and medium-term greenhouse gas emissions through our legally-binding carbon budgets. The fourth, fifth and sixth carbon budgets cover the periods 2023-2027, 2028-2032 and 2033-2037 respectively. In December 2020, the UK committed to an interim target to reduce economy-wide greenhouse gas emissions by at least 68% (compared to 1990 levels) by 2030 as part of our Nationally Determined Contribution towards delivering the goals of the Paris Agreement.³¹

Decarbonising buildings is central to that challenge. To meet our Net Zero goal, we urgently need to address the carbon emissions produced in heating and powering our homes, workplaces and public buildings. Energy is central to our lives, providing comfort and entertainment in our homes, as well as enabling healthy and productive workplaces. We use energy for heating and cooling, cooking, hot water, and other energy-using products. And while the electricity that powers our lighting and appliances is decarbonising fast, the majority of buildings still rely on burning fossil fuels for heating, hot water and cooking.

There are about 30 million buildings in the UK.³² In total, these buildings are responsible for around 30% of our national emissions.³³ The vast majority of these emissions result from heating: 79% of buildings emissions and about 23% of all UK emissions.³⁴

³¹ Further details about the Paris Agreement can be found at: <https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement>.

³² ONS (2020), 'Households projections for England' (<https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/datasets/householdprojectionsforengland>), Table 401 and

BEIS (2020) 'Non-domestic National Energy Efficiency Data-Framework (ND-NEED), 2020' (<https://www.gov.uk/government/statistics/non-domestic-national-energy-efficiency-data-framework-nd-need-2020>) based on 2018 data.

³³ BEIS (2021), 'Final UK greenhouse gas emissions national statistics: 1990 to 2019' (<https://www.gov.uk/government/statistics/final-uk-greenhouse-gas-emissions-national-statistics-1990-to-2019>). And BEIS (2020), 'Energy consumption in the UK 2020' (<https://www.gov.uk/government/statistics/energy-consumption-in-the-uk>). This figure includes indirect and direct emissions but excludes international aviation and shipping.

³⁴ BEIS (2021), 'Final UK greenhouse gas emissions national statistics: 1990 to 2019' (<https://www.gov.uk/government/statistics/final-uk-greenhouse-gas-emissions-national-statistics-1990-to-2019>). Includes indirect and direct emissions but excludes international aviation and shipping.

Figure 2: UK emissions in 2019

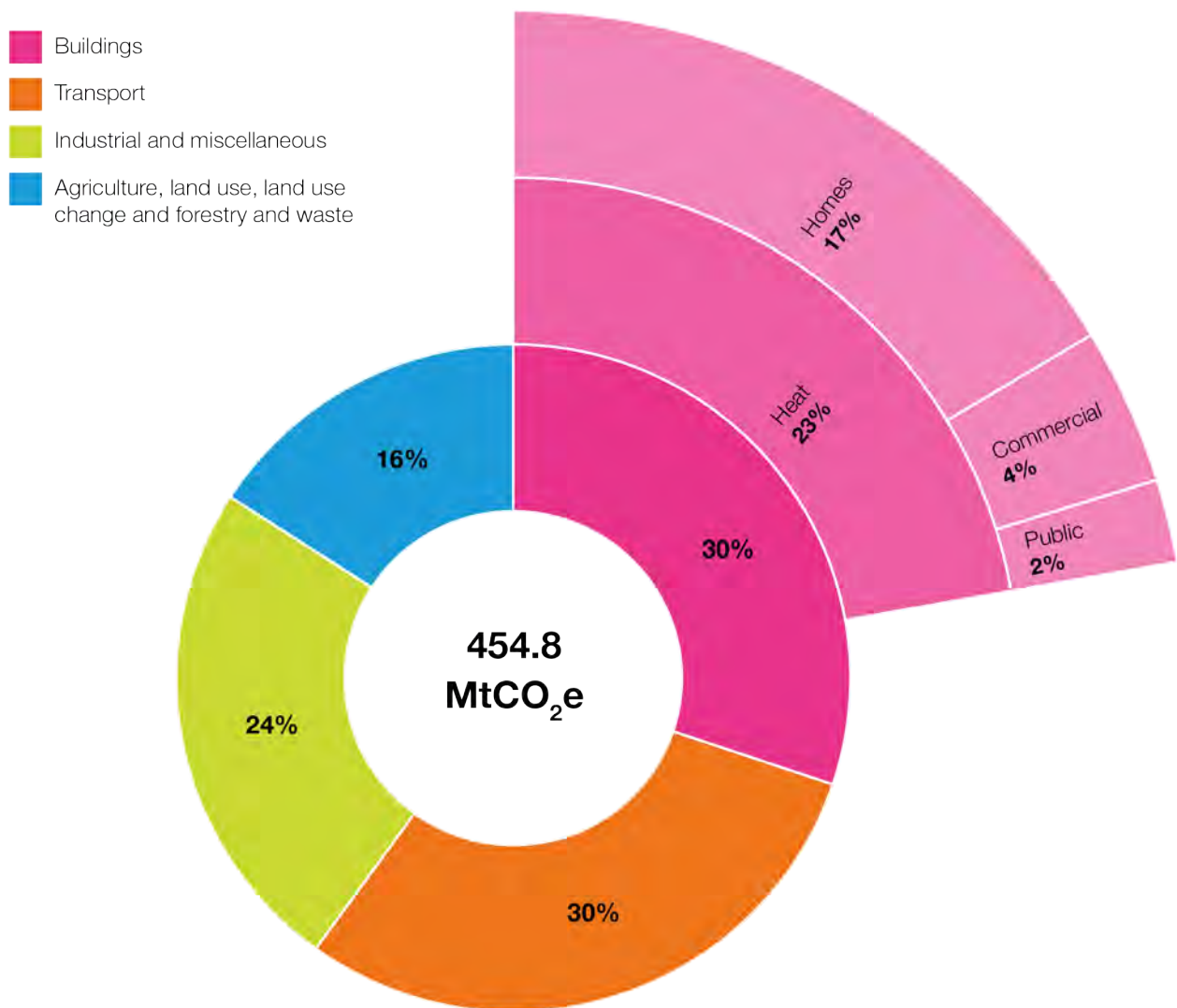


Figure 2 shows the proportion of emissions in 2019 from buildings to the nearest whole number; of the 454.8 mega tonnes of carbon dioxide equivalent (MtCO₂e) total emissions, 23% were due to heating buildings, with the largest proportion of this stemming from homes.³⁵

³⁵ Percentages are given to the nearest whole number. Sources:

BEIS (2021), 'Final UK greenhouse gas emissions national statistics: 1990 to 2019' (<https://www.gov.uk/government/statistics/final-uk-greenhouse-gas-emissions-national-statistics-1990-to-2019>).
BEIS (2021), 'Energy Consumption in the UK 2020' (<https://www.gov.uk/government/statistics/energy-consumption-in-the-uk>). Includes indirect and direct emissions but excludes international aviation and shipping.

Figure 3: Direct emissions from heat in buildings (1990-2019)

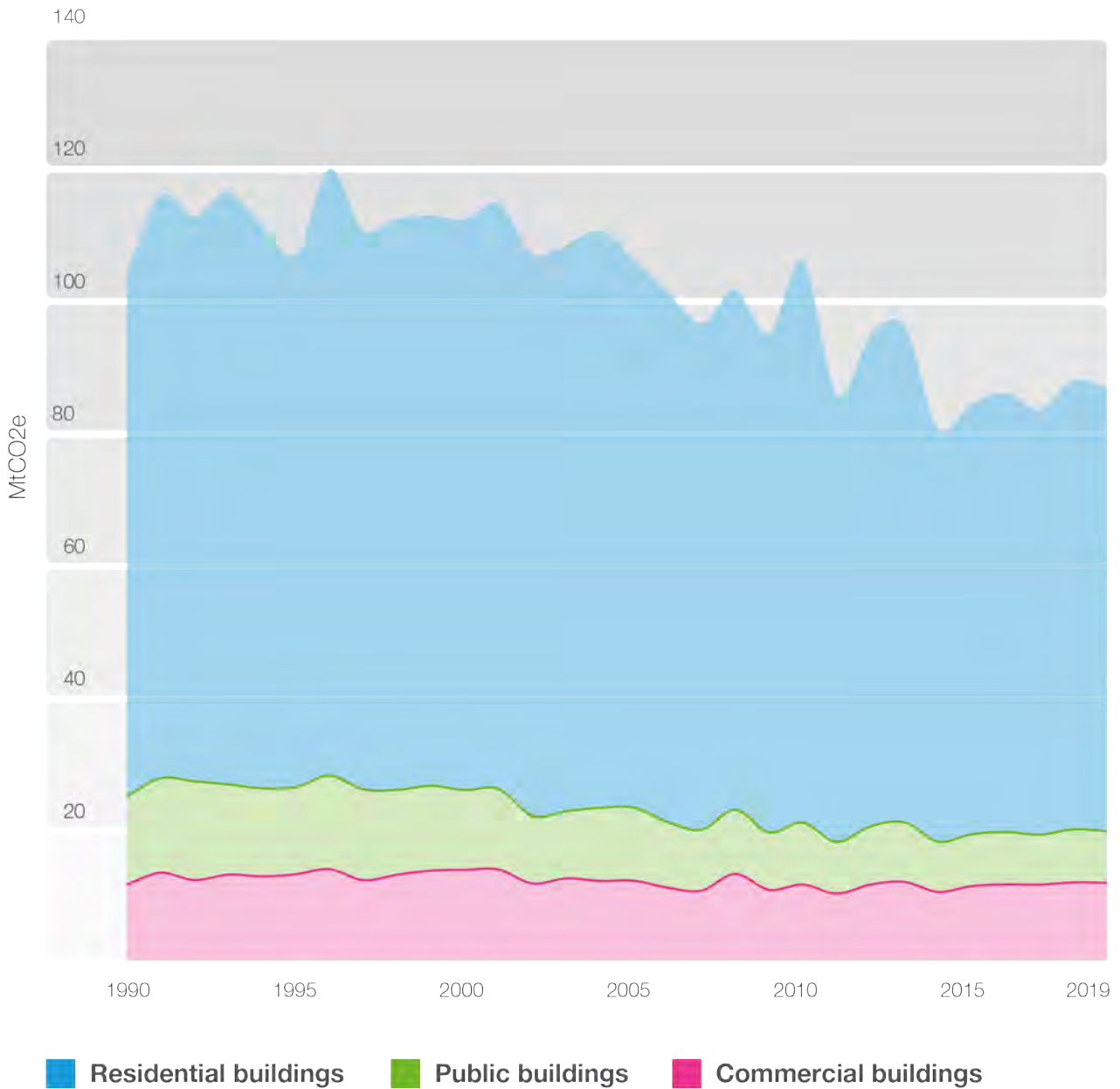


Figure 3 shows the proportion of direct emissions from heat in buildings from 1990 to 2019 split by building type – commercial, public sector and residential.³⁶

³⁶ BEIS (2021), 'Final UK greenhouse gas emissions national statistics: 1990 to 2019', (<https://www.gov.uk/government/statistics/final-uk-greenhouse-gas-emissions-national-statistics-1990-to-2019>). Includes indirect and direct emissions but excludes international aviation and shipping.

The [Clean Growth Strategy](#)³⁷, published in 2017, set out our high-level plans for meeting carbon budgets, and acknowledged the particular challenge posed by decarbonising heating. It set out a range of actions to reduce the energy use of buildings and deliver low-carbon heat through activities such as the Renewable Heat Incentive and the Heat Networks Investment Project.

We followed this in 2018 with [Clean Growth: Transforming Heating](#)³⁸, a review of the evidence and options available for decarbonising heat. The review concluded that it is unlikely that there will be a one-size-fits-all solution, so multiple technologies will play a role on our path to Net Zero. We identified major challenges and barriers that need to be addressed, and the need for strategic decisions for the future of heat infrastructure in the 2020s.

This Heat and Buildings Strategy fulfils the commitment made in [Clean Growth: Transforming Heating](#)³⁹ to produce a roadmap for heat policy, and acts as the UK's Long Term Renovation Strategy.⁴⁰ As well as a roadmap, this document also takes a holistic approach to energy use in buildings, considering product and building efficiency as well as heat decarbonisation. This document builds on the Prime Minister's [Ten Point Plan](#)⁴¹ and the [Energy White Paper](#)⁴² announced in 2020 to provide a clear direction of travel for the 2020s, demonstrating how we will meet our carbon targets, ensure we are on track for Net Zero and rapidly support jobs and levelling up. It also sets out how we are approaching the big strategic choices that need to be taken during this decade.

In this strategy, our primary focus is on reducing emissions from heating, which, given the UK's climate, is the predominant source of emissions from buildings. However, we are mindful of the current and potential future demand of cooling, which we will look to consider further as we continue to develop our approach to long-term choices for low-carbon heating.

The strategy does not include our plans to decarbonise 'process heat' – the heating required for the manufacture of products – as this is included in our [Industrial Decarbonisation Strategy](#)⁴³, published in March 2021.

Improving our buildings goes beyond saving carbon. In 2014, government introduced a statutory fuel poverty target for England⁴⁴ to improve as many fuel poor homes as is

³⁷ BEIS (2017), 'Clean Growth Strategy' (<https://www.gov.uk/government/publications/clean-growth-strategy>).

³⁸ BEIS (2018), 'Heat decarbonisation: overview of current evidence base' (<https://www.gov.uk/government/publications/heat-decarbonisation-overview-of-current-evidence-base>).

³⁹ BEIS (2018), 'Heat decarbonisation: overview of current evidence base' (<https://www.gov.uk/government/publications/heat-decarbonisation-overview-of-current-evidence-base>).

⁴⁰ Required by the Energy Performance of Buildings Directive (2010/31/EU) (<https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02010L0031-20181224>) was revised in 2018 and transposed into UK law via SI/2020/563 (<https://www.legislation.gov.uk/uksi/2020/563/contents/made>).

⁴¹ BEIS (2020), 'The ten point plan for a green industrial revolution' (<https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution>).

⁴² BEIS (2020), 'Energy white paper: Powering our net zero future' (<https://www.gov.uk/government/publications/energy-white-paper-powering-our-net-zero-future>).

⁴³ BEIS (2021), 'Industrial decarbonisation strategy' (<https://www.gov.uk/government/publications/industrial-decarbonisation-strategy>).

⁴⁴ Fuel poverty strategies have been published by Wales (<https://gov.wales/fuel-poverty-strategy>), Scotland (<https://www.gov.scot/policies/home-energy-and-fuel-poverty/fuel-poverty/>) and Northern Ireland (<https://www.communities-ni.gov.uk/publications/fuel-poverty-strategy>).

reasonably practicable to a minimum energy efficiency rating of band C⁴⁵ by the end of 2030. This will mean warmer, healthier homes and lower energy bills. We have also set interim milestones for England, aiming to improve as many fuel poor homes as is reasonably practicable to band E by 2020 and band D by 2025, and in 2019 97.4% of low income households were living in properties with a fuel poverty energy efficiency rating of band E or better.⁴⁶ Our approach to drive energy efficiency improvements in fuel poor households recognises that improving efficiency can help those in fuel poverty afford to keep warm. We published an updated fuel poverty strategy on [Sustainable warmth: protecting vulnerable households in England](#)⁴⁷ in February 2021. In this Heat and Buildings Strategy, we consider how we can continue to reduce emissions from buildings while delivering economic and wider benefits, such as tackling fuel poverty and creating new jobs. This strategy builds upon the foundations set by the Ten Point Plan with initiatives such as the Public Sector Decarbonisation Scheme, already supporting 30,000 jobs across the sector since its launch.

The UK's Presidency of the 26th Conference of the Parties (COP26) under the United Nations Framework Convention on Climate Change, which will be hosted in Glasgow in November 2021, provides an opportunity for the UK to showcase the pioneering work being taken forward in the buildings sector, demonstrating our leadership in this sector to other countries. As action to decarbonise the buildings and construction sector is critical to meeting our Paris Agreement goals, we have organised a dedicated Cities, Regions and Built Environment Day on 11 November at COP26, which will showcase ambitious best practice from around the world.

Leading up to COP26 we have published a comprehensive Net Zero Strategy⁴⁸ – a cross-sector strategy that will set out the Government's vision for transitioning to a net zero economy and making the most of new growth and employment opportunities across the UK. We hope that this strategy, along with other documents that have been and will be released this year, will help to raise UK and global ambition to tackle climate change by decarbonising buildings.



TOGETHER FOR OUR PLANET

⁴⁵ In accordance with our 'Fuel Poverty Energy Efficiency Rating Methodology' (2014) (https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/332236/fpeer_methodology.pdf).

⁴⁶ BEIS (2021), 'Annual fuel poverty statistics report: 2021' (<https://www.gov.uk/government/statistics/annual-fuel-poverty-statistics-report-2021>).

⁴⁷ BEIS (2021), 'Sustainable warmth: protecting vulnerable households in England' (<https://www.gov.uk/government/publications/sustainable-warmth-protecting-vulnerable-households-in-england>).

⁴⁸ BEIS (2021), 'Net Zero Strategy' (<https://www.gov.uk/government/publications/net-zero-strategy>).

1.4. Devolution and decarbonisation

Decarbonising heat and buildings will require joined-up change throughout the UK, but also represents different opportunities and challenges across the four nations. This section:

- *introduces the current devolution arrangements across the UK*
- *highlights the work of devolved administrations that sit alongside this strategy*

To tackle climate change while maximising economic and wider benefits across the UK, collaboration across England, Wales, Scotland and Northern Ireland will be essential⁴⁹. We will continue to work closely with the devolved administrations, and with local leaders and businesses across the UK, as we develop the policies and proposals set out in this strategy.

Decarbonising our heat and buildings is a joint endeavour across the United Kingdom.



⁴⁹ Commitments in Scotland can be found in the 'Energy Efficiency Scotland: route map' (<https://www.gov.scot/publications/energy-efficient-scotland-route-map/>) (2018) and Scotland's Heat In Buildings Strategy (2021) (<https://www.gov.scot/publications/heat-buildings-strategy-achieving-net-zero-emissions-scotlands-buildings/>). Commitments for Wales can be found in their Energy Efficiency Strategy (<https://gov.wales/energy-efficiency-strategy>) (2016). The Department for the Economy in Northern Ireland is currently leading the development of the Northern Ireland Executive's new Energy Strategy (<https://www.economy-ni.gov.uk/articles/northern-ireland-energy-strategy-2050>) to be launched by end 2021.

The [devolution settlements for Scotland, Wales and Northern Ireland](#)⁵⁰ are all unique, including some matters relating to heat and buildings policy.⁵¹

Given the balance between devolved and reserved competencies, there are opportunities for collaboration and leadership across all nations. Working together and coordinating our efforts where appropriate will help us achieve shared objectives relating to local government, planning, housing, the environment, and electricity and gas policy.

In developing this strategy, we recognise that there is great variation across the UK in terms of the building landscape, with differences in the housing mix and the proportion of public sector and commercial and industrial buildings, as well as the activities by businesses. The way we heat our buildings also differs, with a much higher proportion of buildings in England connected to the gas grid than in Wales, Scotland and Northern Ireland. These differences bring different opportunities and challenges for decarbonisation.

In recognition of the different opportunities for emission reductions across the UK, in their publication '[Net Zero – The UK's contribution to stopping global warming](#)'⁵² (2019), the Climate Change Committee (CCC) recommended that the UK as a whole should reach net zero greenhouse gases by 2050 and that Scotland should reach net zero greenhouse gases by 2045.⁵³ In 2020 the CCC also provided a recommendation for Wales to reach net zero greenhouse gases by 2050.⁵⁴

We have set out the geographic extent of the policies covered in this strategy in the [Annex: Current and planned activities](#).

In addition to UK-wide strategies and policies, devolved administrations have previously developed, or are in the process of developing, their own strategies and detailed policy frameworks to best decarbonise their building stock.

Wales

Heating and cooling networks, but not the regulation of them, renewable energy incentive schemes, and encouragement of energy efficiency are devolved, therefore Wales is responsible for its own heat policy in relation to these matters. Wales' net zero target is set in

⁵⁰ Cabinet Office, Office of the Secretary of State for Scotland, Northern Ireland Office, and Office of the Secretary of State for Wales (2013), 'Devolution of powers to Scotland, Wales and Northern Ireland' (<https://www.gov.uk/guidance/devolution-of-powers-to-scotland-wales-and-northern-ireland#contents>).

⁵¹ Heat network policy is devolved to Wales, Scotland, and Northern Ireland. Scotland recently enacted the Heat Networks (Scotland) Act 2021 (<https://www.legislation.gov.uk/asp/2021/9/contents/enacted>), which includes regulation related to heat network zoning, while Wales has introduced heat network policy in the context of the spatial planning document 'Future Wales: The National Plan 2040' (<https://gov.wales/future-wales-national-plan-2040-0>). We work closely with the devolved administrations in Scotland, Wales and Northern Ireland on heat network policy and regulation to secure consistency for the sector across Great Britain.

⁵² CCC (2019), 'Net Zero – The UK's contribution to stopping global warming' (<https://www.theccc.org.uk/publication/net-zero-the-uks-contribution-to-stopping-global-warming/>).

⁵³ The UK and Scottish targets were legislated in 2019 in Westminster and Holyrood respectively. Northern Ireland does not currently have a separate target and is included within UK targets. Legislative policy proposals which would set emissions targets are currently being developed in Northern Ireland.

⁵⁴ CCC (2020), 'The path to Net Zero and progress on reducing emissions in Wales' (<https://www.theccc.org.uk/publication/the-path-to-net-zero-and-progress-reducing-emissions-in-wales/>). The Senedd legislated this Net Zero target in March 2021.

legislation alongside a series of 5-yearly carbon budgets (aligned with electoral cycles) and decadal targets.

The Welsh Government published the [Energy Efficiency Strategy](#)⁵⁵ in 2016, which set out the 10-year strategy for the period to 2026. The role of decarbonising buildings in delivering carbon targets for Wales is set out in the Welsh Government's Low Carbon Delivery Plan, [Prosperity for All: A Low Carbon Wales](#)^{56,57}. The next delivery plan for 2021-2025 will be published in November 2021. Welsh Government published a strategy on ['Tackling fuel poverty 2021 to 2035'](#)⁵⁸ in March 2021.

Scotland

In 2018 the Scottish Government published the [Energy Efficient Scotland: Route Map](#)⁵⁹, which set out their plans for Scottish homes, businesses and public buildings to become more energy efficient over the period to 2040. Scottish Government agreed a new policy programme, which includes several actions to decarbonise buildings,⁶⁰ and published a [Heat in Buildings Strategy](#)⁶¹ for Scotland in October 2021. This strategy sets out the longer-term vision and actions being taken to: deliver Scotland's climate change commitments, maximise economic opportunities, and ensure a just transition which helps to address fuel poverty. [The Fuel Poverty Act](#)⁶² (2019) sets statutory targets for reducing fuel poverty, introduces a new definition of fuel poverty, and requires Scottish ministers to produce a comprehensive strategy to show how they intend to meet the targets. The final Fuel Poverty Strategy will be published in due course.

Northern Ireland

In Northern Ireland, a [consultation on policy options for a new Energy Strategy](#)⁶³ concluded in July 2021. Responses from this consultation have supported the development of a new Energy Strategy, which is due to be published before the end of 2021. The new Northern Ireland Energy Strategy's vision is to achieve net zero carbon and affordable energy by 2050. The strategy will also provide detail on the strategic direction for decarbonising buildings and heat. Northern Ireland published their [Fuel Poverty Strategy](#)⁶⁴ in 2011. The Department for

⁵⁵ Welsh Government (2016), 'Energy efficiency strategy' (<https://gov.wales/energy-efficiency-strategy>).

⁵⁶ Welsh Government (2019), 'Prosperity for All: A Low Carbon Wales' (https://gov.wales/sites/default/files/publications/2019-06/low-carbon-delivery-plan_1.pdf).

⁵⁷ In line with the duties of public bodies under the Wellbeing of Future Generations Act (to set and publish objectives to show how they will achieve the well-being goals).

⁵⁸ Welsh Government (2021), 'Tackling fuel poverty 2021 to 2035' (<https://gov.wales/tackling-fuel-poverty-2021-2035-html>).

⁵⁹ Scottish Government (2018), 'Energy Efficient Scotland: route map' (<https://www.gov.scot/publications/energy-efficient-scotland-route-map/>).

⁶⁰ Scottish Government (2021), 'Scottish Government and Scottish Green Party: draft shared policy programme' (<https://www.gov.scot/publications/scottish-government-and-scottish-green-party-shared-policy-programme/>).

⁶¹ Scottish Government (2021), 'Heat In Buildings Strategy: achieving net zero emissions in Scotland's buildings' (<https://www.gov.scot/publications/heat-buildings-strategy-achieving-net-zero-emissions-scotlands-buildings/>).

⁶² The National Archives (2019), 'Fuel Poverty (Targets, Definition and Strategy) (Scotland) Act 2019' (<https://www.legislation.gov.uk/asp/2019/10/enacted>).

⁶³ Department for the Economy (2021), 'Consultation on policy options for the new Energy Strategy for Northern Ireland' (<https://www.economy-ni.gov.uk/consultations/consultation-policy-options-new-energy-strategy-northern-ireland>).

⁶⁴ Department for Communities (2011), 'Warmer Healthier Homes – a new Fuel Poverty Strategy for Northern Ireland' (<https://www.communities-ni.gov.uk/publications/fuel-poverty-strategy>).

Communities is responsible for developing a new Fuel Poverty Strategy, which will need to reflect a fair and just transition to net zero carbon and the role housing and energy efficiency plays in reducing carbon emissions. To ensure alignment with the content and timeframes of a number of new and emerging strategies in Northern Ireland, responses to the [consultation on policy options for a new Energy Strategy](#)⁶⁵, as well as a [call for evidence for a new Housing Supply Strategy](#)⁶⁶, will help inform future development of a new Fuel Poverty Strategy.

1.5. Why now?

Given the scale of infrastructural change, and the rate at which we typically renovate our buildings and replace our heating systems, meeting Net Zero by 2050 requires action now to:

- *create new, green jobs to boost our economy, drive growth and level up all parts of the UK*
- *keep us on track to meet our carbon budget and fuel poverty commitments*
- *raise public awareness and buy-in to change*
- *build the capacity and capability of markets needed to achieve Net Zero*
- *drive the evidence and innovation required to inform key infrastructural decisions*



Creating opportunities

As well as offering rapid job creation, action on buildings also offers sustained employment opportunities in areas that will be essential for the transition to Net Zero. It is estimated that the UK low-carbon economy could grow more than four times faster than the rest of the economy between 2015 and 2030 and support up to 2 million jobs.⁶⁷ Building on the projections stated in

⁶⁵ Department for the Economy (2021), 'Consultation on policy options for the new Energy Strategy for Northern Ireland' (<https://www.economy-ni.gov.uk/consultations/consultation-policy-options-new-energy-strategy-northern-ireland>).

⁶⁶ Department for Communities (2021), 'Consultation on the new housing supply strategy call for evidence' (<https://www.communities-ni.gov.uk/consultations/consultation-new-housing-supply-strategy-call-evidence>).

⁶⁷ Ricardo Energy and Environment for the CCC (2017) 'UK business opportunities of moving to a low-carbon economy' (<https://www.theccc.org.uk/publication/uk-energy-prices-and-bills-2017-report-supporting-research/>).

the [Ten Point Plan](#),⁶⁸ we project that the heat and buildings domestic market could support over 175,000 direct and indirect jobs by 2030 and 240,000 by 2035.

We will see job creation across a range of sectors – from manufacturing to services, installation to research and development. While different technologies and different pathways to Net Zero can deliver different social and economic opportunities, in every scenario we expect significant levels of job creation across the whole of the UK.

Meeting targets

The more we can increase the energy efficiency of our buildings, and the sooner we make the switch to low-carbon heating, the greater the reduction in lifetime emissions we can achieve. Delaying action could prevent us from meeting near-term carbon budget and fuel poverty targets, making it harder to achieve our targets in later years by increasing the emissions reductions required.

We want our transition to low-carbon heating to provide social and economic benefits. Our policy paper on [Sustainable warmth: protecting vulnerable households in England](#)⁶⁹, published February 2021, sets out our plan to meet our fuel poverty targets while decarbonising housing.⁷⁰ This means that fuel poor households will be among the earliest to benefit from our transition to Net Zero.

Minimising disruption and using trigger points

We plan to transition to Net Zero in a way that minimises disruption and maximises consumer choice. For example, we will look to avoid scrappage and unnecessarily ripping out fully functional heating systems before they come to the end of their lifecycle. We will help smooth this transition by using natural trigger points where possible, such as:

- When people replace heating appliances as they come to the end of their life
- When there are changes to building use or occupancy or ownership
- When building and renovation works are carried out

We know that these trigger points vary across sectors, may not occur very frequently, and take time to produce results – traditional domestic heating systems last approximately 15 years and homes are sold on average every 18 years. Therefore, we need to act now if we are to make the most of these trigger points throughout the 2030s and 2040s.

⁶⁸ BEIS (2020), 'The ten point plan for a green industrial revolution' (<https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution>).

⁶⁹ BEIS (2021), 'Sustainable warmth: protecting vulnerable households in England' (<https://www.gov.uk/government/publications/sustainable-warmth-protecting-vulnerable-households-in-england>).

⁷⁰ Fuel poverty strategies have been published by Wales (<https://gov.wales/fuel-poverty-strategy>), Scotland (<https://www.gov.scot/policies/home-energy-and-fuel-poverty/fuel-poverty/>) and Northern Ireland (<https://www.communities-ni.gov.uk/publications/fuel-poverty-strategy>).

From 2035, we intend to phase out the installation of new and replacement natural gas boilers⁷¹ in line with replacement cycle timelines, to ensure that almost all heating systems used in 2050 are low-carbon.⁷²

When a new technology is introduced, it can take time to understand how consumers interact with it, and therefore deployment can start slowly. Some technologies can take more than 30 years to reach near saturation.⁷³ Therefore, action to encourage uptake of low-carbon heating and energy efficiency measures (supported by enabling measures and regulation) is needed and are being put in place now, to encourage uptake of deployment by 2050. Whilst we are working on boosting deployment of existing low-carbon products, such as heat pumps and heat networks, in areas that are low-regrets (including new-builds and off gas grid properties), we are also researching whether hydrogen for heating is a viable consumer proposition. By 2026, following trials, we will have more certainty about whether hydrogen for heating is a suitable, low cost and attractive technology, and will take strategic decisions on its role. We will take a gradual approach to ramping up deployment will ensure that consumers have time to prepare themselves for the transition to low-carbon heating, and our long-sighted regulations will give consumers clarity about the direction of travel.

We will also need to introduce minimum building energy performance requirements and start to phase out the worst-polluting fossil fuel heating in the 2020s, so that we can prepare buildings for only installing low-carbon heating systems by the early to mid-2030s. We need to ensure that changes to minimum standards for buildings are communicated well in advance, so that businesses and households have time to prepare.

Building and preparing markets and infrastructure

Supply chains will need time to grow. This decade we will need to prepare and grow the market, so that low-carbon technologies can be deployed across all buildings in the 2030s and 2040s.

To help meet increasing UK demand, we need to begin to scale-up UK production, manufacture and supply. This may range from entire systems to specialised high-value components of low-carbon heating systems, such as heat pump housing and controls, valves and pipework. Growing UK manufacture and supply of heat pumps to over 300,000 units a year by 2028 could increase the rate of installation, grow opportunities for exports, and create more than 10,000 manufacturing-related UK jobs. In consultation with stakeholders, we have therefore identified an ambitious minimum market capacity – to be able to deploy at least 600,000 hydronic heat pumps⁷⁴ per year by 2028 – to galvanise industry to increase UK heat

⁷¹ In the next decade we will have taken important strategic decisions on the role of hydrogen in heating and will know more about its regional suitability, therefore we aim that by 2035, hydrogen-ready boilers are not installed in areas that do not and will not have access to a supply of low-carbon hydrogen in the future.

⁷² Subject to technological developments and reserved decisions, Scottish Government are looking to phase out the installation of new replacement fossil fuel boilers from 2025 in off-gas-grid areas and from 2030 in on-gas-grid areas (<https://www.gov.scot/publications/scottish-government-and-scottish-green-party-shared-policy-programme/>).

⁷³ Les Shorrock (2011) 'Time for Change', Proceedings of the European Council for an Energy Efficient Economy Summer Study, pp. 1043-1048. Previously cited in 'The future of heating: meeting the challenge', p. 93, chart 33 (<https://www.gov.uk/government/publications/the-future-of-heating-meeting-the-challenge>).

⁷⁴ Hydronic heat pumps are those that use air-to-water or ground-to-water systems.

pump deployment.⁷⁵ This is a ‘no-regrets’ target as it is necessary even if hydrogen were to become the primary fuel source for heating buildings.

We also believe that developing the market for low-carbon heat networks will be a no-regrets action, in recognition of the Climate Change Committee’s recommendation for around 18% of UK heat to come from heat networks by 2050 as part of a least cost pathway to meeting net-zero.

Large-scale infrastructure, such as electricity, gas and heat networks, can take time to develop and install. Therefore, we need to take action early to prepare, develop and invest in this infrastructure.

With this preparation and growth, the UK aims to become a world-leader in low-carbon heat and building technologies, bringing new products to the market, industrialising and scaling-up production in the UK. We will look to grow our exports of goods and services, so that the rest of the world can also benefit from UK innovation and expertise.

Informing decisions and future policy

Leaving the decision to invest in hydrogen for heat later than the mid-2020s would bring considerable risk of limiting its potential role. This is because there is a likely need for both major construction and operation of new infrastructure. Therefore, we intend to make strategic decisions by 2026, including whether hydrogen is safe and feasible to use as a heat source and the key enabling steps required.

More broadly, the action we take in the 2020s can be used to test and evaluate different approaches to decarbonisation. This will inform our evidence base, from which we can develop new policies and make informed decisions regarding the best pathway to Net Zero.

We need to start the transition now to meet our emissions reductions targets cost-effectively, minimise disruption and maximise benefits for everyone.

Chapter 2: Economic and wider opportunities

Decarbonising how we heat our buildings will create significant demand for low-carbon technologies and skills. This demand will need to be matched by the key markets manufacturing, supplying and installing these materials and measures. The UK will look to industry to invest here in the UK, to scale-up UK manufacture and production and to share the rewards of UK investment through export opportunities, which will support global decarbonisation efforts and could support over 240,000 jobs across the sector in 2035.

This shift will enable:

⁷⁵ We anticipate approximately 200,000 of the 600,000 target to come from new build domestic properties.

- *the creation of new specialist low-carbon roles suiting new entrants to the job market*
- *existing electrical and heating-related professionals, and those in high-carbon industries, to upskill and retrain to acquire jobs in the growing low-carbon market*
- *investment into increasing the capacity of existing UK-manufactured solutions*
- *forward-thinking investments into new UK facilities, bringing new technologies to the UK market, with a view to export*
- *investment into deprived UK regions as part of the levelling up agenda*
- *improvements to residents' standard of living and health, reduced costs of bills, and reduced levels of unemployment*
- *UK leadership, sharing our expertise and technologies with countries across the world*

2.1. Green recovery

Setting out the importance, urgency and scale of opportunity for buildings decarbonisation to drive green recovery.

The transition to Net Zero represents a huge economic opportunity for the UK. We have the oldest building stock in Europe⁷⁶, which will need to be almost completely decarbonised to meet Net Zero.

We will need to deploy energy efficiency improvements and install new, low-carbon heating systems on an unprecedented scale, creating new employment opportunities across the country, new skills, new and expanded factories, and enabling the UK to seize the benefits of exporting our low-carbon goods and expertise. Work tends to be labour-intensive, so scaling-up delivery supports more jobs per pound spent than in most other areas of the transition.

Upgrading our building stock offers significant benefits beyond jobs and carbon savings: greater comfort, improved health outcomes, and reduced energy bills. These benefits will be felt by households and businesses in all corners of the UK.

The economic benefits of upgrading our building stock have been brought into sharp relief by the COVID-19 pandemic. The Confederation of British Industry⁷⁷, CCC⁷⁸, and International Energy Agency⁷⁹ have all highlighted the importance of decarbonising buildings as part of a post-COVID economic response. An Ipsos MORI survey in April 2020 found that 58% of

⁷⁶ Buildings Research Establishment (2020), 'The Housing Stock of the United Kingdom' (https://files.bregroup.com/bretrust/The-Housing-Stock-of-the-United-Kingdom_Report_BRE-Trust.pdf).

⁷⁷ CBI (2020), 'Priorities for a green recovery following the coronavirus pandemic' (<https://www.cbi.org.uk/articles/green-recovery-priorities-following-coronavirus/>).

⁷⁸ CCC (2020), 'Take urgent action on six key principles for a resilient recovery' (<https://www.theccc.org.uk/2020/05/06/take-urgent-action-on-six-key-principles-for-a-resilient-recovery/>).

⁷⁹ IEA (2020), 'Sustainable Recovery' (<https://www.iea.org/reports/sustainable-recovery>).

respondents feel that UK government actions should prioritise climate change in the post-COVID recovery.⁸⁰

We are dedicating significant government funding to tackle heat and energy efficiency in a way that will boost the economy, improve the lives of individuals, and maximise emission reduction – while minimising the overall public expenditure on Net Zero in the long run. Our full list of activities is included at the end of this strategy, in Annex 2: Current and planned activities for the 2020s.

In his [Plans for Jobs speech in July 2020](#)⁸¹, the Chancellor set out a suite of measures to support buildings upgrades. This included funding for the Green Homes Grant scheme (of which £500 million was for the Local Authority Delivery (LAD) scheme in England), £1 billion to decarbonise public sector buildings, including schools and hospitals, and £50 million to test innovative retrofitting approaches in social housing.

Further funding for action on buildings in 2021-22 has been made available through the 2020 Spending Review: investing £1 billion to make our homes and public sector buildings greener, warmer and more energy efficient; allocating funding to help some of the poorest households improve their building's energy performance and switch to low-carbon heating through the Home Upgrade Grant (HUG) in England; and retrofitting social housing as part of the Social Housing Decarbonisation Fund (SHDF).

We also extended the [Domestic Renewable Heat Incentive](#)⁸² for an additional year at Budget 2020. The scheme is now due to close at the end of March 2022.

[We boosted energy efficiency spending to £1.3 billion](#)⁸³, providing an additional £300 million extra funding for home energy efficiency and low-carbon heating upgrades to help lower income households cut emissions and save money on bills, in March 2021. This funding provides an additional £100 million for Wave 1 of the SHDF and £200 million for a third phase of LAD. LAD Phase 3 forms part of a single funding opportunity, alongside £150 million of funding for HUG Phase 1, through the Sustainable Warmth competition.⁸⁴ The competition was launched on 16 June 2021, and we are aiming to grant funding to successful Local Authorities towards the end of 2021, with delivery continuing through to March 2023.

We are boosting funding across schemes to help decarbonisation across the UK building stock, we are investing a further:

- £800 million into the SHDF over financial years 2022/23 to 2024/25
- £950 million into the HUG over 2022/23 to 2024/25

⁸⁰ Ipsos MORI (2020), 'Two thirds of Britons believe Climate Change as serious as Coronavirus and majority want Climate prioritised in economic recovery' (<https://www.ipsos.com/ipsos-mori/en-uk/two-thirds-britons-believe-climate-change-serious-coronavirus-and-majority-want-climate-prioritised>).

⁸¹ HM Treasury (2020), 'A Plan for Jobs speech' (<https://www.gov.uk/government/speeches/a-plan-for-jobs-speech>).

⁸² Domestic Renewable Heat Incentive (RHI) (<https://www.gov.uk/domestic-renewable-heat-incentive>).

⁸³ BEIS (2021), 'Government boosts energy efficiency spending to £1.3 billion with extra funding for green homes' (<https://www.gov.uk/government/news/government-boosts-energy-efficiency-spending-to-13-billion-with-extra-funding-for-green-homes>).

⁸⁴ BEIS (2021), 'Apply for the Sustainable Warmth competition' (<https://www.gov.uk/government/publications/apply-for-the-sustainable-warmth-competition>).

- £1425 million into the Public Sector Decarbonisation Scheme over 2022/23 to 2024/25
- £450 million into the new Boiler Upgrade Scheme over 2022/23 to 2024/25
- £338 million into the Heat Network Transformation Programme over 2022/23 to 2024/25

We remain committed to reviewing and improving our suite of schemes, to deliver the greatest overall benefits to the economy, society, and the environment.

2.2. Jobs

Investing in the green recovery can support up to 240,000 low-carbon buildings-related jobs by 2035, with a huge range of skills and opportunities for new entrants and experienced workers looking to transition to the green buildings sector.

As well as offering rapid job creation, action on buildings also offers sustained employment opportunities in areas that will be essential for the transition to Net Zero. It is estimated that the UK low-carbon economy could grow more than four times faster than the rest of the economy between 2015 and 2030 and support up to 2 million jobs.⁸⁵

We will see job creation across a range of sectors – from manufacturing to services, installation to research and development. While different technologies and different pathways to Net Zero can deliver different social and economic opportunities, in every scenario we expect significant levels of job creation across the whole of the UK.

Building on the projections stated in the [Ten Point Plan](#)⁸⁶, we project that the decarbonisation of the heat and buildings sector, through installing energy efficiency measures, more efficient products and low-carbon heating systems, could support up to 240,000 direct and indirect jobs by 2035.

The efficient products sector already supports the largest number of full-time employment opportunities (about 114,000 FTE) of any sector in the low-carbon and renewable energy economy.⁸⁷ [HM Government's 2019 Energy Innovation Needs Assessment on building fabric](#) estimated that the growth of UK exports in fabric efficiency alone could add over £720 million GVA per annum in the 2030s.⁸⁸

The increase in deployment of low-carbon heating systems over the coming decade will require industry to rapidly increase the number of trained, high-quality installers. However, [social research with installers of heating systems in off gas grid areas of England and Wales](#)

⁸⁵ Ricardo Energy and Environment for the CCC (2017) 'UK business opportunities of moving to a low-carbon economy' (<https://www.theccc.org.uk/publication/uk-energy-prices-and-bills-2017-report-supporting-research/>).

⁸⁶ BEIS (2020), 'The ten point plan for a green industrial revolution' (<https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution>).

⁸⁷ This covers the design, manufacture and installation of energy efficient products such as building materials and heating appliances but excludes smart products such as TVs and refrigerators. ONS (2020), (<https://www.ons.gov.uk/economy/environmentalaccounts/bulletins/finalestimates/2018>).

⁸⁸ Vivid Economics et al. (2019) 'Energy Innovation Needs Assessment: building fabric' commissioned by BEIS (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/845654/energy-innovation-needs-assessment-building-fabric.pdf).

(May 2021)⁸⁹ has shown that existing heating installers are likely to retrain in response to growing demand. In addition, the [Heat Pump Supply Chain Research Project](#) published in December 2020 has shown how confidence in demand can create jobs by encouraging manufacturers to move operations to the UK or expand existing operations.⁹⁰

We have demonstrated opportunities for job creation through some of our current policies and projects.

- BEIS estimates that the Local Authority Delivery (LAD) Scheme, Phases 1 and 2, will support on average 8,000 jobs per year in England between April 2020 – March 2022. The [Sustainable Warmth competition](#), covering LAD Phase 3 and HUG Phase 1, will support almost 8,000 jobs between January 2022 and March 2023.⁹¹
- One of our whole-house retrofit projects (WHR-104) is estimated to require the equivalent of over 50 FTE to retrofit 100 homes by March 2022. This covers a variety of specialisms, including project management, production and construction, as well as any ongoing maintenance needs.
- The £1 billion [Public Sector Decarbonisation Scheme](#) is projected to support up to 30,000 jobs in the low-carbon and energy efficiency sectors.⁹²

Government intends to create jobs by providing a long-term framework for transformational change, which will help UK markets grow. We will look to the market to drive this work forward, while government will seek to provide certainty and stability for businesses by setting clear and timely targets and standards. We will also continue to invest in the development of innovative approaches to decarbonisation, such as hydrogen, and employ a range of enablers to support delivery, including green finance and skills support.

2.3. Skills

Creating the low-carbon workforce we need will require investment in skills – both through retraining the existing workforce and developing the next generation of skilled workers. This section:

- *highlights the case for investing in skills*
- *sets out the ways in which government and industry can work together to achieve it*

⁸⁹ BEIS and Impact Research (2021), 'Social research with installers of heating systems in off gas grid areas of England and Wales' (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/990498/social-research-installers-off-gas-grid-heating.pdf).

⁹⁰ BEIS (2020), 'Heat pump manufacturing supply chain research project' (<https://www.gov.uk/government/publications/heat-pump-manufacturing-supply-chain-research-project>).

⁹¹ BEIS (2021), 'Apply for the Sustainable Warmth competition' (<https://www.gov.uk/government/publications/apply-for-the-sustainable-warmth-competition>).

⁹² BEIS (2020), 'Public Sector Decarbonisation Scheme' (<https://www.gov.uk/government/publications/public-sector-decarbonisation-scheme-psds>).

There are over 140,000 plumbers and heating and ventilation engineers in the UK⁹³, there are 114,000 FTE jobs in the efficient products sector⁹⁴, and 2.4 million in construction⁹⁵. Approximately 80% of people who will be working in the UK in 2030 are already working today.⁹⁶ We know that the transformational change needed to deliver the quantity and quality of building improvements by 2050 will impact those currently working in built environment and heating-related roles, including natural gas engineers.

We predict that, as low-carbon markets' demand for specialist skills grows, the current need for natural gas boiler installers will reduce. Together with industry, we need to encourage current natural gas engineers, electricians, and those with transferrable skills in complementary sectors, to retrain and specialise in smarter, greener and cleaner technologies. As industry provides new training opportunities for key buildings-related sectors to learn 'green skills', this can help preserve and grow key sectors of the economy.⁹⁷ According to a recent Construction Industry Training Board (CITB) survey, approximately 90% of builders stated they would be willing to retrain, as demand for new roles and skills' changes in the future.

We will use the findings of [social research with installers of heating systems in off gas grid areas of England and Wales](#) (May 2021)⁹⁸ and our [Heat Network Skills Review Report](#) (September 2020)⁹⁹ to better understand the existing skills base and how we can grow these skill reserves.

In response to advice from the CCC in their 25 June 2020 progress report¹⁰⁰, we are collaborating between departments and across administrations to ensure skills match the needs of Net Zero. We launched the independent [Green Jobs Taskforce](#)¹⁰¹ with key industry bodies to deliver 2 million Net Zero jobs by 2030 by producing an action plan for Net Zero skills across a range of sectors. The taskforce will pinpoint the skills needed in the near and long term, create high-quality green jobs and a diverse workforce and manage the transition for those working in high-carbon industries. The action plan for England will be published next Spring.

⁹³ NOMIS (2020), (<https://www.nomisweb.co.uk/datasets/aps168/reports/employment-by-occupation>).

⁹⁴ ONS (2020), 'Low carbon and renewable energy economy, UK: 2018' (<https://www.ons.gov.uk/economy/environmentalaccounts/bulletins/finalestimates/2018>).

⁹⁵ C. Rhodes (2019), 'Construction industry: statistics and policy' (<http://researchbriefings.files.parliament.uk/documents/SN01432/SN01432.pdf>).

⁹⁶ Industrial Strategy Council (2019), 'UK Skills Mismatch in 2030' (<https://industrialstrategycouncil.org/sites/default/files/UK%20Skills%20Mismatch%202030%20-%20Research%20Paper.pdf>).

⁹⁷ C. Rhodes (2019), 'Construction industry: statistics and policy' (<http://researchbriefings.files.parliament.uk/documents/SN01432/SN01432.pdf>).

⁹⁸ Impact Research (2021), 'Social research with installers of heating systems in off gas grid areas of England and Wales' for BEIS, (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/990498/social-research-installers-off-gas-grid-heating.pdf).

⁹⁹ BEIS (2020), 'Heat Network skills review' (<https://www.gov.uk/government/publications/heat-network-skills-review>).

¹⁰⁰ CCC (2020), 'Reducing UK emissions: 2020 Progress Report to Parliament' (<https://www.theccc.org.uk/publication/reducing-uk-emissions-2020-progress-report-to-parliament/>).

¹⁰¹ BEIS and DfE (2020), 'UK government launches taskforce to support drive for 2 million green jobs by 2030' (<https://www.gov.uk/government/news/uk-government-launches-taskforce-to-support-drive-for-2-million-green-jobs-by-2030>).

In October 2020, the Department for Education announced that the [National Retraining Scheme](#)¹⁰² would be integrated with the new £2.5 billion [National Skills Fund](#)¹⁰³. The National Skills Fund will help adults to train and gain the valuable skills they need to improve their job prospects. It will support the immediate economic recovery and future skills needs by boosting the supply of skills that employers require. The National Retraining Scheme includes the Construction Skills Fund, which supports the development of construction onsite training hubs.

We have also made £18 million available to support technical bootcamps for training professionals in clean growth, electrotechnical, welding or engineering. [An invitation to tender for skills bootcamps](#)¹⁰⁴ across England was published in January 2021 and the available bootcamps can be found on our [List of Skills Bootcamps](#)¹⁰⁵.

We are delivering specific policies and funds to support high-quality training, which will enable energy efficient low-carbon heating to be deployed.

- Alongside the Green Homes Grant Voucher Scheme, the Government launched a £6.9 million [Skills Training Competition](#)¹⁰⁶, designed to get tradespeople professionally trained to deliver the Government's current and future home decarbonisation schemes. Eighteen [successful applicants](#) have received funding to train individuals with existing skills and those new to the sector, along with support for installation companies to gain PAS 2030 or MCS accreditation and Retrofit Assessor and Coordinator training.¹⁰⁷
- To support delivery of the £1 billion Public Sector Decarbonisation Scheme, we also launched a £32 million [Public Sector Low Carbon Skills Fund](#)¹⁰⁸ to ensure that public sector organisations have access to the expert skills needed to identify, develop and deliver decarbonisation projects.
- As part of BEIS's £25 million Hy4Heat programme, Energy and Utility Skills has delivered a competence framework for training, accreditation, and registration of gas engineers working with hydrogen.¹⁰⁹

There are many factors we need to consider to ensure that this transition is as smooth as possible and tackle any barriers to training. We understand the importance of encouraging and incentivising attendance at training. The Centre for Sustainable Energy's Future Proof pilot in

¹⁰² DfE (2019), 'National retraining scheme' (<https://www.gov.uk/government/publications/national-retraining-scheme/>).

¹⁰³ DfE (2020), 'National Skills Fund' (<https://www.gov.uk/guidance/national-skills-fund>).

¹⁰⁴ DfE (2021), 'DfE - Skills Bootcamps - Digital & Technical' (<https://www.find-tender.service.gov.uk/Notice/000239-2021>).

¹⁰⁵ DfE (2021), 'List of Skills Bootcamps' (<https://www.gov.uk/government/publications/find-a-skills-bootcamp/list-of-skills-bootcamps>).

¹⁰⁶ BEIS (2020), 'Green Homes Grant skills training competition' (<https://www.gov.uk/government/publications/green-homes-grant-skills-training-competition>).

¹⁰⁷ BEIS (2021), 'Green Homes Grant skills training competition: details of successful applicants' (<https://www.gov.uk/government/publications/green-homes-grant-skills-training-competition/winning-projects?preview=4831994>).

¹⁰⁸ BEIS (2020), 'Public Sector Low Carbon Skills Fund (closed)' (<https://www.gov.uk/government/publications/public-sector-low-carbon-skills-fund>).

¹⁰⁹ Energy & Utility Skills (2021), 'Hydrogen Competency Framework Report' (<https://www.euskills.co.uk/download/hydrogen-competency-framework-report/>).

Bristol (one of our [selected local supply chain demonstration projects](#)¹¹⁰) has partnered with the Green Register to produce a training programme that ensured individuals were paid when they attended training. It saw positive outputs as a result.

We will continue to set quality standards, that can guide and be embedded into training, and provide consumer protection by ensuring workers are sufficiently skilled and delivering the high-quality standard interventions required. Further information on quality standards is detailed in section [6.3 Consumer Protection](#).

We are committed to communicating signals for investment to provide certainty and stability for businesses to invest in training. We include projections for technology-specific skill demand in the tables on [Skills demand per technology-type](#) to provide a clear trajectory for demand.

We will also look to manufacturers to continue to provide quality training to installers. Examples of industry exemplifying the action needed to upskill the workforce include:

- Nordic Heat, LOGSTOR and the Swedish Energy Agency are sharing their expertise with the workforce of Stoke-on-Trent by training over 200 students a year in designing, supplying and installing district heating through a new academy. They are also working with Bridgend County Borough Council, Energy Systems Catapult, innovative heat businesses and the local college to develop an academy to support smart system and heat decarbonisation training and skills in the area.¹¹¹
- In August 2021, the Heat Pump Association (HPA) launched a new heat pump installation training course for existing heating engineers¹¹². This course can be completed in one week, including a low temperature heating and hot water qualification developed by the Chartered Institute of Plumbing and Heating Engineering (CIPHE). These courses have support from both heat pump and boiler manufacturers.

As well as upskilling the existing workforce, we will also need to attract new entry-level workers. This is partly because, according to the [Gas Safe register Decade Review](#), a significant proportion of the current workforce are nearing retirement age and therefore may be less incentivised to change specialism.¹¹³ Attracting new entrants to the sector also provides a great opportunity to diversify the workforce.

With this in mind, we are working with the Department for Education to review the existing apprenticeship framework for heating and plumbing and developing a Heat Network Skills Programme to increase the recruitment pool and capability of the workforce for Great Britain. We are working with the Institute for Apprenticeships and Technical Education to convene a sustainability advisory group to:

¹¹⁰ BEIS (2020), 'Selected demonstration projects: summaries' (<https://www.gov.uk/government/publications/energy-efficiency-improvement-rates-local-supply-chain-demonstration-projects/local-supply-chain-demonstration-projects-summaries>).

¹¹¹ Stoke-on-Trent College (2021) 'New academy will heat up region's job prospects' (<https://www.stokecoll.ac.uk/news/new-academy-will-heat-up-regions-job-prospects/#:~:text=Stoke%20on%20Trent%20College%20has,the%20UK's%20newest%20energy%20infrastructu re.&text=Peter%20Anderberg%2C%20founder%20of%20Nordic,partners%20involved%20in%20the%20project>).


¹¹² Heat Pump Association (2021), 'New training course launched by the Heat Pump Association' (<https://www.heatpumps.org.uk/secretary-of-state-welcomes-ground-breaking-new-training-course-launched-by-heat-pump-association/>).

¹¹³ Gas Safe Register (2017), 'Decade Review' (<https://www.gassaferegister.co.uk/decade-review/>).

- encourage trailblazers to align apprenticeships to Net Zero and wider sustainability objectives
- identify which apprenticeships directly support the green agenda
- identify where there are opportunities to create new green apprenticeships

[In September 2020, the Prime Minister announced the Lifetime Skills Guarantee.](#)¹¹⁴ [This was launched in April 2021](#) and backed by £95 million in government funding in 2021/22. This will provide an opportunity for adults in England without an A-Level or equivalent qualification aged 19 and over to be offered a free, fully-funded college course – providing them with skills valued by employers. This represents a long-term commitment to remove the age constraints and financial barriers for adults looking for their first level 3 qualification. [A list of available courses, eligibility and how to apply can be found on GOV.UK.](#)¹¹⁵

Skills demand per technology-type

 Building fabric – energy efficiency	
Where we are now	<p>Sparse and inconsistent educational provision for new entrants as thermal efficiency retrofitting does not generally feature in formal skills training.¹¹⁶</p> <p>There are no Standard Industrial Classification (SIC) codes specific to the energy efficiency retrofit sector.</p> <p>A current lack of installers, retrofit assessors, and retrofit co-ordinators is a major barrier to decarbonising the UK's building stock.</p> <p>According to a Construction Industry Training Board (CITB) survey, approximately 90% of builders stated they would be willing to retrain, as demand for new roles and skills' changes in the future.¹¹⁷ Although one-third of those surveyed stated that their business had not, to date, provided them with any decarbonisation-related training.¹¹⁸</p>
Skills required for improving energy efficiency of building fabric	<p>Retrofit jobs are typically undertaken by a combination of highly specialised professionals and generalist builders.</p>


¹¹⁴ Prime Minister's Office, 10 Downing Street (2020), 'Major expansion of post-18 education and training to level up and prepare workers for post-COVID economy' (<https://www.gov.uk/government/news/major-expansion-of-post-18-education-and-training-to-level-up-and-prepare-workers-for-post-covid-economy>).

¹¹⁵ DfE (2021), 'Free courses for jobs' (<https://www.gov.uk/guidance/free-courses-for-jobs>).

¹¹⁶ BEIS (2020), 'Selected demonstration projects: summaries' (<https://www.gov.uk/government/publications/energy-efficiency-improvement-rates-local-supply-chain-demonstration-projects/local-supply-chain-demonstration-projects-summaries>).

¹¹⁷ Eunomia (2021), 'Building Skills for Net-Zero' for CITB, p. 126 (https://www.citb.co.uk/media/kkpkwc42/building_skills_net_zero_full_report.pdf).

¹¹⁸ Eunomia (2021), 'Building Skills for Net-Zero' for CITB, p. 127 (https://www.citb.co.uk/media/kkpkwc42/building_skills_net_zero_full_report.pdf).


 Building fabric – energy efficiency	
	<p>Potential skills gap¹¹⁹</p> <ul style="list-style-type: none"> • Energy efficiency installers, levels 2-4: 105,000 • Energy efficiency assessors, levels 2-4: 15,000 • Retrofit co-ordinators, level 5: 10,000 <p>Estimated training demand timeline (according to CITB)¹²⁰</p> <ul style="list-style-type: none"> • 1-4 years: training facilities and courses to 12,000 people per year • 5-10 years: training to 30,000 people per year
How we plan to meet this demand	<p>There are British Standards Institution (BSI) standards in place for energy efficiency retrofit. PAS 2030 and PAS 2035 for domestic buildings and PAS 2038 for non-domestic buildings. We will look to incentivise certification to this standard and will work with industry to support training and new routes of entry in key skills shortage areas.</p> <p>There are a wide variety of courses available, some examples include:</p> <ul style="list-style-type: none"> • Nationally accredited Retrofit Co-ordinator course by the Retrofit Academy¹²¹ • Online Carbonlite Retrofit course¹²² by the Association for Environmentally Conscious Buildings • Energy Efficiency Measures for Older and Traditional Buildings course, by the Environment Study Centre (quality-assured by CITB, resulting in an award from the SQA) • Green Register also provide a range of ‘middle-level’ courses

¹¹⁹ BEIS analysis based on the Energy Innovation Needs Assessment. Vivid Economics et al. (2019) (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/845654/energy-innovation-needs-assessment-building-fabric.pdf).

¹²⁰ Eunomia (2021), 'Building Skills for Net-Zero' for CITB, p. 37 (https://www.citb.co.uk/media/kkpkw42/building_skills_net_zero_full_report.pdf).

¹²¹ The Retrofit Academy (<https://www.retrofitacademy.org/>).

¹²² The AECB CarbonLite retrofit online training course (<https://aecb.net/the-aecb-carbonlite-retrofit-online-training-course/>).

 Heat pumps	
Where we are now	<p>According to the Microgeneration Certification Scheme (MCS) database, the UK currently has approximately 1,100 qualified heat pump installing companies.¹²³</p> <p>There are 50,000 F-gas certified installation engineers covering all sectors¹²⁴, however very few in the heat pump sector. To deploy more split heat pump systems¹²⁵, more heat pump installers will need F-gas certification.</p> <p>According to the Gas Safe Register¹²⁶, there are over 130,000 registered gas engineers and our analysis suggests 50% would be willing to retrain to install low-carbon heating systems, if there is sufficient demand.¹²⁷</p>
Skills required for installing heat pumps	<p>Heat pump installation must be compliant with Part L and Part P of the Building Regulations. These regulations relate to energy performance of buildings and electrical safety respectively, and installers have a duty to ensure compliance. Existing heating engineers can be upskilled to install heat pumps in one week or less. For new entrants with no heating installation experience, it is expected to take around three to four years to train as a heat pump installer via an apprenticeship or managed learning programme.¹²⁸</p> <p>To become an MCS accredited heat pump installer requires¹²⁹:</p> <ul style="list-style-type: none"> • level 2/3 NVQ in domestic plumbing • heat pump specific training • on-the-job training for around 6 months •

¹²³ According to the MCS installer database.

¹²⁴ BEIS (2020), 'Heat pump manufacturing supply chain research project' (<https://www.gov.uk/government/publications/heat-pump-manufacturing-supply-chain-research-project>).


¹²⁵ Split heat pump systems have separate units (indoor and outdoor) that can be up to about 30 metres apart, circulating a refrigerant to heat or cool a building. Many split heat pump systems use hydrofluorocarbons – a type of fluorinated gas (F-gas) – as their refrigerant. Conversely, monobloc systems house most components in an exterior unit without the need for refrigerants to enter the building, and therefore do not require F-gas certified installers.

¹²⁶ Gas Safe Register (2020), 'Gas Safe Register: at a glance' (<https://www.gassaferegister.co.uk/media/3117/gas-safe-at-a-glance-lr-web.pdf>).

¹²⁷ CIPHE, GSHPA, HPA, Liquid Gas UK, OFTEC and SEA (2019), 'Installer Survey Results: October 2019' (<https://www.sustainableenergyassociation.com/wp-content/uploads/2019/10/Installer-Skills-Survey-Summary.pdf>)

¹²⁸ BEIS estimate based on BPEC Level 3 Diploma in Plumbing and Domestic Heating (<https://bpec.org.uk/qualification/level-3-diploma-in-plumbing-and-domestic-heating/>).

¹²⁹ BEIS analysis based on the Energy Innovation Needs Assessment, Vivid Economics et al. (2019) (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/845654/energy-innovation-needs-assessment-building-fabric.pdf).

 Heat pumps	
	<p>Estimated demand timeline (according to CITB)¹³⁰</p> <ul style="list-style-type: none"> • 1-4 years: up to 7,500 installers trained per year • 5-10 years: up to a peak of 15,000 installers trained per year <p>Analysis conducted by the Heat Pump Association, based on deployment of 300,000 heat pumps installed in 2025 and 1 million installed in 2030, suggests that we will need at least:</p> <ul style="list-style-type: none"> • 12,400 heat pump installers by 2025 • 50,200 by 2030¹³¹
How we plan to meet this demand	<p>Government is working closely with industry to ensure that appropriate high-quality training is available, both for new entrants to the sector and existing heating installers who do not have heat pump experience.</p> <p>In August 2021 the Heat Pump Association launched a new course, which aims to improve consistency of training for installers with previous heating experience (such as oil and gas engineers).¹³² Manufacturers have said that they have capacity to train 7,000 heat pump installers every year.¹³³</p> <p>We are working with the further education sector to increase and improve the availability of training and apprenticeships.</p> <p>We have also commissioned and conducted research to improve our understanding of the existing installer workforce. Previous BEIS research found that 72% of off-gas-grid heating installers without heat pump experience would upskill to install heat pumps, if demand for fossil fuel heating decreased.¹³⁴ Therefore, we anticipate that, if training is taken up by existing heating engineers, current training capacity is sufficient to ensure we have enough heat pump installers in the future.</p> <p>BEIS has also established an Electrification of Heat Task Group and a Net Zero Buildings Council to consider any barriers to upskilling heat pump installers.</p>


¹³⁰ Eunomia (2021), 'Building Skills for Net-Zero' for CITB, p.40 (https://www.citb.co.uk/media/kkpkwc42/building_skills_net_zero_full_report.pdf).

¹³¹ Heat Pump Association (2019), 'Building the installer base for net zero heating' (https://www.heatpumps.org.uk/wp-content/uploads/2020/06/Building-the-Installer-Base-for-Net-Zero-Heating_02.06.pdf).

¹³² Heat Pump Association (2021), 'New training course launched by the Heat Pump Association' (<https://www.heatpumps.org.uk/secretary-of-state-welcomes-ground-breaking-new-training-course-launched-by-heat-pump-association/>).

¹³³ Heat Pump Association (2019), 'Building the installer base for net zero heating' (https://www.heatpumps.org.uk/wp-content/uploads/2020/06/Building-the-Installer-Base-for-Net-Zero-Heating_02.06.pdf).

¹³⁴ BEIS (2021), 'Heating systems in off gas grid areas: installers' experiences and attitudes towards low carbon heating' (<https://www.gov.uk/government/publications/heating-systems-in-off-gas-grid-areas-installers-experiences-and-attitudes-towards-low-carbon-heating>).

 Heat networks	
Where we are now	<p>There are no standard industrial or occupational codes (SIC/SOC) specific to the heat network sector and no heat network specific qualification is currently available.</p> <p>UK heat network companies already upskill their workforce through in-house training programmes (including Guru Systems, Ramboll UK, and Sweco) and have seen significant staff growth (Engie, E.ON, SSE and Vital Energi).</p> <p>However, our Heat network skills review noted potential intensified gaps due to individuals moving out of the sector, and a lack of science, technology, engineering and mathematics graduates and diverse talent joining the sector.¹³⁵</p>
Skills required for installing heat networks	<p>Heat networks require a multi-disciplinary skillset. Skills needed include:</p> <ul style="list-style-type: none"> • project planners • engineers and developers • design engineers • control systems and programmable logic controller (PLC) specialists • welders • general installers <p>Estimated demand timeline (according to CITB)¹³⁶</p> <ul style="list-style-type: none"> • 1-4 years: 9,500 additional FTE per year, predominantly specialist and technical skills • 5-10 years: reduction rate of training to 866 additional FTE per year • Over 10 years: reduction in numbers required - 1,200 FTE per year <p>The Heat Network Industry Council estimates that the heat network sector could create between 20,000 and 35,000 direct additional jobs by 2050.¹³⁷</p>
How we plan to meet this demand	<p>Some indirect upskilling is being enabled through the Heat Networks Delivery Unit.¹³⁸</p>


¹³⁵ BEIS (2020), 'Heat network skills review' (<https://www.gov.uk/government/publications/heat-network-skills-review>).

¹³⁶ Eunomia (2021), 'Building Skills for Net-Zero' for CITB, p. 41 (https://www.citb.co.uk/media/kpkpwc42/building_skills_net_zero_full_report.pdf).

¹³⁷ Heat Network Industry Council Offer (2020).

¹³⁸ BEIS (2017), 'Heat Networks Delivery Unit' (<https://www.gov.uk/guidance/heat-networks-delivery-unit>).

 Heat networks	
	<p>The Heat Network Skills Programme seeks to create a competitive fund for supply chains and training and increase the recruitment pool and its capability. A full appraisal to identify the most effective delivery route will be carried out over the course of 2021/22.</p> <p>The Green Heat Network Fund will require applicants to make commitments, aligned with Build Back Better: our plan for growth, and result in the projects investing in local infrastructure, skills, and innovation.</p>

 Hydrogen	
Where we are now	<p>Hydrogen boiler engineers and home retrofitters will likely require similar expertise and training as natural gas boiler engineers. However, existing natural gas boiler engineers may still require some additional training to familiarise themselves with the differences between using and installing products that use hydrogen as a fuel source, in contrast to natural gas.</p> <p>As part of BEIS's Hy4Heat programme, Energy and Utility Skills developed a competency framework which included an initial analysis of the additional skills, knowledge and understanding which would be required for natural gas engineers to transition to hydrogen.¹³⁹</p> <p>Further complementary training to improve consideration of other energy needs of the whole building (such as fabric efficiency, smart technologies and storage systems), alongside their heating appliance, could be beneficial to some installers.</p>
Skills required for installing hydrogen boilers	<p>All gas installers (registered with Gas Safe) would require additional training.</p> <p>Estimated demand timeline (according to CITB)¹⁴⁰</p> <ul style="list-style-type: none"> • 1-4 years: existing gas installers will be able to retrain, with an additional 200 FTE per year on average • 5-10 years: existing gas installers can continue re-fitting with hydrogen-ready boilers and begin conversion as hydrogen becomes available. An average of approximately 1,500 additional FTE per year
How we plan to meet this demand	<p>BEIS' Hydrogen Skills and Standards for Heat programme is further developing standards for hydrogen gas installations and installers to re-</p>

¹³⁹ Energy & Utility Skills (2021), 'Hydrogen Competency Framework Report' (<https://www.euskills.co.uk/download/hydrogen-competency-framework-report/>).

¹⁴⁰ Eunomia (2021), 'Building Skills for Net-Zero' for CITB, p.34 (https://www.citb.co.uk/media/kpkpwc42/building_skills_net_zero_full_report.pdf).



Hydrogen

purpose existing natural gas infrastructure to be used with hydrogen downstream of the emergency control valve (ECV).

The standards developed will define the required criteria when using hydrogen to safely repurpose existing natural gas equipment, design and install new pipework and appliances. This work will include engaging with potential training providers.

Paul Leedham is the Managing Director of [Matrix Energy Systems](https://matrixenergysystems.co.uk/)¹⁴¹, a Sheffield-based MCS certified installation company.

He has a passion for heat pumps and has grown to become a leading provider of intelligent renewable energy, heating and cooling solutions in both domestic and commercial markets.

Matrix are certified to install several renewable technologies including: air source heat pumps, ground source heat pumps, biomass boilers, and solar thermal and solar photovoltaic panels. To date, Paul and his team have delivered more than 1,000 renewable energy projects across the UK. He supports consumers on their journey to adopting renewable energy solutions, from design to installation. They install on 30 to 50 sites per year, most of which are integrated systems with more than one technology. Approximately 50% of these installations are not connected to the electricity or gas grid.

Matrix have won ten national awards over the last six years in recognition of their quality heat pump installations. They recently scooped both Air Source Heat Pump Installer of the Year and Ground Source Heat Pump Installer of the Year at the National ACR & Heat Pump Awards 2020¹⁴².

Paul aims to grow his business organically while developing new talent entering the market. Paul authored the BPEC (British Plumbers Employers Council) Heat Pump Installation Training Course and is working with MCS to identify the skills requirements for the growing heat pump installation sector.

“When I first launched the business, it was really challenging due to the immaturity of the market but I’ve worked really hard to make a success of it and grow the business to where we are now. There is lots of opportunity on the horizon and we are working with MCS to make it simpler and easier for others to join the sector. I’m now giving guidance to fossil-fuel-based installers on how they can make the move into renewables. Heat pumps are a well-established, proven technology that offer immediate and substantial carbon savings compared to fossil fuel heating systems.”

“Heat pumps not only maintain a comfortable and stable temperature throughout the day but can also allow for the ‘smart’ consumption of heat. I’ve worked with several consumers to tailor their heating installation to their own preferences and help them lower their fuel bills and save money by shifting heat demand.”

¹⁴¹ Matrix Energy Systems (<https://matrixenergysystems.co.uk/>).

¹⁴² ACR stands for air-conditioning and refrigeration.

Paul Leedham, Managing Director of Matrix Energy Systems.



2.4. Levelling up

Improving our homes and buildings comes with huge benefits to quality of life and economic activity – offering a unique opportunity to level up deprived regions across the UK. This section:

- *sets out the opportunity and ambition for using buildings as a lever for levelling up*
- *gives examples of how policy action is targeted to achieve this*

We need to decarbonise and support clean growth in every region of the UK. This means substantial opportunities for local investment and job creation. The Northern Powerhouse, Midlands Engine, and rural communities represented by Britain's Leading Edge have all highlighted the importance of low-carbon investment to their future economic growth.

The Government will ensure that the benefits of our growing low-carbon economy are shared fairly in every region. We will target areas of greatest need by encouraging manufacturing and training to provide jobs and we are already providing funding where it is most appropriate, supporting low income and fuel poor households, social housing tenants, and vulnerable consumers.

Tangible, targeted benefits can be achieved through action to upgrade poor-performing buildings. This is supported by research conducted by the Energy Efficiency Infrastructure Group¹⁴³, which found a correlation between areas of deprivation and homes with low thermal efficiency and high-carbon heat sources in England. The same report explored the incidence of fuel poverty in England and found it to be typically higher outside of the South East, particularly in rural areas including Cornwall, Cumbria and Lancashire. Therefore, our ambition (as set out in the [Clean Growth Strategy](#)¹⁴⁴) to upgrade as many homes as possible to EPC band C by 2035, where practical, cost-effective and affordable, and action to phase out high-carbon fossil fuel heating in off-gas-grid buildings, can deliver broader benefits to deprived areas.

¹⁴³ EEIG (2020), 'Rebuilding for Resilience - energy efficiency's offer for a net zero compatible stimulus and recovery' (<https://www.theeeig.co.uk/news/starstarnew-reportstarstar-rebuilding-for-resilience-energy-efficiency-s-offer-for-a-net-zero-compatible-stimulus-and-recovery/>).

¹⁴⁴ BEIS (2017), 'Clean Growth Strategy' (<https://www.gov.uk/government/publications/clean-growth-strategy/>).

By its nature, installing energy efficiency measures and new heating systems requires local supply chains. It can also tap into the network of UK supply chains and SMEs, supporting the wider UK economy.

Figure 4: Proportion of fuel poor households (England)

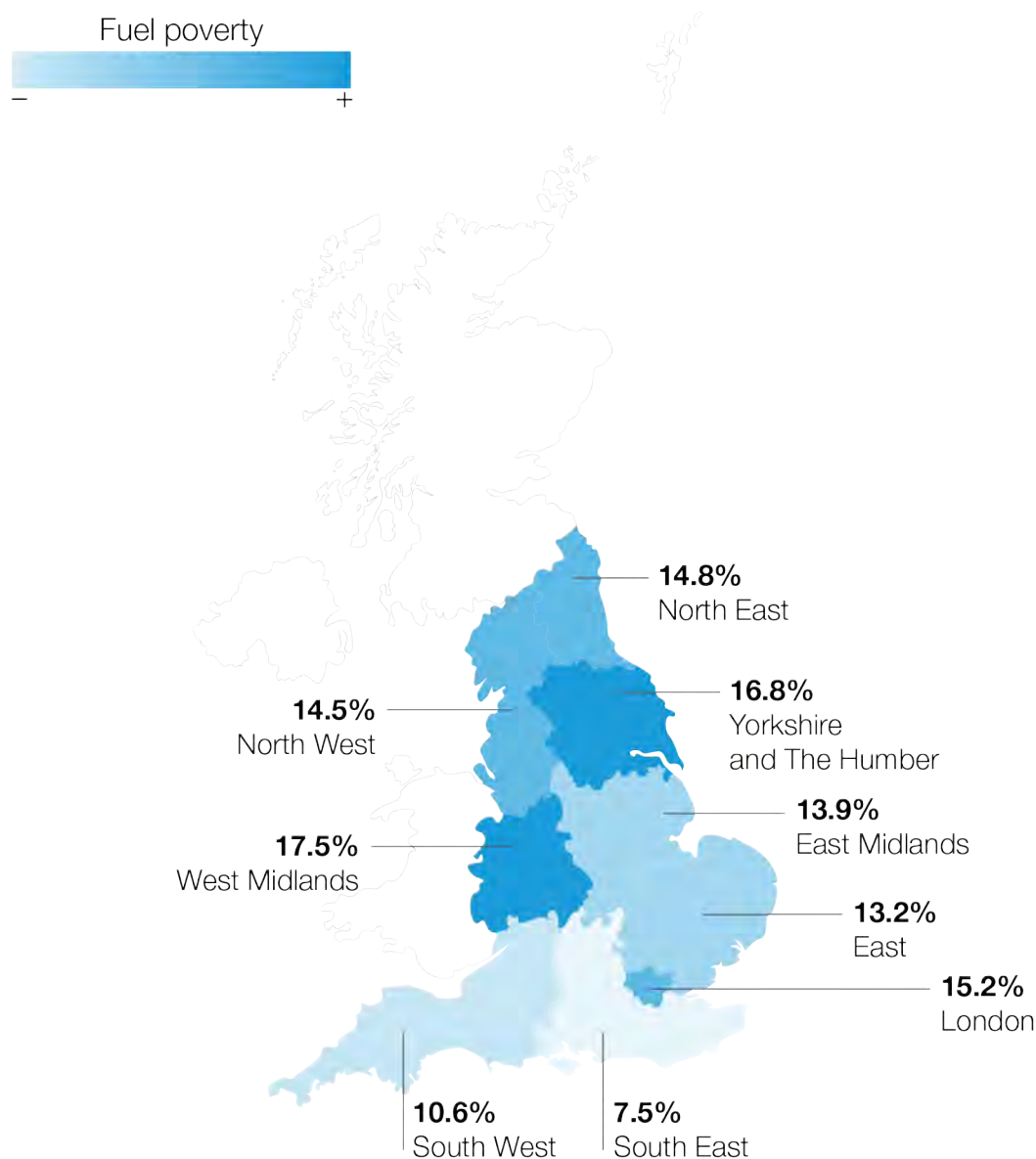


Figure 4 shows that the proportion of households living in fuel poverty varies across England.^{145, 146} Additional support for low income and fuel poor homes can help to level up different regions across the UK.

¹⁴⁵ BEIS (2021), 'Fuel poverty detailed tables 2021' (<https://www.gov.uk/government/statistics/fuel-poverty-detailed-tables-2021>). In our policy paper on 'Sustainable warmth: protecting vulnerable households in England', BEIS (2021) (<https://www.gov.uk/government/publications/sustainable-warmth-protecting-vulnerable-households-in-england>), we announced an update to the fuel poverty metric (from Low Income High Cost to Low Income Low Energy Efficiency).

¹⁴⁶ For Scotland, fuel poverty is defined in section 3 of the 'Fuel Poverty (Targets, Definition and Strategy) (Scotland) Act 2019' (<https://www.legislation.gov.uk/asp/2019/10>). According to this definition, Scottish fuel

Figure 5: Proportion of homes rated EPC band C and above, by region (England)

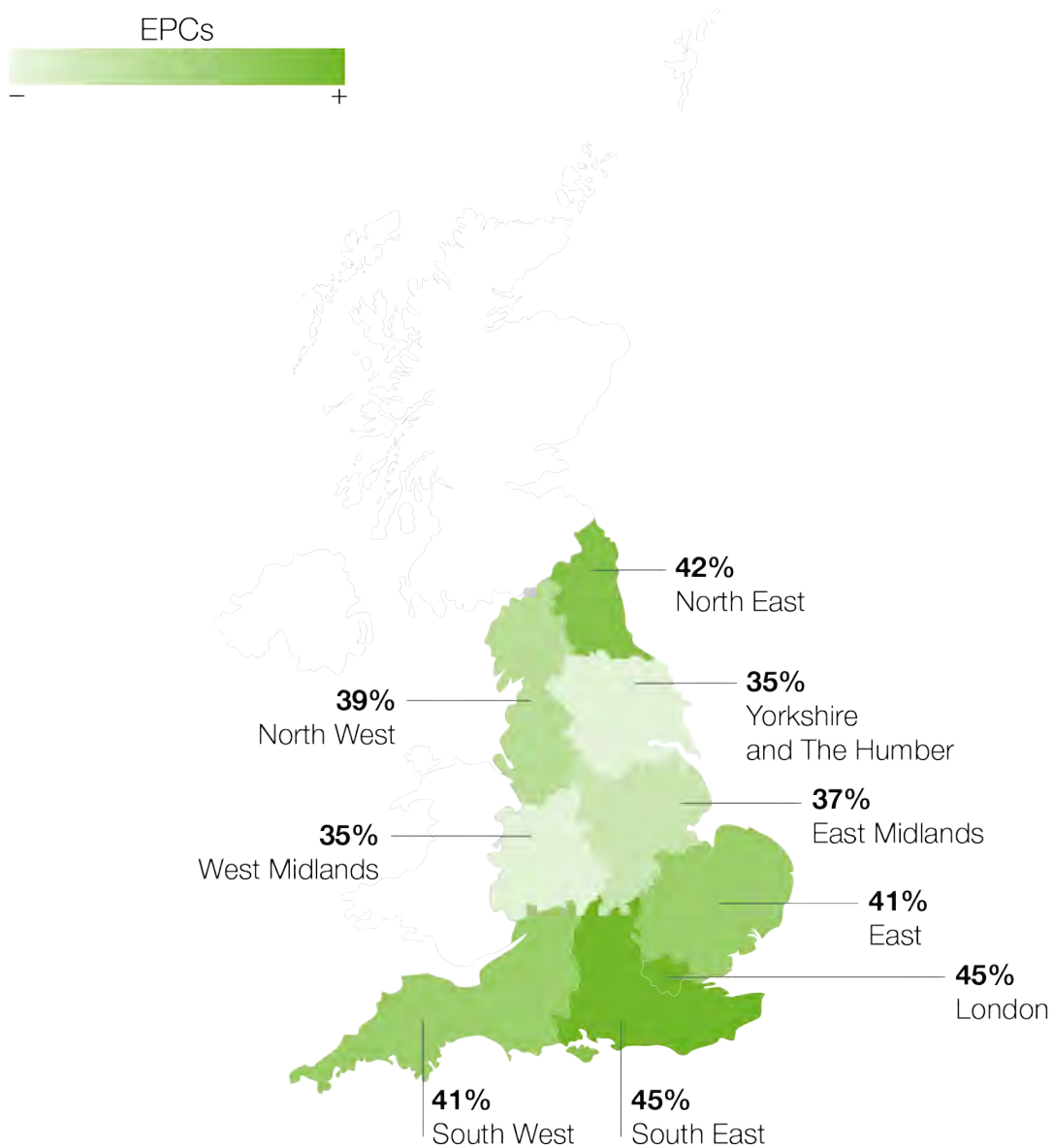


Figure 5 shows that the energy efficiency of building also varies by location.^{147,148} Therefore, upgrading the efficiency of buildings in specific regions can help level up the region.

poverty averages at 25%. Source: Scottish Government (2020), 'Scottish house condition survey: 2018 key findings' (<https://www.gov.scot/publications/scottish-house-condition-survey-2018-key-findings/>) based on a sample size of 2,905. For further information please also see: 'Scottish House Condition Survey: methodology notes 2018' (<https://www.gov.scot/publications/scottish-house-condition-survey-methodology-notes-2018/>).

¹⁴⁷ Source for EPC data for England: DLUHC (2020), 'English Housing Survey 2018: energy report' (<https://www.gov.uk/government/statistics/english-housing-survey-2018-energy-report>).

¹⁴⁸ According to 2018 Scottish house condition survey: 2018 key findings' (<https://www.gov.scot/publications/scottish-house-condition-survey-2018-key-findings/>), based on SAP 2012 (RdSAP v9.93) with a sample size: 2,964, 43% of homes in Scotland are rated EPC C and above.

The UK will continue to support vulnerable and fuel poor households as they decarbonise their homes:

- Through utilising the latest metrics and communicating clear strategies to tackle fuel poverty:
 - Following a public consultation, in February 2021 we updated the fuel poverty metric for England, to better track progress towards our statutory fuel poverty target, and have published a policy paper on [Sustainable warmth: protecting vulnerable households in England](#)¹⁴⁹.
 - Welsh Government published a strategy on '[Tackling fuel poverty 2021 to 2035](#)'¹⁵⁰ in March 2021.
 - [The Fuel Poverty Act](#)¹⁵¹ (2019) sets statutory targets for reducing fuel poverty in Scotland, introduces a new definition of fuel poverty, and requires Scottish ministers to produce a comprehensive strategy to show how they intend to meet the targets. Scottish Government's new Fuel Poverty Strategy will be published in due course.
 - Northern Ireland published their [Fuel Poverty Strategy](#)¹⁵² in 2011. The Department for Communities is responsible for developing a new Fuel Poverty Strategy, which will be informed by responses to the [consultation on policy options for a new Energy Strategy](#)¹⁵³ and the [call for evidence for a new Housing Supply Strategy](#)¹⁵⁴.
- Through providing targeted support for social housing residents, and low income and fuel poor households through government-funded grants:
 - The Green Homes Grant voucher scheme for England offered vouchers to fund up to two thirds of the value of energy performance and low-carbon heat measures up to the value of £5,000 for homeowners and residential landlords (or 100% up to the value of £10,000 for low income owner-occupiers). More than 133,700 applications were received, and more than 79,200 vouchers have been issued.¹⁵⁵ All vouchers issued will be honoured in line with the terms and conditions of the scheme.

¹⁴⁹ BEIS (2021), 'Sustainable warmth: protecting vulnerable households in England' (<https://www.gov.uk/government/publications/sustainable-warmth-protecting-vulnerable-households-in-england>).

¹⁵⁰ Welsh Government (2021), 'Tackling fuel poverty 2021 to 2035' (<https://gov.wales/tackling-fuel-poverty-2021-2035-html>).

¹⁵¹ The National Archives (2019), 'Fuel Poverty (Targets, Definition and Strategy) (Scotland) Act 2019' (<https://www.legislation.gov.uk/asp/2019/10/enacted>).

¹⁵² Department for Communities (2011), 'Warmer Healthier Homes – a new Fuel Poverty Strategy for Northern Ireland' (<https://www.communities-ni.gov.uk/publications/fuel-poverty-strategy>).

¹⁵³ Department for the Economy (2021), 'Consultation on policy options for the new Energy Strategy for Northern Ireland' (<https://www.economy-ni.gov.uk/consultations/consultation-policy-options-new-energy-strategy-northern-ireland>).

¹⁵⁴ Department for Communities (2021), 'Consultation on the new housing supply strategy call for evidence' (<https://www.communities-ni.gov.uk/consultations/consultation-new-housing-supply-strategy-call-evidence>).

¹⁵⁵ On average, more than one voucher has been requested per application.

- The Local Authority Delivery (LAD) scheme provides funding to local authorities across England, supporting low income households in all English regions.
- The Home Upgrade Grant (HUG) is intended to be introduced in 2022 and will support upgrades to the worst-performing off-gas grid homes in England. £150 million funding was granted for the first phase of HUG, and a further £950 million funding is available over 2022/23 to 2024/25.
- The Social Housing Decarbonisation Fund (SHDF) for England aims to upgrade a significant amount of the social housing stock that is currently below EPC band C up to that standard. We are investing a further 800 million into the SHDF over financial years 2022/23 to 2024/25,

In taking action to address buildings with poor energy performance, we can tackle fuel poverty and improve residents' health and wellbeing. Additionally, market growth and increased demand for smart, low-carbon and high-efficiency buildings can drive supply and generate new skilled jobs. Decarbonising buildings can deliver four benefits when levelling up deprived regions:

Health: COVID-19 has highlighted the importance of ventilation for good health. Improving the energy performance of our buildings, without creating airtight spaces, presents an opportunity to ensure our buildings provide warm, well-ventilated spaces and healthy environments from which people can live and work. This can help avoid many physical illnesses, including heart and lung conditions.^{156, 157, 158, 159, 160}

Energy costs: reducing energy bills and business operating costs – as inefficient homes are more expensive to run, the Energy Efficiency Infrastructure Group estimate that upgrading all UK homes to EPC band C could provide annual energy cost savings of £7.5 billion.¹⁶¹

¹⁵⁶ Curl and Kearns (2016), 'Housing improvements, fuel payment difficulties and mental health in deprived communities', (<http://dx.doi.org/10.1080/14616718.2016.1248526>)

¹⁵⁷ Grey et al. (2017), 'Cold homes, fuel poverty and energy efficiency improvements: A longitudinal focus group approach' (<https://journals.sagepub.com/doi/full/10.1177/1420326X17703450>).

¹⁵⁸ Liddell C., C. Morris and S. Langdon (2011), 'Kirklees Warm Zone: The Project and its health impacts: A Cost-Benefit Analysis' (https://www.researchgate.net/publication/278000500_Kirklees_Warm_Zone_The_Project_and_its_health_impacts_A_Cost-Benefit_Analysis).

¹⁵⁹ Public Health England and UCL Institute of Health Equity (2011), 'Local action on health inequalities: Fuel poverty and cold home-related health problems' (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/357409/Review7_Fuel_poverty_health_inequalities.pdf).

¹⁶⁰ Institute of Health Equity Team and Friends of the Earth (2011), 'The Health Impacts of Cold Homes and Fuel Poverty' (<https://www.instituteoftheequity.org/resources-reports/the-health-impacts-of-cold-homes-and-fuel-poverty>).

¹⁶¹ IEEG (2020), 'Rebuilding for resilience - energy efficiency's offer for a net zero compatible stimulus and recovery' (<https://www.theeeig.co.uk/news/starstarnew-reportstarstar-rebuilding-for-resilience-energy-efficiency-s-offer-for-a-net-zero-compatible-stimulus-and-recovery/>). Assumes EPC band C by 2030 with cost savings at 2020 prices.

Employment: addressing the areas of highest unemployment and providing a diverse range of job opportunities, including more technical and specialised skills. Enhancing local skills can improve the prosperity of families in deprived regions.¹⁶²

Wellbeing: setting standards and improving the quality of buildings can improve the quality of living in warmer more comfortable buildings.¹⁶³ Energy efficiency improvements targeting fuel poverty (and the financial stress of coping with high energy bills and debt) can help improve mental wellbeing. In the long-term, energy performance improvements also provide benefits such as increased productivity and improved life expectancy.

Improving air quality

Air pollution is the largest environmental health risk in the UK^{164,165}, which is why the UK's [Clean Air Strategy](#)¹⁶⁶ sets out how we will tackle all types of air pollution, making the air healthier to breathe and protecting nature.

The transition to low-carbon heating and improvements to energy efficiency will need to take into account the air quality and public health impacts of different technologies. The electrification of heat is, in general, highly beneficial for air quality, offering significantly reduced emissions of harmful pollutants in comparison to fossil fuel heating.¹⁶⁷ However, some forms of low-carbon heating, such as biomass and hydrogen, involve emissions of pollutants such as particulate matter and nitrogen oxides. Therefore, air quality controls and monitoring will need to be put in place to protect public health and meet our statutory air quality targets, alongside collecting further evidence to fully understand the air quality impacts of biomass and hydrogen for heat.

More widely on domestic heating, the Government is already taking action on air pollution. We recently legislated to phase out the sale of coal, and wet wood sold in small volumes for immediate use, for domestic burning. This will help reduce a major source to the UK's emissions of fine particulate matter.

We also recognise the importance of reducing the build-up of harmful levels of air pollution within homes. Adequate ventilation is required to ensure a healthy indoor environment and prevent creation of increasingly airtight spaces, which may trap pollutants indoors.

¹⁶² IEEG (2020), 'Rebuilding for resilience - energy efficiency's offer for a net zero compatible stimulus and recovery' (<https://www.theeieg.co.uk/news/starstarew-reportstarstar-rebuilding-for-resilience-energy-efficiency-s-offer-for-a-net-zero-compatible-stimulus-and-recovery/>).

¹⁶³ NICE (2015), 'Excess winter deaths and illness and the health risks associated with cold homes', 4.23-4.25 (<https://www.nice.org.uk/guidance/ng6/chapter/4-Considerations#illness-and-deaths-linked-to-the-cold>).

¹⁶⁴ Public Health England (2020), 'Air pollution: applying All Our Health' (<https://www.gov.uk/government/publications/air-pollution-applying-all-our-health/air-pollution-applying-all-our-health>).

¹⁶⁵ Public Health England (2018), 'Associations of long-term average concentrations of nitrogen dioxide with mortality' (<https://www.gov.uk/government/publications/nitrogen-dioxide-effects-on-mortality>).

¹⁶⁶ DEFRA, DLUHC, DfT, DHSC, HMT, and BEIS (2019), 'Clean Air Strategy' (<https://www.gov.uk/government/publications/clean-air-strategy-2019>).

¹⁶⁷ This is dependent on the way that the electricity is generated, with renewable sources of electricity – such as wind and solar – offering the most significant benefits for air quality.

2.5. Helping shape a ‘Green Global Britain’

As a world-leader in low-carbon technology, we can position Great Britain both as a destination for investment and as an exporter of low-carbon products, skills and expertise.

To meet Net Zero, new products, services and markets will be needed across the UK. We need to develop a robust UK supply chain for the manufacture, installation, and use of low-carbon, high-efficiency technologies. This can provide a major economic stimulus in the UK. Energy efficiency measures alone could support up to 6 billion GVA per year by 2030.¹⁶⁸ In light of the impacts of COVID-19 on the UK economy, this has never been more important.

This market growth presents an opportunity for investment:

- Significant investment has been made by insulation manufacturers operating multiple factories across England and Wales. Analysis by McKinsey and Company estimates that a €50 billion to €80 billion post-COVID investment in retrofit building energy efficiency measures could deliver between 800,000 and 1.7 million jobs, and provide a GVA multiplier of 2.2.¹⁶⁹
- Industry studies suggest that the UK’s heat network investment potential presents between £30 billion and £50 billion by 2050 depending on deployment.¹⁷⁰ Some regions offer particularly attractive opportunities for investment, such as the North East and Tees Valley Combined Authority’s £200 million pipeline. This pipeline offers potential for investment in pipe facilities, design offices, and heat network training centres.
- The use of hydrogen in heating could provide significant additional investment opportunities into major infrastructure (for the production, storage and distribution of hydrogen). More details on our approach to attracting further investment across the hydrogen value chain can be found in our [UK hydrogen strategy](#)¹⁷¹.

If established early, these energy efficiency and low-carbon heat markets can take advantage of additional export opportunities for goods and services and demonstrate our ability to be a green ‘Global Britain’.

- Though the global market for insulation production and components is extremely competitive, in 2016 the construction sector exported over £8 billion of products and services.¹⁷² The UK’s expertise in pre-construction and design (including building

¹⁶⁸ BEIS analysis based on the Energy Innovation Needs Assessment, Vivid Economics et al. (2019) (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/845654/energy-innovation-needs-assessment-building-fabric.pdf).

¹⁶⁹ McKinsey Sustainability (2020), ‘How a post-pandemic stimulus can both create jobs and help the climate’ (<https://www.mckinsey.com/business-functions/sustainability/our-insights/how-a-post-pandemic-stimulus-can-both-create-jobs-and-help-the-climate?cid=eml-web>). Exhibit 4 – Estimated capital mobilised and impact of low-carbon stimulus measures for a European country – based on a European country with a population of 50 million to 70 million with an estimate deep retrofit of 2 million homes.

¹⁷⁰ Heat Networks Industry Council (<https://www.hnic.uk/>).

¹⁷¹ BEIS (2021), ‘UK hydrogen strategy’ (<https://www.gov.uk/government/publications/uk-hydrogen-strategy>).

¹⁷² CCC (2019) ‘UK housing: Fit for the future?’ (<https://www.theccc.org.uk/publication/uk-housing-fit-for-the-future/>).

information modelling) could lead to the capture of 18% of the EU market, and a 14.6% share in the rest of the world market by 2050.¹⁷³

- Building operations, including the development of smart controls using the UK's expertise in IT systems, could plausibly lead to capturing 10% of the global market by 2050.¹⁷⁴
- According to our Energy Innovation Needs Assessment, heat pumps offer the greatest low-carbon heat export opportunity, due to the large existing market in Europe. The UK currently exports heat pumps across Europe, in particular to France, the Netherlands and the Republic of Ireland, and globally, to countries such as New Zealand.^{175,176}
- Export opportunities relating to heat network engineering, procurement, and construction management services are projected to expand and accelerate. The UK's strength in innovations and engineering services, such as automatic monitoring, could lead to opportunities to boost global exports, despite strong competition.
- Countries are developing sector strategies for hydrogen. If the UK pioneers the use of hydrogen for heating buildings, other countries may follow, creating new markets which could benefit from the UK's hydrogen products and expertise. For example, Worcester Bosch¹⁷⁷ and Baxi¹⁷⁸ have both developed prototype hydrogen boilers in the UK, supported by BEIS's Hy4Heat programme.
- The UK has competitive strength in anaerobic digestion, supported by an expanding domestic market. This industry has grown by more than 350% in the last 10 years, with UK firms already exporting specialist components within and beyond Europe.¹⁷⁹ Gasification, engineering, procurement, and construction management services provide further export opportunities.

Industry will have a key role in investing to drive down costs, create more green jobs, provide necessary training for the existing workforce, scale-up UK manufacturing and production, innovate to improve affordability, and ensure products are smart-enabled that deliver high consumer satisfaction.

¹⁷³ Vivid Economics et al. (2019) 'Energy Innovation Needs Assessment: building fabric' commissioned by BEIS (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/845654/energy-innovation-needs-assessment-building-fabric.pdf).

¹⁷⁴ Vivid Economics et al. (2019) 'Energy Innovation Needs Assessment: building fabric' commissioned by BEIS (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/845654/energy-innovation-needs-assessment-building-fabric.pdf).

¹⁷⁵ Vivid Economics et al. (2019) 'Energy Innovation Needs Assessment: building fabric' commissioned by BEIS (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/845654/energy-innovation-needs-assessment-building-fabric.pdf).

¹⁷⁶ BEIS (2020) 'Heat pump manufacturing supply chain research project' (<https://www.gov.uk/government/publications/heat-pump-manufacturing-supply-chain-research-project>).

¹⁷⁷ Worcester-Bosch, 'Hydrogen-fired boiler' (https://www.worcester-bosch.co.uk/hydrogen?gclid=EAlaIqobChMI0repndqz7AIVia3tCh1hLQD5EAAYASAAEgKdmfD_BwE).

¹⁷⁸ Baxi (2019), 'Nigel Evans visits Baxi Heating to see the company's first pure hydrogen boiler' (<https://www.baxi.co.uk/about-us/news/nigel-evans-visits-baxi-heating-to-see-the-companys-first-pure-hydrogen-boiler>).

¹⁷⁹ Vivid Economics et al. (2019) 'Energy Innovation Needs Assessment: building fabric' commissioned by BEIS (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/845654/energy-innovation-needs-assessment-building-fabric.pdf).



Jobs and skills

To support green recovery, a significant escalation in the number of trained, high-quality installers will be required. The Heat Pump Association estimates we will need an additional 12,400 heat pump installers by 2025 and 50,200 by 2030¹⁸⁰ and the Heat Network Industry Council estimates that the heat network sector could create between 20,000 and 35,000 direct additional jobs by 2050. We need to attract new entry-level workers to the low-carbon heat and buildings sector and upskill the existing workforce – encouraging current gas engineers, electricians, and those with transferrable skills, to retrain and specialise in smarter, greener and cleaner technologies.

Industry already has capacity to upskill thousands of heating engineers to install heat pumps every year, and this is set to grow. For example, Octopus Energy is investing £10 million in a new training centre in Slough.¹⁸¹ We are also working with the Department for Education and the further education sector to ensure heat pump training is offered more widely.



Manufacture

To help meet increasing UK demand, we need to scale-up UK production of heat pumps. We are therefore aiming for a 30-fold increase in heat pumps manufactured and sold within the UK by 2028. Currently about 10,000 units are manufactured in the UK each year, which represents only 30% of heat pumps of those sold in the UK. Growing UK manufacture and supply to over 300,000 units a year by 2028, could enable a greater rate of installation as well as grow our opportunity for exports. This could create more than 10,000 manufacturing-related jobs in the UK. According to our independent assessment of the supply chain's ability to scale-up to meet demand¹⁸² and our direct engagement with manufacturers to date, we think that an ambition for 30-fold increase in UK manufacture and supply is a realistic and achievable goal. There is also an opportunity to grow the supply chain for high-value components of low-carbon heating systems, such as heat pump housing and controls, valves and pipework.

¹⁸⁰ Heat Pump Association (2020), 'Building the installer base for net zero heating' (https://www.heatpumps.org.uk/wp-content/uploads/2020/06/Building-the-Installer-Base-for-Net-Zero-Heating_02.06.pdf).

¹⁸¹ Sources: The Times (2021), 'Octopus Energy prepares for air-source heat pump revolution' (<https://www.thetimes.co.uk/article/octopus-energy-prepares-for-air-source-heat-pump-revolution-900brhdrz>). The Mirror (2021), 'Half price heat pumps and '£4,000 grants' coming under plans to ban gas boilers by 2025' (<https://www.mirror.co.uk/money/half-price-heat-pumps-4000-24205418>). The Sun (2021), 'GREEN WIN Millions of Brits can soon afford to rip out boilers & install eco-heat pumps' (<https://www.thesun.co.uk/news/15092377/brits-afford-rip-out-boilers-eco-heat-pumps/>).

¹⁸² BEIS (2020), 'Heat pump manufacturing supply chain research project' (<https://www.gov.uk/government/publications/heat-pump-manufacturing-supply-chain-research-project>).

We are already seeing signs that manufacturing capacity will increase. For example, Vaillant has announced their intention to invest £3 million to expand their Belper manufacturing facility to produce heat pumps from 2022.¹⁸³



Affordability and costs

We want to challenge industry to innovate and improve the affordability and appeal of heat pumps. As part of this challenge, industry should aim to seek significant reductions in the capital and running costs of low-carbon heating and energy efficiency technologies, and promote green finance to increase accessibility and affordability. Our ambition is to work with industry to reduce installed costs by 25-50% by 2025, and towards parity by the end of the decade. This could be achieved through product innovations that improve efficiency, and therefore reduce running costs, or that reduce manufacturing and installation costs. Finding ways to reduce heat pump installation times will make installations not only cheaper, but also a more appealing choice for consumers replacing their existing heating systems. Meeting our target of at least 600,000 installations a year by 2028 is contingent on the market finding ways to reduce the upfront cost of the systems, while continuing to improve consumer experience and appeal. Using competition and economies of scale, and developing new financing models for consumers can also improve affordability. Mortgage lenders and other organisations offering grants and loans will have a key role to play, alongside government-funded grants and subsidies. In parallel, government has a role to play to ensuring the affordability of running low-carbon heating systems, and we will work to address market in energy pricing that can act as a barrier to heat decarbonisation.



Smart and flexible

Industry must push ahead with developing more efficient heat pump models, but crucially these must also be smart-enabled by:

- Being able to learn consumer preferences and maximise comfort
- Being equipped with innovative forms of energy storage
- Being cyber-secure and interoperable with other devices in the home

¹⁸³ Vaillant (2021), 'Vaillant Expands UK Manufacturing Facility to Produce it's aroTHERM plus Heat Pumps' (<https://www.vaillant.co.uk/about-vaillant/news/vaillant-expands-uk-manufacturing-facility-to-produce-it-s-arotherm-plus-heat-pumps/>).

- Being responsive to local and national energy system needs
- Taking advantage of time of use energy tariffs
- Being able to participate in grid services to meet demand at lowest cost



Consumer satisfaction

Survey research conducted between September 2017 and February 2018, showed that amongst domestic RHI applicants with an air source heat pump, 86.3% were satisfied with it. Similarly, 82.5% with a ground source heat pump were satisfied¹⁸⁴. Further findings on consumer perceptions of heat pumps will come from the evaluation of the Electrification of Heat Demonstration project. However, industry must continue to innovate to reduce the barriers to installation that exist today, aiming for the smallest, quietest, easiest to use products, which can be installed in a day or less. Consumers should be as satisfied – or more satisfied – with a low-carbon heating system as they are with a fossil fuel equivalent. By developing new innovative products, industry should aim to tailor technologies to operate effectively in a broader variety of buildings, thereby maximising the potential heat pump market. Targeted government funding to support innovation and product standards will help to support industry in driving the necessary changes in the market.

Chapter 3: Where we are now

Due to the diverse UK building landscape and the variety of technologies available, there are many different ways that we can decarbonise. However, we need to take an approach which keeps us on track to deliver Net Zero and reflects both building-level considerations (such as size and location) and system-level considerations (mindful of action to decarbonise other sectors).

In this chapter we:

- *list the core technologies available to improve energy efficiency, provide low-carbon sources of heat, and create a smart and flexible energy system*

¹⁸⁴ BEIS (2019), 'Applicant survey data tables: Domestic' (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/833066/Domestic-RHI-Retrospective-Survey-Data-Tables.xlsx). Based on 2,331 responses given by domestic RHI applicants who submitted their application between 1st of April 2016 and the 20th of September 2017. Responses weighted to the population of successful applications.

- *review the current state of UK buildings and the different approaches that will encourage decarbonisation across the whole of the building stock*
- *highlight the roles of hydrogen, carbon capture and storage, and electricity in the wider energy system*

We need to take a whole-building and whole-system approach to minimise costs of decarbonisation.

To maximise performance and ensure solutions are suitable, we need to consider the heating (and cooling) system of the building as a whole. This includes: thermal efficiency and ventilation needs, efficiency of energy-related products, energy storage, smart technologies, heating appliances, and internal distribution systems. We will need to accommodate local and regional variations in the building landscape and energy demand. We also need to actively manage the system-level impacts of decarbonising the heating of many buildings so we can build a smart flexible energy system, guarantee energy supply, and complement decarbonisation in other sectors, such as transport.

3.1. Key technologies

Decarbonising heat and buildings will require the adoption of new, smarter technologies and practises. This section:

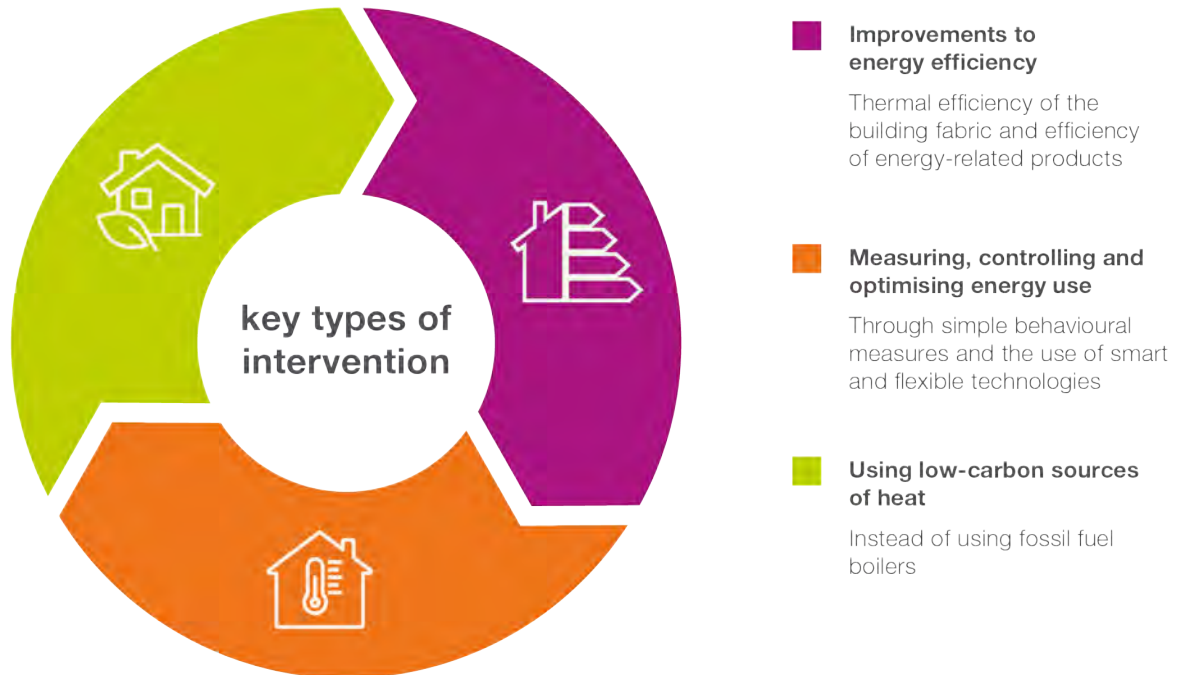
- *sets out the key technologies for improving buildings, decarbonising heating and using energy more efficiently*
- *highlights key factors affecting the suitability of these technologies to different buildings and occupants*
- *provides an illustrative vision of ‘buildings of the future’ to explain how these technologies can work together to create an energy efficient, low-carbon, smart and flexible system, compatible with Net Zero*

There are many different ways that the heating and cooling of buildings can be decarbonised. However, these technologies cannot deliver the same results in isolation. Across a single building we need to consider:

- the fabric and thermal efficiency of the building
- internal heat distribution systems (such as radiators and pipework)
- heat sources and heating appliances
- energy-related products that directly or indirectly affect energy consumption (such as lighting, appliances, and electronics)
- energy storage (such as hot water tanks or batteries)
- meters to measure energy use

- controls to modify energy use, including smart technologies

The combination and integration of these different measures, alongside the behaviours and demands of the building users, define the energy performance of a building and, in turn, the impacts of that building on the energy system. Buildings that successfully integrate energy efficiency, smart technologies and low-carbon heating and appliances can maximise comfort while minimising cost. They can also offer energy system benefits and offset extra demands.



Some technologies will work in a way that is similar to existing products and systems, and some will look and feel very different. Given the diversity of buildings and building use, no single solution can provide the best option for everyone. The appropriateness of installing and using technologies included in this section will be dependent on the building itself. Key characteristics of buildings in the UK in detailed in section [3.2 UK buildings landscape](#).

A mix of technologies and consumer options will need to be available to enable us to decarbonise at scale.

This section provides a summary of some of the key technologies available.

Energy efficiency

Improving the energy efficiency of our buildings will play an important role in increasing thermal comfort and reducing energy demand: the cheapest energy is the energy we don't use. By reducing our energy demand, we can reduce energy bills and contribute towards reducing the size and cost of the whole energy system. This in turn helps to reduce the transition to Net Zero's overall cost to consumers.

Energy efficiency can also increase the ability to shift heat demand to periods when costs and carbon intensity are lower, for example by pre-heating a home before the evening peak (see section on [Energy storage](#)).

Energy efficiency measures in buildings are wide-ranging, but key interventions include: insulation, controls, energy-related products and heat distribution systems.

Improving the energy efficiency of the fabric of the building, the appliances used, and the heat distribution system will reduce wasted energy and therefore reduce carbon emissions.

Insulation: improving thermal efficiency

There are many simple yet effective ways to insulate buildings, which can significantly reduce heat loss while lowering heating bills. Insulation options include:

- **Draught-proofing:** This can increase comfort and slightly reduce energy bills by using simple and cheap methods to prevent cold draughts. Methods might include blocking or sealing gaps around windows, doors, and skirting boards, and chimneys when they are not in use.
- **Loft and floor insulation:** Insulating lofts, roofs and under floorboards (especially on the ground floor) can significantly reduce heat loss and reduce heating bills.
- **Insulating heating systems:** Insulating behind radiators, lagging pipes and hot water tanks can help heating systems operate more efficiently and reduce the amount of heat lost in a building's heat storage and distribution system.
- **Insulating walls:** Many buildings, such as houses built before 1990, were not constructed with wall insulation, though this may have been retrofitted later.¹⁸⁵
 - Cavity walls have a gap between the inner and outer brickwork. An installer can fill this cavity with insulating material by drilling small holes in the brickwork, which are then repaired afterwards. According to the Energy Saving Trust, an installer can do this in around two hours for a regular-sized home with easy access and it will not create any mess.¹⁸⁶
 - Solid walls have no gap and therefore need to be insulated on the inside or the outside of the wall. Though this typically costs more than insulating cavity walls, it delivers bigger energy and bills savings, as more heat is lost through uninsulated solid walls.
- **Windows and doors:** Both double and triple glazing can decrease energy loss and save money on bills. There can be other benefits too, such as soundproofing and reducing condensation.

Energy-related products: improving appliance efficiency

We use energy for far more than just heating our buildings. Choosing more efficient energy-related products can also contribute to reduced greenhouse gas emissions and lower energy bills. Energy-related products can be anything that has an impact on energy consumption during use (such as lighting, heating and cooling systems, household appliances, and commercial products) as well as products that have an indirect impact on energy consumption

¹⁸⁵ Energy Saving Trust, 'Cavity wall insulation' (<https://energysavingtrust.org.uk/advice/cavity-wall-insulation/>).

¹⁸⁶ Energy Saving Trust, 'Cavity wall insulation' (<https://energysavingtrust.org.uk/advice/cavity-wall-insulation/>).

(such as water-using products). Products with higher energy efficiency (which may be displayed on an energy label) use less energy and therefore further reduce bills and emissions.



We will be publishing an updated energy-related products policy framework later this year.

Heat distribution: improving distribution efficiency

Heat distribution systems determine how heat is distributed within a building. These commonly consist of pipes and radiators.

Operating at low flow temperatures¹⁸⁷ delivers benefits to all heating systems. We are considering how we can support and build on the Department for Levelling Up, Housing and Communities (DLUHC) recent proposal to ensure that heat distribution systems being installed are designed to operate at low flow temperatures below 55°C.¹⁸⁸

When condensing boilers operate at flow temperatures below 55°C, they have lower return temperatures, meaning they condense a greater amount, and so are more efficient than when operating at higher temperatures.

It is currently best practice to operate condensing boilers with a return temperature below 55°C, which usually means a maximum flow temperature of about 75°C.¹⁸⁹ However,

¹⁸⁷ The 'flow temperature' is the temperature of the fluid entering a heat emitter (radiator or underfloor heating system) from a heat source (such as a boiler or heat pump) and the 'return temperature' is the temperature of the fluid returning from the emitter to the source.

¹⁸⁸ DLUHC (2021), 'The Future Buildings Standard' (<https://www.gov.uk/government/consultations/the-future-buildings-standard>).

¹⁸⁹ HM Government (2018), 'Domestic Building Services Compliance Guide' (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/697525/DBSC_G_secure.pdf).

according to our [Boiler Plus consultation](#), many boilers “never achieve condensing mode, as the operating temperature is set too high.”¹⁹⁰

The majority of heat pumps only provide low temperature heat, with an optimal flow temperature of about 45°C. However, higher temperature heat pump systems, with 65°C flow temperature, are available, and these may be more suitable for some harder to treat buildings.

To maintain levels of thermal comfort at low flow temperatures, changes may be required to heating distribution systems, such as installing larger or more efficient radiators, alongside thermal efficiency improvements, such as draught-proofing and insulation. Through the Boiler Plus Standards (2018), we encouraged use of technologies and practices which can help heating systems operate effectively at lower temperatures, including:

- **Weather and load compensators**, which reduce flow temperatures based on either on the external temperature or temperature within a home. These can be installed alongside new combination boilers to meet the Boiler Plus regulations.
- **Hydraulic balancing** is an installation practice which ensures that central heating systems’ radiators heat up at the same rate. The Boiler Plus consultation response made clear that balancing is an expected practice when installing a new boiler.¹⁹¹
- **Regular maintenance**, alongside a hydraulically balanced system can support a heating system to operate as efficiently as possible, raising overall system performance.

We recommend that consumers prioritise the most cost-effective energy efficiency measures, in particular those measures that payback within 20 years. However, we appreciate that many households and businesses will be interested in going further, for example for increased comfort or to coordinate with other planned building improvements.

¹⁹⁰ BEIS (2017), ‘Heat in Buildings - The Future of Heat’, Boiler plus consultation response, p. 11 (<https://www.gov.uk/government/consultations/heat-in-buildings-the-future-of-heat>).

¹⁹¹ BEIS (2017), ‘Heat in Buildings - The Future of Heat’, Boiler plus consultation response, p. 16 (<https://www.gov.uk/government/consultations/heat-in-buildings-the-future-of-heat>).

Low-carbon heating and cooling

As well as increasing the energy efficiency of our buildings, we need to decrease the emissions from heating and cooling them. Overall, the majority of our buildings use natural gas (methane) for heating, emitting carbon dioxide (CO₂) at the point of use, with 86% of homes in Great Britain¹⁹² connected to the gas grid and around 63% of non-domestic floor area¹⁹³ being heated by gas in the UK.

As discussed in [Clean Growth: Transforming Heating](#)¹⁹⁴, the main heating solutions currently in use are:

- gas boilers burning natural gas (primarily methane) supplied through the national gas grid (made up of the National Transmission System and eight gas distribution networks)¹⁹⁵
- low-efficiency direct electric heating, such as economy-seven or plug-in space heaters, provides less than one unit of heat for every unit of electricity consumed
- high-carbon oil and liquefied petroleum gas (LPG) boilers, with large storage tanks, used by many homes that are not connected to the gas grid
- solid fuel, either biomass (wood, wood chippings or pellets) or coal

To transform the national heating system, we need to replace many of the existing sources of heat with a variety of energy efficient, low-carbon technologies. We see heat pumps, heat networks and hydrogen as potentially playing a pivotal role in decarbonising heat. But we recognise that other technologies such as bioenergy, geothermal heat, and storage heaters may be a more viable alternative in some cases.¹⁹⁶

We need to prepare to switch to low-carbon sources for heat, such as heat pumps, heat networks and potentially hydrogen. All of these technologies have their costs and benefits, which we are seeking to address through research and innovation (see section [4.3 Research and Innovation](#)).

¹⁹² Sources: BEIS (2013), 'Sub-national estimates of properties not connected to the gas network' (<https://www.gov.uk/government/statistics/sub-national-estimates-of-households-not-connected-to-the-gas-network>), last updated 2021. Scottish Government 'Scottish Household Survey' (<https://www.webarchive.org.uk/wayback/archive/20150218135504/http://www.gov.scot/Topics/Statistics/16002>). Welsh Government (2019), 'Welsh Housing Conditions Survey (energy efficiency of dwellings): April 2017 to March 2018' (<https://gov.wales/welsh-housing-conditions-survey-energy-efficiency-dwellings-april-2017-march-2018>). Housing Executive (2021), 'House Condition Survey' (<https://www.nihe.gov.uk/Working-With-Us/Research/House-Condition-Survey>).


¹⁹³ BEIS (2016) 'Building Energy Efficiency Survey (BEES)' (<https://www.gov.uk/government/publications/building-energy-efficiency-survey-bees>), table 2.12.


¹⁹⁴ BEIS (2018), 'Heat decarbonisation: overview of current evidence base' (<https://www.gov.uk/government/publications/heat-decarbonisation-overview-of-current-evidence-base>).


¹⁹⁵ There are also a small number of gas smaller networks (known as 'separate independent undertakings'). Though these use natural gas as a heat source, as they are not connected to the National Transmission System, in this strategy they will be treated as 'off-gas-grid' properties using fossil fuel heat sources.

¹⁹⁶ We will continue to monitor developments in geothermal heat in the UK and assess whether the technology provides a cost-effective option to help decarbonise heat.

Installing a low-carbon heating system alongside or after other building energy performance improvements can avoid oversizing the system, which leads to lower efficiencies and higher running costs, and more pressure on the energy system as a whole.

Technology	Heat pumps 
Description	Hydronic heat pumps can be both energy efficient and cost-effective, as they work by drawing heat from the air, ground, or a nearby water source – even when it is very cold.
Types	<p>There are many types of heat pump, which differ in:</p> <ul style="list-style-type: none"> • their source of heat (e.g. air, ground or water) • the refrigerant they use (or if they use any) • how the heat is distributed in the building (e.g. changing the air temperature or heating water in a central heating system) <p>Some heat pumps are much larger, designed specifically for bigger buildings such as office block or industrial sites, and some heat pumps are suited to communal use such as in a block of flats.</p> <p>Typically, the majority of domestic-scale heat pumps only provide low temperature heat. Higher temperature systems are currently more commonly seen in large-scale applications (such as commercial buildings and heat networks).</p>
Benefits and opportunities	<p>Heat pumps are a proven technology and are ready to deploy at scale. Electric heat pumps are ultra-efficient, producing several units of heat for every unit of electricity consumed. They use electricity, rather than fossil fuels for power, so they do not produce carbon emissions at the point of use. In time, as the electricity grid decarbonises further, the delivered electricity used to power the heat pump will be net zero carbon.</p> <p>Heat pumps can also provide efficient cooling, making them an ideal choice in many domestic buildings, particularly as we face a hotter climate in the future.</p>
Risks and barriers	<p>Insulation, heat storage and heat emitters may need to be installed or replaced for low temperature heat pumps to work efficiently and maintain a comfortable level of heat. Therefore, many buildings would benefit from first making improvements to their thermal efficiency before installing a heat pump.</p> <p>Heat pumps may not be the most suitable technology for all buildings, for example where there is little outside space or separation distance from neighbouring properties, or where the building has very poor thermal efficiency that cannot be addressed cost-effectively. However, BEIS analysis suggests that around 80% of fossil fuel heated off-gas-grid homes in</p>

Technology	Heat pumps 
	<p>England have sufficient energy efficiency and internal fuse limit electrical connections to accommodate a low temperature heat pump system.¹⁹⁷</p> <p>Oil and gas heating systems typically operate at higher temperatures, so switching to a heat pump may also require behaviour change from users.</p> <p>Many heat pumps use hydrofluorocarbons (HFCs)¹⁹⁸ as their refrigerant. The UK has committed to phase down HFCs and will be considering whether we should be more ambitious in light of our commitment to Net Zero by 2050.¹⁹⁹ Therefore, manufacturers should look to use alternative refrigerants.</p> <p>If deployed at scale, this may affect electricity demand. Therefore, we need to consider wider system impacts (see section 3.3 Wider system impacts).</p>
Our approach	<p>Our 2028 minimum market capacity target of installing 600,000 heat pumps per year specifically focused on hydronic (air-to-water or ground-to-water) heat pump systems. This is because this type of heat pump is able to supply hot water and therefore can fully decarbonise heating of that building.</p> <p>We will continue to support the growth of the UK heat pump market (including production and supply) and work to ensure the installation and operation of heat pumps is accessible and affordable (for example through the new Boiler Upgrade Scheme).</p>

Technology	Heat networks 
Description	<p>Heat networks use hot water in pipes to deliver heating (and in some cases cold water for cooling) to many consumers from a centralised heat source. As this pipe infrastructure can be used to deliver heating from a range of different heat sources, they can be decarbonised by switching to a low-carbon source of heat.</p>
Types	<p>Low-carbon heat sources for heat networks can include:</p> <ul style="list-style-type: none"> • ‘waste heat’ sources (supported in some cases by large-scale heat pumps to upgrade the heat temperatures) • industrial processes

¹⁹⁷ BEIS internal analysis, using the ‘National Household Model’ (2017) (<https://data.gov.uk/dataset/957eadbe-43b6-4d8d-b931-8594cb346ecd/national-household-model>), based on consideration of thermal and electrical constraints at dwelling levels.

¹⁹⁸ Fluorinated gases (F-gases), such as HFCs, are man-made. Though they do not damage the atmospheric ozone layer, they are greenhouse gases with a far greater global warming potential than carbon dioxide.

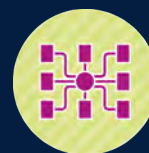
¹⁹⁹ Guidance on current and upcoming bans on F-gases can be found at:

<https://www.gov.uk/government/collections/fluorinated-gas-f-gas-guidance-for-users-producers-and-traders>.



Technology	Heat networks
	<ul style="list-style-type: none"> • data centres • underground transportation • sewage • large environmental, subterranean and geothermal sources (such as ambient air, the ground, rivers, the sea, and water in abandoned mines) • low-carbon fuels <ul style="list-style-type: none"> ○ large biomass boilers ○ low-carbon hydrogen boilers and fuel cells ○ solar energy (to provide hot water) • combined heat and power systems (including some energy from waste) • low-carbon nuclear reactors
Benefits and opportunities	<p>Once in place, heat networks can reduce heating bills and the costs associated with maintaining and repairing individual heating appliances.</p> <p>In most cases heat networks can be decarbonised (by switching their heat source) after installation with minimal disruption to the end user.</p> <p>Depending on their heat source, they can deliver cooling, which means that they can be used throughout the year and enable cities to adapt to climate change and the heat island effect, or offer a similar user experience to gas boilers by providing high temperature heat to rapidly raise the temperature of a building.</p> <p>Heat networks are particularly cost-effective low-carbon heating solutions in dense urban environments.</p> <p>Heat networks provide flexibility through their thermal storage.</p>
Risks and barriers	<p>District heat networks can be complex and expensive to build and connect multiple buildings in a local area. They typically require an organisation to design promote and install and are not normally initiated by individual building owners.</p> <p>Sufficient heat demand is necessary to make the investment required for a heat network economic as is co-ordination between a number of different parties.</p> <p>The sector has been growing and is currently experiencing shortages in delivery professionals with experience of delivering heat networks.</p>
Our approach	<p>We are working with local actors to deploy low-carbon heat networks in suitable areas, developing our zoning approach, and providing capital support through Heat Networks Investment Project and Green Heat Network Fund.</p>


Technology	Heat networks
	<p>Through our transformation programme we will develop regulations to drive decarbonisation, improve consumer protection and performance of legacy networks, grow supply chains and upskill the workforce.</p>




Technology	Hydrogen
Description	<p>Unlike methane, hydrogen does not release CO₂ when it is burned, and can be produced through a range of low-carbon methods. It is therefore being explored as a low-carbon alternative to natural gas.</p>
Types	<p>Low-carbon hydrogen can be produced through multiple methods. To deliver the level of hydrogen needed to meet Net Zero, the UK is committed to a 'twin track' approach, with initial production mostly expected through:</p> <ul style="list-style-type: none"> • steam methane reformation with carbon capture – sometimes referred to as 'blue hydrogen' – this involves using steam and catalysts to break natural gas into hydrogen and CO₂ which is captured and permanently stored underground • electrolysis (predominantly powered by renewables) – sometimes called 'green hydrogen' – this involves using electricity to break water into hydrogen and oxygen <p>Low-carbon hydrogen boilers are likely to display similar variation to natural gas boilers; they could be standalone or combined with a hot water tank, they could differ in size to supply a range of heat demands (domestic properties, larger commercial properties or powering a heat network), they could be combined with heat pumps to create a hybrid system.</p> <p>Hydrogen-ready boilers are heating systems that can operate with a natural gas supply or a low-carbon hydrogen supply.</p>
Benefits and opportunities	<p>Hydrogen gas may be able to be distributed using all or parts of the UK's extensive gas network, which currently services 70% of the UK's total heat demand with natural gas (methane).²⁰⁰</p> <p>Hydrogen could deliver a similar user experience to our current heating system, subject to further testing.</p> <p>Hydrogen-ready boiler may be able to be installed and used prior to conversion to a low-carbon hydrogen supply, reducing disruption to consumers.</p>



²⁰⁰ BEIS (2021), 'Energy Consumption in the UK' (<https://www.gov.uk/government/statistics/energy-consumption-in-the-uk>).


Technology	Hydrogen 
Risks and barriers	<p>We still need to undertake a significant programme of work to build on the outputs of BEIS's Hy4Heat programme to ensure hydrogen is cost-effective, safe, feasible and compatible with Net Zero. This will include considering if and how the existing gas networks would need to be reinforced or replaced.</p> <p>Hydrogen has been identified as an indirect greenhouse gas.²⁰¹ As government, industry and regulatory bodies work together to design systems for the production, distribution and use of hydrogen, we will seek to minimise emissions to the atmosphere. BEIS is funding research to better understand the atmospheric impacts of hydrogen (including refining modelling of its Global Warming Potential), and the potential sources of emissions across the system. Based on this, we will assess how hydrogen infrastructure and processes can best be designed and regulated to minimise releases to the atmosphere and the related impacts.</p> <p>Widespread use of hydrogen for heating would considerably increase the amount of low-carbon hydrogen production required, on top of the likely requirements in other sectors (like industry and heavy transport). This adds to the challenge of upscaling from the minimal levels of production low-carbon hydrogen available today.</p>
Our approach	<p>The role of hydrogen in heating will need to be joined up with our broader strategic planning for hydrogen. We communicated our cross-cutting approach to the role of hydrogen in our UK hydrogen strategy²⁰² in August 2021.</p> <p>Currently, we are looking to: consult on mandating hydrogen-ready boilers, conduct technical research and analysis, deliver consumer trials, explore hydrogen blending, and make strategic decisions on the role of hydrogen in heating buildings in 2026.</p>


Technology	Hybrid heat pump 
Description	<p>Hybrid heat pumps combine an electric heat pump with a combustion boiler (using fossil fuels or low-carbon alternatives). Controls can be used to manage how the different technologies operate together and can be used to optimise on the basis of cost or efficiency.</p>
Types	<p>The market for hybrid systems is developing rapidly and a range of products are available to consumers today. Hybrid systems can range in design and size of heat pump and boiler elements; from heat pumps installed alongside</p>


²⁰¹ Derwent (2018), 'Hydrogen for heating: Atmospheric Impacts. A literature review. BEIS Research Paper Number 2018: no. 21.'

(https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/760538/Hydrogen_atmospheric_impact_report.pdf).

²⁰² BEIS (2021), 'UK hydrogen strategy' (<https://www.gov.uk/government/publications/uk-hydrogen-strategy>).

Technology	Hybrid heat pump 
	<p>existing boilers (standard hybrid), to compact hybrids consisting of a small heat pump and gas boiler integrated within a single unit.</p> <p>Current hybrids use fossil fuels and electricity, but in future there may be hydrogen-electric hybrids.</p>
Benefits and opportunities	<p>Initial research indicates that all hybrid heat pumps have a lot of potential to:</p> <ul style="list-style-type: none"> • reduce dependence on natural gas (when compared to natural gas boilers) • reduce overall peak electricity demand (when compared to standalone heat pumps) – therefore reducing the amount of electricity grid reinforcement needed (as well as the costs and disruption associated with it) • offer a good level of thermal comfort with little need for thermal efficiency improvements • operate similarly to natural gas systems <p>Standard (non-compact) hybrid heat pumps also have the wider benefits including:</p> <ul style="list-style-type: none"> • support growth of heat pump supply chains • provide an opportunity for consumers to become familiar with using a heat pump
Risks and barriers	<p>Significant emission reduction is dependent on consumer behaviour, system design, and the building's thermal efficiency. Our evidence base does not yet give us enough information about how consumers use hybrids for us to make firm conclusions about the potential carbon reductions that they can offer.</p> <p>Like standalone heat pumps, some hybrids use hydrofluorocarbons (HFCs) as their refrigerant, the use of which the UK has committed to phase down.</p> <p>They are also dependent on the boiler fuel source:</p> <ul style="list-style-type: none"> • natural gas-heat pump hybrids are still reliant on a natural gas supply and therefore are not compatible with Net Zero • hydrogen-heat pump hybrids are dependent on the safety and feasibility case for hydrogen, which is still under development
Our approach	<p>Based on the current evidence, we acknowledge that hybrids could play a transitional role in the 2020s and 2030s, but currently remains too early to rule hybrid systems in or out of the 2050 energy mix, particularly in the context of the role of hydrogen for heat. To address this, we are prioritising activity to collect further data. For example, we are gathering data on the real-world use of the hybrid systems through the Electrification of Heat</p>

Technology	Hybrid heat pump	
	Demonstration Project ²⁰³ and will use this data to better understand the effectiveness of hybrid heat pumps in reducing carbon emissions and peak electricity demand.	

Technology	Bioenergy 	
Description	<p>Bioenergy spans all types of fuel of ‘biogenic origin’ (produced by living organisms), whether solid, liquid or gas. A range of bioenergy sources could be used to reduce our use of fossil fuels to heat UK buildings.</p> <p>Aerobic digestion of organic waste can produce renewable fuel, heat or energy, and digestate (which can be used as a fertiliser) as a by-product.</p>	
Types	<ul style="list-style-type: none"> • Biogas and biomethane (produced through gasification or anaerobic digestion) • Bioliquids (such as bioLPG) • Solid biomass (such as wood chippings) 	
Benefits and opportunities	<p>Bioenergy could play a valuable role in reducing emissions in difficult-to-treat properties not connected to the gas grid.</p> <p>Biomethane injection to the gas grid offers a cost-effective way of contributing to near-term legally-binding carbon budgets and in supporting the decarbonisation of the gas grid in the near-term.</p> <p>Anaerobic digestion also helps to reduce emissions from manure storage and waste disposal to landfill.²⁰⁴</p>	
Risks and barriers	<p>In 2018, domestic burning through wood burning stoves and coal fires was the single largest contributor to national emissions of particulate matter. These particles can cause respiratory illnesses and heart disease. Burning of wood and coal also releases nitrogen oxides, which lead to ozone layer depletion, formation of acid rain, as well as causing respiratory diseases.²⁰⁵</p> <p>Burning wet wood has a much lower heat output and can result in more than twice the amount of smoke emissions than from seasoned or dry wood.</p> <p>Additionally, bioenergy needs to be used in a sustainable way (for example – by prioritising use of biogenic waste) to prevent deforestation.</p>	

²⁰³ BEIS (2020), ‘Electrification of Heat Demonstration Project - successful bids’ (<https://www.gov.uk/government/publications/electrification-of-heat-demonstration-project-successful-bids>).

²⁰⁴ DEFRA (2019), ‘Clean Air Strategy 2019’, p. 73 (<https://www.gov.uk/government/publications/clean-air-strategy-2019>).

²⁰⁵ CCC (2018), ‘Biomass in a low-carbon economy’, p. 66 (<https://www.theccc.org.uk/wp-content/uploads/2018/11/Biomass-in-a-low-carbon-economy-CCC-2018.pdf>).

Technology	Bioenergy
Our approach	<p>We note the Climate Change Committee's advice²⁰⁶ to encourage the use of alternative low-carbon sources and limit the use of bioenergy in heating buildings to:</p> <ul style="list-style-type: none"> • Biomethane produced by anaerobic digestion • Part of hybrid heat pumps in hard-to-treat off-gas-grid properties • Local combined heat and power systems and small-scale district heat networks <p>In line with DEFRA's Clean Air Strategy²⁰⁷, government has consulted on cleaner domestic burning of solid fuels and wood, including: restrictions on the sale of wet wood for domestic burning, phasing out the sale of traditional house coal and applying sulphur standards and smoke emission limits to all manufactured solid fuels. We include reasonable exemptions, including the ability to use waste plant material or untreated wood as fuel in a small appliance to produce heat or power.²⁰⁸</p> <p>We will use biomethane to decarbonise the gas grid in the near-term, look to improve how we target use of bioenergy to address buildings unsuitable for alternative sources of low-carbon heat, and continue to ensure our policies have appropriate air quality and sustainability requirements for participants. For example, the RHI requires all applicants to annually submit evidence of their compliance with all environmental regulations.</p>



Energy storage, smart technologies and onsite renewables

It is important that our building stock operates optimally alongside the electricity system, for example by shifting electricity demand away from peak periods to times when there is plenty of renewable electricity on the system, or by generating electricity onsite, in order to minimise overall demand on the electricity grid. As we continue to phase out fossil fuel generation from the electricity grid, reducing extreme high demands (which can only be supplied by fossil fuels where there is low renewable supply) will reduce greenhouse gas emissions in the short to mid-term. By reducing demand, this reduces the amount of network and generation capacity needed, and therefore reduces costs to consumers.

As stated in our [Smart Systems and Flexibility Plan](#)²⁰⁹, a smart and flexible energy system can save up to £10 billion per year by 2050 (in comparison to 2012 prices), compared to a system

²⁰⁶ CCC (2018), 'Biomass in a low-carbon economy', pp. 12-13, 15-16, 119 and 134 (<https://www.theccc.org.uk/wp-content/uploads/2018/11/Biomass-in-a-low-carbon-economy-CCC-2018.pdf>).

²⁰⁷ DEFRA (2019), 'Clean Air Strategy 2019' (<https://www.gov.uk/government/publications/clean-air-strategy-2019>).

²⁰⁸ Environment Agency (2014), 'U4 waste exemption: burning waste as fuel in a small appliance' (<https://www.gov.uk/guidance/waste-exemption-u4-burning-of-waste-as-a-fuel-in-a-small-appliance>).

²⁰⁹ BEIS and Ofgem (2021), 'Transitioning to a net zero energy system: smart systems and flexibility plan 2021' (<https://www.gov.uk/government/publications/transitioning-to-a-net-zero-energy-system-smart-systems-and-flexibility-plan-2021>).

with low levels of flexibility. Government is working with Ofgem to facilitate flexibility through the [Smart Systems and Flexibility Plan and Energy Digitalisation Strategy](#).²¹⁰

Traditionally, many buildings have been passive energy consumers. Smart, digital technology provides greater choice, flexibility and control to consumers. More detail regarding the importance of reducing peak demand is included in section [3.3 Wider system impacts](#).

Flexible use of energy can help create a cost-effective, efficient and secure energy system. This can be achieved through installing smart and flexible technologies within a building.

There are various means of facilitating flexibility in buildings, including smart meters and smart tariffs, home energy management systems and smart appliances, and energy storage.

Smart meters and smart tariffs

Smart meters are the next generation of gas and electricity meters which help to deliver accurate bills and enable pre-paying customers to conveniently track and top-up their credit. They are the enablers of a vital upgrade to our national energy infrastructure, and a critical tool in aiding the transformation of the retail energy market.

As of 30 June 2021, there were 25.2 million smart and advanced meters in homes and businesses across Great Britain, representing 46% smart coverage.²¹¹

The consumption and price data recorded by smart meters enables innovative 'smart' tariffs when combined with half-hourly settlements for suppliers. These tariffs have variable rates depending on the cost of electricity – rewarding consumers with a cheaper rate if they use electricity at off-peak times or when there is excess clean electricity available.

Energy suppliers may be more incentivised to develop and offer smart tariffs if their supply is settled on a half-hourly basis. In April 2021 Ofgem published a decision and full business case for implementing market-wide half-hourly settlement, with the new arrangements taking effect in October 2025.²¹²

The availability of smart tariffs will allow consumers to take advantage of the flexibility afforded by heat pumps and storage; potentially shifting demand and reducing fuel bills.

Home energy management systems and smart appliances

Home energy management systems can be controlled remotely or automatically to optimise energy use and minimise costs to consumers.

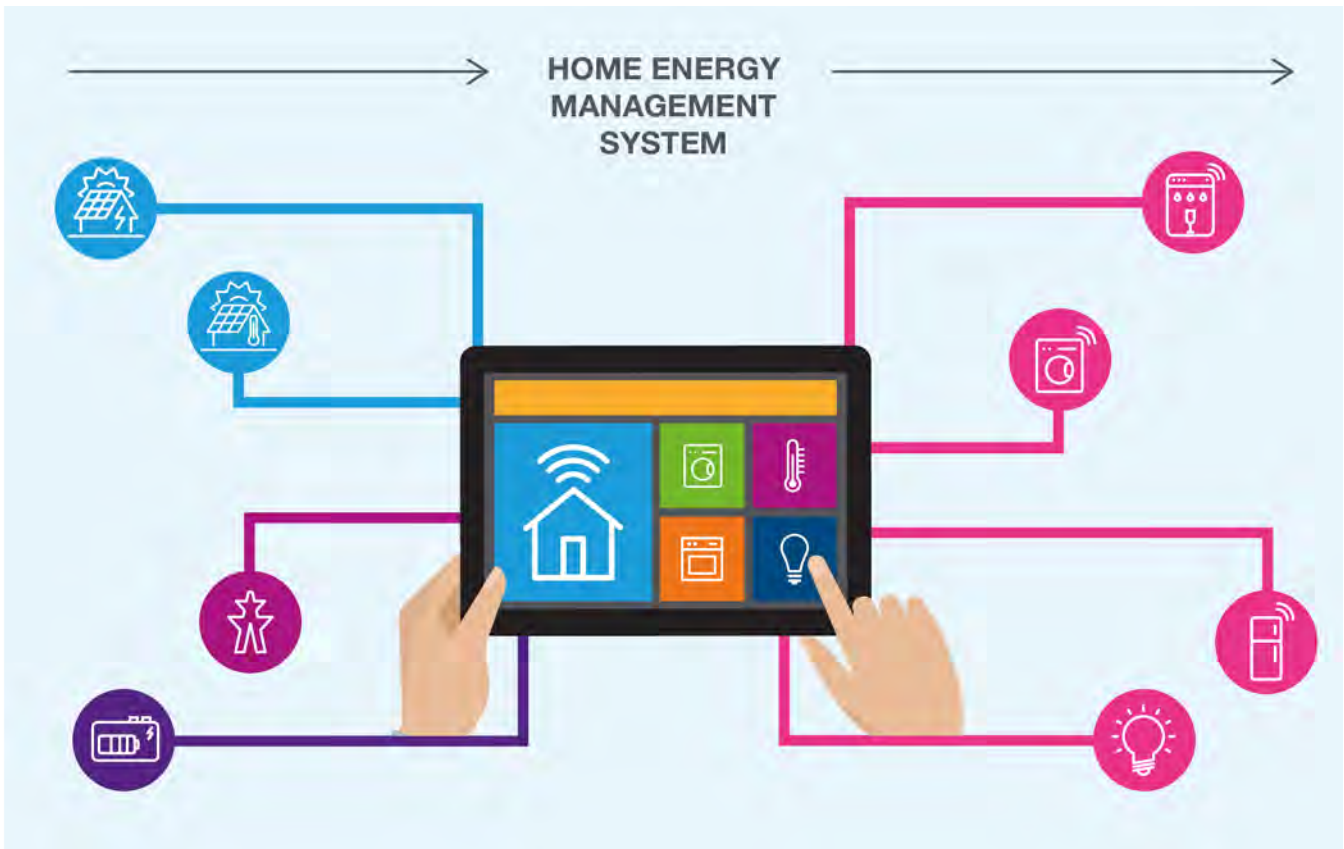
Smart appliances, including heating appliances, are able to respond to price signals such as those from smart tariffs, or from national or local flexibility markets. Government is working with

²¹⁰ BEIS and Ofgem (2021), 'Transitioning to a net zero energy system: smart systems and flexibility plan 2021' (<https://www.gov.uk/government/publications/transitioning-to-a-net-zero-energy-system-smart-systems-and-flexibility-plan-2021>).

²¹¹ BEIS (2021), 'Smart meters in Great Britain, quarterly update June 2021' (<https://www.gov.uk/government/statistics/smart-meters-in-great-britain-quarterly-update-june-2021>).

²¹² Ofgem (2021), 'Electricity settlement reform' (<https://www.ofgem.gov.uk/electricity/retail-market/market-review-and-reform/smarter-markets-programme/electricity-settlement-reform>).

industry to develop standards for these appliances, to ensure interoperability and cyber security.



Energy storage

The energy generated during off-peak periods needs to be stored so that it is available for use at peak periods. Heat and electricity storage technologies include:

- thermal or fabric storage – using materials such as ceramic bricks (as used in storage heaters) and insulation
- hot water storage – in tanks (as used to be common before combination boilers became the most common model in the UK) or in larger-scale district heating systems
- battery storage – storing energy as electricity
- phase change technologies – which contain a substance which releases or absorbs energy when transitioning from a solid to a liquid and vice versa, sufficient to provide useful heating and cooling

Through the use of these technologies, energy consumers may also be able to provide contracted services to local or national networks – for example, shifting energy demand to help balance the system or alleviate a constraint. This will often be through an aggregator, who can bid into markets on consumers' behalf using the flexibility from multiple buildings. We are working with Ofgem and the network companies to enable access to markets for smaller demand side assets.

Some of the technologies that can be used at a household level can be scaled up to deliver local and regional benefits including large thermal stores or batteries.

Consumers can also choose to generate electricity and heat onsite, for example through rooftop solar and solar-thermal. The energy created can then be used, stored for later use, or (following a payment to the consumer) provided back into the electricity grid.

Taking a whole-building approach

We will need a mix of efficient products, low-carbon sources of heat and electricity, and smart and flexible technologies to reduce peak energy demand and keep us on track for Net Zero. In some buildings smart technologies and flexible systems may be more cost-effective than some fabric efficiency improvements, and may offer similar benefits (such as decreasing energy bills). Though the specific technologies installed differ between buildings, given the diversity of the UK building stock (for example – those most suitable for a rural heritage property are likely to be different to those suitable for an urban low-rise 1950s flat), we maintain that most buildings will require a combination of energy efficiency improvements, a low-carbon source of heat and smart and flexible use of energy.

In order to reduce the overall costs of heat decarbonisation, energy efficiency and flexibility improvements should be made prior to or alongside the installation of a low-carbon heating system, wherever possible.

What's our vision: a building of the future

In the future we aim to see much more efficient and integrated use of energy in our buildings.

We commend the innovative, forward-thinking designs submitted to the government's [Home of 2030](#) competition, in particular to the two winners: +Home (designed by igloo Regeneration with Useful Projects, Expedition Engineers and Mawson Kerr) and Connector Housing (designed by Openstudio with Hoare Lea, LDA Design and Gardiner and Theobald).²¹³ These designs include affordable, recyclable, adaptable features, in addition to being compatible with the efficient, smart, low-carbon technologies detailed in this section.

By 2050, buildings should make use of a combination of technologies described in this section to minimise their carbon emissions and maximise their energy performance, thereby achieving the best environmental impact rating possible for that building. Measures include:

- insulation, draught-proofing and double or triple glazing within buildings, which will reduce energy demand for heating through improving thermal efficiency
- using low-carbon sources to heat all buildings
- heat distributors (radiators, underfloor heating) that will ensure heating appliances can work more efficiently and provide lower temperature heat
- smart technologies (that respond to price signals and give the consumer more control over their demand) and more efficient building management policies to manage building energy consumption, alongside measures to better monitor energy usage

²¹³ Home of 2030 (<https://www.homeof2030.com/>).

- energy storage, to help provide energy when grid electricity is expensive and carbon-intensive, through thermal storage, hot water tanks, phase change materials, or battery storage (either in an electric car or elsewhere on the property)
- efficient energy-related products that will require less energy to run than their counterparts
- Some buildings producing their own power through microgeneration, which can be sold back to the grid to generate income when the electricity is not needed in the home

Cooling

Currently, most buildings in the UK only have seasonal demand for cooling for a limited period over the summer²¹⁴, but some buildings require cooling at all times (such as ventilation for supercomputers or chilled foods or medicines). However, as global warming causes temperatures to rise, we anticipate the demand for cooling to increase, across seasons and building types. We have already experienced increases in frequency and severity of local heat waves in recent years.^{215,216} It has been estimated that in the UK, the use of air conditioning increased by about 2% per year between 2012 and 2019.²¹⁷ Therefore, the need for cooling is likely to increase in the coming decades.

If appropriate ventilation measures are not implemented, some thermal efficiency measures made to building fabric (such as draught-proofing and window glazing) can create increasingly airtight spaces which may decrease indoor air quality and increase the need for cooling.

Heat pumps can provide cooling, in addition to heating, when operated 'in reverse', and therefore provide exciting potential to meet both heat and cooling demand in the future. Some cooling measures can improve ventilation and by extension, improve air quality in buildings.²¹⁸

However, some cooling systems use HFCs, which have a far greater global warming potential than carbon dioxide.²¹⁹ Therefore, cooling will need to be delivered in a way that takes into account the heating and cooling of the buildings as a whole, maximising the co-benefits and minimising the contribution to climate change.

²¹⁴ CCC (2019), 'UK housing: Fit for the future?' (<https://www.theccc.org.uk/publication/uk-housing-fit-for-the-future/>).

²¹⁵ CCC (2017), 'UK Climate Change Risk Assessment 2017: Synthesis Report' (<https://www.theccc.org.uk/uk-climate-change-risk-assessment-2017/synthesis-report/>).

²¹⁶ Lowe, J. A. et al. (2019), 'UKCP18 Science Overview Report', p.73. for Met Office; DEFRA; BEIS; Environment Agency (<https://www.metoffice.gov.uk/pub/data/weather/uk/ukcp18/science-reports/UKCP18-Overview-report.pdf>).

²¹⁷ Maidment, G. et al. (2019), 'Reducing energy demand using cooling efficiently (REDUCE)' (<https://openresearch.lsbu.ac.uk/item/87zz1>).

²¹⁸ McKinsey & Company (2020), 'Can HVAC guidance help prevent transmission of COVID-19?' (<https://www.mckinsey.com/industries/advanced-electronics/our-insights/can-hvac-systems-help-prevent-transmission-of-covid-19>).

²¹⁹ The UK has committed to phase down HFCs (the main type of F-gases). Guidance on current and upcoming bans on F-gases can be found at: <https://www.gov.uk/government/collections/fluorinated-gas-f-gas-guidance-for-users-producers-and-traders>.

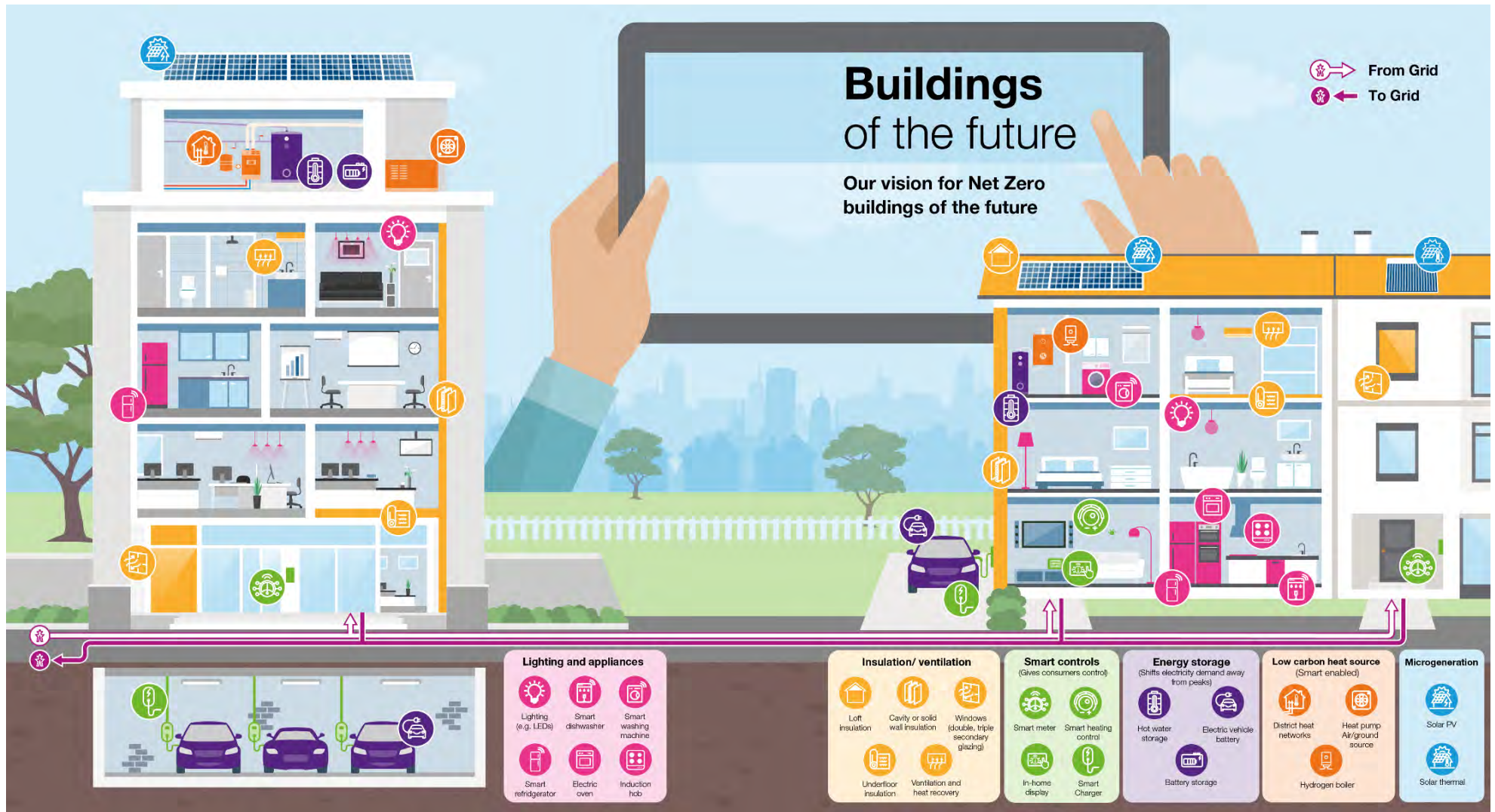


Figure 6 demonstrates an example of how buildings in the future may be designed to use and store energy in a more efficient integrated way. Key elements include: the use of a low-carbon source of heat, measures to ensure high thermal and energy efficiency, and the use of smart technologies.

3.2. UK buildings landscape

Our homes and buildings are hugely diverse, from their ownership and use to their location and design. This has implications for how we approach improving and decarbonising them. This section:

- *outlines the different types of buildings and how their primary use affects their heat demand*
- *explains how different owners and occupiers can decarbonise in different ways*
- *highlights how local parameters can affect the suitability of different technologies*
- *summarises where we are today – in terms of sources of heat used and building energy performance*
- *provides examples of impacts to different types of buildings*

Given the variety of technological options available to us, we need to consider which options are most suited to our diverse buildings stock.

As the UK is effectively one climatic zone, buildings throughout the UK are impacted in similar ways by the climate. For example, wetter winters increase the chance of damp in many buildings across the UK. Affected buildings will therefore benefit from similar mitigations, such as double glazing and improved insulation alongside appropriate ventilation.

However, there are many types of buildings within the UK, with different uses, owners, sizes, locations, fabric efficiencies and heat sources. The most effective way to decarbonise will be dependent on all of these factors. It will also depend on the building structure, and if there are any protections in place (historic or listed buildings).

We need to develop an approach which is mindful of the diversity of the UK building stock, and which also allows individuals to tailor their approach to decarbonisation depending on the building to be addressed.

Key types of building and their use

There are two core uses of buildings:

- Domestic
- Non-domestic (commercial and industrial, and public sector)

However, there are many different individual uses which determine which types of measures may be most appropriate to install.

There are approximately 28 million households in the UK²²⁰, roughly 90% of which currently use fossil fuels, predominantly for space heating, but also for cooking and hot water.²²¹ There are similarities between the structure of some residences, which has an impact on which heating technology and energy efficiency measures may be the most effective to install. In comparison to the non-domestic sectors (commercial, industrial and public), domestic buildings have more in common in terms of how they are used – comfort, cooking, and cleaning – which results in more similar patterns of use. We largely see peaks in heat demand during mornings and early evenings, with much lower demand at night.

We described typical energy use in greater detail in our earlier publication, [Clean Growth: Transforming Heating](#)²²². However, we know that some trends in heating and electricity use have changed as a result of more people working from home during the COVID-19 pandemic, such as greater heat demand for domestic buildings in the middle of the day. This pandemic has highlighted the importance of good ventilation for health. We will look into using regulations and standards to ensure that ventilation is improved hand-in-hand with energy efficiency.

There are approximately 1.7 million non-domestic (commercial, industrial and public) properties in England and Wales²²³, from small businesses to global conglomerates. Of these, 17% are situated in areas with no connections to the gas grid.²²⁴ Non-domestic buildings account for around one-third of UK emissions from the building stock.²²⁵ Buildings in the private commercial and industrial sector have a wider range of uses including shops, factories, and offices. This means they have greater variation in heat demand. Public sector buildings account for 9% of UK building emissions.²²⁶ Public buildings, like commercial and industrial buildings, are very diverse and include hospitals, schools, and government buildings, each of which has different heating needs.

The five largest non-domestic energy users are offices, retail, industry, health, and hospitality, which together account for approximately 71% of non-domestic building energy consumption in England and Wales.²²⁷ However, energy use also varies greatly within these sectors. It is

²²⁰ ONS (2020), 'Households projections for England', Table 401 (<https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/datasets/householdprojectionsforengland>).

²²¹ Estimate based on statistics for England. Source: DLUHC (2020), 'English Housing Survey 2018: energy report', annex table 2.1 (<https://www.gov.uk/government/statistics/english-housing-survey-2018-energy-report>).

²²² BEIS (2018), 'Heat decarbonisation: overview of current evidence base' (<https://www.gov.uk/government/publications/heat-decarbonisation-overview-of-current-evidence-base>).

²²³ BEIS (2020), 'Non-domestic National Energy Efficiency Data-Framework' (<https://www.gov.uk/government/statistics/non-domestic-national-energy-efficiency-data-framework-nd-need-2020>), based on 2018 data.

²²⁴ BEIS (2020), 'Non-domestic National Energy Efficiency Data-Framework (ND-NEED) 2020' (<https://www.gov.uk/government/statistics/non-domestic-national-energy-efficiency-data-framework-nd-need-2020>), geographical annex data tables.

²²⁵ ONS (2021), 'Final UK greenhouse gas emissions national statistics: 1990 to 2019' (<https://www.gov.uk/government/statistics/final-uk-greenhouse-gas-emissions-national-statistics-1990-to-2019>). Includes indirect and direct emissions but excludes international aviation and shipping.

²²⁶ BEIS (2021) 'Final UK greenhouse gas emissions national statistics: 1990 to 2019' (<https://www.gov.uk/government/statistics/final-uk-greenhouse-gas-emissions-national-statistics-1990-to-2019>).

²²⁷ BEIS (2016), 'Building Energy Efficiency Survey (BEES)', figures 3.1 and 3.10 (<https://www.gov.uk/government/publications/building-energy-efficiency-survey-bees>).

therefore important to build flexibility into how buildings with different uses can decarbonise, while maintaining overarching targets to set direction and keep us on track for Net Zero.

Ownership and tenure

The ownership and individuals using a building determines who may be incentivised to decarbonise, and when changes to energy efficiency and their source of heat will be least disruptive. There are four main categories:

- owner-occupied
- private-rented
- social housing
- public-owned buildings

Of the existing homes in England, in 2019 the largest proportion were in the owner-occupier sector (64%), with a much smaller proportion being socially-rented (17%), or privately-rented (19%).²²⁸

There are some correlations between building ownership and tenure and building energy performance. For example, the privately-rented sector has the highest concentration of fuel poor households (26.8%)²²⁹ and privately-rented properties cost over £6 billion in energy bills in 2019, and produce greenhouse gas emissions of around 11 MtCO₂e per year.²³⁰ Socially-rented housing typically have higher energy efficiency (in 2019, about 60% of socially-rented homes in the UK were rated EPC band C and above), whereas owner-occupied buildings have the lowest EPC rating on average (with more than 60% rated EPC band D and below).²³¹



²²⁸ Estimate based on statistics for England. Source: DLUHC (2020), 'English Housing Survey 2019 to 2020: headline report', annex table 1.1 (<https://www.gov.uk/government/statistics/english-housing-survey-2019-to-2020-headline-report>). The English Housing Survey and refers to England only. We note that the proportion of owner-occupied, private- and social-rented properties varies across different regions of the UK and therefore the targeting of policies specific to that area may differ.

²²⁹ BEIS (2013), 'Fuel poverty statistics', 2019 data, table 18 (<https://www.gov.uk/government/collections/fuel-poverty-statistics>). In our policy paper on 'Sustainable warmth: protecting vulnerable households in England', BEIS (2021) (<https://www.gov.uk/government/publications/sustainable-warmth-protecting-vulnerable-households-in-england>), we announced an update to the fuel poverty metric (from Low Income High Cost to Low Income Low Energy Efficiency).

²³⁰ BEIS analysis using 'Energy Consumption in the UK 2020' (<https://www.gov.uk/government/statistics/energy-consumption-in-the-uk>), Consumption Data Tables C1, EHS (English Housing Survey) and National Energy Efficiency Data-Framework (<https://www.gov.uk/government/statistics/non-domestic-national-energy-efficiency-data-framework-nd-need-2020>) 2018 data, tables 9, 10, 27 and 28.

²³¹ DLUHC (2020), 'English Housing Survey 2019 to 2020: headline report', annex table 2.8 (<https://www.gov.uk/government/statistics/english-housing-survey-2019-to-2020-headline-report>).

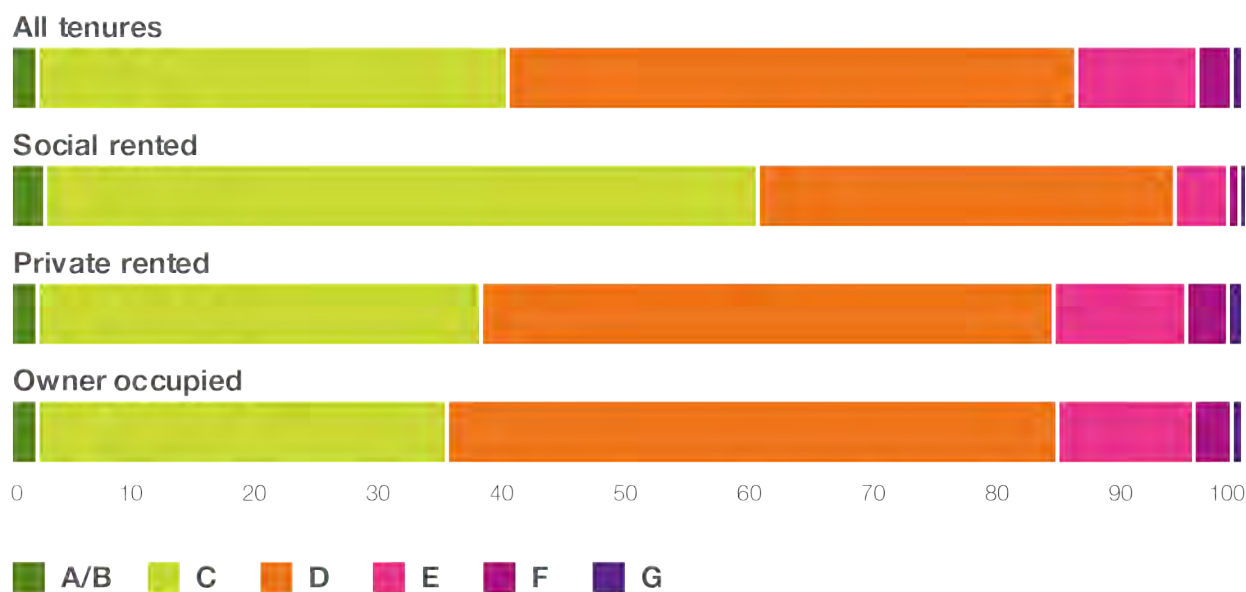
Figure 7: Percentage of EPC ratings A-G in homes with different tenures in England, 2019

Figure 7 highlights the wide variety of EPC ratings for different tenures in England in 2019; though about 60% of socially-rented homes in the UK were rated EPC band C and above in 2019, only about 40% of the total housing stock were EPC band C and above.²³²

Our approach to decarbonising homes must be conscious of the different trigger points for each of these tenures. Incentives and opportunities for homeowners and landlords are different. Therefore, our approach should be tailored based on their tenure-type; using natural trigger points to improve buildings' energy performance, such as when it is most cost-effective and least disruptive to occupants and owners.

Our approach must also be conscious of the complexity in multi-tenure, multi-use buildings, where occupants – and even the owner – may be limited in the changes they can make. For example, there are particular challenges for leasehold property owners, who will have legal restrictions on what they can do to their property. We are exploring how to prevent this from acting as a barrier to upgrading homes. For these types of buildings, upgrading or treating the whole building at once can be more efficient and cost-effective, but the balance of costs and benefits may differ for different occupants.

Around 40% of all energy consumed in commercial and industrial buildings in England and Wales is in the rented sector, placing more responsibility on landlords to make energy efficiency and heating improvements.²³³ The remaining 60% of energy consumed in commercial and industrial buildings are attributed to owner-occupied buildings. Owner-occupied buildings tend to be larger than rented buildings and therefore tend to use more energy.²³⁴

²³² DLUHC (2020), 'English Housing Survey 2019 to 2020: headline report', Annex Table 2.8 (<https://www.gov.uk/government/statistics/english-housing-survey-2019-to-2020-headline-report>).

²³³ BEIS (2016), 'Building Energy Efficiency Survey (BEES)' (<https://www.gov.uk/government/publications/building-energy-efficiency-survey-bees>), table 3.11.

²³⁴ BEIS (2016), 'Building Energy Efficiency Survey (BEES)' (<https://www.gov.uk/government/publications/building-energy-efficiency-survey-bees>), tables 3.11 and C.1.

We are developing policies and measures that cause minimum disruption by tapping into key trigger points. This includes considering the role of mortgage providers and other lenders and what appropriate requirements need to be met before commencing a new tenancy for a rented property. Making changes to the energy performance of buildings between tenants means that tenants are not disturbed and access is easier. Owners might be indirectly compensated for disruption associated with energy performance improvements, for example, through value added to their property, improved comfort, and lower running costs.

Size

The size of a building may impact which heat distribution system will be most effective and the scale of energy efficiency savings. For the majority of buildings, a combination of increased efficiency and low-carbon heating, plus more efficient energy-using products, will deliver Net Zero emissions most cost-effectively.

The size of non-domestic buildings varies considerably compared to domestic homes. This means that there is a far more uneven distribution of energy use across the stock. Only 5% of the total commercial and industrial building stock are over 1,000m² in floor area.²³⁵ However, these buildings are responsible for over one-half of the energy used by commercial and industrial buildings (excluding process heat).²³⁶

At the other end of the spectrum are 'dwelling-like' buildings (less than 150m²), which make up around 15% of the commercial and industrial building stock by count.²³⁷ Because these buildings are likely to possess the same heating systems and building fabrics as domestic homes, they may benefit from similar interventions made in the domestic market.

Proximity, density and location

A building's location and proximity to others may affect which heat source is most suitable. For example, it may be more cost-effective to convert the heating source of an entire block of flats, rather than addressing each dwelling individually – whereas a detached house in a rural area might be best considered in isolation.

Some heat solutions, such as heat networks, may be better suited to higher density areas. This density of demand ensures that high capital costs can be recouped and means that less heat is lost on route to buildings that are far apart from one another. Therefore, heat networks can play a significant role in towns and cities, and new-build projects such as business parks, garden towns and villages. If heat networks are in close proximity to sources of waste heat, they can use and distribute this heat to buildings in their network.

A cost-effective hydrogen system may be dependent to some extent on local geography. This may include how close it is to production plants, available storage options (e.g. in salt caverns), suitability of existing networks to transport hydrogen, availability of new dedicated hydrogen networks, and routes to store the carbon dioxide if hydrogen is produced using methane reformation with carbon capture.

²³⁵ BEIS analysis of BEIS (2016), 'Building Energy Efficiency Survey (BEES)' (<https://www.gov.uk/government/publications/building-energy-efficiency-survey-bees>).

²³⁶ BEIS analysis of BEIS (2016), 'Building Energy Efficiency Survey (BEES)' (<https://www.gov.uk/government/publications/building-energy-efficiency-survey-bees>).

²³⁷ BEIS (2016), 'Building Energy Efficiency Survey (BEES)' (<https://www.gov.uk/government/publications/building-energy-efficiency-survey-bees>), table C.1.

Electric heat pumps may be easier to install in communities that are fully electrified, with reinforced distribution networks, electric vehicle charge points, and smart energy storage already built into the local area or individual premises.

We recognise that there are different levels of fuel poverty and building efficiency in different areas. Therefore, we need to ensure that measures to decarbonise buildings in a given area are appropriate to that location.

Where we are today: heat sources and energy efficiency

²³⁸ However, a smaller proportion of commercial and industrial buildings are dependent on natural gas (heating 63% of the floor area), with about 29% using direct heating.²³⁹ Whether a building is connected to the gas grid is a significant consideration in terms of whether, when and which heat source changes would be most appropriate.

Figure 8: Percentage of homes with different sources of heat in England, 2019

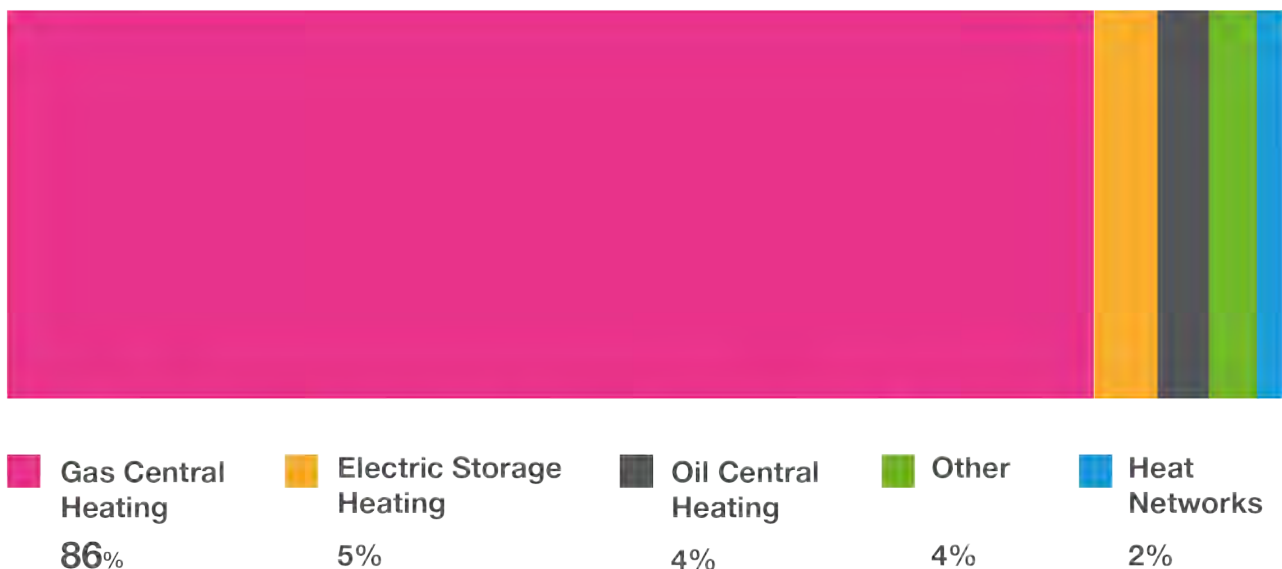


Figure 8 shows the proportion of homes in England using different sources of heat in 2019. Notably gas central heating is used to heat 86% of homes in England.²⁴⁰

²³⁸ DLUHC (2021), 'English Housing Survey 2019 to 2020: energy' (<https://www.gov.uk/government/statistics/english-housing-survey-2019-to-2020-energy>), annex table 2.2.

²³⁹ BEIS (2016), 'Building Energy Efficiency Survey (BEES)' (<https://www.gov.uk/government/publications/building-energy-efficiency-survey-bees>), table 2.12.

²⁴⁰ DLUHC (2021), 'English Housing Survey 2019 to 2020: energy' (<https://www.gov.uk/government/statistics/english-housing-survey-2019-to-2020-energy>), annex table 2.2

Across the UK, in addition to homes using natural gas, 9% of the energy consumed to heat homes is provided by other fossil fuels, such as oil and coal.²⁴¹ However, this 9% accounts for 13% of all domestic heat emissions.²⁴²

Bioenergy sources of heat provide a more similar fuel source to some traditional fossil fuel boilers and are likely to be an appropriate low-carbon alternative to methane for a small proportion of buildings.

Therefore, the building's current source of heat needs to be considered alongside their current and possible level of thermal efficiency to help determine which low-carbon source of heat would be most suitable to install.

There is no single perfect level of energy performance that is appropriate for all buildings, and there are various ways to measure energy performance and use. For example, we published a [consultation on a performance-based energy rating scheme for buildings larger than 1,000m²](#) (detailed in the section on [Improving commercial and industrial places of work](#)).²⁴³

However, we typically use Energy Performance Certificate (EPC) levels to indicate a building's energy performance. In England in 2019, approximately 15 million (60%) of homes were below EPC band C,²⁴⁴ most or all of which will need to be upgraded between now and 2050. We recognise that this may be more challenging in some properties where it is not feasible, affordable, or cost-effective.

The current heat source and energy performance of a building will affect the degree and urgency of changes and improvements needed. For example, some buildings will already be connected to a low-carbon heat network and may not need to change their heat source but could still benefit from improvements to energy efficiency.

New buildings should be made fit for the future – fitted with low-carbon heat sources and high standards of energy efficiency (compliant with the Future Homes Standard and the Future Buildings Standard for England). This will remove any later need for retrofitting.

Given the breadth of the buildings landscape, we need to tailor action so that it minimises the challenges and maximises the opportunities presented to different types of buildings. In section [5.2 How to improve our buildings](#), we set out our proposed approach to improving different building types.

²⁴¹ BEIS analysis based on BEIS (2020), 'Energy Consumption in the UK 2020' (<https://www.gov.uk/government/statistics/energy-consumption-in-the-uk>).

²⁴² National Atmospheric Emissions Inventory (<https://naei.beis.gov.uk/data/data-selector>). National Statistics (2020), 'Final UK greenhouse gas emissions national statistics: 1990 to 2018' (<https://www.gov.uk/government/statistics/final-uk-greenhouse-gas-emissions-national-statistics-1990-to-2018>).

²⁴³ BEIS (2021), 'Introducing a performance-based policy framework in large commercial and industrial buildings' (<https://www.gov.uk/government/consultations/introducing-a-performance-based-policy-framework-in-large-commercial-and-industrial-buildings>).

²⁴⁴ DLUHC (2020), 'English Housing Survey 2019 to 2020: headline report', annex table 2.8 (<https://www.gov.uk/government/statistics/english-housing-survey-2019-to-2020-headline-report>).

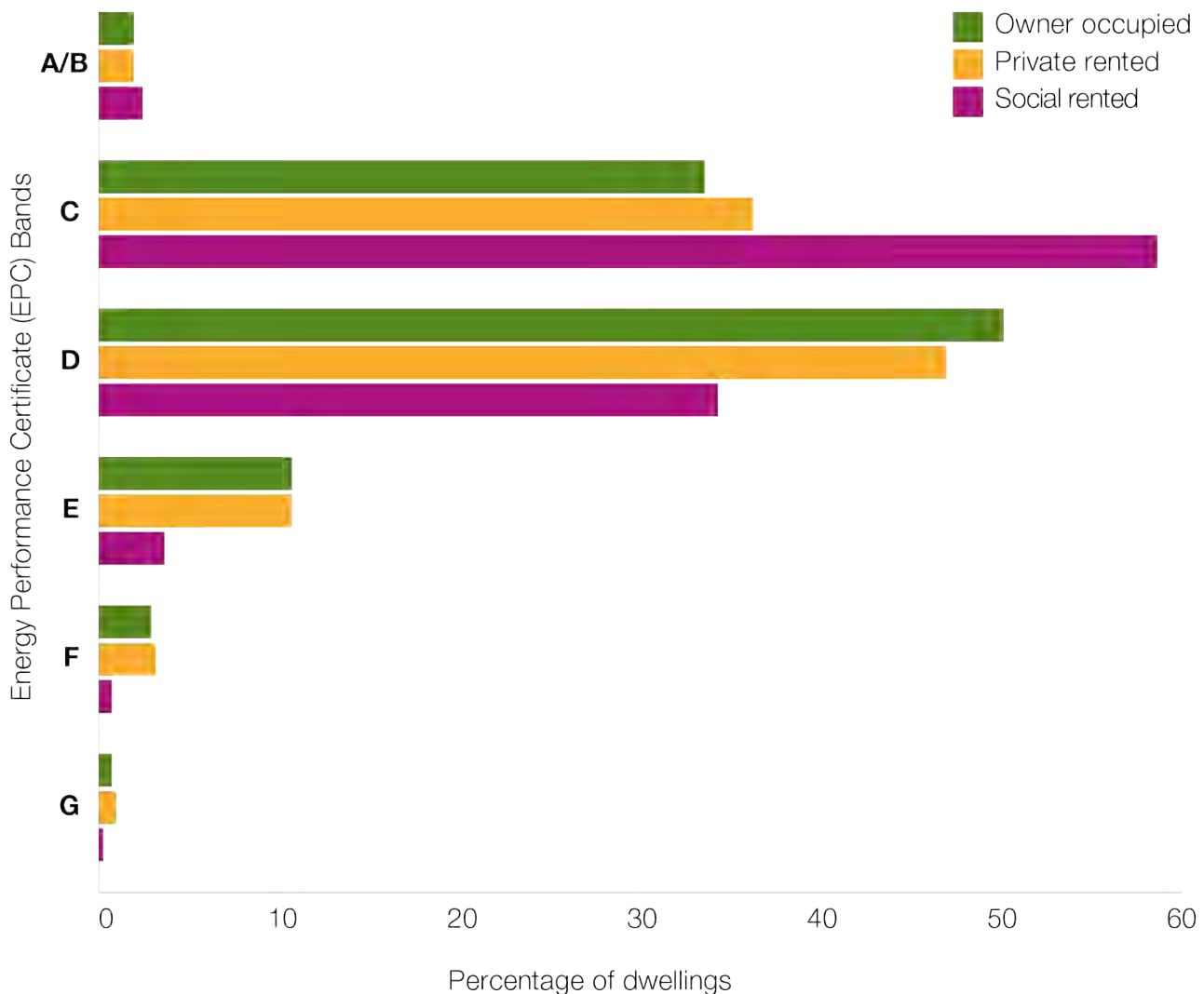
Figure 9: Percentage of dwellings in England with EPC rating A-G, 2019

Figure 9 highlights the wide variety of EPC ratings for different tenures in England in 2019; highlighting the larger number of owner-occupied and private-rented homes with lower energy efficiency rating.²⁴⁵

Potential impacts to different types of building

This section provides illustrative examples and real-world case studies to demonstrate the types of changes that may need to be made to different buildings.

Homes

The Government has committed to upgrading as many homes as possible to achieve EPC band C by 2035 where cost-effective, practical and affordable, and committed to reducing fuel poverty by ensuring as many fuel poor homes in England, as reasonably practicable, achieve a minimum energy efficiency rating of band C by the end of 2030. We have also consulted on driving energy efficiency improvements in the private-rented sector and aim to publish a response before the end of the year.

²⁴⁵ DLUHC (2020), 'English Housing Survey 2019 to 2020: headline report', annex table 2.8 (<https://www.gov.uk/government/statistics/english-housing-survey-2019-to-2020-headline-report>).

The transition to low-carbon heating will be a gradual one, as we test options and bring down costs. For domestic housing types today installing an air source heat pump ranges in cost from £7,000 to £14,000. The wide range in heat pump costs is due to the characteristics of the household: mainly its floor area, fabric efficiency and whether it has already got central heating or not. This is why we are gathering views on how regulatory policy can provide certainty for industry and ensure that installing low-carbon heating takes place during natural replacement cycles at minimum disruption and cost to households; why government will be providing households with £5,000 grants to support consumer choosing to switch to a heat pump, through the new Boiler Upgrade Scheme; and why government will also be providing grant funding through the Home Upgrade Grant and Social Housing Decarbonisation Fund, which will cover the cost of upgrading home energy efficiency and installing low-carbon heat to households who are fuel poor living in poorly insulated off-grid properties and social housing tenants.

However, as the market grows, industry is confident these costs will come down. We are setting an ambition to work with industry to reduce costs of installing a heat pump by 25-50% by 2025 and towards parity between heat pumps and gas boilers by 2030. Our ambition is to ensure that the costs of decarbonising heat and buildings falls fairly across society.

Illustrative examples

Housing Type	Energy Efficiency measures	Heat technology suitability
Highly efficient new-build properties with EPC A or B	Introduction of the Future Homes Standard in England, and interim uplifts in standards, seeks to ensure that new buildings are constructed to a high standard of energy efficiency with low-carbon heat sources (such as a heat pump or heat network), without later need for retrofitting. In 2025, electricity bills of this type of home should be relatively low.	Heat pumps and low-carbon heat networks are likely to be the predominant solution for new homes.

Housing Type	Energy Efficiency measures	Heat technology suitability
<p>Small, rural, off-gas-grid properties with EPC C or above, using high cost direct-electric heating systems</p>	<p>As this type of building has good levels of energy efficiency, it should not require retrofitting.</p>	<p>Owners would not be required to change their heat source. However, our consultation²⁴⁶ proposes that from 2026, when they replace their heating system, they should purchase a low-carbon one.</p> <p>Moreover, due to the sufficient level of thermal efficiency, a heat pump could be installed without any fabric efficiency improvements. Replacing inefficient direct electric heating with a heat pump could lead to a more than 50% reduction in the household's heating bills. This type of building is not suitable for hydrogen heating, as there is no connection to the gas grid.</p> <p>For those who do chose to install a heat pump now, the Boiler Upgrade Scheme which can provide households with £5,000 grants. In addition to government grants, homeowners can capitalise on falling prices of heat pumps, due to industry innovation, and a reduction in the price of electricity over the coming years, due to work to address market distortions in energy pricing.</p>

²⁴⁶ BEIS (2021), 'Phasing out fossil fuel heating in homes off the gas grid' (<https://www.gov.uk/government/consultations/phasing-out-fossil-fuel-heating-in-homes-off-the-gas-grid>).

Housing Type	Energy Efficiency measures	Heat technology suitability
<p>Owner-occupied, semi-detached, 3-bed, suburban properties occupied by families, with EPC C or above, using natural gas for cooking and heating.</p>	<p>As this type of building has good levels of energy efficiency, it should not require retrofitting.</p>	<p>Owners are not required to change their heat source before it comes to the end of its life. However, we intend that from 2035, when their heating system needs replacing, they would choose a low-carbon option.</p> <p>Due to the sufficient level of thermal efficiency, a heat pump could be installed without any fabric efficiency improvements. This type of building may also be suitable for hydrogen heating, so may consider installing a hydrogen-ready boiler in the future.</p> <p>For those who do chose to install a heat pump now, the Boiler Upgrade Scheme which can provide households with £5,000 grants. In addition to government grants, homeowners can capitalise on falling prices of heat pumps, due to industry innovation, and a reduction in the price of electricity over the coming years, due to work to address market distortions in energy pricing.</p>

Housing Type	Energy Efficiency measures	Heat technology suitability
<p>Detached property with EPC E, using oil or LPG for heating</p>	<p>The building's energy performance would benefit from being improved to EPC C. This may include underfloor and loft insulation but not solid wall insulation. Such improvements could lead to considerable bill savings.</p> <p>Those vulnerable households and low income families living in the worst quality off-gas-grid homes (those rated EPC band D, E, F and G) in England are eligible to additional support through:</p> <ul style="list-style-type: none"> • The Home Upgrade Grant, introduced for 2022, which aims to provide funding for energy efficiency and low-carbon heating measures. • The Local Authority Delivery scheme providing up to £10,000 for energy efficiency and low-carbon heating improvements. • Energy Company Obligation funded by £1 billion between 2022 to 2026. 	<p>The owner will not need to replace their existing boiler. However, our consultation proposes that from 2026, once costs have come down, when they require a new heating system, they should purchase a low-carbon one. With a suitable level of thermal efficiency, a low flow temperature heat pump could be installed.</p> <p>For those who do chose to install a heat pump sooner, the Boiler Upgrade Scheme which can provide households with £5,000 grants. In addition to government grants, homeowners can capitalise on falling prices of heat pumps, due to industry innovation, and a reduction in the price of electricity over the coming years, due to work to address market distortions in energy pricing.</p> <p>Hydrogen is not practical for this building as it is not connected to the gas grid.</p>

Housing Type	Energy Efficiency measures	Heat technology suitability
<p>Semi-detached and mid-terrace properties at EPC D, using natural gas for cooking and heating</p>	<p>The building would benefit from improved thermal efficiency (to at least EPC C) to bring down energy bills.</p> <p>This could consist of relatively low-cost measures such as cavity wall insulation, loft insulation and modest draught-proofing and smart controls.</p>	<p>Owners would not be required to change their heat source. However, we intend that from 2035, when their heating system needs replacing, they would choose a low-carbon option.</p> <p>Due to the sufficient level of thermal efficiency, a heat pump could be installed without any fabric efficiency improvements.</p> <p>For those who do chose to install a heat pump now, the Boiler Upgrade Scheme which can provide households with £5,000 grants. In addition to government grants, homeowners can capitalise on falling prices of heat pumps, due to industry innovation, and a reduction in the price of electricity over the coming years, due to work to address market distortions in energy pricing.</p> <p>As this property is connected to the gas grid, there may be the potential for use of hydrogen for heating. The occupier may have installed a hydrogen-ready boiler as a replacement for their natural gas boiler, which should make any future conversion to hydrogen heating more straightforward.</p>

Housing Type	Energy Efficiency measures	Heat technology suitability
<p>Large, detached grade-listed off-grid properties with EPC E or F, using oil or LPG for heating</p>	<p>It may not be cost-effective or practical to increase these buildings to EPC C.</p> <p>However, even with limited energy efficiency improvements, we anticipate that, by 2035, the electricity bills for this home with a high temperature heat pump would be similar or less than their current fossil fuel heating costs.</p> <p>Those vulnerable households and low income families living in the worst quality off-gas-grid homes (those rated EPC band D, E, F and G) in England are also eligible for the Home Upgrade Grant, introduced for 2022, which aims to provide funding for energy efficiency and low-carbon heating measures.</p>	<p>The owner will not need to replace their existing boiler. Our consultation proposes that from 2026, once costs have come down, when they require a new heating system, they should purchase a low-carbon one. This type of home typically has high heating costs and therefore they may be best suited to a high temperature heat pump or may be eligible to choose a biomass system (hydrogen is not practical for this type of building as it is not connected to the gas grid).</p> <p>For those who do chose to install a heat pump now, the Boiler Upgrade Scheme which can provide households with £5,000 grants. In addition to government grants, homeowners can capitalise on falling prices of heat pumps, due to industry innovation, and a reduction in the price of electricity over the coming years, due to work to address market distortions in energy pricing.</p>
<p>Privately-rented terraced housing (which may be converted into flats) with EPC E or F, using natural gas for cooking and heating</p>	<p>This home is likely to be required to meet EPC C or above for new tenancies from 2025. However, it may not be required to make energy efficiency improvements (if it is not practicable or cost-effective to do so) or move away from gas before 2035.</p> <p>The building's energy performance would benefit from being improved to EPC C. This may include underfloor and loft insulation but not solid wall insulation. Such improvements could lead to considerable bill savings for tenants, and potentially higher rental value.</p>	<p>The household would not be required to change their heat source. However, we intend that from 2035, when their heating system needs replacing, they would choose a low-carbon option. This type of building may in future be suitable for hydrogen heating, so may in future consider a hydrogen-ready boiler.</p> <p>If hydrogen is not an option, then very inefficient buildings such as these may be best suited to a high temperature heat pump, which could offset some need for more expensive insulation option.</p> <p>For those who do chose to install a heat pump now, the Boiler Upgrade Scheme which can provide households with £5,000 grants. In addition to government grants, homeowners can capitalise on falling prices of heat pumps, due to industry innovation, and a reduction in the price of electricity over the coming years, due to work to address market distortions in energy pricing.</p>

Housing Type	Energy Efficiency measures	Heat technology suitability
<p>Owner-occupied, semi-detached, 3-bed, suburban properties occupied by families, with EPC C or above, using natural gas for cooking and heating.</p>	<p>As this type of building has good levels of energy efficiency, it should not require retrofitting.</p>	<p>Owners would not be required to change their heat source. However, we intend that from 2035, when their heating system needs replacing, they would choose a low-carbon option. As the home is already well-insulated, a low temperature heat pump could be installed without energy efficiency improvements.</p> <p>By installing a hydrogen-ready boiler the occupier could minimise later disruption and/or scrappage. Some remedial work to homes could be required to ensure suitability for hydrogen, but what changes might be involved is still being researched.</p> <p>For those who do chose to install a heat pump now, the Boiler Upgrade Scheme which can provide households with £5,000 grants. In addition to government grants, homeowners can capitalise on falling prices of heat pumps, due to industry innovation, and a reduction in the price of electricity over the coming years, due to work to address market distortions in energy pricing.</p>

Case study 1: Unused off-gas-grid barn conversion

As part of a broader renovation project to convert an unused barn in Lancashire built in the 1600s into a two-storey family home. The building had no insulation or heating system.

Matrix Energy Systems conducted an appraisal of the property, location and client requirements, and concluded that an air source heat pump would be the most appropriate solution (due to local wildlife, ground shading, and accessibility). Matrix installed two Viessmann Vitocal air source heat pumps to deliver 28 kilowatts (kW) of high efficiency power to the farm (even in -10°C). Alongside this, Matrix installed a Vitotronic control unit, a hot water cylinder, and solar thermal and solar photovoltaic panels to provide the consumer with greater control and flexibility.

The client noted that *“Matrix made it easy for us to understand each option fully and therefore the decisions we made were fully informed. We have been through two winters now and have complete confidence in the system.”*

Some of the installation costs were offset by the Domestic Renewable Heat Incentive and the Feed-In Tariff. Overall, the renovation saved the consumer about £5,700 per year, a 70% saving compared to their previous property.

Non-domestic buildings

Case study 2: Owner-occupied grade II listed building, using natural gas

Some energy efficiency improvements were made to the building, which was originally constructed in 1853, while retaining its original character. Given the high thermal efficiency potential and limited outdoor space, Boss Model Management chose to replace their gas boiler with three 12kW air source heat pumps to provide underfloor heating and radiant ceiling heating for their 614m² warehouse/office, which cost approximately £60,000 and was supported by a bank loan. Boss Model Management chose to operate their business remotely while the building was renovated.

Case study 3: Small off-gas-grid office, using direct electric heating

Ellergreen Hydro spent about £16,000 replacing their direct electric heating system with a 6kW water source heat pump, given their proximity to a water supply, to meet the heating demand of their 100m² office. The building was already well-insulated, with underfloor heating and suitable heat emitters. Due to the building's layout, the building did not need to close while the system was installed, and business activity could continue.

Case study 4: Leased rural village hall, using an oil boiler

A local environmental funder carried out an evaluation of Fringford Village Hall and recommended that they consider low-carbon heating. Given the limited outdoor space, the high efficiency potential and the heat demand of the building, a local renewable heating company recommended air source heat pumps as the most appropriate technology.

Two air source heat pumps (16kW and 12kW) were installed to replace Fringford Village Hall's oil boiler. Renovation works also included: upgrading to a 3-phase electricity connection, insulation improvements, installing solar panels and energy efficient light fittings. This cost the organisation about £25,000, which was funded by local fund-raising.

Plans were already in place to close the building for the renovation; therefore business activity was not disrupted.

Public sector buildings

Illustrative examples

Building type	Energy Efficiency measures	Heat technology suitability
District general hospital, using a natural gas boiler	Public Sector Decarbonisation Scheme capital grant funding of £750,000 could be used to install energy efficiency measures, such as lighting upgrades, improved insulation and intelligent automated building management controls, resulting in no overall increase in operating costs for the hospital even if the fuel costs of electricity remained constant.	<p>The current cost for a hospital's gas consumption is about £250,000 per year. A Public Sector Decarbonisation Scheme grant can be used to cover a significant portion of the capital costs of installing a heat pump and any additional measures, such as electricity supply infrastructure reinforcement costs and heating distribution system modifications.</p> <p>The total funding available under the Phase 2 Public Sector Decarbonisation Scheme to carry out all this work is capped at £325 per tonne of non-traded carbon saved over the lifetime of the measures funded, with a maximum grant award of £5 million per application.</p>
Secondary school using a natural gas boiler with low energy efficiency	The Public Sector Decarbonisation Scheme grant funding of £35,000 could install solar photovoltaic panels that generate sufficient electricity to save £500 per year, combined with lighting upgrades to save a further £250 per year, resulting in no overall increase in operating costs if the fuel costs of electricity remained constant.	<p>The cost of a school's gas consumption is about £11,750 per year. The building is poorly insulated which is a significant source of heat loss. Ahead of the heating system being replaced with a heat pump, £75,000 of Public Sector Decarbonisation Scheme funding could cover the full capital costs of improving the roof insulation and windows, providing an additional 30,000 kilowatt-hours (kWh) of heat savings per year, and allowing a smaller heat pump to be installed than would otherwise have been required. A £180,000 Public Sector Decarbonisation Scheme grant could be used to cover the increase in capital costs of the heat pump installation.</p>

Case study 5: Gloucestershire Hospitals NHS Foundation Trust

Gloucestershire Hospitals NHS Foundation Trust has been awarded £13,719,342 as part of Phase 1 of the Public Sector Decarbonisation Scheme to upgrade a range of buildings across the hospital's main sites. Heat pumps, solar panels and battery storage will be installed. Lighting, pipework insulation, fans and air handling units, and transformers will be improved, and the building management system will be upgraded. These measures will support the Trust's commitment to delivering on the NHS's plan to reach net zero by 2040.

Case study 6: East Midlands Education Trust: The Ripley Academy, Derbyshire, using coal-fired boilers

East Midlands Education Trust has been awarded £689,029 to deliver improvements across the Ripley Academy secondary school and sixth form. Coal fired boilers will be replaced with air source heat pumps and an ageing uninsulated roof will be replaced with a modern high performance insulated roof to reduce heat demand.

3.3. Wider system impacts

To realise our Net Zero goal, we need to create a whole system that efficiently, effectively and securely produces, stores and delivers heat to all UK buildings. In this section, we explore key elements of a wider Net Zero-compatible system, including:

- *the role of hydrogen*
- *carbon capture and storage*
- *our electricity system*

A further challenge, beyond ensuring the technologies deployed are suitable for the building and its use, is how to co-ordinate with broader action to decarbonise other sectors.

We recognise that elements of the energy system will influence and be impacted by how we decarbonise heat. Therefore, in the lead-up to 2050, decisions made for heat will need to be linked to other key decisions within the wider energy system.²⁴⁷ We will take a whole-system approach, which considers how changes to the broader energy system can affect the optimal route to decarbonisation, and how the combined behaviour and technologies used by individuals impacts the whole energy system.

In light of this, and in the lead-up to COP26, we have published a comprehensive Net Zero Strategy²⁴⁸, setting out the government's vision for transitioning to a Net Zero economy.²⁴⁹

By reducing and shifting energy demand, we can reduce the need to increase energy generation and reinforce network capacity. This can be achieved through reducing wasted energy and using our energy in a smarter way (for example, by improving buildings' thermal efficiency and shifting demand to off-peak times).

The role of hydrogen

Hydrogen is one of the low-carbon solutions that will be critical for the UK's transition to Net Zero. It could be a versatile replacement for high-carbon fuels used today – helping to bring down emissions and provide flexible energy for power, transport and potentially heat. Our

²⁴⁷ We note the development of an Energy Strategy for Northern Ireland (<https://www.economy-ni.gov.uk/articles/northern-ireland-energy-strategy-2050>). We will continue to work together to deliver a Net Zero UK energy system.

²⁴⁸ BEIS (2021), 'Net Zero Strategy' (<https://www.gov.uk/government/publications/net-zero-strategy>)

²⁴⁹ Welsh Government are also looking to publish a Low Carbon Delivery Plan in the lead-up to COP26.

[UK hydrogen strategy](#)²⁵⁰ sets out our plan to develop the production, distribution and storage of hydrogen as demand increases over time.

Production

We are clear that hydrogen will play a key role in delivering our Net Zero Target. To meet the demand from different sectors, we need to significantly increase the production of low-carbon hydrogen. Around 1,700 Terawatt-hours (TWh) of hydrogen is produced globally each year, of which the UK produces up to 27TWh.²⁵¹ However, around 95% of global hydrogen production is fossil fuel based.²⁵²

To deliver the level of hydrogen needed to meet Net Zero, the UK is committed to a ‘twin track’ approach, with initial production mostly expected through:

- steam methane reformation with carbon capture – sometimes referred to as ‘blue hydrogen’
- electrolysis (predominantly powered by renewables) – sometimes called ‘green hydrogen’

Widespread use of hydrogen in heat decarbonisation would necessitate an increase in hydrogen production, which would require an increase in primary energy inputs (such as renewables, methane reformation with CCUS, and/or biomass). This issue is considered in the [UK hydrogen strategy](#)²⁵³ and will be further addressed in the forthcoming hydrogen production strategy (due in early 2022). This will include the actions we are taking to ensure supply can grow from a near-zero base at present to between 250-460 TWh of hydrogen by 2050, to meet demand across the economy.

Storage and flexibility

Hydrogen gas storage is likely to be needed to:

- help the early development of the hydrogen economy where demand takes time to build or if there is a change in the profile and nature of off-takers
- help smooth the intermittency of renewable energy
- meet seasonal heat demand variations (if hydrogen is used for heating) – hydrogen produced in the summer could be stored and used in the winter when demand is greater, to support flexible hydrogen production

Natural gas and hydrogen networks

Hydrogen offers the potential opportunity to repurpose all or parts of the existing gas network to a low-carbon alternative, which could reduce the need for new network infrastructure more

²⁵⁰ BEIS (2021), ‘UK hydrogen strategy’ (<https://www.gov.uk/government/publications/uk-hydrogen-strategy>).

²⁵¹ Energy Research Partnership (2016), ‘Potential Role of Hydrogen in the UK Energy System’, p. 7 (<http://erpuk.org/wp-content/uploads/2016/10/ERP-Hydrogen-report-Oct-2016.pdf>).

²⁵² CCC (2018), ‘Hydrogen in a low-carbon economy’, p. 19 (<https://www.theccc.org.uk/publication/hydrogen-in-a-low-carbon-economy/>).

²⁵³ BEIS (2021), ‘UK hydrogen strategy’ (<https://www.gov.uk/government/publications/uk-hydrogen-strategy>).

broadly. However, further work is required to assess hydrogen network requirements as the hydrogen economy scales up, and how future decisions on heat might affect this.

Ahead of these decisions, we are working with key stakeholders including gas networks, wider industry, and regulatory organisations to deliver a programme of testing, trialling, research and development to help assess the feasibility, costs and benefits of widespread use of hydrogen in heat and buildings.

Carbon capture

The scale of carbon capture, usage, and storage (CCUS) needed is dependent on the balance of hydrogen production methods and ongoing research regarding using hydrogen as a heat source.

In the UK, CCUS is likely to play an essential role in meeting our Net Zero target. This was outlined recently by the CCC, who described carbon capture and storage as “*a necessity, not an option*”.²⁵⁴ It may also play a vital role in levelling up the economy by supporting the low-carbon economic transformation of our industrial regions by creating new high-value jobs.

The [UK CCUS Deployment Pathway: An Action Plan](#), published in November 2018, sets out the government’s ambition to have the option to deploy CCUS at scale during the 2030s.²⁵⁵ This was reinforced by further commitments in the [Energy White Paper](#)²⁵⁶ (2020).

In the Prime Minister’s [Ten Point Plan](#)²⁵⁷ we:

- committed to support the establishment of CCUS in four industrial clusters by 2030, and to establish CCUS in two of these clusters by the mid 2020s
- announced the £1 billion CCUS Infrastructure Fund, which will provide industry with the certainty required to deploy large-scale CCUS at pace

Electricity system

As many sectors are looking to decarbonise through electrification (including heat), the importance of building a smart, flexible and secure electricity network is paramount.

²⁵⁴ CCC (2020), ‘Reducing UK emissions: Progress Report to Parliament’, p. 54 (<https://d423d1558e1d71897434.b-cdn.net/wp-content/uploads/2020/06/Reducing-UK-emissions-Progress-Report-to-Parliament-Committee-on-Cli..-002-1.pdf>).

²⁵⁵ BEIS (2018), ‘The UK carbon capture, usage and storage (CCUS) deployment pathway: an action plan’ (<https://www.gov.uk/government/publications/the-uk-carbon-capture-usage-and-storage-ccus-deployment-pathway-an-action-plan>).

²⁵⁶ BEIS (2020), ‘Energy white paper: Powering our net zero future’ (<https://www.gov.uk/government/publications/energy-white-paper-powering-our-net-zero-future>).

²⁵⁷ BEIS (2020), ‘The ten point plan for a green industrial revolution’ (<https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution>).

Electricity generation

Peak electricity demand in Great Britain was approximately 59GW in 2020.²⁵⁸ BEIS analysis suggests this could increase by over 10% by 2030, and could more than double by 2050 if large parts of transport, heating and industry decarbonise by switching from fossil fuels to low-carbon electricity.

Electric heating appliances, such as heat pumps, are only low-carbon if the electricity used to run them is generated from low-carbon sources.

If electrolysis is used to produce low-carbon hydrogen, this could further add to electricity demand, and its ability to reduce emissions will depend on the type of power generation used.

A low-carbon system that meets future electricity demand at low cost will likely be composed predominantly of wind and solar, complemented by less weather-dependent technologies (such as nuclear power, interconnectors, and gas with carbon capture and storage). We have made recent commitments to continue decarbonising electricity generation. The Prime Minister's commitments in his [Ten Point Plan](#)²⁵⁹ included investing in offshore wind, building on the strengths of the North Sea.

However, it is not practical or cost-effective to meet daily and seasonal peak demand solely by increasing low-carbon electricity generation. Therefore, it is important that we consider flexible technologies and storage solutions to reduce and accommodate peak electricity demand.

Storage and flexibility

A flexible energy system is essential for meeting Net Zero by 2050. Smart technologies (such as storage and smart heating systems) help match energy supply and energy demand, which enables us to maximise the amount of intermittent renewable electricity (from the sun and wind) used to power our homes and businesses (and electric vehicles). For example, a household might store energy during the daytime (when there is lower demand and more solar power being generated) for use during the evening peak (when there is higher national demand and less solar power being generated). As electricity is more costly during peak periods, this will also help reduce energy bills. This technique can also reduce greenhouse gas emissions by moving demand to where there is an abundance of renewable electricity generation.

Flexibility reduces the cost of balancing the system and the need to build generation and network capacity. This benefits all consumers by reducing overall system costs – we estimate that a flexible energy system could cost as much as £10 billion less per year by 2050.²⁶⁰ The

²⁵⁸ National Grid ESO (2020), 'Electricity Capacity Report' (<https://www.emrdeliverybody.com/Capacity%20Markets%20Document%20Library/Electricity%20Capacity%20Report%202020.pdf>).

²⁵⁹ BEIS (2020), 'The ten point plan for a green industrial revolution' (<https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution>).

²⁶⁰ BEIS and Ofgem (2021), 'Transitioning to a net zero energy system: smart systems and flexibility plan 2021' (<https://www.gov.uk/government/publications/transitioning-to-a-net-zero-energy-system-smart-systems-and-flexibility-plan-2021>).

government and Ofgem are working with industry to facilitate a smart energy system through the [Smart Systems and Flexibility Plan](#).²⁶¹

Hybrid systems (including individual hybrid systems and heat networks using multiple heat sources) offer flexibility by switching between fuels to avoid adding to electricity demand at peak times. However, our evidence base is not conclusive regarding how they should be best deployed. For this reason, it is still unclear how significant a role they will play in our path to Net Zero.

In addition to making buildings smarter, flexibility can be built-into a network through:

- intra-day electrical storage systems such as lithium ion batteries
- inter-seasonal storage systems such as power-to-gas-to-power systems currently in development.
- interconnection between the UK energy system and our continental neighbours
- dispatchable renewable generation such as burning biomass instead of fossil fuels
- back-up generation (with carbon capture)

Electricity networks

Flexible demand and supply (from technologies such as grid energy storage and interconnection) will mean that less network and generation capacity is needed to decarbonise our energy system than would otherwise be the case.

However, even with a smart and flexible building stock and grid, any path to Net Zero will require significant additional network capacity, in particular on the lower-voltage electricity distribution networks.

We have been engaging with distribution network operators (DNOs) and the Energy Networks Association to understand the potential scale of the need for local network reinforcement and preparations for electrification of heat. For these reinforcements to be carried out effectively, we need to ensure that DNOs can make strategic investments that reduce the need for network upgrades, investing ahead of need, where possible and useful. DNOs will submit their final business plans to Ofgem in December 2021, setting out their proposed projects and actions for the 2023-2028 price control, RIIO-ED2.

Ofgem has confirmed RIIO-ED2 will support strategic investment to deliver Net Zero emissions targets, including through the use of uncertainty mechanisms. Ofgem's Business Plan Guidance sets out clear expectations that DNO's "*will need to plan to accommodate increasing demand that will come from the electrification of heating and transport, while accounting for and maximising the potential of these and other new technologies to provide system flexibility and limit the need for network upgrades.*"²⁶² We are supportive of Ofgem in their work to ensure network regulation enables low-carbon technologies to join the system, and that

²⁶¹ BEIS and Ofgem (2021), 'Transitioning to a net zero energy system: smart systems and flexibility plan 2021' (<https://www.gov.uk/government/publications/transitioning-to-a-net-zero-energy-system-smart-systems-and-flexibility-plan-2021>).

²⁶² Ofgem (2021), 'RIIO ED2 Business Plan Guidance' (<https://www.ofgem.gov.uk/publications/riio-ed2-business-plan-guidance>), 5.1.

networks consider flexibility.

We are facilitating improved visibility of heat pump installations on the network and will encourage collaboration between ourselves, Ofgem, DNOs and industry to establish asset data requirements and ensure data is being collected and shared effectively.

We appreciate that any need to reinforce the electricity system needs to be co-ordinated with other planned reinforcements, such as those responding to increased requirements from other sectors such as transport and renewable generation.

Chapter 4: Planning for Net Zero

When taking action to decarbonise buildings and continue our trajectory to Net Zero, we have a responsibility to ensure that we take into account the impacts from and to the wider energy system, and that decisions are informed by the latest research and evidence, and are taken at the right level.

In this chapter, we explore:

- *system-level interdependencies*
- *the types of decisions that need to be made at different levels*
- *the progress made against national-level decisions and some of the key challenges to be overcome*
- *how local actors have a crucial role in delivering buildings decarbonisation*
- *our ongoing portfolio of research and development to inform decisions and improve existing technologies*

Research and development are essential to drive innovation, improve options and inform policies and decisions.

Improving our evidence base will help to inform the strategic decisions and individual policies that keep us on track to deliver our emission reduction targets. Technology and supply chain innovation and smart solutions can improve performance and drive down costs, giving greater value for money and making the transition more affordable.

4.1. Planning for strategic decisions

There are a number of key strategic decisions that need to be made in the next decade to drive transformative change. This section explores:

- *the decisions that will be needed over the next few years*

- *how we can ensure decisions are taken at the right level and in a joined-up, whole-system way*
- *the progress that has already been made to inform these decisions*

What Net Zero means for buildings

We know that meeting Net Zero will require almost all buildings to fully decarbonise. Many buildings will benefit from similar solutions to reduce their energy use (through improved product and thermal efficiency, and increased use of smart technologies). However, homes, businesses and public buildings around the UK will also need to use low-carbon heat sources by 2050.

To meet the needs of our diverse housing stock, any path to Net Zero will require a mix of technologies. We know that some technologies (such as heat pumps and heat networks) will have a key role and we already know which types of buildings these technologies are most effective in. Therefore, over the next decade, we want to address these areas of greater certainty.

There are certain areas of the building stock in which the solution is clear:

New buildings: We remain committed to building around 300,000 new homes a year by the mid-2020s in England.²⁶³ As we look to end new connections to the gas grid, heat pumps and heat networks will play a key role in heating new buildings, which have much lower heating demand and far fewer barriers to installation.²⁶⁴ Building low-carbon heat into new-builds from the outset will ensure these buildings do not need to be retrofitted later.

Off-gas-grid buildings: There are over 4 million homes in Great Britain²⁶⁵ and around 278,000 non-domestic buildings in England and Wales that are in areas off the gas grid.²⁶⁶ Broadly, these fall into a few categories:

- Homes with oil, LPG and coal boilers are generally located in rural areas, small towns and valleys. Our [Clean Growth Strategy](#)²⁶⁷ sets out our commitment to phase out the installation of high-carbon fossil fuel heating in new and existing off-gas-grid homes during the 2020s, which we have consulted on in parallel to this strategy²⁶⁸, and our

²⁶³ HM Treasury (2017), 'Building the homes the country needs' (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/661430/Building_the_homes_the_country_needs.pdf).

²⁶⁴ We anticipate approximately 200,000 of our 2028 heat pump target – to deploy 600,000 heat pumps annually – to be installed in new build domestic properties.

²⁶⁵ BEIS (2020), 'Sub-national estimates of properties not connected to the gas network' (<https://www.gov.uk/government/statistics/sub-national-estimates-of-households-not-connected-to-the-gas-network>), local authority estimates for the number of properties without mains gas.

²⁶⁶ BEIS (2021), 'Non-domestic National Energy Efficiency Data-Framework (ND-NEED), 2020' (<https://www.gov.uk/government/statistics/non-domestic-national-energy-efficiency-data-framework-nd-need-2020>), geographical annex data tables.

²⁶⁷ BEIS (2017), 'Clean Growth Strategy' (<https://www.gov.uk/government/publications/clean-growth-strategy>).

²⁶⁸ BEIS (2021), 'Phasing out fossil fuel heating in homes off the gas grid' (<https://www.gov.uk/government/consultations/phasing-out-fossil-fuel-heating-in-homes-off-the-gas-grid>).

policy paper on [Sustainable warmth: protecting vulnerable households in England](#)²⁶⁹ stated our intention to remove support for new LPG and oil heating systems from 2022. Therefore, most homes with oil, LPG and coal boilers will need to transition to heat pumps. Homes that cannot reasonably practicably install a heat pump will have a viable choice of high-performing, commercially available alternative heating technologies that are consistent with Net Zero, such as high temperature heat pumps or solid biomass.

- Homes which are electrically heated are typically flats which are highly suitable for communal heating via a heat network or, where appropriate, heat pumps (which can dramatically decrease bills for these households).
- Non-domestic buildings which are heated using oil, LPG or coal. Our [Clean Growth Strategy](#)²⁷⁰ sets out our commitment to phase out the installation of high-carbon fossil fuel heating in off-gas-grid buildings during the 2020s, which we have consulted on in parallel to this strategy.²⁷¹ Many of these buildings will transition to heat pumps for their heat and hot water use, but we expect other technologies to play a role for some harder to treat buildings, such as limited use of bioenergy, accompanied by solar, energy storage and smart systems.
- Non-domestic buildings which use direct electric heating may also be well-suited for heat pumps.

However, for most buildings (including those connected to the gas grid) the most suitable technology is less clear-cut and depends on a combination of factors.

Ahead of strategic decisions on the role of hydrogen for heating in 2026, we are prioritising action on building UK markets and supply chains and testing options, while ensuring support is available to households on the gas grid who want to make the switch to low-carbon heat now.

The national gas transmission and distribution network is an important asset that provides homes and businesses with gas heating. However, meeting Net Zero means we will need to stop unabated burning of natural gas to heat our homes and places of work.

Hydrogen offers the potential to repurpose the gas network to a low-carbon alternative. This, in combination with hydrogen-compatible appliances, could offer a virtually like-for-like replacement for the natural gas appliances that we use today. However, further work is required to assess the cost and feasibility of converting to a hydrogen system. We are working with industry to deliver a programme of research, development, testing and trialling projects. This will include assessing any requirements for new large-scale infrastructure.

Even if this work proves that using hydrogen to heat buildings connected to the gas grid is safe, feasible and cost-effective, some building types and locations are likely to be better suited to alternative heat technologies such as heat pumps and heat networks. A potential conversion of the natural gas grid to become hydrogen-compatible could therefore take a variety of forms – including a full gas grid conversion, or a more regional approach, i.e. with hydrogen use centred in regions where there are assets that could assist the transition, such

²⁶⁹ BEIS (2021), 'Sustainable warmth: protecting vulnerable households in England' (<https://www.gov.uk/government/publications/sustainable-warmth-protecting-vulnerable-households-in-england>).

²⁷⁰ BEIS (2017), 'Clean Growth Strategy' (<https://www.gov.uk/government/publications/clean-growth-strategy>).

²⁷¹ BEIS (2021), 'Phasing out fossil fuel heating systems in businesses off the gas grid' (<https://www.gov.uk/government/consultations/phasing-out-fossil-fuel-heating-systems-in-businesses-and-public-buildings-off-the-gas-grid>).

as existing natural gas import terminals, salt caverns for hydrogen storage, or proximity to offshore carbon storage sites.

Decisions to be made – an illustrative overview

Many decisions will need to be taken to deliver affordable low-carbon heating with high levels of comfort and convenience. We will make the most of local expertise while retaining an overarching strategic framework for the transition as a whole. We recognise that there are three interdependent levels where these decisions can be made:

- national
- sub-national and regional
- local

Below we provide illustrative examples of the types of decisions which might be appropriate to make at each level.

National decisions	Sub-national decisions	Local decisions
<ul style="list-style-type: none"> • Strategic case for using hydrogen to heat buildings • CCUS requirements • Economic prioritisation if resources are constrained (e.g. biomass) • Major / national network infrastructure requirements • Fairly distributing costs and support • Customer protection and product standards • Regulatory framework 	<ul style="list-style-type: none"> • Regional hydrogen infrastructure requirements • How to best utilise regional geography and opportunities • Pace and timing of infrastructure upgrades and whether a regional framework is required 	<ul style="list-style-type: none"> • Distribution network upgrades needed (some of these decisions may also need to be taken at a sub-national level) • How to best utilise local geography and consider population density (informing suitability of different heat sources) • Suitability of local heat networks (location, size and heat sources used) • What local level smart and flexible solutions should be implemented (e.g. local energy storage) – some of these decisions may also need to be taken at a sub-national level

We also recognise that building owners and users will need to decide for themselves which of the available options are most suitable for their own needs and preferences.

Progress on national-level decisions

We know that we need to make national decisions in a coordinated way, so we are undertaking a programme of work to build our evidence base to inform those decisions and are working to establish a long-term framework for transformation.

Is it feasible and cost-effective to use hydrogen for heating?

Since [Clean Growth: Transforming Heating](#)²⁷² was published in 2018, we have substantially improved our understanding of hydrogen production, distribution and heating technology costs and performance. These findings include: [hydrogen supply chain](#), [logistical transitional challenges](#), [atmospheric impacts](#) and [domestic hydrogen appliances](#), but further work is needed to build the evidence base around hydrogen for heat.²⁷³ We are working with key stakeholders, including gas networks, wider industry, and regulatory organisations, to deliver a programme of testing, trials, research and development, planning work and policy development on markets and regulation. The findings from this work will inform national strategic decisions in 2026 regarding the role of hydrogen in heat decarbonisation, including whether to proceed with a hydrogen heated town by the end of the decade.

What scale of carbon capture and storage is required to support production of low-carbon hydrogen?

Low-carbon hydrogen could bring down emissions and provide flexible energy for a range of sectors (such as power, transport and potentially heat), as stated in our Net Zero Strategy.²⁷⁴

The role and requirements for CCUS-enabled hydrogen production is detailed in our [UK hydrogen strategy](#)²⁷⁵ and will be further addressed in the forthcoming hydrogen production strategy (due in early 2022).

Widespread use of hydrogen in heat decarbonisation would necessitate an increase in hydrogen production and could also require an increase in our CCUS infrastructure.

What are the major infrastructure requirements of using hydrogen?

We are working with industry and other stakeholders to assess potential new infrastructure requirements to enable a transition of parts or all of our gas network to hydrogen, including:

- reinforcements or additions needed to our natural gas networks
- gas storage needs (possible location, capacity, type and technology)

Economic prioritisation: if resources are scarce (e.g. biomass and potentially hydrogen), where are they needed most?

- Bioenergy has potential to address some hard-to-treat buildings
- Biomass gasification could produce significant quantities of hydrogen with carbon capture and storage

²⁷² BEIS (2018), 'Heat decarbonisation: overview of current evidence base' (<https://www.gov.uk/government/publications/heat-decarbonisation-overview-of-current-evidence-base>).

²⁷³ These findings can be found on GOV.UK: BEIS (2018): 'Hydrogen supply chain: evidence base' (<https://www.gov.uk/government/publications/hydrogen-supply-chain-evidence-base>), 'Logistics of domestic hydrogen conversion' (<https://www.gov.uk/government/publications/logistics-of-domestic-hydrogen-conversion>), 'Atmospheric impacts of hydrogen: literature review' (<https://www.gov.uk/government/publications/atmospheric-impacts-of-hydrogen-literature-review>) and 'Appraisal of domestic hydrogen appliances' (<https://www.gov.uk/government/publications/appraisal-of-domestic-hydrogen-appliances>).

²⁷⁴ BEIS (2021), 'Net Zero Strategy' (<https://www.gov.uk/government/publications/net-zero-strategy>)

²⁷⁵ BEIS (2021), 'UK hydrogen strategy' (<https://www.gov.uk/government/publications/uk-hydrogen-strategy>).

- Biomethane can play a significant interim role in decarbonising the gas grid through biomethane injection

However, we recognise the CCC's proposal of a strict hierarchy of biomass use in the UK.²⁷⁶

Low-carbon hydrogen has the potential to decarbonise several UK sectors, including heavy industry, heavy transport, power and potentially heating.

Therefore, we will continue to consider the cross-sectoral role of different technologies, especially those with issues of scarcity, security or sustainability of supply to ensure that their use is consistent with our wider objectives on Net Zero, affordability, environmental sustainability and air quality. Government will seek to prioritise sectors which have no alternatives to decarbonisation other than biofuels.

Further detail on the role of hydrogen can be found in our [UK hydrogen strategy](#)²⁷⁷, published in August 2021, and in our Net Zero Strategy²⁷⁸. We will communicate our latest thinking on the role of hydrogen and bioenergy in our Biomass Strategy.

Is it technically and economically feasible to operate a dual-fuel (hydrogen-electric) energy system?

The high diversity and regional difference in the UK building stock means that one type of low-carbon heat source will not be most suitable for all buildings.

However, in any scenario where hydrogen is proven to be a cost-effective, safe and feasible heat source, there will continue to be a significant role for electric heat pumps, which will be the most suitable heat source for many buildings (including off-gas-grid buildings and new-builds).

We currently have a multi-fuel energy system. However, the costs, complexity and feasibility of operating an energy system that supplies considerable amount of both low-carbon electricity and hydrogen may be significant.

Based on the current evidence, we acknowledge that hybrids could play a transitional role in the 2020s and 2030s, but it is too early to determine the Net Zero energy system composition and whether to rule hybrid systems in or out of the 2050 energy mix.

What are the national electricity system needs?

The extent to which heat is electrified, and the way in which electrification of heat is deployed, will have implications for the timing and cost of requirements for new electricity generation capacity and transmission network reinforcements.

The UK electricity market is already set up to bring forward investment in generation to meet demand. For example, the Contracts for Difference scheme supports significant investment in low-carbon generation, while the Capacity Market is our main tool for ensuring security of supply, and we are confident it will enable us to meet electricity demand into the future.

Network investment is regulated by Ofgem through the price control process. At a national level, we need to ensure that transmission owners, the electricity system operator, and Ofgem

²⁷⁶ CCC (2018), 'Biomass in a low-carbon economy' (<https://www.theccc.org.uk/publication/biomass-in-a-low-carbon-economy/>).

²⁷⁷ BEIS (2021), 'UK hydrogen strategy' (<https://www.gov.uk/government/publications/uk-hydrogen-strategy>).

²⁷⁸ BEIS (2021), 'Net Zero Strategy' (<https://www.gov.uk/government/publications/net-zero-strategy>)

have the information they need to make the appropriate plans for transmission network requirements. This includes:

- the prevalence of heat pump use
- increased electrical demand from other sectors and existing plans for additional low-carbon electricity generation
- changes to consumer behaviour to reduce typical energy use
- improvements to building and product efficiency
- the role of flexible technologies

We are working to improve the collection and use of this data to inform our approach to investing in and reinforcing our national electricity transmission network.

How do we create a regulatory framework to support heat decarbonisation?

We recognise that our regulatory framework should:

- not be unnecessarily burdensome or restrictive
- evolve over time, using the latest evidence and feedback
- be communicated in advance

Communicating upcoming mandatory requirements in advance is essential to provide market certainty and stability, give individuals enough time to prepare and maximise compliance. By building-in consumer choice and flexibility regarding how requirements are met, businesses and residents can decarbonise in a way that is easiest and most effective for their circumstances.

As stated in [our principles in Chapter 1](#), our regulatory framework will embed flexibility and minimise disruption by using natural trigger points to affect change.

What consumer protection is needed and how should it be implemented?

We continue to review and refine our approach to consumer protection. This is explored in more detail in section [6.3 Consumer protection](#).

What market mechanisms and product standards do we need and how can we best ensure the preservation of the internal UK market?

Government has a role in providing a framework within which the market can operate to ensure that the UK meets emission reduction milestones and keeps on track for Net Zero in a socially responsible way. In the 2020s we plan to establish a number of these mechanisms, including the market-based mechanism for low-carbon heat (a consultation on which was published in parallel to this strategy)²⁷⁹, which we will review and refine on our path to Net Zero.

²⁷⁹ BEIS (2021), 'Market-based mechanism for low carbon heat' (<https://www.gov.uk/government/consultations/market-based-mechanism-for-low-carbon-heat>).

Minimum energy performance standards, displayed through energy labels, are one of the most cost-effective ways to improve the energy efficiency of products, reduce energy bills, and make significant energy and carbon savings. We will continue to:

- explore how existing standards can be improved
- identify any currently unregulated energy-using products, where we could apply minimum standards and energy labels to deliver significant carbon savings

How do we ensure that costs of mass decarbonisation are distributed fairly?

We know that decarbonising the building stock needs to be accessible and affordable to all, which is why we are tailoring policies to support those less able to pay, and reviewing the cost distribution of this transformation.

Some decisions regarding different types of costs will need to be made at a national level, including policy costs, network costs and taxes:

- Policy – Cost of programmes to save energy, reduce emissions and encourage and enable uptake of low-carbon technologies.
- Network – The cost of building, maintaining and operating the system within which the individual technology operates, for example a gas pipe network for delivering hydrogen or transformers and cabling for delivering electricity.
- Fiscal Policy – Targeted fiscal policy can be used to fund particular activities or influence consumer behaviour. Currently households pay a reduced VAT rate of 5% on all gas and electricity used, which businesses do not.

In Chapter 6 we:

- set out our plans to distribute costs in a socially and economically responsible way
- highlight the funding already provided by government
- explain the important role of private green finance

How do we ensure that support is distributed fairly?

We need to deliver a comprehensive framework which drives change and provides the necessary support and advice to enable and encourage uptake. We need to provide a level of support, be that advice or funding, that is available to all. However, we also appreciate the need for and benefits of targeted additional support for the fuel poor and for people in deprived areas.

Balancing national, regional and local decision-making

We understand that to deliver buildings decarbonisation there needs to be a process or mechanism for clearer decision-making at each level, and a co-ordinated approach across all three levels. If we fail to keep strategic oversight of these decisions, we run the risk of a taking sub-optimal path to Net Zero. If national decisions are made without input from local actors, they will not adequately reflect the local landscape. Similarly, if local decisions precede or are made in isolation to a national approach, this could cause greater regional difference and inequality, and possibly result in higher costs for consumers. Additionally, we need to ensure

that all areas are able to meet their own legally-binding targets, which may differ across administrations.

To make these decisions on buildings decarbonisation in a co-ordinated way across these levels, we may need to rely on or increase the responsibilities of existing bodies and groups of organisations (such as local authorities, cities, Ofgem, system operators, network owners and operators, and markets). We will need to consider what type of decisions and responsibilities will be held (whether that be planning, co-ordinating or delivery). We also need to consider how best to ensure impartiality is maintained, local expertise is used, and impacts of and to the wider energy system are taken into account. We will review the suitability of our current institutional arrangements required to meet this challenge as part of our work on strategic decisions. This links to our broader commitment, made in the [Energy White Paper](#)²⁸⁰, to ensure the institutional arrangements governing the energy system are fit for purpose for the long-term. Our work in this area will be informed by consultations we held this year on proposals for a Future System Operator and its new and enhanced roles²⁸¹, and energy code governance.

Using data to deliver an informed and co-ordinated approach

Data on the current capacity and constraints of existing gas and electricity networks is an essential component to inform strategic choices about the future of heat decarbonisation. Data is also essential for effectively integrating flexibility into our heat decarbonisation pathways.

Data constitutes a key element of our strategy. We will continue to build our evidence base and collect and use new data to inform and refine our approach. We will continue to ensure that data is collected and used in line with the latest data protection regulations.

Data about the capacity and performance of our energy networks and the energy assets (such as heat pumps) connected to them is currently difficult to find and use. In some cases, the required data is not currently collected or, when it is collected, is not of the desired quality. The data problem is further complicated in the context of heat decarbonisation because of the geographical context and variety of different stakeholders involved. These stakeholders have different levels of access and capabilities to gather and analyse the information for their respective purposes.

The Energy Digitalisation Strategy²⁸², developed by the government, Ofgem and Innovate UK in coordination with the energy sector, sets out a vision and suite of policies to digitalise the energy system. Digitalisation will enable millions of low-carbon assets, including solar PV, electric vehicles and heat pumps, to be optimised across our energy system by providing the necessary data to significant stakeholders in a timely, safe and secure way. We will work with stakeholders to improve access to transparent, accessible, interoperable and accurate data, which will be used to inform our planning for the required infrastructure and any market-led interventions. This improved data will help network operators and Ofgem to plan for strategic

²⁸⁰ BEIS (2020), 'Energy white paper: Powering our net zero future' (<https://www.gov.uk/government/publications/energy-white-paper-powering-our-net-zero-future>).

²⁸¹ BEIS and Ofgem (2021), 'Proposals for a Future System Operator role' (<https://www.gov.uk/government/consultations/proposals-for-a-future-system-operator-role>)

²⁸² BEIS, Ofgem and Innovate UK (2021), Digitalising our energy system for net zero: strategy and action plan' (<https://www.gov.uk/government/publications/digitalising-our-energy-system-for-net-zero-strategy-and-action-plan>).

investment through Ofgem's RIIO process. In the 2020s, investment analysis to accommodate greater demand for heating is likely to be focused on:

- electricity networks in areas not connected to the gas grid
- electricity networks with significant low-carbon heat network opportunities in areas with connections to the gas grid

A key activity to be undertaken in the next few years is to get a better understanding of the local constraints and opportunities for different low-carbon heating technologies. We will work with many stakeholders – including local authorities, Ofgem and gas and electricity distribution network operators – to understand the potential for different technologies and the infrastructure that those solutions would require, including network reinforcement or gas pipe replacement. This will help inform our action in the 2020s, including measures to facilitate heat network growth, promote new and innovative business models, and help plan for greater numbers of people switching to low-carbon heating.

Interoperable data will allow us to combine our assessment of heating demand and the associated flexibility, with analysis of other requirements for network capacity – such as electrification of transport. This combined view is very important, because, once shared with local actors, it can provide a clearer view of the impacts and trade-offs of action across different sectors and in different locations. For example, data on network capacity could help inform decisions on optimum siting of heat networks and EV charge points.

4.2. Local action

Though some areas require national-level direction and decisions, we recognise the important role of local action to:

- *make progress towards Net Zero*
- *deliver the regional benefits discussed in Chapter 2*
- *collect evidence to inform national decisions*

Local and devolved governments across the UK²⁸³ have a combination of democratic accountability, powers, assets, local knowledge and relationships with key stakeholders, and so can drive and co-ordinate local progress towards Net Zero in a way that maximises the benefits to the communities they serve. Across the UK, local areas have already made great strides towards our Net Zero future.

Both the National Audit Office and the Climate Change Committee have identified the need for action at local, as well as national, level to achieve Net Zero. The 'Local Climate Action' chapter in the Net Zero Strategy²⁸⁴ outlines the specific action that Government is taking to enable local actors to deliver Net Zero.

²⁸³ We will work with devolved administrations to further consider how to best align our work on devolved policy areas including local-level decarbonisation and energy planning.

²⁸⁴ BEIS (2021), 'Net Zero Strategy' (<https://www.gov.uk/government/publications/net-zero-strategy>)

Local authorities already play a key role in:

- developing and delivering heat network connections
- implementing and enforcing national regulations and policy (such as enforcing minimum energy efficiency standards)
- carrying out key statutory duties such as planning and controls for new-builds
- piloting innovative low-carbon heating and energy efficiency measures
- engaging with businesses and constituents

Local authorities can also play a critical role in targeting support where it is most needed, and where the opportunities are greatest, to ensure a green economic recovery from the impacts of COVID-19. We are committed to supporting all local areas and communities, ensuring that none are left behind, and creating Net Zero solutions which work for all of them. Further details on how we will do this can be found in the Net Zero Strategy. We will also publish a Levelling Up White Paper in due course, which will build on actions the government is already taking to level up across the country, and set out bold new policy interventions to improve livelihoods, spread opportunity, and drive economic growth in all parts of the UK.

The BEIS-funded Local Net Zero Programme established in 2017 supports local authorities, local partners, and communities across England to play a leading role in delivering Net Zero and clean growth. To date, almost £22 million has been invested in the programme, which has funded a range of measures designed to build local capacity and capability, and encourage joined-up working between local areas, investors and central government. Part of the programme has been used to establish and run five Local Net Zero Hubs (previously referred to as Local Energy Hubs) across England – which provide access to expertise to help develop and secure investment in low-carbon projects.

These Hubs work with local partners and local authorities in their region to identify a pipeline of low-carbon projects and provide practical support for the initial stages of project development through a range of good practice guidance, tools and resources. The Net Zero Strategy announced the continuation the Local Net Zero Programme to support all local areas with their capability and capacity to meet Net Zero.

DIT and BEIS are working together with local enterprise partnerships (LEPs) to stimulate the development of a low-carbon heat cluster in the North East of England and Tees Valley. This DIT high potential opportunity is promoting inward investment into district heat networks and capturing mine heat, with a view to stimulating investment across the value chain, including consulting, pipe manufacturing, construction services and training.

In the North East, Yorkshire, and Humber region, the Local Energy Hub piloted the 'OnGen' project, using a web-based software tool to model the energy performance of public sector buildings and assess the feasibility of installing renewable and low-carbon energy technologies to reduce energy use and produce financial models for investment. The Hub partnered with Durham County Council in 2020 to test the software tool to ensure the accuracy of the outputs, before commencing a larger pilot with 12 local and combined authorities across all 6 LEP areas. This delivered 76 individual assessments across a range of buildings, including: adult learning and children's centres, care homes, transport hubs, town halls, vehicle depots, leisure centres, crematoriums, museums and libraries, and demonstrated a very positive response to the tool's effectiveness in

assisting local authorities in prioritising low-carbon investment. As a result, investable decarbonisation and energy generation projects with sound financial models (on which to base investment decisions) have been identified. These were unlikely to have been realised without using the tool and its support service.

We recognise the work that many local authorities are already doing to decarbonise heat and buildings, and understand that there are barriers to local action, including limited resources and ability to access relevant technical expertise. We acknowledge there is further work to do to understand these constraints and identify how government can best support and work with local authorities to decarbonise heat and buildings.

Local actors can play a crucial role in decarbonising their local area and informing our national approach. We will continue to use local expertise to deliver solutions that are suitable for local areas.

Although there is still work to be done to inform national decisions that deliver affordable low-carbon heating and energy efficient UK buildings, there are actions that local authorities and other local actors can take now to decarbonise buildings. These include:

- planning for decarbonisation including gathering and mapping data on local energy infrastructure
- decarbonising their own stock (including their own non-domestic buildings), focusing support to help tackle homes with low energy performance and address fuel poverty
- providing information and raising awareness of the support available to increase voluntary uptake of low-carbon sources of heat and energy efficiency measures
- continuing to make tackling climate change a priority

Energy planning and mapping for decarbonisation

Local authorities understand the local context of their built environment and have established relationships with key local stakeholders including utilities, highways, public sector partners, social housing landlords, businesses, industry and developers. This puts them in a good position to undertake local area energy planning and mapping for decarbonisation.²⁸⁵ Local authorities can use this data and information to:

- identify the most appropriate areas for heat networks
- support uptake of low-carbon technologies
- understand supply chain and economic growth opportunities
- partner with businesses

²⁸⁵ The aim of Scotland's Local Heat and Energy Efficiency Strategy pilots (<https://www.gov.scot/publications/local-heat-energy-efficiency-strategies-phase-1-pilots-social-evaluation/>) is to establish local priorities and plans for improving building energy performance and using low-carbon heat. Scottish Government ran a consultation on whether to make Local Heat and Energy Efficiency Strategies a statutory duty (<https://www.gov.scot/publications/scotlands-energy-efficiency-programme-analysis-second-consultation-local-heat-energy-efficiency-strategies-regulation-district-communal-heating/pages/2/>).

We know that, in planning for the transformation of the energy system, we need to consider impacts on local energy networks and systems. We need to understand the local infrastructure including local heat networks, gas and electricity distribution network investment and reinforcement needs. We also need to establish how these upgrades align with national planning, co-ordinating and decision making. We are working with Ofgem to ensure that distribution network data is available to help support national and local decision making (for more detail, see section on [Using data to deliver an informed and co-ordinated approach](#)).

We are keen that any energy planning that happens at a local level considers local needs and constraints to decarbonise and – as a minimum – should:

- provide robust evidence to inform network planning so that network capacity can be increased to accommodate projected changes in demand
- take a robust, data-based approach at a local level, which can evolve with national strategic decisions and relevant advancements in technology and innovation
- ensure clear and involved engagement between local and national actors, network companies and local authorities to enable a coherent and consistent planning process
- harness local knowledge and expertise to inform our thinking on the transformation of the energy system
- take a joined-up, whole-system approach that considers the decarbonisation action needed in other sectors and how this interrelates with the broader energy system
- be long-sighted to provide time to develop and install major infrastructure projects, such as heat networks, before connections need to be made

BEIS has work underway with Ofgem to develop a better understanding of the opportunities and challenges presented by local area energy mapping and planning and is considering the most appropriate policy options to take forwards. This work could help to bring together key local stakeholders to explore the impact of decarbonisation choices across sectors and how different technology options may impact on local energy networks.

Local authorities have a role to play in identifying and developing heat network opportunities. In addition to using heat network policies and projects (the Heat Networks Delivery Unit, Heat Networks Investment Project, Green Heat Network Fund), the [Energy White Paper](#)²⁸⁶ committed us to introduce heat network ‘zoning’ in England²⁸⁷ by 2025 (explored in greater detail in the section on [Local approaches to low-carbon heat](#)). We are currently consulting on proposals that would involve central and local government working together with industry and local stakeholders to identify and designate areas within which heat networks are the lowest cost, low-carbon solution for decarbonising heating. This will help heat network developers to

²⁸⁶ BEIS (2020), ‘Energy white paper: Powering our net zero future’ (<https://www.gov.uk/government/publications/energy-white-paper-powering-our-net-zero-future>).

²⁸⁷ Heat network policy is devolved to Wales, Scotland, and Northern Ireland. Scotland recently enacted the Heat Networks (Scotland) Act 2021 (<https://www.legislation.gov.uk/asp/2021/9/contents/enacted>), which includes regulation related to heat network zoning, while Wales has introduced heat network policy in the context of the spatial planning document ‘Future Wales: The National Plan 2040’ (<https://gov.wales/future-wales-national-plan-2040-0>). We work closely with the devolved administrations in Scotland, Wales and Northern Ireland on heat network policy and regulation in order to secure consistency for the sector across Great Britain.

accelerate deployment of heat networks where they are most appropriate and help deliver heat networks' contribution to our Net Zero commitments.²⁸⁸

Tackling the worst performing buildings first and supporting those in fuel poverty

Local authorities already play a pivotal role in identifying areas in need of support and targeting and delivering energy efficiency and low-carbon heat measures. Ensuring the effective use of government schemes (such as the Energy Company Obligation, Local Authority Delivery scheme, and the Social Housing Decarbonisation Fund) helps to deliver targeted action to tackle the worst performing buildings and address fuel poverty, and, more broadly, to improve the building stock to help reduce carbon emissions.

Support voluntary uptake of low-carbon sources of heat and energy efficiency measures

In addition to raising awareness and increasing uptake of initiatives to help homes and businesses decarbonise, local authorities also have a role to play in engaging with the public on the broader challenge of tackling the contribution to climate change from buildings. Increased engagement and improved understanding will encourage building owners and occupiers to take steps to improve energy efficiency, adopt low-carbon heating and make use of available green financing options. Some of the existing communication channels for information and advice on decarbonising buildings are detailed in section [6.4 Public engagement](#).

Making climate change a priority

Local authorities should, and already do, build climate change considerations into their work to ensure that they are prepared to take the necessary actions to meet Net Zero. For example, they should take Net Zero into account in operating their statutory functions and in how they manage their own estate. We already work closely with local authorities and their representative bodies to discuss their role in delivering Net Zero. For example, BEIS have committed to rolling out Carbon Literacy training to local authority staff across different areas to increase the awareness and ability to reduce emissions across all the policies and programmes local government work on. Further details on how we will work with local authorities to deliver Net Zero and enable them to make climate change a priority is outlined in the Local Chapter of the Net Zero Strategy.

4.3. Research and innovation

Our strategic decisions and policies will continue to be underpinned by the latest research and innovation. This section sets out our approach to research and innovation to tackle barriers to deployment.

We will continue to drive research and innovation to inform strategic decisions and improve technologies as well as the application of technology.

²⁸⁸ BEIS (2021), 'Proposals for heat network zoning' (<https://www.gov.uk/government/consultations/proposals-for-heat-network-zoning>).

We have developed a broad understanding of the decarbonisation challenge ahead, building on our publication [Clean Growth: Transforming Heating](#)²⁸⁹.

Further research and evidence relating to [heat decarbonisation](#) and [energy efficiency](#) is available on GOV.UK.²⁹⁰

We will continue to dedicate time and resource to drive research and innovation and ensure that evidence is reviewed and considered when developing policies.

- Research to improve our evidence base will inform strategic decisions regarding our pathway to Net Zero. By better understanding our building landscape and how heat is used, we can make more accurate projections, close the gap between predicted and actual building performance, and shape policy to best meet consumers' needs.
- Innovation, whether through the creation of new technologies and systems, or the scale-up and refinement of existing ones, can drive improved performance, increase sustainability, improve consumer experience and improve value for money. By enabling the market to explore quicker, cheaper manufacturing and delivery, costs to consumers can be reduced and technologies can be made more affordable.

We will continue investing in research and innovation to help us decarbonise in the most efficient and effective way. The Net Zero Innovation Portfolio (NZIP) is a £1 billion fund announced in Point 10 of the Prime Minister's [Ten Point Plan](#)²⁹¹ - Green Finance and Innovation. The Portfolio provides funding to accelerate the commercialisation of innovative low-carbon technologies, systems and business models, decreasing the costs of decarbonisation and enabling the UK to end its contribution to climate change. The NZIP follows on from government's successful £505 million Energy Innovation Programme (2016-2021), which has so far supported 700 organisations and invested approximately £90 million to develop low-carbon heating and energy efficiency options for UK homes and businesses.

We are publishing a UK Net Zero Research and Innovation Framework alongside the Government's overarching Net Zero Strategy, to communicate key aims, activities to be prioritised, and technologies to be developed and improved to keep us on track to deliver Net Zero.

We work in partnership with many research organisations, such as UK Research and Innovation and Energy Systems Catapult, and are part of a number of the International Energy Agency's technology collaboration programmes. By advocating for stronger international collaboration, we can share best practice, develop new technologies faster, and bring down the costs of buildings decarbonisation.

We will continue to work alongside Ofgem by feeding into and helping identify appropriate innovation challenges that may draw upon the Strategic Innovation Fund. This fund is anticipated to replace the Network Innovation Competition this year for the electricity

²⁸⁹ BEIS (2018), 'Heat decarbonisation: overview of current evidence base' (<https://www.gov.uk/government/publications/heat-decarbonisation-overview-of-current-evidence-base>).

²⁹⁰ Further technical research and evidence available on GOV.UK relating to heat decarbonisation (<https://www.gov.uk/government/collections/heat-pump-research>) and energy efficiency (<https://www.gov.uk/government/collections/buildings-energy-efficiency-technical-research>).

²⁹¹ BEIS (2020), 'The ten point plan for a green industrial revolution' (<https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution>).

transmission and gas sectors as well as for the Electricity System Operator. Ofgem will also consider the application of this strategy when assessing bids submitted for innovation funding.

We encourage industry, academia, third sector and advisory groups to continue to share evidence. Through early engagement with industry, we will seek to stimulate investment here in the UK to prove technologies and industrialise them for the benefit of UK and overseas decarbonisation.

BEIS aims to:

- build the energy efficiency market by refining technologies and reducing costs
- build the low-carbon heat source market by developing technologies, exploring electricity and gas system impacts, shifting heat demand, and reducing costs
- provide evidence to inform strategic decision-making in the 2020s and further policy development
- review and improve the route to market for new technologies

Priorities

Energy efficiency

- reduce upfront costs
- improve and develop retrofit solutions
- reduce the space requirements for energy efficiency solutions
- tackle the low levels of awareness
- improve financing options

Heat pumps

- reduce the upfront and running costs
- improve installation process and increase consumer satisfaction
- increase public awareness and consumer familiarity
- improve UK supply chain capacity and capability

Heat networks

- bring forward and reduce the cost of different low-carbon heat sources and systems
- mechanisms to incentivise voluntary connection of existing buildings and reduce the cost
- explore the role of local and regional networks and the benefits that they can bring to the wider energy system

- innovation in delivery models to maximise carbon reduction, expand networks and reduce costs

Hydrogen

- work with industry to assess the feasibility and impacts of converting parts or the whole of the existing gas network to full hydrogen.
- encourage innovation in hydrogen-ready appliances

Bioenergy

- review the appropriate role of bioenergy (solid biomass, biofuels and biomethane) in heat decarbonisation, with appropriate mitigations of environmental impacts
- further explore advanced gasification

Electricity system

- increase network visibility of heat pump assets
- develop solutions to pre-empt and sustainably manage network capacity, creating a flexible energy system while ensuring security of supply
- develop strategies for coordinating network reinforcement that support heat pump installations with the reinforcement required for the installation of other low-carbon technologies, such as electric vehicles
- explore how to design and install the most effective heating systems using a combination of technologies, such as rooftop solar, battery storage, smart heating controls and smart appliances

Consumer engagement

- continue research into how best to engage with consumers, provide information, and raise awareness of energy efficiency and low-carbon heating measures
- encourage further research to help tackle barriers to energy performance improvements and the uptake of low-carbon heating
- improve our understanding of consumer preferences and identifying opportunities to support and encourage green choices

Current research and innovation activities



We know that upfront costs, low awareness and a lack of finance options can act as barriers to installation of **energy efficiency measures**. Funded by the Energy Innovation Programme:

Our [Whole House Retrofit competition](#)²⁹², which launched in June 2019, awarded £7.7 million to three projects to demonstrate a cost reduction trajectory for domestic retrofits across a range of building types in the UK through economies of scale and process innovations, including the testing of modular and off-site retrofit and refurbishment solutions.

A total of £1.8 million grant funding has been awarded to three organisations through the [Green Home Finance Innovation Fund competition](#)²⁹³ to test the establishment of green lending products for domestic owner-occupiers. The programme provides funding for the initial development and piloting of green home finance products to overcome barriers posed by development costs, and provide proof-of-concept models for other lenders.

The [Boosting Access for SMEs to Energy Efficiency competition](#)²⁹⁴ offered up to £6 million of funding for innovative solutions that encourage the take up of energy efficiency by SMEs. The competition helps address some of the key market failures faced by SMEs such as the lack of economies of scale, high upfront capital costs, high transaction costs and difficulty accessing finance.

The [Demonstration of Energy Efficiency Potential](#) (DEEP)²⁹⁵ project is investigating taking a system-level approach to retrofit, considering the entire dwelling rather than the performance of individual measures (i.e. a whole house approach). Though primarily a study of the scientific mechanisms for heat loss and airtightness and how they are affected by different measures, the project is also comparing novel methods for testing these parameters and installing measures. There may also be findings related to the costs of undertaking retrofit.



The key barriers to **heat pump** deployment include: the upfront and running costs, public awareness, current supply chain capacity and capability, and **electricity system** constraints due to mass use of electric heat pumps.

BEIS has conducted [research into off-gas-grid installer skills](#) to learn how to grow the heat pump installer base.²⁹⁶ This research demonstrates a willingness of installers to train to install heat pumps in response to falling demand for fossil fuel heating. We are now conducting follow-up research into the wider heating and cooling installer workforce.

The £14.6 million Electrification of Heat Demonstration Project, funded by the BEIS Energy Innovation Programme, launched in October 2019. It aims to demonstrate the feasibility of a large-scale transition to electrification of heat by installing innovative heat pump systems in a representative range of homes.

As part of the Net Zero Innovation Portfolio, we plan to launch new innovation opportunities later this year. They will be aimed at advancing heat electrification to support the

²⁹² BEIS (2020), 'Whole House Retrofit competition - successful bids' (<https://www.gov.uk/government/publications/whole-house-retrofit-competition-successful-bids>).

²⁹³ BEIS (2020), 'Green Home Finance Innovation Fund competition - successful bids' (<https://www.gov.uk/government/publications/green-home-finance-innovation-fund-competition-successful-bids>).

²⁹⁴ BEIS (2020), 'Boosting access for SMEs to energy efficiency (BASEE) competition: winning projects' (<https://www.gov.uk/government/publications/boosting-access-for-smes-to-energy-efficiency-basee-competition-winning-projects>).

²⁹⁵ BEIS (2019) 'Demonstration of Energy Efficiency Potential (DEEP)' (<https://www.gov.uk/government/publications/demonstration-of-energy-efficiency-potential-deep>).

²⁹⁶ BEIS (2021), 'Heating systems in off gas grid areas: installers' experiences and attitudes towards low carbon heating' (<https://www.gov.uk/government/publications/heating-systems-in-off-gas-grid-areas-installers-experiences-and-attitudes-towards-low-carbon-heating>).

decarbonisation of homes. These new opportunities will build on the Electrification of Heat Demonstration Project.

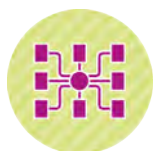
A Heat Pump Manufacturing Supply Chain project, published in December 2020, concluded that manufacturers could adapt flexibly to the level of demand required and increase supply into the UK market relatively quickly (by a minimum of 25% to 30% year-on-year for the next 15 years).²⁹⁷

BEIS is providing funding towards energy innovation activities that will support the development of innovative solutions for deployment, tools, and technologies across the heat pump sector. This includes £60 million investment in the Net Zero Innovation Portfolio (NZIP) 'Heat Pump Ready' Programme which will support the development of innovative solutions across the heat pump sector.

BEIS has conducted research that investigates the impact of the future transition away from high-carbon fossil fuel heating systems on non-domestic consumers who are not connected to the gas grid.²⁹⁸ The research suggested that non-domestic consumers are generally more aware of the future transition to low-carbon heating than domestic consumers. It also explored key barriers which must be addressed in order to encourage the uptake of low-carbon heat in non-domestic buildings off the gas grid.

To assess heat pump suitability in non-domestic buildings, we are investigating the existing heating, ventilation and air conditioning appliances in non-domestic buildings.

We are modelling and analysing the level of generation capacity and network investment and reinforcement that may be required to meet the projected increase in electricity demand and exploring the extent to which flexibility can reduce running costs for consumers, and infrastructure costs.



Priorities for **heat networks** include tools for identifying those areas that are most suitable for deployment, approaches for improving performance of heat networks, reducing construction costs, and growing a competitive UK supply chain.

A pilot programme of six city-scale heat decarbonisation projects is underway in Birmingham, Greater Manchester, Leeds, Nottingham, Bristol and Newcastle. The outputs of this pilot will contribute to the national and local evidence base, progress the delivery of a project pipeline for key intervention areas (where possible), and identify replicable measures of relevance to other towns and cities.

We have commissioned and published the [‘Opportunity Areas for District Heating networks in the UK’²⁹⁹](#) which provides estimates of the low-carbon heat and waste heat available across the UK as well as geographical information on the areas with highest economic potential for heat networks.

We have recently undertaken work on improving performance across a number of operational heat networks and communal heating systems. This study will provide an evidence base for

²⁹⁷ BEIS (2020), ‘Heat pump manufacturing supply chain research project’, p. 14 (<https://www.gov.uk/government/publications/heat-pump-manufacturing-supply-chain-research-project>).

²⁹⁸ BEIS (2021), ‘Heating non-domestic buildings in off gas grid areas: consumer experiences and attitudes towards low carbon heating’ (<https://www.gov.uk/government/publications/heating-non-domestic-buildings-in-off-gas-grid-areas-consumer-experiences-and-attitudes-towards-low-carbon-heating>).

²⁹⁹ BEIS (2021), ‘Opportunity areas for district heating networks in the UK: second National Comprehensive Assessment’ (<https://www.gov.uk/government/publications/opportunity-areas-for-district-heating-networks-in-the-uk-second-national-comprehensive-assessment>).

the development of the Heat Network Efficiency Scheme³⁰⁰ (HNES) which will part-fund operational performance improvements and emission reduction in existing systems, and where possible enable transition of these systems to lower carbon heat sources.

We are working with the Heat Networks Industry Council to identify how the costs associated with constructing heat networks can be best reduced.

We are undertaking pilots across towns and cities in England over the next 12 months to inform the methodology that will be used to identify potential Heat Network zones.

Nuclear

While large-scale nuclear reactors are typically used for electricity generation, there are global examples of using heat from nuclear reactors for district heating systems; countries such as Canada, Finland, Sweden, Japan, Russia, and Switzerland have all used nuclear reactors to heat homes.

More recently, designers of new small and advanced modular reactors are focusing on systems with smaller power outputs which could offer 'beyond the grid' applications such as low-carbon heat for heat networks, industrial process heat, hydrogen production, flexible power generation and energy storage.

The Ten Point Plan announced up to £385 million for an Advanced Nuclear Fund to invest further in these technologies. That includes up to £215 million to develop a domestic Small Modular Reactor (SMR) design and up to £170 million for an ambitious Advanced Modular Reactor (AMR) R&D programme. Some AMR designs have the potential to produce high-quality, high temperature heat up to 950°C which could significantly extend the opportunity for heat use. By the early 2030s, Government's aim is to have an operational AMR demonstrator and to have the first SMRs commercially deployed.



Key outstanding uncertainties regarding the use of **hydrogen** for heat include: feasibility and cost-effectiveness of safe use; production methods and scalability; and new infrastructure requirements for transmission, distribution and storage. We will work with industry to accelerate work on the evidence base, building on the existing range of relevant R&D for both hydrogen blends and use of 100% hydrogen.

The Hy4Heat hydrogen innovation programme (of approximately £22 million) explores the safety and feasibility of using 100% hydrogen for heat in the home and is funded by BEIS' Energy Innovation Programme. Hy4Heat launched in 2017 and is due to conclude by the end of this year. The programme includes development of hydrogen-compatible heating appliance prototypes including gas fires, cookers and boilers, the development of hydrogen gas meters, a safety assessment for key typical properties (e.g. terraced housing), and technical standards and studies. We are continuing to invest in research and innovation that will help to generate further evidence on the feasibility of safe and efficient use of hydrogen for heating. This includes supporting industry to delivery first-of-a kind hydrogen heating trials. This will begin with a hydrogen neighbourhood trial (H100 project) in Fife, Scotland by 2023, and a village trial

³⁰⁰ BEIS (2021), 'Heat Networks Efficiency Scheme Demonstrator' (<https://www.gov.uk/government/publications/heat-network-efficiency-scheme-demonstrator>).

by 2025. Earlier this year, BEIS and Ofgem wrote to the gas network operators inviting them to develop proposals for the village trial.³⁰¹ We also launched a [consultation on facilitating a grid conversion hydrogen heating trial](#)³⁰² in August 2021.

By 2025, we will also develop plans for a possible hydrogen heated town before the end of the decade. The local trials and planning work, together with the results of our wider research and development and testing programme, will enable strategic decisions by 2026 on the role of hydrogen for heat and whether to proceed with the hydrogen town

The £1 billion Net Zero Innovation Portfolio (NZIP) will fund projects over the next 4 years (2021-2025) to accelerate the commercialisation of innovative, low-carbon technologies, systems and business models. One of its aims is to reduce the risks and costs of accelerating the roll out of hydrogen. We are currently assessing applications for the £60 million Low Carbon Hydrogen Supply 2 competition.³⁰³ Similar to the first competition in 2018, this is an innovation competition able to support a range of demonstration projects including hydrogen storage technologies, alongside wider hydrogen supply solutions. Further relevant competitions will follow.

The HyDeploy programme is an industry-led hydrogen blending project, exploring the safety case of up to 20% hydrogen blends in isolated gas networks and thereby building early demand for hydrogen production. HyDeploy trials are exploring up to a 20% hydrogen and 80% natural gas mix, which may be compatible with current distribution networks, in-home heat sources, distribution systems and appliances.



We need to improve our understanding of in-situ performance, consumer impacts and suitability of **hybrid systems** to inform interventions and consumer guidance offered.

BEIS is currently exploring the role of hybrid heat pump systems as part of the Electrification of Heat Demonstration Project. The project aims to gather further evidence on how these systems operate in practice, which will provide more in-depth understanding of hybrids' role in decarbonising heating going forwards.

Through the Heat Ventilation and Air Conditioning Project and the Non-Domestic Building Survey, we are reviewing heating and cooling assumptions and the suitability of electric and hybrid heat pumps in non-domestic buildings.

A key strand of Wales' Optimised Retrofit Programme in social housing is trialling around 400 hybrid heat systems across a range of house types to demonstrate the benefits of carbon reduction, maintain affordable fuel bills, stimulate early demand and consumer familiarity with air-source heat-pump technology, and grow installer capability and capacity.



Biomethane can be produced via anaerobic digestion or gasification. Biomethane from anaerobic digestion has higher upfront and operating costs compared to natural gas, as well as environmental, sustainability and air quality considerations. Mitigating these environmental impacts is important for government and industry,

³⁰¹ Ofgem (2021), 'Hydrogen Consumer Trial - Open Letter to GDNs' (<https://www.ofgem.gov.uk/publications/hydrogen-consumer-trial-open-letter-gdns>).

³⁰² BEIS (2021), 'Hydrogen for heat: facilitating a grid conversion hydrogen heating trial' (<https://www.gov.uk/government/consultations/hydrogen-for-heat-facilitating-a-grid-conversion-hydrogen-heating-trial>).

³⁰³ BEIS (2021), 'Low Carbon Hydrogen Supply 2 Competition' (<https://www.gov.uk/government/publications/low-carbon-hydrogen-supply-2-competition>).

and as stated in our '[Future Support for Low Carbon Heat and The Green Gas Levy: Government response to consultations](#)', we expect all anaerobic digestion operators to be doing everything commercially viable to mitigate these environmental impacts.³⁰⁴ Currently there are no UK advanced gasification plants capable of producing biomethane, as commercially available gasification technologies normally generate a low-quality gas that cannot be used to generate biomethane, biohydrogen or other energy products.

A £190,000 UK-funded Advanced Gasification Technologies (AGT) project was established in May 2020 to produce an analysis of gasifying biomass and waste to produce methane, hydrogen and liquid fuels, assess the reasons for the failure of previous AGT projects, identify the risks and barriers to successful development of commercial scale AGT projects, and identify existing and emerging technologies that have the potential for commercial development and cost reduction. This project has recently been concluded and will inform future policy and innovation support to help develop AGT technologies for deployment over the next 10 years.

Deployment of **biofuels** for off-gas-grid heating will be limited by constraints on the global availability of sustainable biomass feedstocks, and potential alternative uses to decarbonise other sectors of the economy. Further research on the economics of biomass is required to inform strategic policy decisions to improve value for money and only incentivise deployment of biomass boilers in properties not suitable for hydrogen, heat pumps or heat networks. The research should also take into account the air quality and wider sustainability issues associated with biomass use.

The renewable fuel industry is currently investing in research and development, trialling the use of hydrotreated vegetable oil biodiesel in domestic heating systems, and looking to develop ways to increase production of bioLPG. However, these biofuels are not yet widely available to consumers. With the limited availability of biofuels, hybrid heating systems comprising of a biofuel boiler and air source heat pump may provide a route for limited bio-resources to stretch further.

BEIS is in regular contact with the oil and LPG industries, and other stakeholders to gather more evidence on potential market developments and the sustainability, costs and consumer impacts of biofuels.



Key barriers to the deployment of **smart technologies** for heating include: a lack of active coordination and joint programmes to trial, test and evaluate smart technologies to aid low-carbon heating; knowledge of how best to encourage consumer participation or the best ways to protect consumers; standardisation of smart technology; and currently available economies of scale. We have minimal evidence demonstrating the best type of storage (fabric, hot water, heat battery, electric battery) to use in different types of home. We are considering smart systems and flexibility across all heat and energy efficiency policies. The Government has sought to support innovation across industry by launching several innovation projects designed to encourage new approaches that aid market development and encourage consumer take-up.

³⁰⁴ BEIS (2021), 'Future Support for Low Carbon Heat and The Green Gas Levy: Government response to consultations', pp.30-31 (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/970565/green-gas-levy-future-support-low-carbon-heat-govt-response.pdf).

The [Smarter Tariffs – Smarter Comparisons project](#)³⁰⁵ has developed an open-source, [smart-tariff comparison tool](#)³⁰⁶ which, along with supporting research and development findings, is available to consumers and industry. This tool provides an accurate, independently evaluated smart tariff recommendation based on actual usage data recorded by consumers' smart meters, or from information about their household. This gives consumers the information they need to switch to the best deals and, at a system level, integrate new technologies with renewable energy sources.

The [Smart Meter Enabled Thermal Efficiency Rating \(SMETER\) programme](#)³⁰⁷ aims to develop, test and demonstrate technologies that measure the thermal performance of homes using smart meter and other data. Funded by the Energy Innovation Programme, the first phase of the competition provided up to £4.1 million for innovation projects to develop SMETER tools, which are being tested in the second phase. SMETER tools could deliver more accurate and reliable energy efficiency ratings, help consumers to save money, reduce emissions and drive innovation to improve performance of building fabric energy efficiency measures. In April 2021, results were released showing that some SMETER products have proven high levels of accuracy. Expert stakeholders discussed how to design and deliver an in-use thermal performance metrics system through a joint [SMETER workshop](#).³⁰⁸

BEIS also funded the [Smart Systems and Heat: Phase 2](#)³⁰⁹ programme delivered by Energy Systems Catapult in partnership with Newcastle City Council, Greater Manchester Combined Authority and Bridgend County Borough Council. This programme ran consumer trials of smart energy services, explored new business models and market structures and developed local area energy plans with the three local authorities.

In September 2020 BEIS commissioned a [rapid evidence review to explore the relationships between heat, energy efficiency, smart technology and health](#) in high-income countries (with a focus on the UK).³¹⁰

BEIS has also undertaken research through the [Cost Optimal Domestic Electrification project](#)³¹¹ to improve our understanding of the most cost-effective combination of technologies to facilitate smart and flexible heating systems. We will use this analysis to develop policies to incentivise smart systems.

³⁰⁵ BEIS (2019), 'Smart meter-enabled tariffs comparison project: Smarter Tariffs – Smarter Comparisons' (<https://www.gov.uk/government/publications/smart-meter-enabled-tariffs-comparison-project-smarter-tariffs-smarter-comparisons>).

³⁰⁶ Smart Tariff Comparison (<http://www.smarttariffsmartcomparison.org/home>).

³⁰⁷ BEIS (2018), 'Smart Meter Enabled Thermal Efficiency Ratings (SMETER) Innovation Programme' ([https://www.gov.uk/guidance/smart-meter-enabled-thermal-efficiency-ratings-smeter-innovation-programme#:~:text=Funding%20programmes-.Smart%20Meter%20Enabled%20Thermal%20Efficiency%20Ratings%20\(SMETER\)%20Innovation%20Programme,smart%20meter%20and%20other%20data](https://www.gov.uk/guidance/smart-meter-enabled-thermal-efficiency-ratings-smeter-innovation-programme#:~:text=Funding%20programmes-.Smart%20Meter%20Enabled%20Thermal%20Efficiency%20Ratings%20(SMETER)%20Innovation%20Programme,smart%20meter%20and%20other%20data)).

³⁰⁸ UCL (2021), 'SMETER workshop explores requirements for effective UK system of in-use thermal performance metrics' (<https://www.ucl.ac.uk/bartlett/energy/news/2021/apr/smeter-workshop-explores-requirements-effective-uk-system-use-thermal-performance>).

³⁰⁹ Energy Systems Catapult (2020) 'Smart Systems and Heat: Phase 2' (<https://es.catapult.org.uk/project/smart-systems-and-heat-phase-2/>).

³¹⁰ BEIS (2020), 'Heat, energy efficiency, smart technology and health review' (<https://www.gov.uk/government/publications/heat-energy-efficiency-smart-technology-and-health-review>).

³¹¹ BEIS (2021), 'Cost Optimal Domestic Electrification (CODE)' (<https://www.gov.uk/government/publications/cost-optimal-domestic-electrification-code>).

Through the Energy Innovation Programme, BEIS also commissioned the [participation of low income and vulnerable consumers in a smart energy system \(Project InvoLVe\) programme](#)³¹². The findings identified how innovation can help ensure that these consumers are not left behind in the transition to a smarter and more flexible energy system.



Research and innovation into development and deployment of key technologies needs to be complemented by research into addressing overarching **barriers to uptake and accommodating preferences of consumers**.

Basis Social and the University of Cambridge led research on 'Future Homes'³¹³, looking at the public's needs and preferences around information, support, and advice to aid the future transition to low-carbon homes.

There is ambition to extend research in this area to more fully understand the decision-making process involved in transitioning to a low-carbon homes, as well as how best to encourage the needed behaviour changes.

BEIS led research to understand how performance metrics based on smart meter data can support the adoption and delivery of low-carbon heat through improved measurement of home thermal performance and new consumer engagement products.

³¹² BEIS (2021), Participation of low income and vulnerable consumers in a smart energy system (<https://www.gov.uk/government/publications/participation-of-low-income-and-vulnerable-consumers-in-a-smart-energy-system>).

³¹³ BEIS (2021), Future Homes (<https://www.gov.uk/government/publications/net-zero-future-homes>)

Figure 10: Illustrative timeline for research and innovation

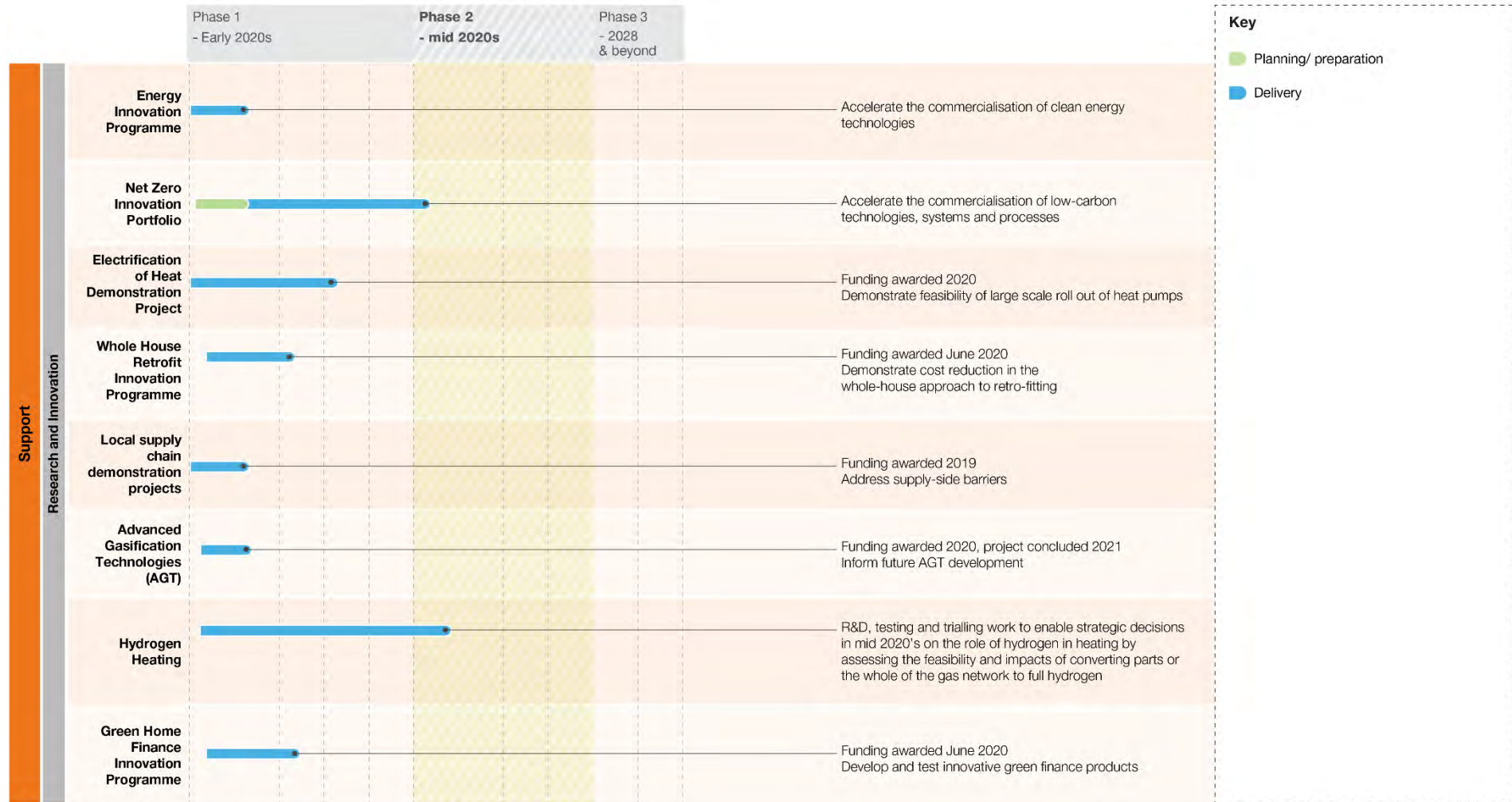


Figure 10 provides an illustrative diagram of some of the research and innovation to be undertaken over the next decade, according to BEIS' current thinking

Chapter 5: Reducing emissions in the 2020s

While we continue to build our evidence base and make strategic decisions, we need to take action in the 2020s to improve the energy performance of our buildings and prepare for and begin the switch to low-carbon sources of heat.

To balance the certainty and stability needed for market growth, ensure we remain on track for Net Zero, and build-in flexibility and consumer choice, in the 2020s we will:

- *introduce and improve energy performance standards*
- *develop our policies on smart and flexible technology*
- *begin phasing out use of fossil fuel sources of heat*
- *build and support low-carbon heat markets*

We need to accelerate ‘no- and low-regrets’ action now – such as improving the efficiency of our buildings (fabric-first), and tackling the most polluting, and most expensive fossil fuels first.

Concentrating efforts on action that we can be certain is required is common-sense. This will mean prioritising action on tackling the worst-performing buildings (with the lowest energy efficiency or responsible for the greatest carbon emissions) and signalling how we will take action where the strategic choices are straightforward (such as phasing out fossil fuel heating in off-gas-grid buildings), and ensuring buildings are energy efficient before a mass transition to low-carbon sources of heat. Alongside this, we need to work with network companies and industry to increase capacity and build up supply chains, so that we are prepared for mass transformation of low-carbon heat sources. In the longer term, we are setting the ambition to phase out the installation of new fossil fuel boilers from 2035, once costs have come down.

We will provide long-term signals to investment by setting requirements (e.g. deploying 600,000 heat pumps per year by 2028) and embed flexibility in how they are achieved.

We will begin to set out our plan to deliver a transition which balances consumer choice and grows the UK market, while being underpinned by a regulatory framework that ensures we are on track to deliver Net Zero. We will provide signals to investors when establishing new mandatory requirements to provide market certainty and stability. We will ensure consumers have choices (and are equipped with the relevant information and advice to make those choices), so they can decarbonise in a way that reduces disruption, keeps costs down, and meets individual needs.

5.1. Measuring energy performance

The whole-house energy performance can be measured and improved through different interventions. This section sets out our:

- *energy labelling and ecodesign policy to improve energy efficiency of products*
- *consideration of integrating smart technologies as part of SAP*
- *continued use of minimum EPC ratings*
- *commitment to move to a performance-based approach for some buildings*

Why is it important?

Investing in energy performance measures to reduce energy demand delivers a wide range of benefits, such as:

- reducing emissions by minimising heat loss from buildings
- mitigating issues with peaks in demand and reducing overall energy demand
- preparing buildings for low-carbon heat sources
- reducing consumer energy bills

Improving the thermal performance of buildings before transitioning to low-carbon heating will further reduce energy demand. This is because, once the building is more energy efficient, a smaller heating system can be installed. This reduces operating costs and enables low temperature systems to operate more efficiently and effectively.

Improving energy performance is also an investment in health and wellbeing, as it leads to warmer, more comfortable buildings with better air quality, when paired with adequate ventilation.³¹⁴ In the long-term, energy performance improvements also provide benefits such as increased productivity, longevity, and higher life satisfaction.³¹⁵

For domestic buildings, improving energy performance therefore supports the government's broader ambition of smarter, healthier, cleaner and greener homes. These ambitions are even more critical to achieve when increasing numbers of people are currently spending more time at home due to COVID-19. Reducing energy demand also helps to directly address fuel poverty by lowering energy costs for households.

In contrast, buildings with poor thermal efficiency, where excess cold, dampness and mould growth are present, create significant:

- direct costs (health and NHS treatment costs, higher energy bills)

³¹⁴ IEA (2019), 'Multiple Benefits of Energy Efficiency' (<https://www.iea.org/reports/multiple-benefits-of-energy-efficiency/health-and-wellbeing>).

³¹⁵ BEIS (2020), 'Improving the energy performance of privately rented homes' (<https://www.gov.uk/government/consultations/improving-the-energy-performance-of-privately-rented-homes>).

- indirect costs (opportunity costs, e.g., underperformance at school, lost working days, lost business opportunities, lost property value, lack of wellbeing)

Some efficiency measures are lower cost and cause less disruption. These measures – such as draught-proofing or loft and cavity wall insulation – will likely be appropriate for most buildings. Other measures such as solid wall insulation can result in significant savings but can have higher cost-benefit ratios and are not necessarily appropriate for every building or consumer. Alongside thermal efficiency improvements there are a range of other cost-effective efficiency technologies, such as low-energy lighting, more efficient heating systems, and smart controls. These are detailed in section [3.1 Key technologies](#).

Maximising the number of buildings improved during the 2020s will ensure the later transition to low-carbon heating can progress smoothly, and result in an efficient, affordable and secure energy system, reducing our dependence on imported energy.

Therefore, we encourage all owners and occupiers to review how they can improve the energy performance of their buildings, making use of supportive policies and subsidies, and the latest information and guidance, available through GOV.UK, Citizen’s Advice and the [Simple Energy Advice](#) online platform.³¹⁶

Measuring whole-building energy performance

Existing energy performance policy typically uses the energy performance certificate (EPC) rating system to indicate overall building performance. This allows us to predict the energy a building will use, and the carbon it will emit. By setting minimum energy performance standards across tenures, and increasing these over time, we can improve building performance across the stock. For the longer-term we will consider whether, when and how to ensure that all homes meet a Net Zero minimum energy performance standard before 2050.

We have already taken steps to address the buildings with the poorest energy performance by:

- setting interim milestones for England to improve as many fuel poor homes as is reasonably practicable to a minimum energy efficiency rating of band E by 2020, band D by 2025, and band C by 2030,³¹⁷ in line with our 2030 fuel poverty target for England
- consulting on tightening minimum energy efficiency standards for privately-rented homes in England and Wales to EPC band C
- regulating so all privately-rented non-domestic buildings need to reach EPC band B by 2030, where cost-effective. We will set out the detail of the policy in the coming months.

EPCs are a useful tool for understanding the performance of the building stock, and the degree of accuracy and consistency of these assessments has continued to improve over time.

The [EPC action plan](#)³¹⁸, published earlier in 2020, sets out 35 actions to deliver an EPC system that:

³¹⁶ Simple Energy Advice online platform, available at: <https://www.simpleenergyadvice.org.uk/>.

³¹⁷ In accordance with our ‘Fuel Poverty Energy Efficiency Rating Methodology’ (2014) (https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/332236/fpeer_methodology.pdf).

³¹⁸ BEIS and DLUHC (2020), ‘Energy Performance Certificates for Buildings: Action Plan’ (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/922660/EPC_Action_Plan.pdf).

- produces accurate, reliable, and trusted EPCs
- supports action to reduce energy use in buildings
- engages with consumers and gives people access to the data they need to make decisions

For some of the largest, most complex, and highest energy-using buildings, it is challenging to model energy performance accurately. This is particularly true for larger non-domestic buildings. In March 2021, we published a consultation for a performance-based policy framework that measures real-world performance of private non-domestic buildings above 1,000m².³¹⁹ It aims to better reflect real-world, rather than modelled performance across the whole building stock and we aim to publish more details about the scheme later this year.

In addition to the thermal efficiency of a building, to improve overall energy performance, we need to consider the efficiency and flexibility of energy-related products and how they are used within the building.

When improving energy performance, we need to build-in flexibility to allow for:

- innovative technologies and techniques
- solutions tailored to building types
- consumer choice that meets individual needs

There are factors that impact the energy used in a building that are not related to the building fabric or heating system, but are related to:

- the way occupants use the building,
- how the building operates and is managed (including smart technologies)
- the energy-related products in the building

There are lots of actions households and businesses can take to reduce emissions, such as installing a smart meter and purchasing energy efficient products.

Methodologies such as the Standard Assessment Procedure (SAP) will continue to be refined to ensure they appropriately assess whole-building energy performance and environmental impact, considering energy efficiency, heat source and system flexibility.

Using smart and flexible technologies to measure and improve energy performance

Smart meters and advanced meters help consumers to be more informed about their energy use. This can encourage energy-saving behaviour, such as turning the thermostat down, which then leads to lower energy bills.

³¹⁹ BEIS (2021), 'Introducing a performance-based policy framework in large commercial and industrial buildings' (<https://www.gov.uk/government/consultations/introducing-a-performance-based-policy-framework-in-large-commercial-and-industrial-buildings>).

We have set out [plans for the installation of smart meters in households across GB](#), confirming a four-year smart meter policy framework which will start from January 2022, with annual installation targets for energy suppliers to deliver market-wide roll-out in Great Britain.³²⁰

Smart technologies and energy storage improve the energy performance of a building by matching demand to periods of greater renewable energy supply – which are also cheaper for the consumer. We will consider how to build smart and flexible technologies, including heating systems, into our policies. We are in the process of reviewing the next version of the Standard Assessment Procedure (SAP 11), which is the methodology used for compliance with the Building Regulations and for generation of domestic EPC ratings. As part of this review, we are considering how to better recognise the benefits of flexibility and storage to encourage smart systems in new and existing homes. We will consider how to integrate flexibility from smart technologies into our energy efficiency, fuel poverty and heat policies in an appropriate way. This could involve product innovations, adding new measures to schemes, better incentivising smart solutions, or requiring measures adhere to technical standards.³²¹

Using product efficiency to improve energy performance

The efficiency of products and appliances have a significant role in delivering cost-effective carbon savings and reducing energy demands and bills for consumers. Our existing policy drives change through energy-related product standards, ecodesign and energy labelling. Minimum energy performance standards, along with energy labels, are one of the most cost-effective ways to improve the energy efficiency of products, reduce energy bills, and make significant energy and carbon savings. We will continue to review and improve these standards and energy-related product policies to ensure the market keeps moving towards more energy efficient and sustainable products.

Following consultations in 2021, we implemented [new ecodesign measures](#)³²² which cover a range of products such as washing machines, dishwashers, televisions and [lighting products](#).³²³ All of these measures include resource efficiency requirements in addition to energy efficiency.

³²⁰ BEIS (2020), 'Government sets out plans to drive up smart meter installations' (<https://www.gov.uk/government/news/government-sets-out-plans-to-drive-up-smart-meter-installations>).

³²¹ As part of the Optimised Retrofit Programme, Welsh Government is making Intelligent Energy System (IES) mandatory to enable response capability and allow real-time measurement of building energy performance. IES will help access to flexible energy tariffs from suppliers and mitigate possible fuel cost increases associated with increased electrification of heat. Once the benefits of IES are proven, the Welsh Government is considering making it a condition of Welsh Housing Quality Standard and any retrofit funded by the Welsh Government.

³²² BEIS (2020), 'Draft Ecodesign and Energy Labelling Regulations 2021' (<https://www.gov.uk/government/consultations/draft-ecodesign-and-energy-labelling-regulations-2021>).

³²³ BEIS (2020), 'Draft Ecodesign and Energy Labelling Regulations (Lighting Products) 2021' (<https://www.gov.uk/government/consultations/draft-ecodesign-and-energy-labelling-regulations-lighting-sources-2021>).

On 1 January 2021, existing EU ecodesign and energy labelling regulations were retained in UK law.³²⁴ In 2021, we estimate that existing ecodesign standards will save 8 MtCO_{2e}, and £75 on annual energy bills for the average dual-fuel household in the UK.³²⁵

We are now exploring how existing standards can be improved to maximise the energy- and carbon-saving potential of products (through better energy performance and better resource efficiency). We are also exploring whether there are other, currently unregulated, energy-related products where minimum standards and energy labels could achieve significant savings. Our call for evidence, which closed in September 2020, addressed these topics. Products covered included: cooking appliances, lighting, boilers, heat pumps, smart appliances, heat distribution systems, space cooling and ventilation where Ecodesign measures exist, and taps and showers where the current scope of Ecodesign and energy labelling could be expanded.³²⁶ The 2018 Boiler Plus Standards for England set a minimum efficiency standard for domestic gas boiler replacement that is 6% higher than the Ecodesign minimum requirements.³²⁷ We have also launched an [UK Energy-related Products Policy Study](#)³²⁸ to explore the energy and resource efficiency improvement potential of products sold in the UK and the associated carbon savings.

We will publish a policy framework which will set out illustrative proposals for raising minimum energy performance standards and improving consumer information for a range of high potential products, including but not limited to space heating, cooking, taps and showers and lighting. We plan to consult on more concrete proposals between 2022 and 2023 ahead of implementing measures from 2025.

We will also continue to improve the efficiency of boilers. We recently published our [initial review of the Boiler Plus standards](#).³²⁹ We will use an upcoming consultation, which will consider the case for enabling, or requiring new gas boilers to be hydrogen-ready, to also test proposals on the future of broader boiler and heating system efficiency and explore the best ways to reduce carbon emissions from our heating systems over the next decade.

We are taking action to ensure products are more energy efficient, sustainable and resource efficient through our commitment to new product standards and better consumer information. We have laid legislation to do this for a range of products and our future policy will be outlined in our upcoming Energy-Related Products Policy Framework, which we aim to publish later this year.

³²⁴ Under the terms of the Northern Ireland Protocol certain legislation, including both existing and future EU Ecodesign and Energy Labelling regulations, will continue to apply automatically in Northern Ireland, as long as the protocol has the consent of the people of Northern Ireland. The UK's approach to the Northern Ireland Protocol can be found at: <https://www.gov.uk/government/publications/the-uks-approach-to-the-northern-ireland-protocol>.

³²⁵ BEIS (2020), 'Draft Ecodesign and Energy Labelling Regulations 2021' (<https://www.gov.uk/government/consultations/draft-ecodesign-and-energy-labelling-regulations-2021>).

³²⁶ BEIS (2020), 'Energy-related products: call for evidence' (<https://www.gov.uk/government/consultations/energy-related-products-call-for-evidence>).

³²⁷ Seasonal Space Heating Energy Efficiency as defined in Commission Regulation (EU) No 813/2013. Available at: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32013R0813>.

³²⁸ ICF, BEIS and DEFRA (2021), 'UK Energy-related Products Policy Study' (<https://erpproductspolicystudy.uk/>).

³²⁹ BEIS (2021), 'Boiler Plus: initial policy review' (<https://www.gov.uk/government/publications/boiler-plus-initial-policy-review>).

Figure 11: Illustrative timeline for product standards

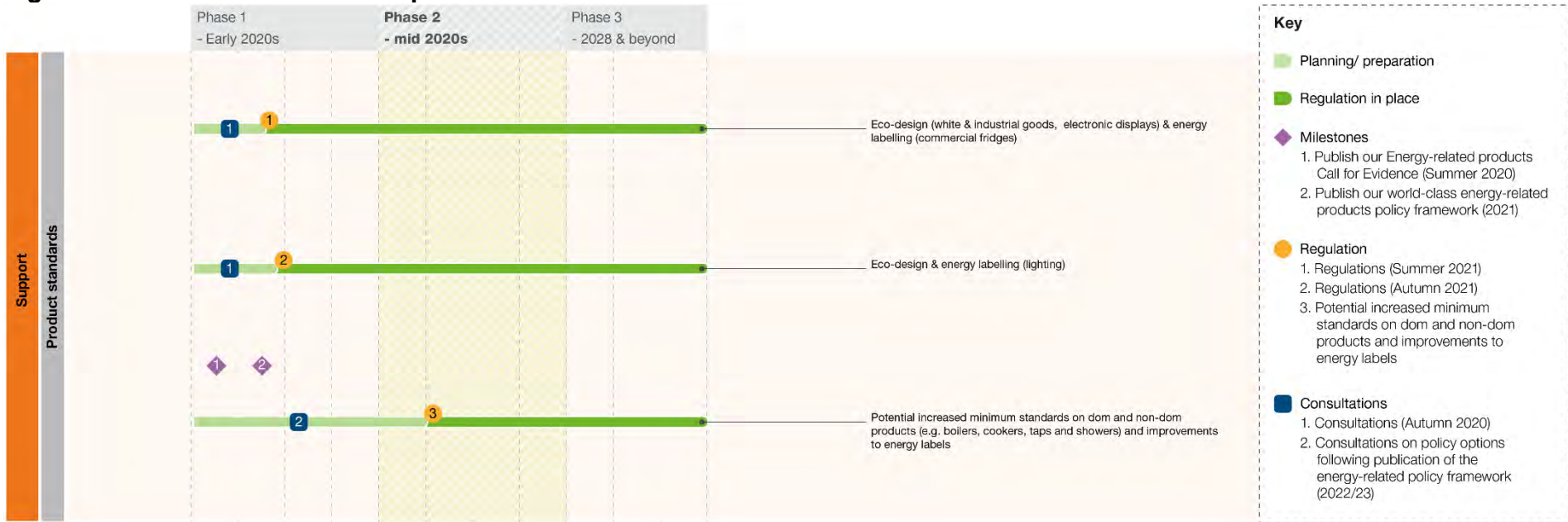


Figure 11 provides an illustrative diagram of the breadth of activities planned to improve energy-related products over the next decade, according to BEIS' current thinking.

For commercial and industrial buildings, the government's [Energy Technology List](#)³³⁰ (ETL) provides a useful procurement tool to help identify some of the most efficiently performing technologies such as boilers, air conditioning and refrigeration. The ETL:

- sets eligibility criteria for technologies that typically represent the top 25% performance level in the market
- addresses information barriers
- provides independent assurance of technology performance
- reduces transaction costs for businesses

In December 2020, we published [the outcome of our consultation on the future direction of the ETL scheme, and on proposed technical changes for the 2020 update of the Energy Technology Criteria List](#).³³¹

Heating water (excluding for space heating) accounts for 17% of household energy use.³³² We are working across government departments to explore whether better consumer information such as labelling, as well as minimum standards, could help to reduce the volume of water used by these products – and therefore the energy used to produce, supply and heat the water. In addition to increasing the climate resilience of our water supplies, Energy Saving Trust suggest that carbon savings of up to 50 MtCO_{2e} could be achieved over 25 years.³³³

We will take different approaches to different types of buildings to reflect the diversity of the building stock and use existing trigger points relevant to each building-type to minimise disruption. This will ensure that all consumers have the flexibility to make the changes that work best for them and have the support to do so. This will include targeted action to address our least efficient buildings (worst-first), while tackling fuel poverty.

- 2.6% of low income households in England have an energy efficiency rating F or G³³⁴
- 21.5% of households living in homes with a fuel poverty energy efficiency rating (FPEER) of band F, are in fuel poverty^{335,336,337}

³³⁰ Energy Technology List (<https://etl.beis.gov.uk/>).

³³¹ BEIS (2020), 'Energy Technology List Scheme: its future direction and technical changes to the 2020 update' (<https://www.gov.uk/government/consultations/energy-technology-list-scheme-its-future-direction-and-technical-changes-to-the-2020-update>).

³³² BEIS (2021), 'Energy Consumption in the UK 2020' (<https://www.gov.uk/government/statistics/energy-consumption-in-the-uk>).

³³³ Energy Saving Trust (2019), 'Independent review of the costs and benefits of water labelling options in the UK', p. 8 (https://waterwise.org.uk/wp-content/uploads/2019/10/WESTrategy001-EXT_SummaryReport_2.3-1.pdf).

³³⁴ National Statistics (2021), 'Fuel poverty factsheet 2021', p. 10 (<https://www.gov.uk/government/statistics/fuel-poverty-factsheet-2021>).

³³⁵ National Statistics (2021), 'Fuel poverty detailed tables 2021', table 3 (<https://www.gov.uk/government/statistics/fuel-poverty-detailed-tables-2021>).

³³⁶ National Statistics (2021), 'Fuel poverty detailed tables 2021', table 3 (<https://www.gov.uk/government/statistics/fuel-poverty-detailed-tables-2021>).

³³⁷ In our policy paper on 'Sustainable warmth: protecting vulnerable households in England', BEIS (2021) (<https://www.gov.uk/government/publications/sustainable-warmth-protecting-vulnerable-households-in-england>), we announced an update to the fuel poverty metric (from Low Income High Cost to Low Income Low Energy Efficiency).

5.2. How to improve our buildings

We have tailored our policy to drive and enable improvements across the UK building stock, including:

- *future-proofing new-builds*
- *upgrading housing through: funding for improving fuel poor and social housing, regulatory levers tailored to individual sectors and tenures for the private-rented sector, and gathering further evidence to inform our approach for owner-occupied buildings*
- *trailblazing a whole-building approach for public sector buildings*
- *initiating a performance-based rating system to begin decarbonising large commercial and industrial buildings*

Future-proofing new buildings

New buildings offer a unique opportunity – if we build them to be low-carbon and highly efficient, they will not need to be retrofitted later. Therefore, we plan to future-proof new buildings ready for Net Zero.

Approximately 1 million new dwellings have been built in England over the last 5 years.³³⁸ We expect to significantly increase the rate of homes built over the next decade and remain committed to progress to an additional 300,000 homes built per year.³³⁹ By 2039 we expect the number of households in the UK to increase from 28 million currently to 31 million.³⁴⁰ This could rise even further by 2050, increasing the number of heat replacements per year.

It is significantly cheaper and easier to install energy efficiency and low-carbon heating measures as buildings are constructed, rather than retrofitting them afterwards. This also reduces disruption to consumers.

Making our homes and workplaces healthier and more comfortable also means making them resilient to the impacts of climate change. In accordance with the Climate Change Act, the government will continue to develop five-yearly assessments of the risks arising from climate

³³⁸ DLUHC (2012), 'Live tables on housing supply: net additional dwellings', 'Table 122: housing supply; net additional dwellings, by local authority district, England 2001-02 to 2019-20' (<https://www.gov.uk/government/statistical-data-sets/live-tables-on-net-supply-of-housing>).

³³⁹ HM Treasury (2017), 'Building the homes the country needs' (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/661430/Building_the_homes_the_country_needs.pdf).

³⁴⁰ ONS (2020), 'Households projections for England' (<https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/datasets/householdprojectionsforengland>), table 401.

change and a programme of adaptation measures to improve climate resilience.^{341,342} When developing policies to future-proof buildings, we will consider our current and possible future scenarios, including overheating risk, indoor air quality risk, flood risk and water scarcity.

Energy efficiency measures, when installed incorrectly or without appropriate adaptation measures, can create airtight spaces, which can increase the risk of overheating and decrease indoor air quality. This is of particular importance as we anticipate the demand for cooling to increase. Improving energy performance, while reducing the need for active cooling, is key to future-proofing these buildings and minimising carbon emissions.

We will increase standards for new-builds in the 2020s to ensure that they are ready for Net Zero.

In 2019, the Government announced the introduction of a Future Homes Standard for England³⁴³ by 2025. The standard will ensure that new-build homes are future-proofed with low-carbon heating and high levels of energy efficiency. We expect that homes built to this standard will produce no operational carbon dioxide (once the supply has been decarbonised), with 75% to 80% lower emissions than those built to current Building Regulations standards.

As a stepping-stone to the Future Homes Standard, we plan to introduce an interim uplift in standards for England, effective from June 2022, that would result in a 31% reduction in carbon emissions from new homes compared to current standards.

The [consultation for a Future Buildings Standard](#) for England closed in April 2021.³⁴⁴ Subject to final analysis of consultation responses, we aim to ensure non-domestic buildings are constructed to be highly efficient, better for the environment, and fit for the future, with implementation of this standard starting from 2025. The Future Buildings Standard consultation also proposes mitigation against the risk of overheating in new residential buildings.

In addition to building regulations, we will continue to examine how we can ensure that all new buildings are designed and constructed to be ready for Net Zero.

We will review the gas regulatory framework (as set out in the Gas Act 1986), to ensure that the appropriate powers and responsibilities are in place to deliver Net Zero. BEIS are planning to consult on whether it is appropriate to prevent new-build homes from connecting to the gas grid in England from 2025. This will look at how best to ensure new dwellings use low-carbon sources of heat and therefore would allow for later connections to the gas grid if low-carbon hydrogen becomes part of our heat decarbonisation pathway.

³⁴¹ HM Government (2017), 'UK Climate Change Risk Assessment 2017' (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/584281/uk-climate-change-risk-assess-2017.pdf).

³⁴² DEFRA (2017), 'Climate change: second national adaptation programme (2018 to 2023)' (<https://www.gov.uk/government/publications/climate-change-second-national-adaptation-programme-2018-to-2023>).

³⁴³ In March 2020, the Part L consultation for new dwellings in Wales closed.

³⁴⁴ DLUHC (2021), 'The Future Buildings Standard' (<https://www.gov.uk/government/consultations/the-future-buildings-standard>).

Of the UK's 28 million households³⁴⁵, there are approximately 17 million properties below EPC band C³⁴⁶. To cost-effectively decarbonise heat, most or all these buildings will need to be treated between now and 2050. In 2017, the government set out the aspiration in the [Clean Growth Strategy](#)³⁴⁷ for as many homes in England as possible to be upgraded to EPC band C by 2035.³⁴⁸

Figure 12: Percentage of homes rated EPC A-G in England, 2004-2019

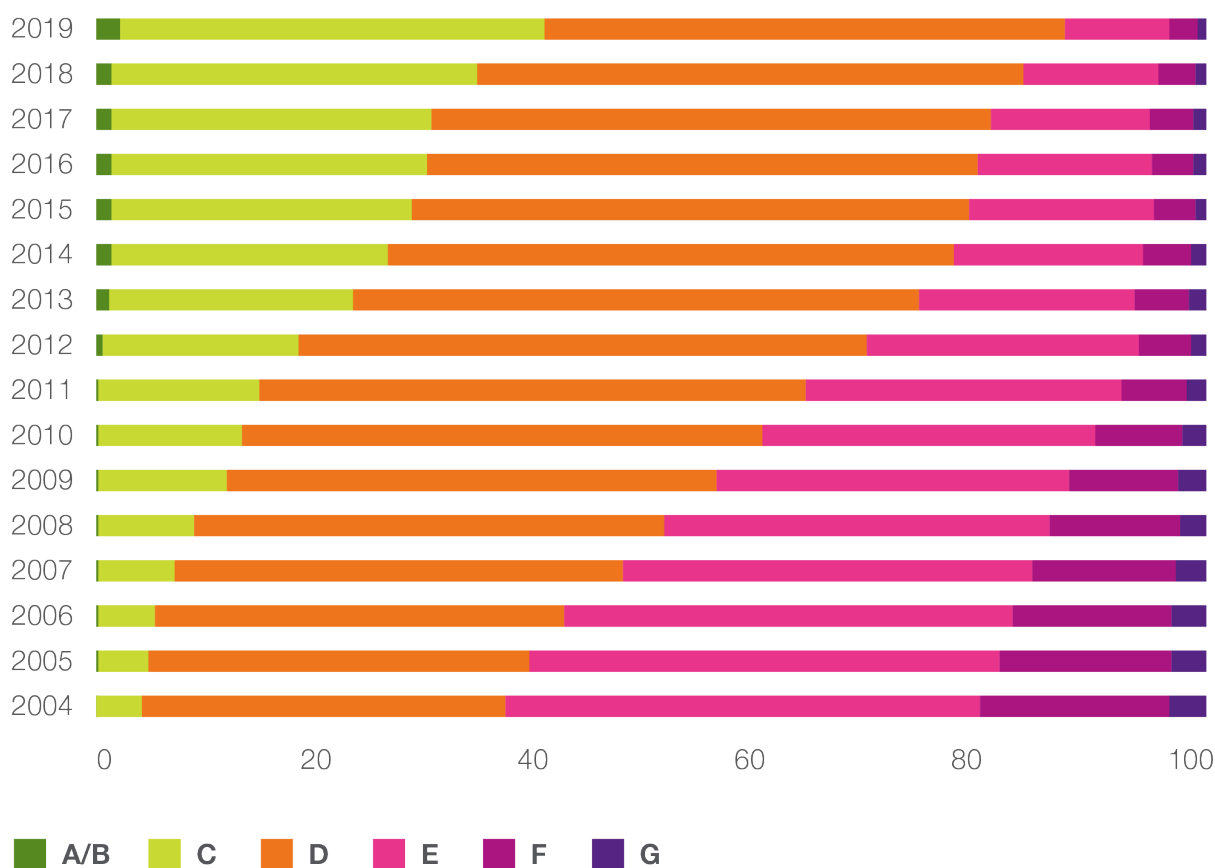


Figure 12 shows the proportion of the building stock in England by EPC ratings. This clearly demonstrates the progress that has been made since 2004, but the significant action that needs to be taken to bring as many homes as practicable to EPC band C.³⁴⁹

³⁴⁵ ONS (2020), 'Households projections for England', table 401

(<https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/datasets/householdprojectionsforengland>).

³⁴⁶ Figures taken from the English (<https://www.gov.uk/government/collections/english-housing-survey>), Scottish (<https://www.gov.scot/publications/scottish-house-condition-survey-2019-key-findings/pages/5/>), Welsh (<https://gov.wales/welsh-housing-conditions-survey-energy-efficiency-dwellings-april-2017-march-2018>), and Northern Ireland (<https://www.nihe.gov.uk/Working-With-Us/Research/House-Condition-Survey>) housing surveys.

³⁴⁷ BEIS (2017), 'Clean Growth Strategy' (<https://www.gov.uk/government/publications/clean-growth-strategy>).

³⁴⁸ As stated in their 2021 policy programme (<https://www.gov.scot/publications/scottish-government-and-scottish-green-party-shared-policy-programme/>), Scottish Government are seeking to upgrade the majority of homes in Scotland to at least EPC Band C by 2033, where feasible and cost-effective.

³⁴⁹ BEIS (2020), 'Government response to the Committee on Climate Change's 2020 progress report to Parliament', p. 25 (<https://www.gov.uk/government/publications/committee-on-climate-changes-2020-progress-report-government-response>), and DLUHC (2020), 'English Housing Survey 2019 to 2020: headline report', annex table 2.8 (<https://www.gov.uk/government/statistics/english-housing-survey-2019-to-2020-headline-report>).

We recognise that a well-functioning housing market is important to deliver the affordable homes this country needs. We aim to deliver interventions that minimise impacts on the housing market. It is important that we make progress across all tenures (e.g. by introducing more stringent minimum standards in all sectors), while minimising disruption to consumers by using natural trigger points, and continuing to provide incentives and support for households who cannot pay.

We are developing proposals to improve the energy performance of homes (including through the Decent Home Standard Review) and will continue to consult on the role of minimum energy performance standards across England, in line with our approach to the private-rented sector. Alongside these regulations, we know that some households and businesses will require support to meet these standards, in the form of:

- financing to make improvement measures more affordable
- further engagement to help households and businesses make informed choices
- consumer protection to ensure the improvements deliver the expected results

We have provided targeted grants and schemes to improve affordability.

- The Green Homes Grant voucher scheme was created to encourage and enable individuals to install energy efficiency and low-carbon heating measures in their homes in England to help reduce energy bills and greenhouse gas emissions, as part of the short-term Economic Stimulus Package announced in July 2020. The voucher scheme was open to owner-occupiers, park homeowners³⁵⁰, and landlords who let privately or through the social-rented sector. It offered financial support through vouchers covering up to two-thirds of the cost (up to £5,000) of installing energy efficient and low-carbon heating improvements to homes. This increased to up to 100% of the cost (up to £10,000) for low income households. The scheme closed to new applications at the end of March 2021. To date, more than 133,700 applications were made, and more than 79,200 vouchers have been issued.³⁵¹
- The Local Authority Delivery scheme provides funding for local authorities throughout England to support low income households in their area with energy efficiency and low-carbon heating upgrades. This scheme has been extended, so that it can continue to support consumers in 2021 who wish to adopt new energy efficiency or low-carbon heating measures.
- We have consulted on proposals for a new Boiler Upgrade Scheme³⁵² (previously named the Clean Heat Grant), to support low-carbon heat source installation through upfront capital grants (of £5,000) for households and small businesses.

In addition to government grants, loans and other schemes, we are also supporting the growth of private green finance, building on existing measures to protect consumers, and ensuring

³⁵⁰ Park homes are detached bungalow-style homes, measuring less than 20 x 6.8 x 3.05 metres that must be relocatable. They are covered by the Mobile Homes Act 1983 and British Standard BS3632 building regulations. Park homeowners own the building, but do not own the land underneath.

³⁵¹ On average, more than one voucher has been requested per application.

³⁵² BEIS (2020), 'Future support for low carbon heat' (<https://www.gov.uk/government/consultations/future-support-for-low-carbon-heat>).

that they are provided with the relevant information and advice. This is discussed in greater detail in section [6.2 Green finance](#).

We continue to consult over options for regulatory measures to improve energy performance of all homes, and ensure these measures are sequenced appropriately, providing certainty to the market and clear signals to homeowners, landlords and tenants.

Socially-rented housing

DLUHC has published the [Social Housing White Paper](#)³⁵³ in which we commit to reviewing the Decent Homes Standard to consider how it can better support the decarbonisation and improve the energy efficiency of social homes in the context of expectations for other tenures, and wider government policies.

The 2020 Summer Economic Update announced the UK Social Housing Decarbonisation Fund (SHDF) Demonstrator³⁵⁴, launched in 2020, which awarded £62 million of funding to social landlords across England and Scotland to test innovative approaches to retrofitting at scale.³⁵⁵ The Government has announced up to £160 million funding in financial year 21/22, delivering up to January 2023 as the first wave of the SHDF, which is England only. We are investing a further £800 million over financial years 2022/23 to 2024/25.

We will also consider setting a long-term regulatory standard to improve social housing to EPC band C, with levers required to decarbonise the stock in line with Net Zero. We will consult the sector before setting any regulatory standard.

Decarbonising socially-rented homes in Wales

In November 2020, Wales launched the £20 million Optimised Retrofit Programme for testing and trial of a whole-building approach to decarbonisation of homes. The trial period also identifies capacity, skills and capability gaps in the delivery system. This scheme will trial several approaches to decarbonise social housing.

New green standards for new homes in Wales ([Welsh Development Quality Requirements 2021: Creating Beautiful Homes and Places by 2025](#)³⁵⁶) include energy efficiency requirements in new social homes to reduce carbon emissions and energy bills while supporting delivery of the aim to build 20,000 high quality, low-carbon homes for rent over the next five years.

Tirion Homes and Pobl Living are working in partnership with Sero to build 225 smart, affordable, [low-carbon homes in Parc Eirin](#), Rhondda Cynon Taff.³⁵⁷ Welsh Government

³⁵³ DLUHC (2020), 'The charter for social housing residents: social housing white paper' (<https://www.gov.uk/government/publications/the-charter-for-social-housing-residents-social-housing-white-paper>).

³⁵⁴ BEIS (2021), 'Social Housing Decarbonisation Fund Demonstrator- Successful Bids' (<https://www.gov.uk/government/publications/social-housing-decarbonisation-fund-demonstrator-successful-bids>).

³⁵⁵ Wales are also looking to fund the fitting of energy efficiency measures in up to 1000 existing homes owned by registered social landlords and councils through their Optimised Retrofit Programme (<https://gov.wales/9-and-half-million-programme-reduce-housing-carbon-footprint>)

³⁵⁶ Welsh Government (2021), 'Welsh Development Quality Requirements 2021: Creating Beautiful Homes and Places by 2025' (<https://gov.wales/sites/default/files/publications/2021-08/development-quality-requirements-for-housing-associations.pdf>).

³⁵⁷ Tirion Homes, Parc Eirin development (<https://tirionhomes.co.uk/developments/parc-eirin/>)

have committed to fund around £7.5 million to this scheme, which started in April 2020. In the initial phases, social housing will be constructed, with owner-occupied housing following in a later phase.

Private-rented homes

Our consultation on improving the energy performance of privately rented homes³⁵⁸ (September - January 2021) proposed increasing energy performance requirements from 2025, fulfilling our public commitment to review whether we are on trajectory for private-rentals to meet or exceed EPC band C by 2030. This policy proposes to bring the majority of privately-rented properties in England and Wales up to at least EPC band C in the period from 2025 to 2028. We are aiming to publish a response before the end of the year. The Energy Efficiency (Private Rented Property) (England and Wales) Regulations 2015 require that, from April 2020, all privately-rented homes in England and Wales which are required to have an EPC must have a minimum energy performance rating of EPC band E, unless a valid exemption has been registered.^{359,360}

We have provided significant additional support to local authorities to ensure compliance and enforcement of these regulations, building on earlier compliance and enforcement pilots. This includes providing £4.3 million to 57 local authorities to support activity in these areas. We plan to scale-up activity further in the coming years. We have also set out proposals to strengthen the compliance and enforcement framework under our recent EPC band C consultation. This includes the introduction of a compliance and exemption database to support local authority enforcement of the regulation.

We have consulted on introducing and enforcing minimum energy performance standards for rented properties in the 2020s.

Owner-occupied homes

In the owner-occupier sector we have identified potential points of intervention in the lifecycle of home ownership where policies could help to improve properties:

Key points in home lifecycle	
Property sales	830,000 per year in England and Wales ³⁶¹

³⁵⁸ BEIS (2020), 'Improving the energy performance of privately rented homes' (<https://www.gov.uk/government/consultations/improving-the-energy-performance-of-privately-rented-homes>).

³⁵⁹ BEIS (2018), 'Private Rented Sector minimum energy efficiency standard exemptions' (<https://www.gov.uk/government/publications/private-rented-sector-minimum-energy-efficiency-standard-exemptions>).

³⁶⁰ BEIS (2017), 'Domestic private rented property: minimum energy efficiency standard - landlord guidance' (<https://www.gov.uk/guidance/domestic-private-rented-property-minimum-energy-efficiency-standard-landlord-guidance>).

³⁶¹ 830,000 per year for year ending June 2019. Source: ONS (2021), 'Residential property sales for administrative geographies: HPSSA dataset 6' (<https://www.ons.gov.uk/peoplepopulationandcommunity/housing/datasets/numberofresidentialpropertysalesforationalandsubnationalgeographiesquarterlyrollingyearhpssadataset06>).

Key points in home lifecycle	
	The average owner-occupied home changes hand every 18 years in England and Wales ³⁶²
Property financing	New mortgages ~ 680,000 per year in England and Wales ³⁶³ Refinancing ~ 550,000 per year in England and Wales ³⁶⁴
Repairs and improvements	Extensions ~ 135,000 per year in England ³⁶⁵ Window replacements ~ 2.5 million per year in England ³⁶⁶ Boiler replacements over 1 million per year in England ³⁶⁷

We are exploring opportunities to improve the energy performance of owner-occupier homes. We have conducted a series of stakeholder workshops on the case for regulation, with over 50 representatives from the housing sector, landlord representatives, retrofit supply chain, and non-government and consumer organisations. We are planning to consult further, to gather views on a broad range of options to upgrade homes in this sector, which will inform policy design. We will work with owner-occupiers to help them improve the performance of their homes. The provision of green finance will be an important step in making this easier and more accessible.

This year, we closed a [consultation on improving home energy performance through lenders](#)³⁶⁸ (November 2020 – February 2021) on proposals to require mortgage lenders to disclose energy performance across their property portfolio and on introducing voluntary targets to improve the energy performance of their portfolios to an average of EPC band C by 2030. The consultation proposes making these targets mandatory if insufficient progress is being made. Collectively, this would:

- encourage significant product innovation and new partnerships

³⁶² DLUHC (2020), 'English Housing Survey 2018 to 2019' (<https://www.gov.uk/government/collections/english-housing-survey#2018-to-2019>).

³⁶³ Bank of England statistics (<http://www.bankofengland.co.uk/boeapps/iadb/index.asp?Travel=NlxSTxTax&levels=1&XNotes=Y&G0Xtop.x=20&G0Xtop.y=1&C=112&C=100&C=101&C=ZZ&C=10Z&C=102&C=103&C=104&XNotes2=Y&Nodes=X8699X8700X8715X79883X8745X37884X37893X37883X37890X8761X35672X79911X8762X69339X37892&SectionRequire d=A&HideNums=-1&ExtraInfo=false#BM>). These figures are subject to relatively high-frequency variation.

³⁶⁴ Bank of England statistics (<http://www.bankofengland.co.uk/boeapps/iadb/index.asp?Travel=NlxSTxTax&levels=1&XNotes=Y&G0Xtop.x=20&G0Xtop.y=1&C=112&C=100&C=101&C=ZZ&C=10Z&C=102&C=103&C=104&XNotes2=Y&Nodes=X8699X8700X8715X79883X8745X37884X37893X37883X37890X8761X35672X79911X8762X69339X37892&SectionRequire d=A&HideNums=-1&ExtraInfo=false#BM>). These figures are subject to relatively high-frequency variation.

³⁶⁵ DLUHC (2021), 'Future Buildings Standard Consultation Impact Assessment', p.46 (<https://www.gov.uk/government/publications/the-future-buildings-standard-consultation-impact-assessment>).

³⁶⁶ DLUHC (2021), 'Future Buildings Standard Consultation Impact Assessment', p.46 (<https://www.gov.uk/government/publications/the-future-buildings-standard-consultation-impact-assessment>).

³⁶⁷ BSRIA (2020), 'Domestic Boiler Market Analysis – United Kingdom' (<https://www.bsria.com/uk/>).

³⁶⁸ BEIS (2020), 'Improving home energy performance through lenders' (<https://www.gov.uk/government/consultations/improving-home-energy-performance-through-lenders>).

- drive the development of a green home finance market to support homeowners to make energy efficiency improvements

We will provide support and advice to homeowners on how they can improve their building's energy efficiency (for example, through the [Simple Energy Advice](#) online platform³⁶⁹). We are considering setting minimum standards to ensure buildings are compatible with Net Zero.

Supporting low income and fuel poor households

We consider improving the energy efficiency of homes to be the best long-term method of tackling fuel poverty. In 2019 there were around 1.3 million fewer fuel poor households living in properties with fuel poverty energy efficiency ratings of E, F or G, compared to 2010.

We have directly and indirectly supported improvements in homes for many years and targeted support to those who need it most, including low income and fuel poor groups. So far, the main ways in which we have done this have been through obligations on suppliers, grants, and discounts on heating bills.

The first Energy Company Obligation (ECO) scheme was introduced in 2013, replacing the former energy supplier obligations (Carbon Emissions Reduction Target and Community Energy Savings Programme). The current ECO is an obligation on larger energy suppliers to provide energy efficiency and heating measures for fuel poor consumers across Great Britain. Since the programme began, over 3 million measures have been installed in over 2.2 million homes. Eligible households can save up to £300 on their energy bills. Households are eligible if they receive certain benefits, live in the least efficient social housing or if they are referred by their local authority.

We have committed to extending ECO and will increase the ambition for installing energy efficiency measures. The next iteration of ECO will run from 2022 to 2026 with an increase in value from £640 million to £1 billion per year. ECO will primarily focus on improving the worst-quality homes across Great Britain, helping as many to achieve EPC band C as is cost-effective and suitable for the property. This will support progress towards achieving our fuel poverty target for England to ensure that as many fuel poor homes achieve a minimum fuel poverty energy efficiency rating (FPEER) of band C³⁷⁰, as is reasonably practicable, by 2030. We have committed to a four-year, £4 billion successor to the Energy Company Obligation across Great Britain.

The [Warm Home Discount](#)³⁷¹ scheme currently provides over 2 million low income and vulnerable households with a £140 rebate off their winter energy bill. In 2020 we ran a [consultation on whether to extend our Warm Home Discount scheme](#) to provide an annual discount to heating bills for low income and vulnerable households, for winter 2021 to 2022. Government has since committed to reforming and expanding the scheme until at least 2026, meaning 780,000 additional households would receive rebates every winter.

In March, the government committed to spending an [additional £300 million on green home upgrades through local authorities](#). This increase in funding to local authorities will be through the Social Housing Decarbonisation Fund and an extension to the Local Authority Delivery

³⁶⁹ Simple Energy Advice online platform, available at: <https://www.simpleenergyadvice.org.uk/>.

³⁷⁰ In accordance with our 'Fuel Poverty Energy Efficiency Rating Methodology' (2014) (https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/332236/fpeer_methodology.pdf).

³⁷¹ Warm Home Discount Scheme (<https://www.gov.uk/the-warm-home-discount-scheme>).

scheme, with anticipated delivery to January and March 2023 respectively. The Sustainable Warmth competition was launched on 16 June 2021, this funding opportunity brings together two fuel poverty schemes (Local Authority Delivery Phase 3 and Home Upgrade Grant Phase 1) into a single funding opportunity for Local Authorities. Local Authorities can continue to target low income households living in inefficient properties through the £200 million LAD Phase 3 focused on gas fuelled homes and the £150 million Home Upgrade Grant for off-gas-grid properties.

The Local Authority Delivery Phase 3 (LAD3) – The LAD scheme provides support for low income households through local authorities in England. Households can benefit from energy efficiency and low-carbon heating improvements of up to £10,000. Around £200 million of funding is also available for new projects delivering to low income households in the most inefficient homes that are on-the-gas grid in England Through LAD3. We expect the main criteria for on-gas-grid properties to remain the same as those in the first two phases of LAD, including the cost caps for owner-occupier and rented properties, along with landlord contributions.

Home Upgrade Grant (HUG) – aims to provide funding for energy efficiency and low-carbon heating measures. It focuses on vulnerable households and low income families living in the worst quality off-gas-grid homes (those rated EPC band D, E, F and G) in England. It aims to improve these homes to EPC band C, making progress towards our FPEER C target, while decarbonising the housing stock. This targeted funding intends to enable the installation of multiple measures in these homes to substantially improve performance and help tackle fuel poverty. We are investing a further £950 million into the HUG over 2022/23 to 2024/25.

Social Housing Decarbonisation Fund (SHDF) – The SHDF will deliver energy performance improvements in Social homes. There is up to £160 million total funding for the first wave of the programme in 2021/22, an increase from the £60 million announced by the Chancellor at the Autumn 2020 Spending Review. This first wave will offer the potential for registered providers of social housing, including Private and Local Authority providers, in England to apply retrofit solutions to their stock. The bid window for this first wave of funding opened 23 August 2021 and the delivery will run until January 2023. We are investing a further 800 million into the SHDF over financial years 2022/23 to 2024/25.

We will continue to prioritise providing support where it is needed most, and help consumers make improvements to their buildings.

Approximately 60% of homes in England were below EPC band C in 2019.³⁷² Our portfolio of policy levers aims to decarbonise across the building stock and help us to upgrade as many as homes as possible to EPC band C by 2035. We project that the policies outlined in this document could bring up to 70% of the English housing stock to EPC band C or above by 2035.

We understand that the combination of policies and regulations for improving different types of homes may leave some untreated in the near-term. We therefore appreciate the role of the wider market to encourage more voluntary action. We will monitor building improvements and consider whether future targeted action is required, including whether further use of minimum

³⁷² DLUHC (2020), 'English Housing Survey 2019 to 2020: headline report' (<https://www.gov.uk/government/statistics/english-housing-survey-2019-to-2020-headline-report>), annex table 2.8.

energy performance standards in the 2030s and 2040s, can support cost-effective decarbonisation of our housing stock.

Figure 13: Illustrative timeline for support for fuel poor and low income households

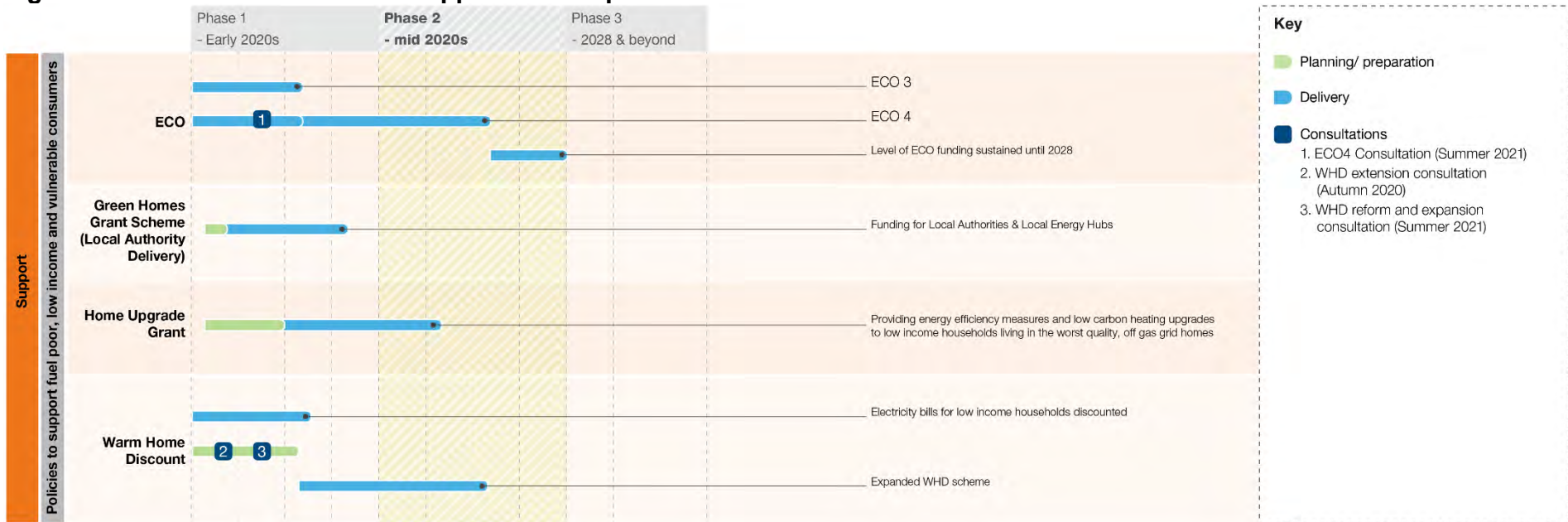


Figure 13 provides an illustrative diagram of some of the schemes available to support upgrades for low income, fuel poor and vulnerable households, according to BEIS' current thinking.

Improving public sector buildings

Decarbonising public sector buildings will demonstrate leadership, encouraging action in other sectors as well as making a direct contribution to Net Zero. We will therefore aim to reduce direct emissions from public sector buildings by 75% against a 2017 baseline by the end of carbon budget 6^{373,374}.

We want the public sector to lead the way in decarbonising our buildings in the 2020s by providing funding and demonstrating high standards with transparency and building capacity and capability.

Funding

The £1 billion [Public Sector Decarbonisation Scheme](#)³⁷⁵ was announced as part of the summer economic update and the [Plans for Jobs speech in July 2020](#)³⁷⁶, to provide funding across 2020/21 and 2021/22. The scheme is providing grants to decarbonise public sector buildings in England and reserved public services across the UK. In the 2020 Spending Review, further funding was allocated to public sector decarbonisation to make public buildings greener and the second phase of the Public Sector Decarbonisation Scheme was launched in April 2021 with £75 million funding for 2021/22. We are investing a further £1425 million for the Public Sector Decarbonisation Scheme over 2022/23 to 2024/25.

This funding will provide public sector organisations with grants to fund energy efficiency and heat decarbonisation measures, and supports the decarbonisation of the public sector in line with our Net Zero target.

The first phase of the scheme was launched on 30 September 2020, alongside a £32 million Public Sector [Low Carbon Skills Fund](#)³⁷⁷ available to all organisations eligible for the first phase of the Public Sector Decarbonisation Scheme. This provided funding to public sector organisations which lack the expert skills to develop and deliver decarbonisation projects and heat decarbonisation plans. The second phase of the Low Carbon Skills Fund was launched on the 21 July 2021 and is providing up to £15 million of funding in 2021/22.

Combined, the Public Sector Decarbonisation Scheme and Public Sector Low Carbon Skills Fund provide tangible benefits beyond delivering carbon savings by:

- supporting skilled jobs in the low-carbon and energy efficiency sectors
- helping develop the necessary supply chains to support the decarbonisation of commercial and industrial sectors

³⁷³Welsh Government has set the ambition for the public sector to be carbon neutral by 2030. Welsh Government Energy Service provides practical support, grants and loans, to public sector organisations and communities to help them develop energy efficiency and renewable energy schemes.

³⁷⁴ Scottish Government are committed to develop phased targets to help all public sector buildings to meet zero emission requirements between 2024 and 2036, as stated in their new policy programme (<https://www.gov.scot/publications/scottish-government-and-scottish-green-party-shared-policy-programme/>).

³⁷⁵ BEIS (2020), 'Public Sector Decarbonisation Scheme' (<https://www.gov.uk/government/publications/public-sector-decarbonisation-scheme-psds>).

³⁷⁶ HM Treasury (2020), 'A Plan for Jobs speech' (<https://www.gov.uk/government/speeches/a-plan-for-jobs-speech>).

³⁷⁷ BEIS (2020), 'Public Sector Low Carbon Skills Fund' (<https://www.gov.uk/government/publications/public-sector-low-carbon-skills-fund>).

- delivering energy efficiency and heat decarbonisation improvements to organisations (such as schools, hospitals and public sector offices)
- demonstrating the UK's global reputation as a world leader in the fight against climate change
- presenting an opportunity to build wider support and acceptance for transformation of how we heat our buildings

Building on the success of the Public Sector Decarbonisation Scheme, we will continue and extend the scheme to ensure that public sector bodies have access to finance to continue decarbonising their estates.

High standards with transparency

All public sector organisations should be thinking about how they will achieve Net Zero and should be taking steps to start this process now. As publicly-funded organisations, they should also be held accountable to the public by reporting their progress.

Government departments and their arms-length bodies already set and report against targets to reduce their greenhouse gas emissions in the [Greening Government Commitments](#)³⁷⁸ (GGCs). Government reduced its emissions by 46% in 2018/19 compared to 2009/10, meeting the target reduction of 43% one year ahead of the 2020 deadline.

We expect all public sector organisations to show leadership by taking steps to reduce direct greenhouse gas emissions. This should include:

- monitoring their energy use (recorded in their energy bills)
- making plans, including setting themselves targets, to reduce their emissions over the next five years

In particular, we expect public sector organisations to plan to reduce direct emissions from their heating systems by:

- insulating buildings better
- making buildings more energy efficient
- switching to low-carbon heating sources when it is time for heating systems to be replaced
- implementing smart technology
- installing low-carbon heating in new buildings, which means retrofitting will not be needed

Different targets will be appropriate for different organisations, but all public sector organisations should publicly report progress against their plans and targets. We plan to provide guidance to make clear the government's expectations in this regard.

³⁷⁸ DEFRA and Cabinet Office (2016) 'Greening Government Commitments' (<https://www.gov.uk/government/collections/greening-government-commitments>).

We will also legislate to enable us to require the reporting of public sector emissions on a consistent and coherent basis if this is not done on a voluntary basis, and, if insufficient progress is made on reducing emissions in the public sector, to require that all public sector organisations are working toward and reporting against a legally binding target to reduce their greenhouse gas emissions.

Support to increase capacity and capability

Public sector organisations will require specialist skills and expertise to decarbonise by making infrastructure improvements and by better managing operational energy use.

As well as the funding provided through the Public Sector Low Carbon Skills Fund, we will continue to work with partners across government and the wider public sector to understand their needs relating to decarbonisation capacity and capability.

Improving commercial and industrial places of work

Alongside the 25 million homes in England and Wales, there are around 1.5 million commercial and industrial buildings³⁷⁹ which account for around one-third of UK emissions from the total building stock.³⁸⁰

Reducing carbon emissions from these buildings will therefore be key to:

- meeting the 2017 [Clean Growth Strategy](#)³⁸¹ ambition to enable businesses to reduce energy use by at least 20% by 2030, which would save business £6 billion per year on energy bills
- achieving our Nationally Determined Contribution of a 68% reduction in greenhouse gas emissions (compared to 1990 levels) by 2030
- meeting our carbon budgets
- delivering Net Zero by 2050

Delivering Net Zero can allow businesses to make substantial savings on energy bills at a crucial time as the UK recovers from the disruption caused by COVID-19. It will also help to create safer and healthier working environments.

There is huge variety across the commercial and industrial building stock in terms of business size, building size (by floor area), use, and tenure. Our policy package respects this diversity and avoids a one-size-fits-all approach. We have developed an approach where regulatory frameworks are tailored to the size of the building and the businesses operating in that building, function and energy use of commercial and industrial buildings.

³⁷⁹ BEIS internal analysis of BEIS (2020), 'Non-domestic National Energy Efficiency Data-Framework (ND-NEED), 2020 (<https://www.gov.uk/government/statistics/non-domestic-national-energy-efficiency-data-framework-nd-need-2020>) based on 2018 data and BEIS (2016), 'Building Energy Efficiency Survey (BEES)' (<https://www.gov.uk/government/publications/building-energy-efficiency-survey-bees>).

³⁸⁰ CCC (2019), 'Net Zero Technical report' (<https://www.theccc.org.uk/wp-content/uploads/2019/05/Net-Zero-Technical-report-CCC.pdf>).

³⁸¹ BEIS (2017), 'Clean Growth Strategy' (<https://www.gov.uk/government/publications/clean-growth-strategy>).

The largest commercial and industrial buildings in England and Wales (those above 1,000m²) use more energy than all other commercial and industrial buildings combined, despite only accounting for around 7% of the stock.³⁸² The government has proposed to introduce a regulatory requirement for these buildings to obtain a performance-based energy rating based on measured energy data. This will ensure building users are aware of their energy use and where they are on their trajectory to becoming a Net Zero compatible building. The government intends to publish more details about the scheme in due course.

This performance-based approach is right for these buildings because it takes account of all the factors which influence building performance. This includes optimising the existing services and systems, behavioural changes, installing improved equipment or investing in the building's fabric efficiency or low-carbon heat. The proposal would require building owners and tenants to obtain and publicly disclose a rating on an annual basis.

For smaller commercial and industrial buildings, the picture is different, as these buildings use far less energy per building.³⁸³ Building owners and businesses should look to understand and optimise their energy performance, but there is not the same need for government regulation to ensure owners and businesses to measure, benchmark and disclose their annual energy use. Instead, the government's preferred approach through the 2020s is to set long-dated regulatory targets based on the EPC, which requires building owners to invest in the quality of their building's fabric and services. For the rented sector, we have confirmed an ambitious target of requiring landlords in the rented sector to improve their buildings to EPC band B by 2030, where cost-effective, and we are now looking into how best to enforce this target.³⁸⁴ For owner-occupied commercial and industrial buildings, the government is considering an equivalent long-dated regulatory target. We aim to consult on our approach to by the end of 2021.

Privately-rented commercial and industrial buildings

Between October 2019 and January 2020, the government consulted on introducing requirements for all rented buildings in England and Wales to meet EPC band B by 2030, where cost-effective.³⁸⁵ This will potentially save businesses around £1 billion per year in energy costs by 2030.

In the responses to that consultation, 91% of respondents were supportive of EPC band B and 86% agreed that 2030 was an appropriate date. However, respondents and evidence from a pilot study confirmed that there were significant implementation issues that needed to be addressed if the policy was going to be a success. A further consultation in March set out the

³⁸² Internal BEIS analysis of BEIS (2016), 'Building Energy Efficiency Survey (BEES)' (<https://www.gov.uk/government/publications/building-energy-efficiency-survey-bees>). Private buildings only. Excluding energy used for manufacturing and refining.

³⁸³ BEIS (2020), 'Non-domestic National Energy Efficiency Data-Framework (ND-NEED), 2020' (<https://www.gov.uk/government/statistics/non-domestic-national-energy-efficiency-data-framework-nd-need-2020>).

³⁸⁴ BEIS (2021), 'Non-domestic Private Rented Sector minimum energy efficiency standards: EPC B implementation' (<https://www.gov.uk/government/consultations/non-domestic-private-rented-sector-minimum-energy-efficiency-standards-epc-b-implementation>).

³⁸⁵ BEIS (2019), 'Non-domestic Private Rented Sector minimum energy efficiency standards: future trajectory to 2030' (<https://www.gov.uk/government/consultations/non-domestic-private-rented-sector-minimum-energy-efficiency-standards-future-trajectory-to-2030>).

Government's approach for improving the implementation and enforcement of the regulations – ensuring that the EPC band B target can be delivered in practice.³⁸⁶

Large and complex commercial and industrial buildings

In March 2021, we published a [consultation package on a proposed performance-based energy rating](#) that will become mandatory for some buildings larger than 1,000m² in the coming years.³⁸⁷ Large buildings account for 64% of energy consumed by non-domestic buildings in England and Wales.³⁸⁸ The consultation sets out the government's proposals to reduce carbon emissions in this portion of the building stock, by recognising and rewarding actual improvements in energy and carbon performance for the first time. The strategy paper proposes a phased roll-out, starting with commercial offices in England and Wales.

The government's proposal is to use the performance-based approach to set sector-by-sector energy reduction targets which will be in line with the reductions required to meet our carbon budgets. Progress against these targets will be tracked on an annual basis. By structuring the policy in this way, we can provide building owners and businesses with visibility over the rate of progress that will be required out to 2050 to make a building compatible with Net Zero. The government aims to identify appropriate sector-level targets when ratings are rolled out to other commercial and industrial sectors and building types, subject to further sector-specific consultations.

Improving the measured energy performance of large buildings will be a key contribution to the UK meeting its long-term climate targets. At the same time, large buildings need to take steps to decarbonise their heat sources through the 2020s. The performance-based framework will work alongside proposals to prohibit new fossil fuel installations in large commercial and industrial buildings which are not connected to the gas grid.

If your business operates in a building over 1,000m², our proposed performance-based energy rating will recognise measured reductions in actual energy use and carbon emissions.

Smaller buildings and businesses

Smaller private owner-occupied buildings under 1,000m² account for 17% of all the energy used by commercial and industrial buildings in England and Wales.³⁸⁹ BEIS is considering policy approaches to this segment of the non-domestic building stock, including whether to adopt minimum energy efficiency standards similar to the private-rented sector approach. We are aiming to consult on owner-occupied buildings by the end of 2021.

SMEs can significantly benefit from improving the energy performance of their buildings by reducing energy bills and improving their bottom-line competitiveness. However, the barriers to

³⁸⁶ BEIS (2021), 'Non-domestic Private Rented Sector minimum energy efficiency standards: EPC B implementation' (<https://www.gov.uk/government/consultations/non-domestic-private-rented-sector-minimum-energy-efficiency-standards-epc-b-implementation>).

³⁸⁷ BEIS (2021), 'Introducing a performance-based policy framework in large commercial and industrial buildings' (<https://www.gov.uk/government/consultations/introducing-a-performance-based-policy-framework-in-large-commercial-and-industrial-buildings>).

³⁸⁸ BEIS (2016), 'Building Energy Efficiency Survey (BEES)' (<https://www.gov.uk/government/publications/building-energy-efficiency-survey-bees>).

³⁸⁹ BEIS internal analysis of BEIS (2016), 'Building Energy Efficiency Survey (BEES)' (<https://www.gov.uk/government/publications/building-energy-efficiency-survey-bees>). Private buildings only.

decarbonisation are particularly high (for example, they may struggle to invest due to high capital costs). Therefore, we believe targeted support is vital to drive the scale and pace of improvements required.

We plan to provide targeted support to improve the energy efficiency of SME sector buildings. As part of the Spring Statement 2019 we published a [call for evidence on a new Business Energy Efficiency Scheme for SMEs](#)³⁹⁰. A summary of responses from this consultation was published in June 2020. We have commissioned further research to inform policy development.

We have been exploring new business models to stimulate the SME energy efficiency market through [the Boosting Access for SMEs to Energy Efficiency competition](#)³⁹¹. The competition, now closed, offered up to £6 million of funding for innovative solutions that encouraged the uptake of energy efficiency by SMEs.

If you are a small or medium-sized business, we plan to provide support to help your buildings become more energy efficient and adopt low-carbon heat.

Large businesses

The UK-wide [Energy Savings Opportunity Scheme](#)³⁹² (ESOS) currently requires large businesses to measure their total energy consumption every four years and to carry out an audit covering energy use from buildings, transport and industrial processes. It recommends practicable and cost-effective energy efficiency measures to ensure that businesses have tailored information on the opportunities for saving energy in their buildings. These recommendations can include both investing in building improvements and other measures to use energy more effectively (such as investing in better controls or training staff to change behaviour). ESOS reports can be used by businesses to identify how they can make savings that will improve their performance-based rating.

In July 2021, we published [a consultation on strengthening ESOS](#)³⁹³, looking to:

- increase the number of participants that take action to reduce energy use by raising the quality of their ESOS audit
- increase the carbon and cost savings from ESOS by increasing the number and scope of recommendations taken up by participants
- ensure that recommendations are consistent with the UK's Net Zero commitments

³⁹⁰ BEIS (2019), 'Energy efficiency scheme for small and medium sized businesses: call for evidence' (<https://www.gov.uk/government/consultations/energy-efficiency-scheme-for-small-and-medium-sized-businesses-call-for-evidence>).

³⁹¹ BEIS (2020), 'Boosting access for SMEs to energy efficiency (BASEE) competition: winning projects' (<https://www.gov.uk/government/publications/boosting-access-for-smes-to-energy-efficiency-basee-competition-winning-projects>).

³⁹² BEIS and Environment Agency (2014) 'Energy Savings Opportunity Scheme (ESOS)' (<https://www.gov.uk/guidance/energy-savings-opportunity-scheme-esos>).

³⁹³ BEIS (2021), 'Strengthening the Energy Savings Opportunity Scheme (ESOS)' (<https://www.gov.uk/government/consultations/strengthening-the-energy-savings-opportunity-scheme-esos>).

In 2019 we introduced [Streamlined Energy and Carbon Reporting](#)³⁹⁴ that requires large businesses to report annually on their energy use and carbon emissions within their company reporting. This mandatory obligation now falls on all large or quoted companies and large limited liability partnerships incorporated in the UK – increasing the coverage from an estimated 1,200 quoted companies who were previously required to report on greenhouse gas emissions to a new total of 11,900 organisations.³⁹⁵ This will increase transparency around emissions from non-domestic buildings and how this is managed by businesses. The reporting requirement applies to reports for financial years starting on or after 1 April 2019.

³⁹⁴ BEIS (2017), 'Streamlined energy and carbon reporting' (<https://www.gov.uk/government/consultations/streamlined-energy-and-carbon-reporting>).

³⁹⁵ BEIS (2017) 'Streamlined energy and carbon reporting' (<https://www.gov.uk/government/consultations/streamlined-energy-and-carbon-reporting>).

Figure 14: Illustrative timeline affecting different types of building



Figure 14 provides an illustrative diagram of some of the policies and regulations to be delivered over the next decade to address different types of buildings, according to BEIS' current thinking.

5.3. Kickstarting the transition to low-carbon heat

The transition to low-carbon heat will be a gradual one, starting with building markets, improving technology and driving down costs. We will use of natural replacement cycles and trigger points we need to set long-term signals to build markets now.

- *For on-gas-grid buildings, this means:*
 - *setting the long-term ambition to phase out installation of new natural gas boilers from 2035, once the cost of low-carbon alternatives has come down*
 - *building markets for low-carbon sources of heat, including heat pumps and heat networks*
 - *consulting on the case for gas boilers to be hydrogen-ready by 2026 and improving the efficiency of gas boilers in the near term*
 - *decarbonising the gas grid through biomethane injection*
- *For off-gas-grid buildings, we propose phasing out the installation of new fossil fuel heating systems and switching to low-carbon alternatives from 2026 (2024 for non-domestic properties)*
- *We are introducing measures to continue testing and researching, build low-carbon markets, and make these technologies more accessible and affordable for consumers by:*
 - *investing in innovation of heat pumps – making them smaller, easier to install, beautifully designed and lower cost*
 - *increasing deployment of low-carbon heat networks using the Heat Networks Delivery Unit, Heat Networks Investment Project, Green Heat Network Fund and by employing a zoning approach*
 - *exploring the role of hydrogen for heating buildings through neighbourhood and village trials, with strategic decisions on its role taken in 2026*

Improving buildings' energy efficiency alone will not be enough to deliver Net Zero. We must also replace carbon-emitting fossil fuel heating systems with alternative low-carbon heating. Much like the transition to electric vehicles, this will be a gradual transition, led by incentivising consumers and reducing costs first.

We are setting the ambition that, from 2035 new heating system installations should be low-carbon or hydrogen-ready (in areas where we know there will be future hydrogen supply) so we keep pace with the natural replacement cycles of heating systems throughout the late 2030s and 2040s and minimise disruption and costs to householders and building owners. By this time, costs should be low – we anticipate cost reductions of at least 25-50% by 2025 and towards parity with boilers by 2030 as the market grows. Alongside action on fuel price distortions we anticipate heat pumps will be no more expensive to buy and run than fossil fuel boilers. We therefore need to set long-sighted plans for the next decade to increase consumer

take-up and confidence, and prepare markets, bringing down costs and improving consumer appeal, so technologies can be deployed at a large-scale in the 2030s and 2040s.

Currently 1.7 million fossil fuel boilers are installed per year (natural gas, oil and coal).³⁹⁶ Therefore, the low-carbon heating supply chain will need to grow considerably to be capable of matching this capacity and rate of deployment. Our Net Zero technology balance will be determined through evidence gathered and decisions made by 2026. Over the coming years, we need to continue to develop heat pump, heat network, and hydrogen-compatible markets – ensuring that we have the best possible choices.

We have consulted on proposals for a new £450 million Boiler Upgrade Scheme³⁹⁷ (previously named the Clean Heat Grant) from 2022, to support the installation of low-carbon heating systems following the closure of the Domestic Renewable Heat Incentive. This will provide upfront capital grants of £5,000 to households and small businesses looking to install heat pumps and, in some limited circumstances, biomass boilers. By helping grow low-carbon heat supply chains and driving cost reductions across the market, the scheme will keep us on track to deliver Net Zero and will enable the introduction of planned regulatory and market-based policies. We intend to limit our support for new gas heating systems and remove support for new LPG and oil heating systems from 2022, only supporting fuel poor households with new fossil fuel-based heating systems under very limited circumstances.

Phasing out unabated fossil fuels

Off-gas-grid

In the consultations published in parallel to this document^{398,399}, we set out our proposals to phase out the installation of new fossil fuel heating systems in buildings not connected to the gas grid (off-gas-grid) in England. Addressing off-gas-grid homes will enable us to start to decarbonise 1.1 million high-carbon fossil fuel heated buildings in England⁴⁰⁰, and provide up to 8 MtCO_{2e} of carbon savings⁴⁰¹ over carbon budget 5 (2028 to 2032). This will mainly happen through the shift from high-carbon fossil fuels (such as oil and LPG) to electric heating with heat pumps.

We propose to introduce regulation to ensure new fossil fuel heating installations in England are phased out in line with the natural appliance replacement cycle. We plan to introduce regulation to address large off-gas-grid non-domestic buildings (over 1,000m²) no earlier than 2024, followed by small and medium non-domestic buildings and all homes from 2026. We are keen to hear views on this approach, and in particular whether there are sectors or building types with specific needs that should be taken into account, for example, heritage buildings or

³⁹⁶ BSRIA (2020), 'Domestic Boiler Market Analysis – United Kingdom' (<https://www.bsria.com/uk/>).

³⁹⁷ BEIS (2020), 'Future support for low carbon heat' (<https://www.gov.uk/government/consultations/future-support-for-low-carbon-heat>).

³⁹⁸ BEIS (2021), 'Phasing out fossil fuel heating in homes off the gas grid' (<https://www.gov.uk/government/consultations/phasing-out-fossil-fuel-heating-in-homes-off-the-gas-grid>).

³⁹⁹ BEIS (2021), 'Phasing out fossil fuel heating systems in businesses off the gas grid' (<https://www.gov.uk/government/consultations/phasing-out-fossil-fuel-heating-systems-in-businesses-and-public-buildings-off-the-gas-grid>).

⁴⁰⁰ DLUHC (2020), 'English Housing Survey 2018: energy report' (<https://www.gov.uk/government/statistics/english-housing-survey-2018-energy-report>).

⁴⁰¹ According to BEIS internal analysis.

those occupied by voluntary sector organisations. These off-gas-grid regulations will be supported by number of policy levers to enable the transition.

We expect most off-gas-grid buildings will be able to transition to a low-carbon heat pump. BEIS analysis shows that around 80% of fossil fuel heated off-gas-grid homes in England have sufficient energy efficiency and internal fuse limit electrical connections to accommodate a low temperature heat pump system.⁴⁰² Other homes may require further upgrades to operate low temperature heat pumps to meet thermal comfort. Where low temperature heat pumps cannot be reasonably practicably accommodated subject to minor energy efficiency measures, other low-carbon heating options (such as solid biomass boilers, high temperature heat pumps, and potentially liquid biofuels) may offer an alternative.

We are offering support to those buildings transitioning to low-carbon heating. These supporting activities are detailed in [Annex: Current and planned activities for the 2020s](#)⁴⁰³ and include financial support to those unable to pay (through the Local Authority Delivery scheme, Home Upgrade Grant, ECO, Social Housing Decarbonisation Fund and the Public Sector Decarbonisation Scheme), and for the installation of low-carbon heating in all homes (through the Boiler Upgrade Scheme).

We will continue to work on the wider enabling framework, ensuring the cost of transformational change is fair as we move forwards, and off-gas-grid buildings are upgraded to low-carbon heating systems as part of their natural replacement cycle.

We are providing significant support to help off-gas-grid buildings decarbonise their heating.

On-gas-grid

We will take decisions on the use of hydrogen for heating in 2026, following neighbourhood and village trials. While we do this, there are a number of low-regrets actions we can take:

1. **Setting long-term direction:** Signalling our ambition that from 2035, once costs of low-carbon alternatives have come down, we will phase out the installation of new natural gas boilers.
2. **Supporting early adopters:** For households and businesses who are keen to make the switch to low-carbon heating, we are providing £5,000 grants to help overcome the current cost differential between heat pumps and boilers, through our £450 million Boiler Upgrade Scheme.
3. **Ending new connections to the gas grid:** We will be publishing a consultation on ending new connections to the gas grid for new-build domestic properties in England by 2025. This is supported by our policy paper on [Sustainable warmth: protecting vulnerable households in England](#)⁴⁰⁴, published February 2021, which stated our intention to limit support for new gas heating systems from 2022. This will prevent us

⁴⁰² BEIS internal analysis based on BEIS (2017), 'National Household Model' (<https://data.gov.uk/dataset/957eadbe-43b6-4d8d-b931-8594cb346ecd/national-household-model>).

⁴⁰³ The geographical extent of these schemes is listed in [Annex: Current and planned activities for the 2020s](#). Equivalent schemes may be available in Wales, Scotland or Northern Ireland.

⁴⁰⁴ BEIS (2021), 'Sustainable warmth: protecting vulnerable households in England' (<https://www.gov.uk/government/publications/sustainable-warmth-protecting-vulnerable-households-in-england>).

from expanding our reliance on natural gas and fossil fuels, and is compatible with Net Zero.

- 4. Improving the efficiency of new boilers:** We will continue to improve the efficiency of new and existing boilers, through the promotion of smart controls and system management, and explore options to strengthen and extend the Boiler Plus standards. Boiler Plus measures for combination boilers (such as smart controls and weather compensators) further raise the standard of domestic boiler installations, reducing carbon emissions and making it cheaper to heat homes. We recently published an [initial review of the Boiler Plus standards](#).⁴⁰⁵ This, along with the findings from our recent [call for evidence on energy-related products](#)⁴⁰⁶, will help us determine if there is more that can be done to improve efficiency and drive additional carbon savings. An important element of this work will be supporting the continued development of behaviours and technologies which support achievement of greater comfort, efficiency, and carbon savings in natural gas systems, but which also pave the way for efficient operation for low-carbon heating systems. We will look to test proposals on future boiler and heating system efficiency through our consultation that considers the case for hydrogen-ready boilers, which we are aiming to publish shortly.
- 5. Greening the gas in the grid:** While we are looking to end new gas grid connections in England, new gas boilers will continue to be installed on the existing gas grid well beyond that point. For those already connected to the gas grid, we are exploring how best to improve efficiency and replace the current supply with alternative low-carbon fuels (biomethane and hydrogen) to reduce natural gas demand. This is why we have committed to enabling the blending of hydrogen in the gas grid (up to 20% volume) and continuing to support the deployment of biomethane through the Green Gas Support Scheme.

Biomethane injection



Biomethane injection from anaerobic digestion is currently supported by the Non-Domestic Renewable Heat Incentive and will receive future support under the Green Gas Support Scheme for Great Britain, which is expected to run from November 2021 for 4 years for new applicates. The primary objective for this policy is to increase the proportion of green gas in the grid, which will in turn reduce gas-grid-related emissions through providing a greener source of natural gas. The funds will be raised by the Green Gas Levy, which is also expected to launch in November 2021 – with the first levy payment from gas suppliers being collected in April 2022. This support for the biomethane sector will lead to carbon savings of up to 3.7 MtCO₂e over carbon budgets 4 and 5 and 8.2 MtCO₂e over the lifetime of the scheme.⁴⁰⁷ It will also help to boost green jobs by maintaining and building growth in the biomethane industry at a time when economic recovery will be very important.

Unlocking the potential of hydrogen for heating

⁴⁰⁵ BEIS (2021), 'Boiler Plus: initial policy review' (<https://www.gov.uk/government/publications/boiler-plus-initial-policy-review>).

⁴⁰⁶ BEIS (2020), 'Energy-related products: call for evidence' (<https://www.gov.uk/government/consultations/energy-related-products-call-for-evidence>).

⁴⁰⁷ Assuming that the scheme would be open for four years, and the tariff payments would be for 15 years.



We will work in partnership with industry to test and evaluate the potential of hydrogen as an option for heating our homes and workplaces. This will include ensuring that we clearly define the evidence needed to make a policy decision about the role hydrogen for heating can play in our future energy system.

We are supporting the gas industry to deliver core research and development projects, such as developing new appliances and testing conversion of the gas grid including through community trials. Further detail is included in section [4.3 Research and innovation](#). This work will allow us to evaluate the technical and practical feasibility of using hydrogen instead of natural gas for heating and provide an assessment of the expected costs, benefits and impacts, and practical delivery implications.

In advance of our strategic decision in 2026 on the role of hydrogen in heating buildings, we aim to consult on enabling, or requiring, new gas boilers to be readily convertible to hydrogen ('hydrogen-ready') by 2026 to prepare homes for a potential hydrogen conversion. We will also use this consultation to test proposals on the future of broader boiler and heating system efficiency and explore the best ways to reduce carbon emissions from our heating systems over the next decade.

We will continue to work with industry to test and evaluate the potential role for hydrogen in heating our buildings and will take strategic decisions in 2026.

Building a market for heat pumps



Hydronic heat pumps are the only currently proven scalable low-carbon heat technology. Therefore, we need to take action now to build a market for them, and to prepare buildings for their installation. Heat pumps will be a key technology for many buildings, including:

- properties not connected to the gas grid
- new-builds (following the launch of the Future Homes and Future Buildings Standards from 2025)
- properties that do not have an opportunity to connect to a local heat network
- consumers that may prefer to install a heat pump over other low-carbon alternatives (for example, as part of broader improvements to create a 'smart home')

Even in a scenario where hydrogen is the predominant heat source for the UK, the CCC estimate that around 13 million heat pumps (including hybrid heat pumps) would be used in homes by 2050.⁴⁰⁸

We acknowledge the recommendations provided by many stakeholders to increase our deployment of heat pumps:

⁴⁰⁸ CCC (2020), 'Sixth Carbon Budget' (<https://www.theccc.org.uk/publication/sixth-carbon-budget/>).

- Centrica, PwC and Energy UK state that we should have 1 million low-carbon heating systems by 2025⁴⁰⁹, many of which will be heat pumps
- The CBI⁴¹⁰ have advised that we aim to deploy 1 million heat pump installations a year by 2025
- the CCC advised that we aim to install 1 million heat pumps per year in homes by 2030⁴¹¹
- E3G have advised installing 10 million heat pumps in total by 2030⁴¹²

We believe that in all future heat scenarios, 600,000 hydronic heat pump installations per year is the minimum market size that will be required by 2028 to be on track to deliver Net Zero. As part of this, we will aim for cost parity between heat pumps and gas boilers by 2030 with significant cost reductions of at least 25-50% by 2025 and ensuring heat pumps are no more expensive to buy and run than boilers by 2030.

It may ultimately prove desirable to pursue greater levels of heat pump deployment. For example, if limited low-carbon hydrogen is used for heating, we would need to further grow the heat pump market to install up to 1.7 million heat pumps per year by the mid-2030s if we wish to switch over remaining gas boilers by 2050 through natural replacement cycles. However, we have set our minimum market capacity target at 600,000 heat pump per annum to ensure that deployment is low-regrets and offers a cost-effective route to decarbonisation. In 2023 we will look to review and consult on our approach to heat pump deployment; on whether and how this should be accelerated beyond the 2028 target of 600,000 per year.

We expect this ambition to be met through deployment over a range of different segments of the building stock. The majority of the additional deployment is likely to be retrofits into existing on- and off-gas-grid homes, with a significant but smaller contribution of about 200,000 annual heat pump installations in new homes from 2028.

We want manufacturers to scale-up UK production to help meet UK demand. We know that supply chains can expand rapidly to meet this demand, with the support of a range of policy measures. In line with forecasts of UK manufacturing capability in the [Heat Pump Manufacturing Supply Chain Research Project Report](#)⁴¹³ (published in December 2020), we are aiming for a 30-fold increase in heat pumps manufactured and sold within the UK by the end of the decade, while also growing our heat pump exports. In the early part of the decade, subsidy measures (such as the Boiler Upgrade Scheme) will be essential to building supply chain capacity ahead of the introduction of regulation for new and off-gas-grid buildings. To support a transition to a market-led approach, we also propose the introduction of a market-

⁴⁰⁹ Centrica, PwC and Energy UK (2020), 'Rebuilding the UK economy' (<https://www.energy-uk.org.uk/our-work/pwc-and-energy-uk-rebuilding-the-uk-economy.html>).

⁴¹⁰ CBI (2020), 'Net Zero: the road to low-carbon heat' (<https://www.cbi.org.uk/articles/net-zero-the-road-to-low-carbon-heat/>).

⁴¹¹ CCC (2020), 'Sixth Carbon Budget' (<https://www.theccc.org.uk/publication/sixth-carbon-budget/>).

⁴¹² E3G (2020), 'Getting on Track to Net Zero: Ten million heat pumps for homes by 2030' (<https://www.e3g.org/publications/getting-on-track-to-net-zero/>).

⁴¹³ BEIS (2020), 'Heat pump manufacturing supply chain research project' (<https://www.gov.uk/government/publications/heat-pump-manufacturing-supply-chain-research-project>).

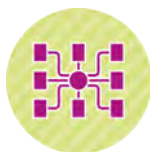
based mechanism⁴¹⁴ to put industry at the heart of efforts to develop heat pump supply chains and transform the consumer proposition for heat pumps in the UK. This market obligation will provide a stretching but clear direction of travel for industry, and a framework of incentives to encourage investment in expanding the market for low-carbon heat. It will do so while keeping the choice to install a heat pump voluntary to consumers.

As set out in the consultation published alongside this strategy⁴¹⁵, we are proposing an obligation for fossil fuel boiler manufacturers to achieve heat pump sales in line with the trajectory of market growth needed to put us on a path for 2050 and our ambition for 600,000 installations per year by 2028. This would operate similarly to tradable market-based mechanisms in other sectors, for instance ‘fleet-wide’ obligations on car manufacturers to increase the proportion of sales of lower-emission vehicles. The proposal will not only ensure we are on track to achieve our longer-term targets and deliver carbon savings, but will provide industry with the incentive and confidence to invest in heat pumps, so that the choice to switch to a heat pump becomes easier, more attractive and more affordable.

Against this strategic and policy context, we would expect to see industry take a wide range of steps, including to:

- innovate with products and processes to broaden the consumer appeal of heat pumps and make it easier for consumers to make the switch
- expand consumer marketing and the range of ways they reach consumers
- develop partnerships across the wider marketplace, for instance on service-based or green finance offers available for heat pump consumers
- build the awareness of and skills for heat pumps among heating installers throughout the UK
- explore how to address barriers to and deployment of heat pumps that use alternative refrigerants to HFCs

Transforming the market for heat networks



Heat networks have the advantage of being compatible with a range of heat sources, including heat pumps and hydrogen. Particularly when electrifying heat, networks have benefits over individual building-scale solutions, including:

- unlocking heat sources which result in higher performance compared to individual solutions (for example by using larger water source heat pumps operating at higher efficiencies)
- reducing peak energy loads by using thermal energy storage

⁴¹⁴ BEIS (2021), ‘Market-based mechanism for low carbon heat’ (<https://www.gov.uk/government/consultations/market-based-mechanism-for-low-carbon-heat>).

⁴¹⁵ BEIS (2021), ‘Market-based mechanism for low carbon heat’ (<https://www.gov.uk/government/consultations/market-based-mechanism-for-low-carbon-heat>).

In their Net Zero modelling, the CCC showed that 18% of the UK's heat supply will need to come from heat networks by 2050, an increase from the current figure of 3%.⁴¹⁶ Therefore, we must accelerate the deployment of these systems in the 2020s. We will continue to provide financial support for:

- identifying and developing project opportunities through the Heat Networks Development Unit
- the roll-out of heat networks by supplying gap funding for schemes through the Heat Networks Investment Project
- very low-carbon heat sources, such as heat pumps and waste-heat recovery through the [Green Heat Network Fund](#)⁴¹⁷
- improving the performance of existing poor-performing heat networks through the Heat Network Efficiency Scheme

This is part of a broader Heat Network Transformation Programme, in which we are investing £338 million (over 2022/23 to 2024/25), designed to create the market conditions in the first half of the 2020s by helping to overcome barriers to heat network market entry, providing an environment for regulation and market mechanisms to successfully support increased deployment in the second half of the 2020s and into the 2030s.

Regulation will be core to the transformation of the heat network market, and we intend to introduce Heat Networks Regulation as soon as possible. The regulations will:

- introduce consumer standards
- give equivalent statutory rights for heat networks as other utilities
- enable carbon emissions limits to be set on the market

It is intended that the Heat Networks Market Framework will introduce maximum CO₂ emission limits for district heating by the early 2030s at the latest. These will be set so that heat networks swap gas generation for other low-carbon options.

We will also help the transition by regularly reviewing the contributions of different technologies. For example, gas combined heat and power (CHP) has previously been one of the most viable heat sources for heat networks as a result of the heat and electricity generation revenue streams. However, as the electricity network decarbonises the emission saving benefits of this technology are declining. Therefore, we conducted a consultation on new emissions factors for gas CHP in the [Standard Assessment Procedure \(SAP\)](#)⁴¹⁸, published [a](#)

⁴¹⁶ BEIS internal analysis of BEIS (2018), 'Energy Trends: March 2018, special feature article - Experimental statistics on heat networks' (<https://www.gov.uk/government/publications/energy-trends-march-2018-special-feature-article-experimental-statistics-on-heat-networks>). Total UK heat demand in 2017 derived from BEIS (2019) 'Energy Consumption in the UK 2020' (<https://www.gov.uk/government/statistics/energy-consumption-in-the-uk>).

⁴¹⁷ BEIS (2020), 'Green Heat Network Fund: proposals for the scheme design' (<https://www.gov.uk/government/consultations/green-heat-network-fund-proposals-for-the-scheme-design>).

⁴¹⁸ BEIS (2021), 'Standard Assessment Procedure (SAP 10.2): proposals for updates for heat networks' (<https://www.gov.uk/government/consultations/standard-assessment-procedure-sap-102-proposals-for-updates-for-heat-networks>).

[call for evidence on future CHP policy and the role of CHP in our path to Net Zero](#)⁴¹⁹ (which closed in September 2020). This was followed by a further [call for evidence on decarbonisation pathways for CHP operators](#)⁴²⁰, which is open to 20 December 2021.

Through the Heat Network Transformation Programme, we will continue to grow the market for low-carbon heat networks through the 2020s and provide financial support through the Green Heat Network Fund, combined with heat network zoning in the latter half of the decade.

We are currently consulting on proposals to provide local authorities in England with powers to put in place heat network zones, within which certain buildings will be required to connect to heat networks.⁴²¹ This zoning will provide the market with a level of certainty that the demand for heat networks will be there to support investment decisions and growth in the market.

Heat network zoning

We consider zoning to be a solution for supporting the development of existing and new heat networks in the 2020s. We are proposing the introduction of heat network zones in England by 2025,⁴²² providing local authorities with the powers to identify and designate areas best suited for heat networks as the lowest cost, low-carbon solution. Given the diversity of local authorities we recognise that a one-size-fits-all is not appropriate and intend to ensure a flexible approach regarding the level of support and split of functions between central and local government (and industry), to ensure the most appropriate approach can be taken in each locality. Heat network zoning builds on the work the Heat Networks Delivery Unit has been doing since 2013 with local authorities to identify and develop heat network opportunities and we are already piloting how zoning could work through our City Decarbonisation Delivery Programme⁴²³.

Heat network zoning will help drive demand for heat network connection and grow the market by requiring certain buildings in heat network zones to connect to networks, where it is cost-effective to do so. Providing certainty that some types of building within a heat network zone will connect to the network and use the heat provided will give project sponsors and investors greater assurance which helps support delivery of viable, large-scale heat networks. This also helps drive the pace of deployment while reducing cost and enabling new investment models. Giving local authorities the powers to require buildings within heat network zones to connect to the network would help households and businesses to plan for their transition to Net Zero. It would also provide investment certainty to heat network developers and local authorities.

⁴¹⁹ BEIS (2020), 'Combined Heat and Power (CHP): the route to 2050 - call for evidence' (<https://www.gov.uk/government/consultations/combined-heat-and-power-chp-the-route-to-2050-call-for-evidence>).

⁴²⁰ BEIS (2021), 'Combined heat and power: pathway to decarbonisation call for evidence' (<https://www.gov.uk/government/consultations/combined-heat-and-power-pathway-to-decarbonisation-call-for-evidence>).

⁴²¹ BEIS (2021), 'Proposals for heat network zoning' (<https://www.gov.uk/government/consultations/proposals-for-heat-network-zoning>).

⁴²² Scotland recently enacted proposals on zoning in the 'Heat Networks (Scotland) Act 2021'. See: <https://www.legislation.gov.uk/asp/2021/9/contents/enacted>.

⁴²³ BEIS have worked with six cities (Bristol, Birmingham, Greater Manchester, Leeds, Newcastle and Nottingham) to pilot the identification of potential heat network zones. Whilst we are planning further, more detailed pilots this work has informed the approach outlined in our recent consultation, particularly in relation to the methodology and the data likely to be required in the identification and designation of potential zones.

We propose that within heat network zones, large public sector buildings, large non-domestic buildings, all new-builds and residential buildings which are already heated via communal systems (such as tower blocks) should be required to connect to the heat network within a given timeframe. We also propose that buildings could apply for an exemption from the requirement to connect, in order to avoid suboptimal outcomes – for example, where a low-carbon heating system is already installed. Many of these building types align with the buildings that are best equipped in 2020s for the transition, including public sector buildings, new-builds, social housing and large commercial and industrial buildings.

Starting the natural transition of these buildings in the 2020s will support the action needed to save emissions and grow the low-carbon heating markets ready for wholesale transition in the 2030s and 2040s.

Zoning can also support the wholesale move to low-carbon heating alongside the wider framework of regulation and enablers which will drive the transition. Zoning has the potential to play a valuable role beyond the 2020s, when we start to transition all buildings on the gas grid to low-carbon heat. Zoning may provide some flexibility in timings up to 2050, potentially allowing buildings to delay their low-carbon heating transition so that they can connect to new infrastructure as it becomes available.

While the objective of heat network zoning is to identify areas most appropriate for heat network deployment, it will also help highlight areas where other low-carbon solutions may be more appropriate. This knowledge could help inform our longer-term strategic decisions on the most appropriate, cost-effective solutions to decarbonising heat across the country.

Figure 15: Indicative heat network zoning output

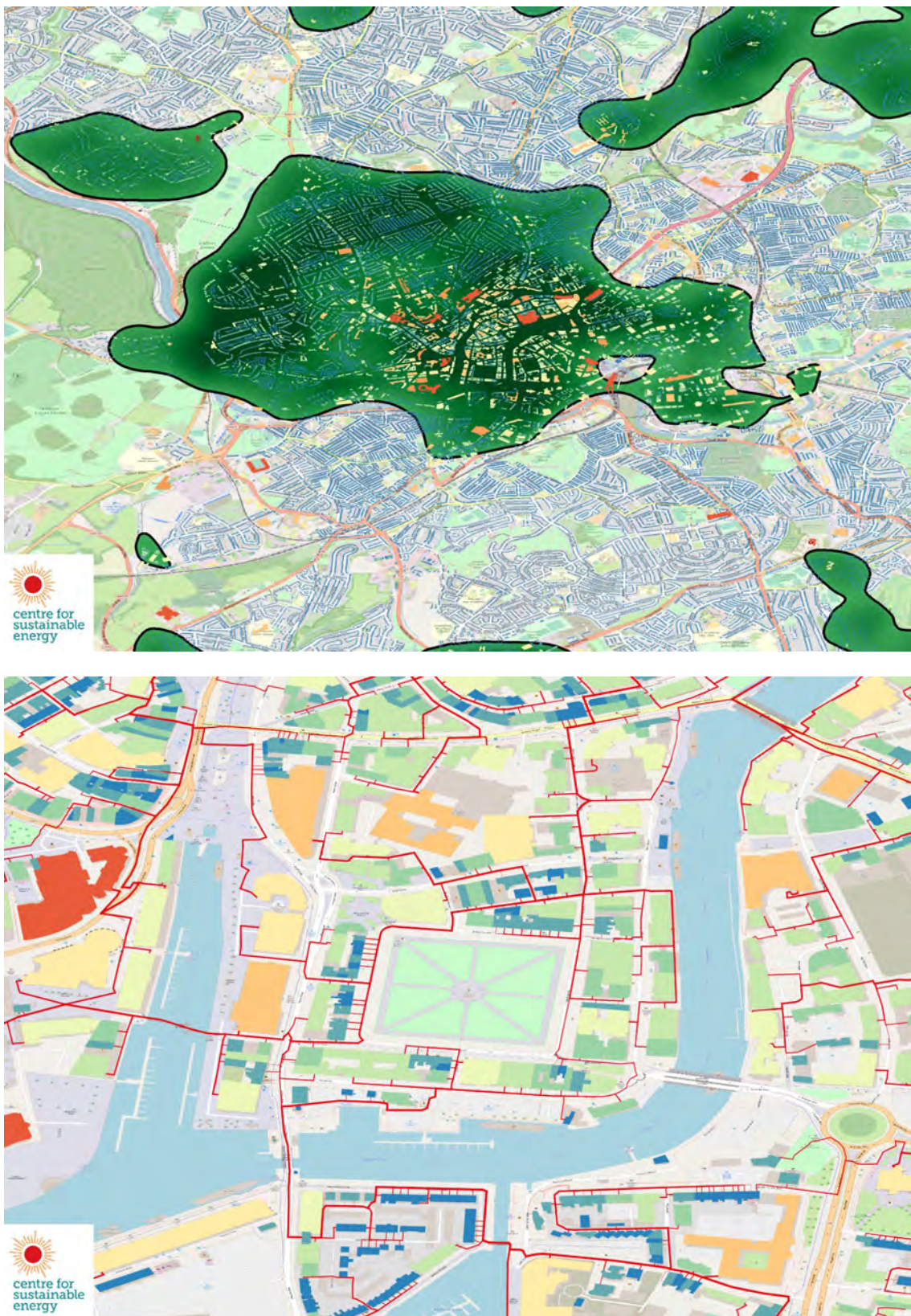


Figure 15 is an indicative heat zoning output undertaken on behalf of Bristol City Council. The green zones reflect areas of the city where heat networks are theoretically the lowest-cost option to achieve heat decarbonisation based on current parameters and assumptions.

Figure 16: Illustrative timeline for different sources of heat

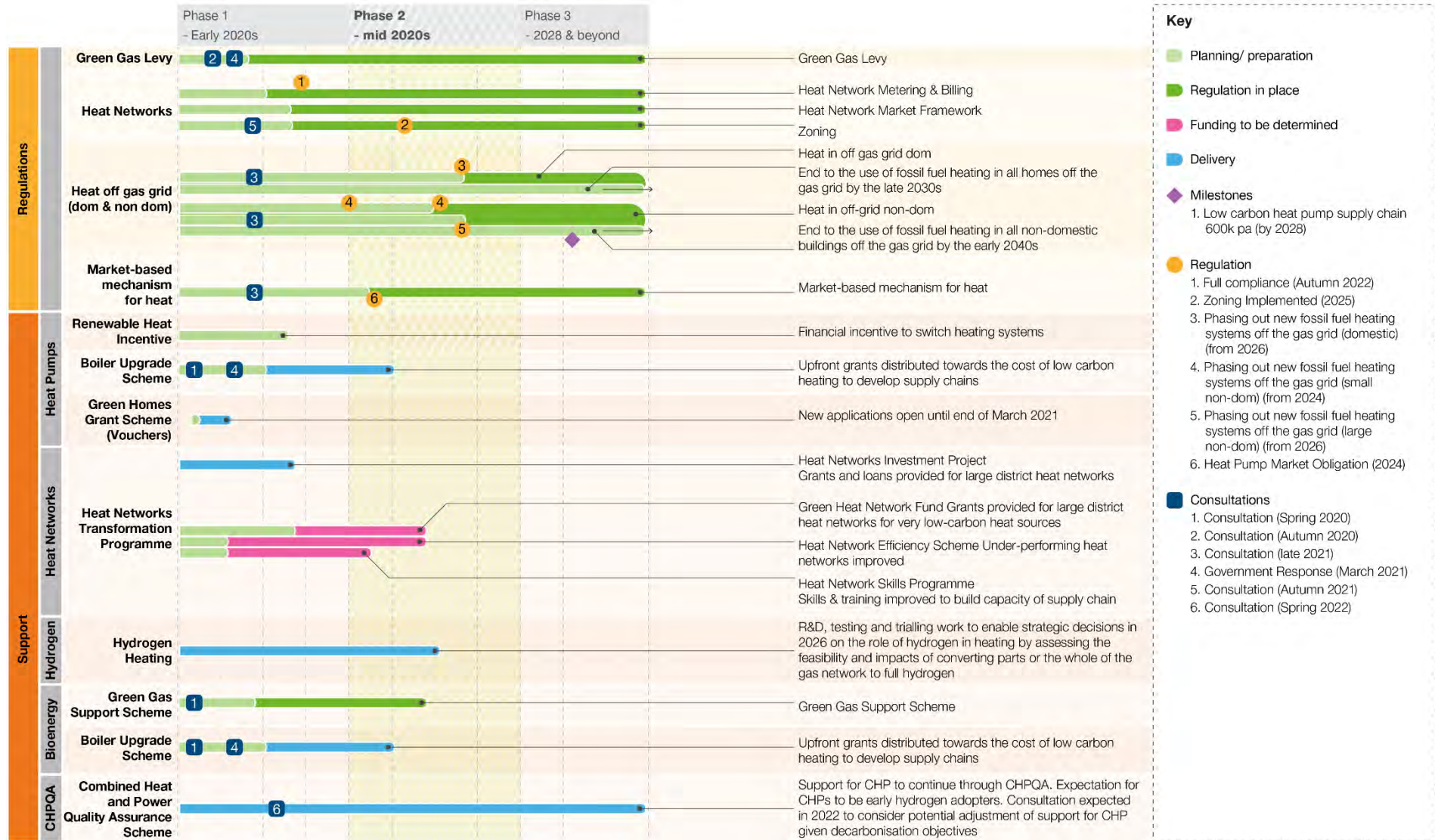


Figure 16 provides an illustrative diagram of some of the policies and regulations to be delivered over the next decade, across a range of heat sources and technologies, according to BEIS' current thinking.

Chapter 6: Creating the conditions for change

To be most effective, clear regulatory drivers and market-based approaches need to be accompanied by a cross-cutting framework for transformation which ensures that measures are accessible and affordable, that consumers have confidence in choosing and deploying these measures, and that we use lessons learned to remain on track for Net Zero.

Therefore, we need a comprehensive strategy for:

- *cost distribution – which ensures costs are distributed fairly in a way that incentivises positive action to decarbonise*
- *green finance – which ensures that those less able to pay are supported by relevant funding and financing measures*
- *consumer protection – which provides consumers with the confidence that the measures they choose to install deliver the expected results*
- *public engagement – which equips the public to make decisions best suited to their building and heating needs*
- *monitoring and evaluation – which uses evidence and feedback to inform our ongoing policy development*

Government will target support to enable action for those in most need.

We recognise the challenge faced by businesses and consumers in recovering from the impacts of the COVID-19 pandemic, and we want to make sure that our policies support those who are hardest hit, such as small businesses and the fuel poor. We intend to provide more direct support at earlier stages of the transition, while growing the green finance sector to improve affordability and generate self-supporting markets in the longer term. We will also use taxpayer money efficiently to transform public sector buildings. We will build on the support and consumer protection available to ensure that measures are accessible and affordable, and that individuals have the confidence to take steps to decarbonise their home and place of work.

6.1. Cost distribution and fuel prices

We want to ensure a smart, energy efficient, low-carbon heating system can be affordable and accessible to all. We will continue to review how best to fairly distribute the costs of:

- *national and local infrastructure construction, reinforcement and operation including energy generation, transmission and distribution*
- *retrofitting measures to upgrade individual buildings*
- *moving away from fossil fuels*
- *running costs of low-carbon heating*

Fairness

As we face the costs of moving to clean forms of energy, fairness will be at the heart of our approach. Every household and business should be confident that all of us are paying our fair share of the costs of transitioning to Net Zero and that these costs are spread across all consumers.

We will ensure that price incentives are fair, continue to address fuel poverty, and help achieve Net Zero.

We need to strike the right balance between how costs are distributed amongst:

- different types of households
- domestic and business consumers, including the big energy users in industry
- energy bills and taxes

There are a number of distortions within the existing business rates determination structures that restrict investment in low-carbon technologies. If these were addressed, businesses could more easily deploy the technologies needed to meet Net Zero while also improving productivity. [HM Treasury's fundamental review of business rates: call for evidence](#)⁴²⁴ explored how we can ensure business rates are not a barrier to our Net Zero ambitions.

We will work to ensure that the transition to Net Zero is fair and proportionate across the UK through improving our approach to affordability.

⁴²⁴ HM Treasury (2020), 'HM Treasury fundamental review of business rates' (<https://www.gov.uk/government/consultations/hm-treasury-fundamental-review-of-business-rates-call-for-evidence>).

Driving down capital costs

To help the market drive down the upfront costs of technologies, we will look to provide certainty and stability for businesses by setting clear and timely targets and standards.

We want to create the conditions where innovative products and business models can flourish, leading to a downward pressure on costs, including investing in the development of innovative technologies, such as hydrogen, and employ a range of enablers to support delivery, including green finance and skills support. We will continue to learn from other sectors on reducing costs, including offshore wind.

Some leading manufacturers and suppliers have already made great strides in reducing capital costs, demonstrating the direction of travel we are keen for industry to take.

Sharing the costs

There are numerous factors that can influence the cost of heat decarbonisation. Energy efficiency improvements in buildings, demand shifting tariffs, the efficiency of heat pumps and the extent to which hybrid heat pumps are deployed will all have an impact.

Alongside these improvements, and action to address distortions in energy prices, we anticipate that in future, heat pumps will be no more expensive to buy and run than gas boilers. We will launch a Fairness and Affordability Call for Evidence on options to shift or rebalance energy levies and obligations over this decade.

We are planning to introduce a range of policy measures to support our ambition to grow the heat pump market, including the regulations on heating off-gas-grid buildings and the market-based mechanism. We are also exploring the possibility that a certain amount of targeted financial support for heat pumps may be needed both to ensure that complying with regulations is affordable for all consumers and that the balance of costs associated with the market mechanism remains proportionate.

Separately, we are also considering how a market for hydrogen heating could operate ahead of making strategic decisions in 2026 on hydrogen's role in heat decarbonisation. We will engage with stakeholders on these issues in due course.

6.2. Green finance

Improving the performance of our buildings and installing low-carbon heating often involves a high upfront cost, with long and uncertain payback periods. A portfolio of green funding and finance options needs to be available to prevent this from acting as a major barrier to uptake, in addition to working with industry to drive down costs through innovation and refining supply chains. In this section we:

- *set out the currently available government grants, subsidies, and loans to support the public, especially for those less able to pay*
- *highlight the growing demand for private finance*
- *encourage the private sector to continue to evolve and improve the green finance options available for consumers*

Government financial support

To build a market for energy efficiency and low-carbon heat, we need to make it as easy as possible for people to pay for and make these improvements. Therefore, our planned portfolio of action in the 2020s seeks to distribute costs in a socially and economically responsible way.

To support those who are least able to pay, we will continue to provide targeted support and funding to ensure that the transition to energy efficient low-carbon heating is accessible and affordable to all, including through the:⁴²⁵

- Boiler Upgrade Scheme
- Local Authority Delivery Scheme
- Social Housing Decarbonisation Fund
- Home Upgrade Grant

We have pledged over £9 billion of taxpayer funding over the next decade through proposals on public sector, social housing and fuel poor schemes.

In August 2020, we announced a Net Zero building package worth in excess of £3 billion.

The Prime Minister's [Ten Point Plan](#)⁴²⁶ for a green industrial revolution invests £1 billion to make our homes, schools and hospitals greener, warmer and more energy efficient.

Private green finance

However, the scale of investment required to fully decarbonise buildings is huge – therefore private finance, as well as government support, will be critical. Estimates suggest that upgrading as many homes to EPC band C by 2035 where practicable, affordable, and cost-effective will require mobilising up to £65 billion of investment for the UK.⁴²⁷ Between 2018-2019, around 60% of EPC registrations in England and Wales for non-domestic buildings were below EPC band C.⁴²⁸ For non-domestic buildings, estimates suggest it could require around £20 billion in investment to deliver our [Clean Growth Strategy](#)⁴²⁹ commitments.⁴³⁰

Therefore, in addition to government schemes which provide targeted support to those less able to pay, we need to establish a fit-for-purpose green finance market that provides a range

⁴²⁵ Further government funded activities are provided in Annex 2: Current and planned activities for the 2020s. Equivalent schemes may be available in Wales, Scotland or Northern Ireland.

⁴²⁶ BEIS (2020), 'The ten point plan for a green industrial revolution' (<https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution>).

⁴²⁷ BEIS and HM Treasury (2019), 'Green finance strategy', p. 37 (<https://www.gov.uk/government/publications/green-finance-strategy>).

⁴²⁸ DLUHC 'Live tables on Energy Performance of Buildings Certificates' (<https://www.gov.uk/government/statistical-data-sets/live-tables-on-energy-performance-of-buildings-certificates>), last updated 2021.

⁴²⁹ BEIS (2017), 'Clean Growth Strategy' (<https://www.gov.uk/government/publications/clean-growth-strategy>).

⁴³⁰ BEIS and HM Treasury (2018), 'Helping businesses to improve the way they use energy: call for evidence' (<https://www.gov.uk/government/consultations/helping-businesses-to-improve-the-way-they-use-energy-call-for-evidence>).

of financing options to meet the needs of all consumers, especially those to whom less government-funded support is available.

A comprehensive portfolio of government and private-funded green finance products will encourage homeowners to take earlier and more comprehensive action than is required through regulations.

A range of private finance options, alongside government support, is needed to ensure affordable, accessible decarbonisation for all. We want to continue to stimulate the market to provide innovative financial support.

Growing demand for green finance

Decarbonising buildings will require the development of a market for finance, so that:

- building owners and occupiers can access appropriate financing when they require it
- investors have opportunities of a suitable scale, and a good enough understanding of risks, to invest significant capital

The demand for green finance has been low to date. However, long-sighted regulatory signals, and the gradual reduction of public funding available to those more able to pay, should see significant demand for green finance over the 2020s. The investment market will increase in size if we incentivise building owners and occupiers to invest in low-carbon heating and energy efficiency measures. Additionally, improving consumer protection and public engagement will be key to encouraging action by consumers, which will further grow the market and investment demand. Ensuring that high-quality installations deliver expected outcomes also reduces the associated financial risk for investors.

We acknowledge that a single financial product will not suit the needs of all consumers and that the types of investment required may vary between property types, tenure types, technologies, and business users. Some consumers will be able to meet the costs of these measures upfront. However, others are likely to need to spread the cost over time – and low income and fuel poor consumers and SMEs may not be able to pay at all. Larger buildings, and those with many occupants use shared infrastructure and bring economies of scale, while individual houses have individual costs per property. Similarly, some of the technologies we are developing (such as hydrogen for heating) do not have an investment track record, and therefore proxy investment indicators (such as natural gas boilers and networks) are needed.

Large investors typically look for large-scale investments. However, much of the investment to decarbonise buildings and heating will be in a large number of small investments (individual building improvements). Therefore, multiple small investments will need to be aggregated to create large enough packages to be attractive to large investors.

Each type of energy efficiency or heat source replacement measure carries its own investment profile in terms of risk, returns, and duration. There are likely to be opportunities to bundle interventions together and match financing to the expected lifetime of a measure. This could include infrastructure-type approaches for very long-life assets that may be shared between multiple beneficiaries (such as ground arrays for certain types of ground source heat pumps, where the asset may last up to 100 years and be shared across properties). This would enable long-term investments (such as pension funds) into the space.

As trailed in the [Green Finance Strategy](#)⁴³¹ in 2019, and given the support for a pay-as-you-save option to green financing, we will explore opportunities to simplify and improve the GB Green Deal framework to support the funding of energy efficiency measures.

Developing supply of green finance

Different types of buildings – with different users, owners, and heating needs – will require different types of financial support to decarbonise. Therefore, we need to support the development of a competitive, fit-for-purpose green finance market that provides a range of financing options to meet the needs of different consumers. This may include loans, mortgages, or other financing products.

There is investor interest in green finance products globally, but this has yet to be converted into established financial products in the UK. Government action is vital to create a flourishing market for UK green finance products, which could see capital flow into those areas, including from institutional investors.

Therefore, as set out in our [Green Finance Strategy](#)⁴³², there is a need to stimulate innovation in green finance products to increase the options available to households, building owners and businesses. Opportunities of a suitable size, duration, and risk profile will encourage investors to invest in the sector.

A total of £1.8 million grant funding has been awarded to three organisations in the [Green Home Finance Innovation Fund competition](#).⁴³³ This programme, which will conclude by March 2022, is aiming to promote the establishment of green lending products to be made available to domestic owner-occupiers for energy performance improvements. To overcome the barrier to innovation posed by high initial development costs in an untapped green finance market, the programme is providing funding for the initial development and piloting of a limited number of green home finance products, including:

- a digital platform that connects green vendors to mortgage lenders
- an online home energy saving tool and a mortgage product
- an additional borrowing product to encourage customers to install energy efficiency measures

⁴³¹ HM Treasury and BEIS (2019), 'Green finance strategy' (<https://www.gov.uk/government/publications/green-finance-strategy>).

⁴³² HM Treasury and BEIS (2019), 'Green finance strategy' (<https://www.gov.uk/government/publications/green-finance-strategy>).

⁴³³ BEIS (2020), 'Green Home Finance Innovation Fund competition - successful bids' (<https://www.gov.uk/government/publications/green-home-finance-innovation-fund-competition-successful-bids>).

Building on the outputs and learnings from the Green Home Finance Innovation Fund competition, a further programme will look to provide grant funding to stimulate more innovation in the UK green home finance market. This may include support for UK retail lenders to design, develop and pilot a range of finance propositions that encourage domestic installation of energy efficiency measures and low-carbon heat. This funding programme will formally launch by Spring 2022. BEIS has invited the UK Infrastructure Bank (UKIB) to help steer the design and delivery of the green home finance programme, and we will work further with UKIB to explore whether they can play a wider role in scaling-up green home finance.

Lenders will have a significant role in building a competitive green finance market. They may be able to offer green financing options as part of:

- a secured loan, such as a mortgage
- green equity release products
- unsecured concessional loans, that would allow consumers to spread the costs of installing energy efficiency and low-carbon heat sources and systems

For mortgaged properties, lenders are uniquely placed to influence homeowners, landlords and businesses at key trigger points, such as at the point of purchase, renovation, or re-mortgage. We ran a [consultation on the potential role of mortgage lenders in financing green improvements](#)⁴³⁴ (November 2020 – February 2021). The consultation builds on feedback from the government's [call for evidence on building a market for energy efficiency](#),⁴³⁵ which was published in July 2019.

Lloyds, RBS, and Nationwide, which account for about 40% of the UK's residential and buy-to-let mortgage market⁴³⁶, made commitments to support homeowners to improve the energy efficiency of their homes in 2020.⁴³⁷ As part of their commitment to support a post-COVID green recovery, Lloyds Banking Group have also committed to explore how they can support the non-domestic sector to invest in low-carbon heat and energy efficiency measures.⁴³⁸ This action from the market demonstrates that they are beginning to recognise the important role they play in decarbonisation. In addition, there is emerging evidence suggesting a link between investments in energy efficiency and low-carbon technology on the one hand and property values and a lower risk of default on the other.

⁴³⁴ BEIS (2020), 'Improving home energy performance through lenders' (<https://www.gov.uk/government/consultations/improving-home-energy-performance-through-lenders>).

⁴³⁵ BEIS (2017), 'Building a market for energy efficiency: call for evidence' (<https://www.gov.uk/government/consultations/building-a-market-for-energy-efficiency-call-for-evidence>).

⁴³⁶ UK Finance (2019), 'largest mortgage lenders' (<https://www.ukfinance.org.uk/data-and-research/data/mortgages/largest-mortgage-lenders>).

⁴³⁷ Lloyds (2020) (<https://www.lloydsbankinggroup.com/assets/media/press-releases/lloyds-banking-group/2020/lloyds-banking-group-pledges-to-cut-carbon-by-half.pdf>), NatWest (<https://www.natwestgroup.com/our-purpose/climate.html>) and

Nationwide (2020) (<https://www.nationwideannualreport.co.uk/media/0fh0qiip/review-of-the-year-2020.pdf>).

⁴³⁸ Lloyds Banking Group (2020) (<https://www.lloydsbankinggroup.com/assets/pdfs/who-we-are/financing-a-green-future/executive-summary-supporting-a-green-recovery-post-covid19.pdf>).

In the non-domestic sector, there are existing finance products for energy efficiency in larger buildings. However, for smaller properties and particularly those occupied by SMEs, the availability of finance for such projects is limited. This is a general challenge for SMEs. In the latest [BVA BDRC SME Finance Monitor report](#), 41% of SMEs stated that it was difficult for them to access finance.⁴³⁹ With a new focus on Net Zero, lenders and industry leaders (such as [Bankers for NetZero](#)⁴⁴⁰ and the [Green Finance Institute](#)⁴⁴¹) are working to understand the types of financial products that will be most effective for businesses, particularly SMEs.

We also launched the [Boosting Access for SMEs to Energy Efficiency competition](#).⁴⁴² The competition offered up to £6 million in funding for innovative solutions that reduce transaction costs and introduce economies of scale for lenders investing in small-scale energy efficiency. It also aimed to attract SMEs to use external finance through simple online platforms.

We will work to provide an environment which enables innovation in business models for homes and businesses. This will include building on pay-to-save models, wider use of energy service contracts, and new offerings such as 'heat- or comfort-as-a-service', which provides customers with an agreed heating or comfort plan rather than fuel alone.

6.3. Consumer protection

Consumers need to be assured that upgrades to their homes and workplaces will be deliver the expected results, this can be achieved by:

- *setting quality standards*
- *upskilling installers*
- *providing protection for consumers*

Poor-quality installations of any heating system can lead to over or under heating of properties, dampness, higher energy bills, and at worst could leave consumers feeling cold in their homes, or even be unsafe. Therefore, consumer protection is a critical part of the transition to low-carbon buildings.

Consumer protection is a key part of enabling a transition to Net Zero. We will continue to ensure we have a rigorous technical standards regime to provide households and businesses with assurance of high-quality decarbonisation measures.

⁴³⁹ BVA BDRC (2011), 'SME Finance Monitor' (<https://www.bva-bdrc.com/products/sme-finance-monitor/>), last updated January 2021.

⁴⁴⁰ APPG Fair Business Banking, 'Bankers for NetZero' (<https://www.appgbanking.org.uk/parliament-2020-onwards/bankers-for-netzero/>).

⁴⁴¹ Green Finance Institute (<https://www.greenfinanceinstitute.co.uk/>).

⁴⁴² BEIS (2020), 'Boosting access for SMEs to energy efficiency (BASEE) competition: winning projects' (<https://www.gov.uk/government/publications/boosting-access-for-smes-to-energy-efficiency-basee-competition-winning-projects>).

Quality of work delivered – skills and standards

Section [2.3 Skills](#) discusses action to upskill the workforce to prepare for mass decarbonisation and deliver Net Zero.

Energy efficiency

In the [Each Home Counts Review](#)⁴⁴³ we considered what is needed to encourage and enable consumers to decarbonise their buildings safely and confidently. We have implemented recommendations made in the review, including the TrustMark government-endorsed quality scheme, supported by a Code of Practice and Consumer Charter, and the [Simple Energy Advice](#) online platform.⁴⁴⁴

The TrustMark scheme is a quality mark based on the recommendations from the [Each Home Counts Review](#).⁴⁴⁵ To register with TrustMark, businesses must adhere to its framework operating requirements, its code of conduct and consumer charter, thereby demonstrating technical competence, good trading practices and good customer service. To ensure sufficient consumer protection and guarantees are in place, businesses installing measures under government schemes (such as the Energy Company Obligation) are required to be registered with TrustMark or equivalent schemes.

Publicly Available Specification (PAS) standards set an agreed level of quality and good practice, and help to maintain and build trust on the market products and services. The British Standards Institute published a new, more robust version of these standards (from the existing PAS 2030:2017 standard) in June 2019. From 1 July 2021, most government schemes will not accept PAS 2030:2017.⁴⁴⁶ The new standards mark a step change for industry and cover the end-to-end delivery of energy efficiency measures (PAS 2035:2019 and PAS 2030:2019). These have been embedded within the new TrustMark government-endorsed quality scheme.

- PAS 2035 covers how to assess dwellings for retrofit, identify improvement options, design and specify energy efficiency measures, and monitor retrofit projects
- PAS 2030 was redeveloped in conjunction with PAS 2035 and covers the installation, commissioning, and handover of retrofit projects

PAS 2038:2021 sets out requirements to improve energy efficiency (as part of a whole-building approach) when retrofitting non-domestic buildings. The government is exploring how to encourage the uptake of the non-domestic standard.

⁴⁴³ BEIS and DLUHC (2016), 'Each Home Counts: Review of Consumer Advice, Protection, Standards and Enforcement for Energy Efficiency and Renewable Energy' (<https://www.gov.uk/government/publications/each-home-counts-review-of-consumer-advice-protection-standards-and-enforcement-for-energy-efficiency-and-renewable-energy>).

⁴⁴⁴ Simple Energy Advice online platform, available at: <https://www.simpleenergyadvice.org.uk/>.

⁴⁴⁵ Independent review chaired by Peter Bonfield (2016), 'Each Home Counts: Review of Consumer Advice, Protection, Standards and Enforcement for Energy Efficiency and Renewable Energy' (<https://www.gov.uk/government/publications/each-home-counts-review-of-consumer-advice-protection-standards-and-enforcement-for-energy-efficiency-and-renewable-energy>).

⁴⁴⁶ BEIS, UKAS and the British Standards Institute agreed that the PAS 2030:2017 standard would be accepted for remaining installations under the Green Homes Grant Voucher Scheme and Local Authority Delivery Scheme (Phase 1) until 31st October 2021.

We have demonstrated a whole building approach through mandating the use of PAS 2035 for the Social Housing Decarbonisation Fund (SHDF) Demonstrator. This is helping develop capacity and capability, improving and increasing use of new tools, and allowing better investment decisions to be made for each building archetype.

Low-carbon and renewable heat technologies

The [Microgeneration Certification Scheme](#) (MCS)⁴⁴⁷ produces product and installation standards for small-scale renewable technologies that allow for the certification of products and installers. These standards ensure that an installer must install to a defined quality, using products that have met rigorous testing standards.

A certification scheme is run on behalf of MCS by certification bodies who hold UKAS accreditation to ISO 17065.⁴⁴⁸ To be certified, installers must both adhere to MCS standards and be members of a consumer code that has been approved by the Chartered Trading Standards Institute. These consumer codes set out standards that installers must meet in contracting with consumers. The codes cover advertising and promotion, estimates and quotes, cancellation rights, and protect against mis-selling.

To ensure high-quality installations, we currently mandate that installers must be MCS certified or equivalent to participate in government incentive schemes (such as the Boiler Upgrade Scheme). They must also use MCS certified (or equivalent) products and carry out the installation in compliance with the relevant MCS (or equivalent) installation standard for that technology.⁴⁴⁹ They must also comply with the requirements of the relevant consumer code. We intend to continue to mandate this requirement. However, we will keep this under review as part of our work to continuously improve consumer protection across low-carbon and renewable heat schemes. We will also consider whether further measures should be introduced to ensure consumers have confidence in the quality of installations.

We recognise that many businesses and public buildings will require a heating system with a capacity over 45 kW, and we will consider how consumers in these instances are protected against poor-quality installations.

We are also looking to consider the role of standards (like PAS 4444, production of which was funded by BEIS's Hy4Heat programme) if hydrogen is widely used as a heat source for buildings. We are currently consulting on a UK standard for low-carbon hydrogen production⁴⁵⁰, which will establish a greenhouse gas emissions threshold to ensure the hydrogen production routes we support provide real carbon reduction benefits. In developing the standard, we have commissioned extensive external research to consider the carbon intensity of different hydrogen production pathways and have published this report alongside the consultation.

⁴⁴⁷ Further information about the Microgeneration Certification Scheme can be found at: <https://mcs-certified.com/about-us/>.

⁴⁴⁸ A list of UKAS training courses is available at: https://www.ukas.com/training-and-advisory/training/?gclid=EAlaIqobChMI6Mv-8eSS8wIVUertCh0X4gppEAAAYASAAEgLeMvD_BwE.

⁴⁴⁹ Ofgem (2020), 'Domestic RHI Product Eligibility' (<https://www.ofgem.gov.uk/publications/domestic-rhi-product-eligibility>).

⁴⁵⁰ BEIS (2021), 'Designing a UK low carbon hydrogen standard' (<https://www.gov.uk/government/consultations/designing-a-uk-low-carbon-hydrogen-standard>).

Heat networks

In this parliament we intend to take primary powers to regulate the heat network market to protect consumers and provide assurance of high-quality standards.

In 2018, the Competition and Markets Authority (CMA) set out recommendations for introducing sector-specific heat network regulations to protect consumers. The government accepted this recommendation and published the [Heat Networks Market Framework consultation](#)⁴⁵¹ on 6 February 2020.

We are committed to developing a heat network market where consumers are properly protected and benefit from reliable and affordable heating. We want heat network consumers to have easy access to information about their heat network, a good quality of service, fair and transparently priced heating and a route for redress if these standards are not met.

Building standards

All heating installations must comply with [Building Regulations](#).⁴⁵² Where installers certify compliance through a Competent Person Scheme⁴⁵³, consumers receive additional protections. Competent Person Schemes must ensure that consumers are provided with appropriate financial protection (for a minimum of six years) to correct work done on dwellings that is not compliant with Buildings Regulations.

In 2021, Government consulted on changes to Building Regulations and the accompanying Approved Documents, which provide practical guidance on how the Building Regulations can be satisfied. These proposals included additional guidance on the standard expected of heat pump installations. The consultation closed in April 2021 and Government is currently considering the responses.

Protecting vulnerable consumers

Following the results of our [consultation on proposals to update the 2015 Fuel Poverty Strategy for England](#)⁴⁵⁴, we have included further detail of our vulnerability principle in our policy paper on [Sustainable warmth: protecting vulnerable households in England](#)⁴⁵⁵, published February 2021.⁴⁵⁶ Under the vulnerability principle, we specifically consider the needs of low income households most at risk from the impact of living in a cold home while designing fuel poverty policy. Based on NICE guidance⁴⁵⁷, in England, we consider low income

⁴⁵¹ BEIS (2020), 'Heat networks: building a market framework' (<https://www.gov.uk/government/consultations/heat-networks-building-a-market-framework>).

⁴⁵² Information and advice about building regulations approvals is available on GOV.UK at: <https://www.gov.uk/building-regulations-approval>.

⁴⁵³ Information about competent person schemes is available on GOV.UK at: <https://www.gov.uk/building-regulations-approval/use-a-competent-person-scheme>.

⁴⁵⁴ BEIS (2019), 'Fuel poverty strategy for England' (<https://www.gov.uk/government/consultations/fuel-poverty-strategy-for-england>).

⁴⁵⁵ BEIS (2021), 'Sustainable warmth: protecting vulnerable households in England' (<https://www.gov.uk/government/publications/sustainable-warmth-protecting-vulnerable-households-in-england>).

⁴⁵⁶ Welsh Government is currently consulting on the fuel poverty strategy for Wales.

⁴⁵⁷ Based on NICE (2015), NG6 guidance on 'Excess winter deaths and illness and the health risks associated with cold homes' (<https://www.nice.org.uk/guidance/ng6>).

households to be vulnerable if at least one member of the household falls into one (or more) of the following categories:

- 65 or older
- younger than school age
- living with a long-term health condition which makes them more likely to spend most of their time at home, such as mobility conditions which further reduce ability to stay warm
- living with a long-term health condition which puts them at higher risk of experiencing cold-related illness (for example, a health condition which affects their breathing, heart or mental health)

As trailed in the [ECO3, Improving Consumer Protection government response](#)⁴⁵⁸ we are committed to ensuring that high standards for consumer protection become the norm, especially for low income households. Our long-term ambition is that anyone improving the heating efficiency of their home or workplace will have the same level of confidence in that product or installation as they would expect of other comparable goods.

We will continue to consider how to best support vulnerable households as we design fuel poverty policies.

Information and advice

To deliver consumer protection, we need to help consumers make choices that best suit their situation and deliver high-quality heating in their homes through clear, accurate and relevant information and advice. Our key communication channels are detailed in section [6.4 Public engagement](#).

6.4. Public engagement

Public engagement is a vital element of successful decarbonisation, since the public will need to take action to change the way they heat their homes and workplaces. We will ensure that all consumers are made aware of the actions they should be taking, the specific changes that will affect them, and the support available.

The importance of public engagement

If people are adequately informed, they are able to make choices that best suit their heating needs and maximise carbon reduction. Without engagement and understanding, the public will be less able to be early adopters of energy efficiency measures and low-carbon heating, or make use of the green finance options available.

We all have a shared responsibility to achieve Net Zero by 2050. Mass transition will require extensive co-operation and collaboration both nationally and locally between a range of actors. However, according to the CCC, behaviour change and contributions from households have so

⁴⁵⁸ BEIS (2018), 'Energy Company Obligation: ECO3, 2018 to 2022' (<https://www.gov.uk/government/consultations/energy-company-obligation-eco3-2018-to-2022>).

far played little to no role in emissions reductions.⁴⁵⁹ We understand that a lack of consumer engagement can be a barrier to deployment of low-carbon heating, as individuals may feel hesitant to affect change that they do not understand. Ultimately, more information leads to more acceptability.

We want more consumers to understand the importance and urgency of decarbonising how we heat our buildings and opt to voluntarily upgrade their buildings. We will continue to review and improve the way we communicate information and provide support.

Public engagement should be used to:

- inform and shape policies by drawing on the expertise of others, through public consultation and advisory groups, such as Citizens Advice
- raise awareness and acceptance of substantial infrastructural and behavioural change needed to decarbonise buildings over the next 30 years
- improve understanding of the rationale behind Net Zero and the need to decarbonise heat
- inform the public and industry of relevant policy and regulatory changes to ensure they have time to prepare
- provide tailored advice so that individuals can confidently make informed choices regarding heat sources and energy efficiency measures in their homes and workplaces
- help individuals be equipped to use these technologies effectively, building confidence and readiness for change

Inward engagement

We view public engagement as a two-way exchange of information and advice. In our policy development, we will continue to engage, listen to, and use the expertise of others to inform policy development by:

- commissioning expert advice for setting and meeting targets
- publicly consulting on our proposals before launching policies
- collecting and channelling feedback into policy development, as part of our monitoring and evaluation process

We have used the responses to our consultations and calls for evidence to inform our portfolio of actions and will continue to inform our ongoing heat and buildings strategy. Key consultations include:

⁴⁵⁹ CCC (2019), 'Behaviour change, public engagement and Net Zero' (<https://www.theccc.org.uk/wp-content/uploads/2019/10/Behaviour-change-public-engagement-and-Net-Zero-Imperial-College-London.pdf>).

- [RHI: A reformed and refocused scheme](#)⁴⁶⁰ (published 2016, response 2018)
- [Non-domestic RHI: further proposed amendments](#)⁴⁶¹ (published 2017, response 2018)
- [Building a market for energy efficiency: call for evidence](#)⁴⁶² (published 2017, response 2019)
- [A future framework for heat in buildings: call for evidence](#)⁴⁶³ (published and response 2018)
- [Energy Performance Certificates in buildings: call for evidence](#)⁴⁶⁴ (published 2018, response 2020)
- [RHI: biomass combustion in urban areas](#)⁴⁶⁵ (published 2018, response 2020)
- [Heat Networks \(Metering and Billing\) Regulations 2014: proposed amendments](#)⁴⁶⁶ (published 2019, response 2020)
- [Fuel poverty strategy for England](#)⁴⁶⁷ (published 2019, response 2021)⁴⁶⁸
- [Non-domestic RHI: ensuring a sustainable scheme](#)⁴⁶⁹ (published 2020, response 2021)
- [Future support for low-carbon heat](#)⁴⁷⁰ (published 2020, response 2021)
- [Proposals for a green gas levy](#)⁴⁷¹ (published 2020, response 2021)

⁴⁶⁰ BEIS (2016) 'The Renewable Heat Incentive: A reformed and refocused scheme' (<https://www.gov.uk/government/consultations/the-renewable-heat-incentive-a-reformed-and-refocused-scheme>).

⁴⁶¹ BEIS (2017,) 'The Non-domestic Renewable Heat Incentive: further proposed amendments' (<https://www.gov.uk/government/consultations/the-non-domestic-renewable-heat-incentive-further-proposed-amendments>).

⁴⁶² BEIS (2017), 'Building a market for energy efficiency: call for evidence' (<https://www.gov.uk/government/consultations/building-a-market-for-energy-efficiency-call-for-evidence>).

⁴⁶³ BEIS (2018), 'A future framework for heat in buildings: call for evidence' (<https://www.gov.uk/government/consultations/a-future-framework-for-heat-in-buildings-call-for-evidence>).

⁴⁶⁴ BEIS (2018), 'Energy Performance Certificates in buildings: call for evidence' (<https://www.gov.uk/government/consultations/energy-performance-certificates-in-buildings-call-for-evidence>).

⁴⁶⁵ BEIS (2018), 'Renewable Heat Incentive: biomass combustion in urban areas' (<https://www.gov.uk/government/consultations/renewable-heat-incentive-biomass-combustion-in-urban-areas>).

⁴⁶⁶ BEIS (2019), 'Heat Network (Metering and Billing) Regulations 2014: proposed amendments' (<https://www.gov.uk/government/consultations/heat-network-metering-and-billing-regulations-2014-proposed-amendments>).

⁴⁶⁷ BEIS (2019), 'Fuel poverty strategy for England' (<https://www.gov.uk/government/consultations/fuel-poverty-strategy-for-england>).

⁴⁶⁸ Welsh Government published a strategy on 'Tackling fuel poverty 2021 to 2035' (<https://gov.wales/tackling-fuel-poverty-2021-2035.html>) in March 2021.

⁴⁶⁹ BEIS (2020), 'Non-domestic Renewable Heat Incentive: ensuring a sustainable scheme' (<https://www.gov.uk/government/consultations/non-domestic-renewable-heat-incentive-ensuring-a-sustainable-scheme>).

⁴⁷⁰ BEIS (2020), 'Future support for low carbon heat' (<https://www.gov.uk/government/consultations/future-support-for-low-carbon-heat>).

⁴⁷¹ BEIS (2020), 'Proposals for a green gas levy' (<https://www.gov.uk/government/consultations/green-gas-levy>).

[Warm Home Discount Scheme 2021 to 2022](#)⁴⁷² (published 2020, response 2021)

[Energy-Related Products: call for evidence](#)⁴⁷³ (published 2020, response 2021)

[Green Heat Network Fund: scheme design](#)⁴⁷⁴ (published 2020, response 2021)

[Draft Ecodesign and Energy Labelling Regulations 2021](#)⁴⁷⁵ (published and response 2021)

[Heat networks: building a market framework](#)⁴⁷⁶ (published 2020)

[Improving the energy performance of privately rented homes](#)⁴⁷⁷ (published 2020)

[Improving home energy performance through lenders](#)⁴⁷⁸ (published 2020)

[Domestic RHI: ensuring a stable scheme](#)⁴⁷⁹ (published 2021)

[The Future Buildings Standard](#)⁴⁸⁰ (published 2021)

[Warm Home Discount: better targeted support from 2022](#)⁴⁸¹ (published 2021)

[Strengthening the Energy Savings Opportunity Scheme \(ESOS\)](#)⁴⁸² (published 2021)

[Design of the Energy Company Obligation ECO4: 2022-2026](#)⁴⁸³ (published 2021)

[Hydrogen for heat: facilitating a grid conversion hydrogen heating trial](#)⁴⁸⁴ (published 2021)

⁴⁷² BEIS (2020), 'Warm Home Discount Scheme 2021 to 2022'
(<https://www.gov.uk/government/consultations/warm-home-discount-scheme-2021-to-2022>).

⁴⁷³ Footnote: BEIS (2020), 'Energy-Related Products: call for evidence'
(<https://www.gov.uk/government/consultations/energy-related-products-call-for-evidence>)

⁴⁷⁴ BEIS (2020), 'Green Heat Network Fund: proposals for the scheme design'
(<https://www.gov.uk/government/consultations/green-heat-network-fund-proposals-for-the-scheme-design>).

⁴⁷⁵ BEIS (2021), 'Draft Ecodesign and Energy Labelling Regulations 2021'
(<https://www.gov.uk/government/consultations/draft-ecodesign-and-energy-labelling-regulations-2021>).

⁴⁷⁶ BEIS (2020), 'Heat networks: building a market framework'
(<https://www.gov.uk/government/consultations/heat-networks-building-a-market-framework>).

⁴⁷⁷ BEIS (2020), 'Improving the energy performance of privately rented homes'
(<https://www.gov.uk/government/consultations/improving-the-energy-performance-of-privately-rented-homes>).

⁴⁷⁸ BEIS (2020), 'Improving home energy performance through lenders'
(<https://www.gov.uk/government/consultations/improving-home-energy-performance-through-lenders>).

⁴⁷⁹ BEIS (2021), 'Domestic Renewable Heat Incentive: ensuring a stable scheme'
(<https://www.gov.uk/government/consultations/domestic-renewable-heat-incentive-ensuring-a-stable-scheme>).

⁴⁸⁰ BEIS (2021), 'The Future Buildings Standard' (<https://www.gov.uk/government/consultations/the-future-buildings-standard>).

⁴⁸¹ BEIS (2021), 'Warm Home Discount: better targeted support from 2022'
(<https://www.gov.uk/government/consultations/warm-home-discount-better-targeted-support-from-2022>).

⁴⁸² BEIS (2021), 'Strengthening the Energy Savings Opportunity Scheme (ESOS)'
(<https://www.gov.uk/government/consultations/strengthening-the-energy-savings-opportunity-scheme-esos>).

⁴⁸³ BEIS (2021), 'Design of the Energy Company Obligation ECO4: 2022-2026'
(<https://www.gov.uk/government/consultations/design-of-the-energy-company-obligation-eco4-2022-2026>).

⁴⁸⁴ BEIS (2021), 'Hydrogen for heat: facilitating a grid conversion hydrogen heating trial'
(<https://www.gov.uk/government/consultations/hydrogen-for-heat-facilitating-a-grid-conversion-hydrogen-heating-trial>).

[Combined heat and power: pathway to decarbonisation call for evidence](#)⁴⁸⁵ (published 2021)

[Proposals for heat network zoning](#)⁴⁸⁶ (published 2021)

While developing this strategy we have published the following consultations, consultation responses, and strategies:

- the [government response to consultation on updating the fuel poverty strategy for England](#), setting out changes, including changes to metrics⁴⁸⁷
- a policy paper on [Sustainable warmth: protecting vulnerable households in England](#)⁴⁸⁸, published February 2021, which updates our 2015 Fuel Poverty Strategy for England
- a [consultation on introducing a performance-based policy framework for large non-domestic buildings](#)⁴⁸⁹
- a consultation on the [implementation of EPC band B minimum energy efficiency standards in non-domestic private-rented buildings](#)⁴⁹⁰
- a [UK hydrogen strategy](#)⁴⁹¹
- a [consultation on facilitating a grid conversion hydrogen heating trial](#)⁴⁹²
- a [consultation on a market-based mechanism for low-carbon heat](#), to grow the numbers of low-carbon heating appliances installed in existing premises each year⁴⁹³

⁴⁸⁵ BEIS (2021), 'Combined heat and power: pathway to decarbonisation call for evidence'

<https://www.gov.uk/government/consultations/combined-heat-and-power-pathway-to-decarbonisation-call-for-evidence>

⁴⁸⁶ BEIS (2021), 'Proposals for heat network zoning' (<https://www.gov.uk/government/consultations/proposals-for-heat-network-zoning>)

⁴⁸⁷ BEIS (2021), 'Government Response to Consultation on Updating the Fuel Poverty Strategy for England' (<https://www.gov.uk/government/consultations/fuel-poverty-strategy-for-england>).

⁴⁸⁸ BEIS (2021), 'Sustainable warmth: protecting vulnerable households in England' (<https://www.gov.uk/government/publications/sustainable-warmth-protecting-vulnerable-households-in-england>).

⁴⁸⁹ BEIS (2021), 'Introducing a performance-based policy framework in large commercial and industrial buildings' (<https://www.gov.uk/government/consultations/introducing-a-performance-based-policy-framework-in-large-commercial-and-industrial-buildings>).

⁴⁹⁰ BEIS (2021), 'Non-domestic Private Rented Sector minimum energy efficiency standards: EPC B implementation' (<https://www.gov.uk/government/consultations/non-domestic-private-rented-sector-minimum-energy-efficiency-standards-epc-b-implementation>).

⁴⁹¹ BEIS (2021), 'UK hydrogen strategy' (<https://www.gov.uk/government/publications/uk-hydrogen-strategy>).

⁴⁹² BEIS (2021), 'Hydrogen for heat: facilitating a grid conversion hydrogen heating trial' (<https://www.gov.uk/government/consultations/hydrogen-for-heat-facilitating-a-grid-conversion-hydrogen-heating-trial>).

⁴⁹³ BEIS (2021), 'Market-based mechanism for low carbon heat' (<https://www.gov.uk/government/consultations/market-based-mechanism-for-low-carbon-heat>).

- a [consultation on regulations to phase out fossil fuel heating in homes not connected to the gas grid](#)⁴⁹⁴
- a [consultation on regulations to phase out fossil fuel heating in businesses not connected to the gas grid](#)⁴⁹⁵
- the government response to Clean Heat Grant proposals within 'Future support for low-carbon heat' consultation, '[Future Support for Low Carbon Heat: Boiler Upgrade Scheme](#)'⁴⁹⁶

Outward engagement

There are clear benefits of providing support through effective consumer engagement.

This was evidenced by the smart meter roll-out. [Smart Energy GB](#)⁴⁹⁷ was established in 2013 as the independent, not-for profit body responsible for delivering coordinated consumer engagement activity.

Whilst energy suppliers have the primary responsibility for engaging their customers and encouraging them to upgrade to smart metering, Smart Energy GB complement this with national campaign activities which have focused on:

- promoting awareness and understanding of smart metering
- driving behaviour change
- helping consumers benefit from smart metering

These activities, combined with energy suppliers' communication to their customers and word-of-mouth based on consumers' own experiences, have driven high levels of awareness and demand for smart metering. Awareness and understanding of smart meters has risen steadily over time, with 97% of people across Great Britain now aware of smart meters.⁴⁹⁸ In addition, the majority of consumers are satisfied with their smart meters and many are advocates of the technology, with just over two-thirds of smart meter owners indicating they would recommend getting one.⁴⁹⁹

⁴⁹⁴ BEIS (2021), 'Phasing out fossil fuel heating in homes off the gas grid' (<https://www.gov.uk/government/consultations/phasing-out-fossil-fuel-heating-in-homes-off-the-gas-grid>).

⁴⁹⁵ BEIS (2021), 'Phasing out fossil fuel heating systems in businesses off the gas grid' (<https://www.gov.uk/government/consultations/phasing-out-fossil-fuel-heating-systems-in-businesses-and-public-buildings-off-the-gas-grid>).

⁴⁹⁶ BEIS (2021), 'Government response: Future support for low carbon heat' (<https://www.gov.uk/government/consultations/future-support-for-low-carbon-heat>).

⁴⁹⁷ Smart Energy GB (<https://www.smartenergygb.org/en>).

⁴⁹⁸ Smart Energy GB (2021), 'Smart Energy Outlook 2021' (<https://www.smartenergygb.org/media/3dkp32k1/smart-energy-outlook-2021.pdf>).

⁴⁹⁹ Smart Energy GB (2021), 'Smart Energy Outlook 2021' (<https://www.smartenergygb.org/media/3dkp32k1/smart-energy-outlook-2021.pdf>).

We have multiple established channels to provide information to the public relating to decarbonisation and energy efficiency of buildings. We are currently reviewing their effectiveness.

Our Citizen's Advice portal⁵⁰⁰ already provides advice on:

- [energy efficiency in homes in England](#)⁵⁰¹
- [saving money on gas and electricity bills in England](#)⁵⁰²
- [help with home improvements in England](#)⁵⁰³

The [Simple Energy Advice](#) online platform⁵⁰⁴ has been developed to provide consumers with information and advice on energy efficiency and low-carbon heating tailored to the consumer's home. Over 1.5 million unique users have utilised this service since its launch. This was enhanced in September 2020 to provide consumers with more information and help to find local tradespeople, including heat pump installers registered with TrustMark.⁵⁰⁵ We will enhance our digitally-led service and move our Simple Energy Advice service to GOV.UK, which will improve user experience. Our redesigned [Energy Performance of Buildings Register](#)⁵⁰⁶ provides simple access to EPCs, Display Energy Certificates and air conditioning inspection reports with their associated recommendations to help consumers improve the energy efficiency of the building that has been assessed.

There are other technologies and interventions which can improve public understanding of energy use and energy efficiency:

- in-home displays for smart meters give accurate information about energy consumption to help consumers easily understand how to use less energy and save money on their bills

⁵⁰⁰ Advice for homes in Northern Ireland (<https://www.citizensadvice.org.uk/about-us/northern-ireland/>).

⁵⁰¹ Energy efficiency advice for homes in England (<https://www.citizensadvice.org.uk/consumer/energy/energy-supply/get-help-paying-your-bills/make-sure-your-home-is-energy-efficient/>), Scotland (<https://www.citizensadvice.org.uk/scotland/consumer/energy/energy-supply/making-energy-efficient-home-improvements/funding-for-energy-efficiency-in-homes-s/>) and Wales (<https://www.citizensadvice.org.uk/wales/consumer/energy/energy-supply/get-help-paying-your-bills/make-sure-your-home-is-energy-efficient/>).

⁵⁰² Advice on saving money on energy bills in England (<https://www.citizensadvice.org.uk/consumer/energy/energy-supply/get-a-better-energy-deal/save-money-on-your-gas-and-electricity/>), Scotland (<https://www.citizensadvice.org.uk/scotland/consumer/energy/energy-supply/get-a-better-energy-deal/save-money-on-your-gas-and-electricity/>) and Wales (<https://www.citizensadvice.org.uk/wales/consumer/energy/energy-supply/get-a-better-energy-deal/save-money-on-your-gas-and-electricity/>).

⁵⁰³ Help with improvements in England (<https://www.citizensadvice.org.uk/housing/moving-and-improving-your-home/help-with-home-improvements/>), Scotland (<https://www.citizensadvice.org.uk/scotland/consumer/energy/energy-supply/making-energy-efficient-home-improvements/green-deal-funding-for-energy-efficient-home-improvements-s/>) and Wales (<https://www.citizensadvice.org.uk/wales/housing/moving-and-improving-your-home/help-with-home-improvements/>).

⁵⁰⁴ Simple Energy Advice online platform, available at: <https://www.simpleenergyadvice.org.uk/>.

⁵⁰⁵ There also exist other sources of support beyond Simple Energy Advice and Citizen's advice, such as Care and Repair Cymru (<https://www.careandrepair.org.uk/en/>), which offers help to older people to live independently in warm, safe, accessible homes.

⁵⁰⁶ Find an energy certificate on GOV.UK: <https://find-energy-certificate.digital.communities.gov.uk/>.

- energy labels provide consumers with easy-to-understand information about the energy performance of products through a scale similar to the EPC, which encourages people to purchase more efficient products
- the [Energy Technology List](#)⁵⁰⁷ sets out the most energy efficient energy-using products, and acts as an incentive scheme for businesses to invest in these technologies

We appreciate the significant role of local actors engaging at a local level to provide more targeted advice to consumers relevant to their local area. We are considering options to support tailored advice in local areas to help more households improve the energy performance of their homes, and get ready for Net Zero.

Current public awareness and understanding

Despite these existing channels, we recognise that there is currently low public awareness of any need to switch to low-carbon heat sources and systems and little understanding of the scale of the challenge.^{508,509,510}

We commissioned NatCen to engage with the public to better understand current attitudes towards transition to low-carbon heating. The results were published in September 2020.⁵¹¹ Key findings include:

- low public understanding of the need for a mass heating transition
- high levels of support for policies seeking to reduce carbon emissions
- agreement that levels of awareness would need to be tackled to achieve heat decarbonisation

Consumers who considered, but did not proceed with, a heat pump installation through the Renewable Heat Incentive, fed back that the main barrier was the difficulty finding trustworthy and consistent advice bespoke to their needs.⁵¹²

We see this Heat and Buildings Strategy and its accompanying documents as a significant step toward improving awareness of the challenge ahead and the options and opportunities available for households, businesses, and industry to transition to energy efficient low-carbon heat systems.

We will review and improve our communications to ensure that the public have the information they need to make decisions that are best suited to their building and heating needs.

⁵⁰⁷ The Energy Technology List, available at: <https://etl.beis.gov.uk>.

⁵⁰⁸ BEIS (2020), 'Transforming heat: public attitudes research', Public Attitudes Tracker Wave 32 (<https://www.gov.uk/government/publications/transforming-heat-public-attitudes-research>).

⁵⁰⁹ CCC, (2019) 'Behaviour change, public engagement and Net Zero' (<https://www.theccc.org.uk/wp-content/uploads/2019/10/Behaviour-change-public-engagement-and-Net-Zero-Imperial-College-London.pdf>).

⁵¹⁰ Modassar Chaudry and others (2015), 'Uncertainties in decarbonising heat in the UK' (<https://orca.cf.ac.uk/75558/7/OA-20152016-43.pdf>).

⁵¹¹ BEIS (2020), 'Transforming heat: public attitudes research' (<https://www.gov.uk/government/publications/transforming-heat-public-attitudes-research>).

⁵¹² BEIS (2019), 'RHI evaluation interim report: applicant reaction to reform announcements' (<https://www.gov.uk/government/publications/rhi-evaluation-interim-report-applicant-reaction-to-reform-announcements>).

We communicate our broader approach to public engagement in our Net Zero Strategy⁵¹³. The Heat and Buildings Strategy and Net Zero Strategy should act as stepping stones towards generating widespread awareness and acceptance of the need to decarbonise how we heat buildings and make green choices.

6.5. Continuous improvement

We are committed to review and improve our policy and regulatory approach to decarbonisation. We will monitor and evaluate progress to remain on track for Net Zero.

To measure the effectiveness of our portfolio of action in the 2020s, we will continue to review and refine our approach to ensure it keeps us on track to deliver our carbon reduction commitments in a socially and economically responsible way. These include carbon budgets, our Nationally Determined Contribution (NDC) to the Paris Agreement, and our Net Zero target. In December 2020, the Prime Minister announced that the UK would increase its Nationally Determined Contribution (NDC) from 65% to 68-69% by 2030, to reflect a substantial increase in ambition. We will continue to iterate and develop policies to ensure that our targets are met.

The Prime Minister chairs the Cabinet Committee on Climate Change, which brings together ministers in England and galvanises action to meet our emission reduction commitments.^{514,515}

Recognising the need to decarbonise across all sectors, emissions reduction is one of the core measures that we assess our heating and energy efficiency policies against. Each year we publish updated [energy and emissions projections](#)⁵¹⁶ calculated through analysing and projecting future energy use and greenhouse gas emissions in the UK. These projections allow us to monitor progress towards meeting the UK's carbon budgets and are used to inform energy policy and associated analytical work across government departments.

Using the latest data on our policies and projects, we will continue to monitor and evaluate projected and achieved energy use and carbon emission reductions during planning and delivery. In this way, we will be able to strengthen and adapt our strategy over time to plot the optimal path to Net Zero, while reducing emissions and meeting our carbon budgets along the way. This includes considering the latest advice from the Climate Change Committee. Our response to the CCC's carbon budget 6 advice⁵¹⁷ was published alongside the Net Zero Strategy in October 2021.

⁵¹³ BEIS (2021), 'Net Zero Strategy' (<https://www.gov.uk/government/publications/net-zero-strategy>).

⁵¹⁴ In Wales, climate change is discussed at Cabinet every term, led by the First Minister. Over the next 12 months, Cabinet will be revising the legislative framework, updating emissions budgets and targets, delivering existing climate mitigation and adaptation plans, and developing the next All-Wales Low Carbon Delivery Plan (2021-2025).

⁵¹⁵ The DAERA Minister, Edwin Poots, will chair an inter-ministerial group to oversee development of the NI Executive's multi-decade Green Growth Strategy and associated Climate Action Plan for Northern Ireland. The Green Growth Strategy and associated Climate Action Plan will be Northern Ireland's routemap to climate action, green jobs and a clean environment. The Strategy will look out to 2050 and provide a pathway with sector-specific greenhouse gas emission targets. It will also set a pathway for a clean environment and green jobs. The associated Climate Action Plan will focus on shorter term actions across all sectors.

⁵¹⁶ BEIS (2013) 'Energy and emissions projections' (<https://www.gov.uk/government/collections/energy-and-emissions-projections>).

⁵¹⁷ CCC (2020), 'Sixth Carbon Budget' (<https://www.theccc.org.uk/publication/sixth-carbon-budget/>).

We will continue to monitor and track our progress to Net Zero and are committed to reviewing and improving our policy and regulatory approach to decarbonising buildings.

The emissions reductions contributions anticipated by key technology and building type are shown in figures 17 and 18.

Figure 17: Breakdown of estimated potential emissions savings from heating UK buildings by 2030, by building type

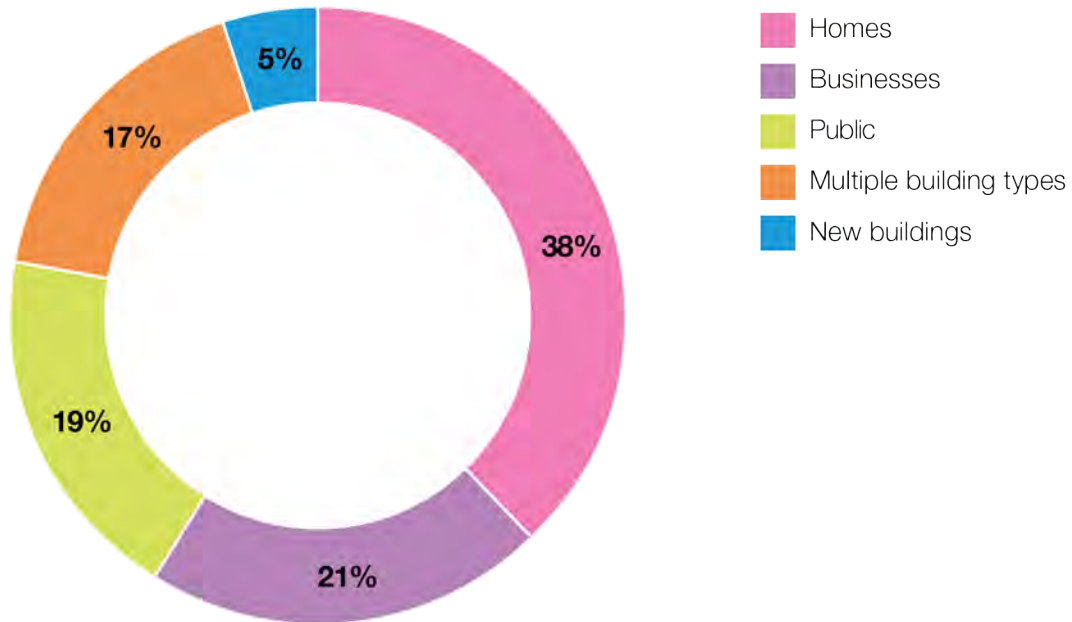


Figure 17 shows how current policies and projections seek to deliver emissions reduction by 2030 through addressing a range of building types.

Figure 18: Breakdown of estimated potential emissions savings from heating UK buildings by 2030, by technology type

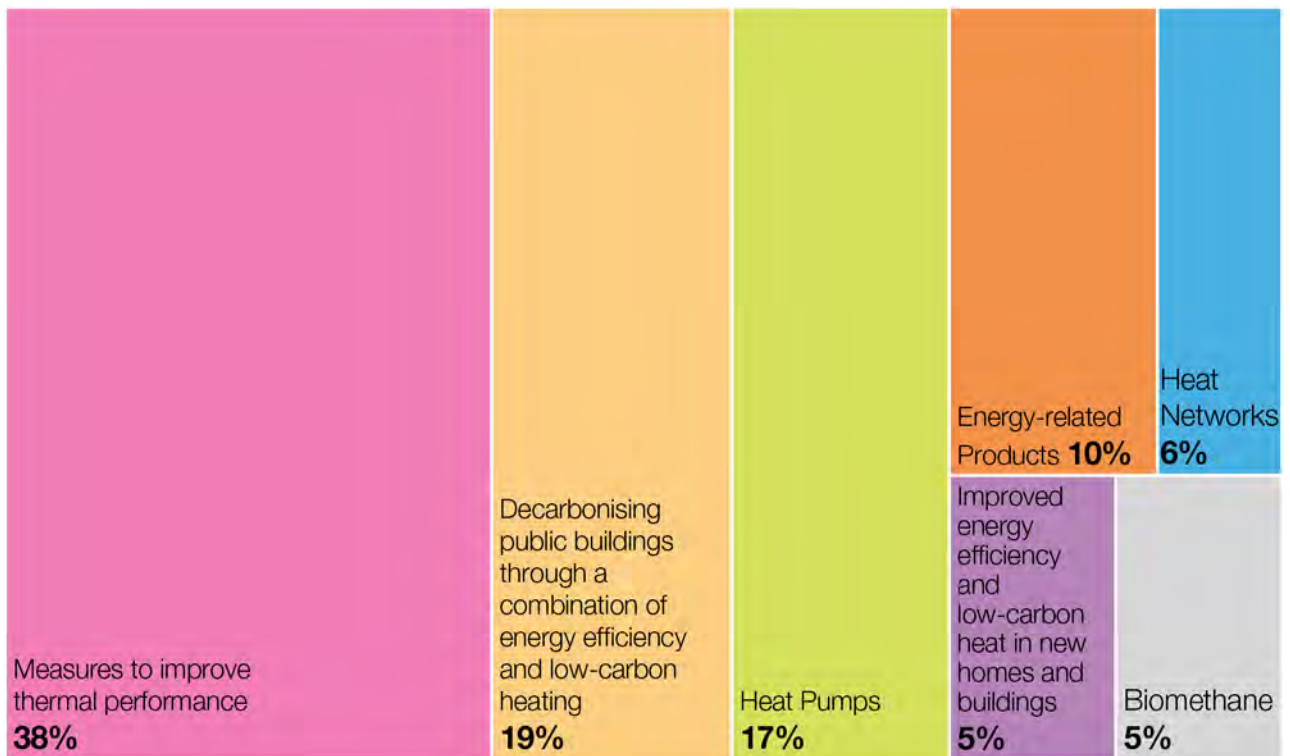


Figure 18 shows how current policies and projections seek to deliver emissions reduction by 2030 through using different technologies and heat sources.

Chapter 7: Conclusion

The UK is home to about 30 million buildings⁵¹⁸, which are responsible for around 30% of UK emissions⁵¹⁹. The majority of buildings still rely on burning high-carbon fossil fuels for heating, hot water and cooking, and have low thermal efficiency which means that much of the heat that is generated is wasted.

To reach our Net Zero target, in the next 30 years, we need to decarbonise the way we heat and cool our homes and workplaces to near zero (between 0 and 2 MtCO₂e). We also need to ensure that in the nearer-term we meet our fuel poverty targets and emission reduction targets.

The main ways we can achieve this are through:

- improving the energy efficiency of buildings
- switching high-carbon sources of heat (and cooling) to low-carbon alternatives

To deliver near and long-term benefits, we have developed 5 principles:

1. We will take a whole-buildings and whole-system approach to ensure decisions at any level are not made in isolation – they will consider the relevant interdependencies and impacts to create a secure, efficient, cost-effective energy system.

To achieve this, we will:

- encourage improvements to energy performance and use of low-carbon sources of heat (and cooling) to be considered together, where appropriate
- encourage the use of smart and flexible technologies at work and in the home
- continue to develop our approach on action to decarbonise heat alongside action to tackle climate change in other sectors

2. We will continue to invest in research and development to drive innovation, improve data collection, and inform policies at national, sub-national and local levels.

As part of our programme of research and innovation, we will:

- drive cost reduction and innovation in energy efficient and low-carbon technologies
- continue to develop, test and improve smart technologies and services

⁵¹⁸ National Statistics (2020), 'Households projections for England', table 401 (<https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/datasets/householdprojectionsforengland>).

And BEIS (2020), 'Non-domestic National Energy Efficiency Data-Framework' (<https://www.gov.uk/government/statistics/non-domestic-national-energy-efficiency-data-framework-nd-need-2020>).

⁵¹⁹ BEIS (2021), 'Final UK greenhouse gas emissions national statistics: 1990 to 2019' (<https://www.gov.uk/government/statistics/final-uk-greenhouse-gas-emissions-national-statistics-1990-to-2019>).

And BEIS (2020), 'Energy Consumption in the UK' (<https://www.gov.uk/government/statistics/energy-consumption-in-the-uk>).

- collect data to inform and prepare for increased deployment of heat pumps
 - use local expertise and data to encourage increased efficiency and decreased emissions associated with heat networks
 - continue to consider how hydrogen may be safely and cost-effectively used to heat buildings through local trials and planning work, which will inform strategic decisions on the role of hydrogen in heating by 2026
 - continue to research technologies which may play a smaller role in decarbonisation, such as hybrid heat pumps and bioenergy heating systems
3. We will accelerate ‘no and low-regrets’ actions needed in any scenario to continue to drive down emissions and meet our carbon budget targets.

As these activities are needed in all paths to Net Zero, we will:

- support industry to deliver a workforce with the skills to meet Net Zero
 - increase use of smart technologies, improve energy-related product policies, set minimum standards for existing homes and new-builds, and move to a performance-based rating for large and complex commercial and industrial buildings to improve building energy performance
 - futureproof buildings by setting high standards for new-builds and mitigating risks of overheating and poor ventilation leading to poor air quality
 - reduce direct emissions from public sector buildings, in line with our aim to reduce direct emissions from public sector buildings by 75% against a 2017 baseline by the end of carbon budget 6
 - stimulate and grow heat pump, heat networks, and green finance markets
4. We will clearly communicate upcoming regulatory changes so that households, businesses and industry can prepare in advance. We will ensure that we build flexibility and optionality for consumers into our policies, to help individuals and organisations decarbonise in the way that works for them.

In this strategy, we have committed to:

- explore how best to support improvement of owner-occupied houses
- consider setting new minimum energy performance standards in social housing, and to consult the sector before setting such a standard
- consult on minimum energy performance standards in owner-occupied commercial and industrial buildings across England and Wales
- support deployment of at least 600,000 hydronic heat pumps per year by 2028 through our proposed market mechanism⁵²⁰

⁵²⁰ BEIS (2021), ‘Market-based mechanism for low carbon heat’ (<https://www.gov.uk/government/consultations/market-based-mechanism-for-low-carbon-heat>).

- aiming to end new and replacement installations of natural gas boilers, including any hydrogen-ready boilers in areas not converting to hydrogen, from 2035
 - signal an end to high-carbon heat sources, subject to the outcomes of our consultations on off-gas-grid regulations^{521,522} and hydrogen-ready boilers
 - introduce heat network regulation as soon as possible
5. We will target our activities and policies to support those in most need to ensure that the decarbonisation of heat and buildings is accessible and affordable to all.

Therefore, we will:

- provide financial support in the early 2020s through a range of schemes including the Home Upgrade Grant and the Boiler Upgrade Scheme
- review the costs of decarbonisation and the difference in fuel costs, and work to ensure they are distributed in a socially and economically responsible way
- improve consumer protection
- increase public engagement through improved information and advice

By employing these principles, we can ensure that heat decarbonisation:

- is fair and cost-effective for individuals and the energy system as a whole
- allows us to meet our carbon budgets

⁵²¹ BEIS (2021), 'Phasing out fossil fuel heating in homes off the gas grid' (<https://www.gov.uk/government/consultations/phasing-out-fossil-fuel-heating-in-homes-off-the-gas-grid>).

⁵²² BEIS (2021), 'Phasing out fossil fuel heating systems in businesses off the gas grid' (<https://www.gov.uk/government/consultations/phasing-out-fossil-fuel-heating-systems-in-businesses-and-public-buildings-off-the-gas-grid>).

Annex 1: Descriptions of key heat sources

Technology	Description
Air source heat pumps	Extract heat from the outside air to heat your home and hot water.
Ground source heat pumps	Extract heat from pipes that are buried in the ground to heat your home and hot water.
Hybrid heat pumps	Combine heat pump and standard gas boiler technology to heat your home and hot water. Use of smart controls help optimise the system based on cost or efficiency.
Biomass boilers	Work in a similar way to a standard gas boiler to heat your home and hot water using a renewable energy source such as wood pellets as fuel.
Solar thermal panels	Capture heat from the sun to provide hot water, typically in a storage tank.
Hydrogen boilers	Work in a similar way to standard gas boilers to heat your home and hot water but use hydrogen gas rather than natural gas as fuel. This technology is not commercially available in the UK and is dependent on the extent to which hydrogen could replace natural gas in the gas grid.
Hydrogen-ready boilers	Optimally designed to run using 100% hydrogen gas but are initially configured for use with natural gas to heat your home and hot water. Minimal component conversion is required to convert appliances to use with hydrogen. This technology is not yet commercially available.
Heat networks	Provide heat or cooling from a central source and distribute it to multiple customers in a building or across several buildings.

Further details of these and other technologies can be found in section [3.1 Key technologies](#).

Annex 2: Current and planned activities for the 2020s

We have grouped each activity into

- *type of heat source*
- *measures to improve building energy performance and building-specific activities*

to demonstrate the comprehensive nature of our approach. We are committed to ensuring that no-one is left behind, providing solutions that work for all buildings, income groups and housing types.

Decarbonising heat

By spanning different technologies, heat sources, and distribution systems, these policies and projects can meet the variety of heat and energy efficiency requirements of UK homes and non-domestic buildings and provide options to consumers. The technology-specific themes for action in the 2020s are: heat pumps, heat networks, hydrogen for heat, and bioenergy.

Phasing out fossil fuels

Policy/project	Description	Location
Phasing out the installation of new natural gas boilers	Aiming to phase out the installation of new and replacement natural gas boilers from 2035, once costs of low-carbon alternatives have fallen, in line with the natural replacement cycle, including any hydrogen-ready boilers in areas not converting to hydrogen, to ensure that all heating systems used in 2050 are compatible with Net Zero.	England
Consultation on ending new connections to the gas grid	Consulting on whether it is appropriate to end gas grid connections to homes constructed from 2025, in favour of alternative low-carbon heat sources.	England
Consultation: off-gas-grid regulations for domestic buildings from 2026 ⁵²³	Potential introduction of regulations to end installation of new fossil fuel heating systems in existing off-gas-grid homes from 2026.	England

⁵²³ BEIS (2021), 'Phasing out fossil fuel heating in homes off the gas grid' (<https://www.gov.uk/government/consultations/phasing-out-fossil-fuel-heating-in-homes-off-the-gas-grid>).

Policy/project	Description	Location
Consultation: off-gas-grid regulations for non-domestic buildings from 2024 ⁵²⁴	A consultation on phasing out high-carbon fossil fuel systems for space heating and hot water in businesses and public buildings off the gas grid. We propose to end the installation of new fossil fuel systems from 2024 at the earliest for the largest buildings and bring the remaining stock into scope from 2026, using the natural replacement cycle and taking a heat pump first approach.	England

Heat pumps

Policy/project	Description	Location
Boiler Upgrade Scheme (from 2022 to 2025)	Provides upfront capital grants to households and small businesses to support the installation of air source and ground source heat pumps. Consultation closed July 2020, response published in parallel to this strategy. ⁵²⁵ Formerly known as the Clean Heat Grant.	England and Wales
Market-based mechanism for low-carbon heat ⁵²⁶	To create an incentive framework to drive market growth resulting in significantly increased deployment of hydronic heat pumps, supporting growth from around 35,000 to 600,000 installations (across domestic and non-domestic buildings) per year by 2028.	UK-wide proposal, subject to consultation
Local Authority Delivery (2020 to 2021)	Local authorities can support low income households to benefit from low-carbon heating upgrades through the Local Authority Delivery scheme.	England
Social Housing Decarbonisation Fund (2021) and Demonstrator (2020)	The Social Housing Decarbonisation Fund aims to upgrade a significant amount of the social housing stock that is currently below EPC C up to that standard, delivering warmer and more energy efficient homes, and reducing carbon emissions and bills, as well as supporting green jobs.	Demonstrator: UK Main scheme: England ⁵²⁷

⁵²⁴ BEIS (2021), 'Phasing out fossil fuel heating systems in businesses off the gas grid' (<https://www.gov.uk/government/consultations/phasing-out-fossil-fuel-heating-systems-in-businesses-and-public-buildings-off-the-gas-grid>).

⁵²⁵ BEIS (2021), 'Government response: Future support for low carbon heat' (<https://www.gov.uk/government/consultations/future-support-for-low-carbon-heat>).

⁵²⁶ BEIS (2021), 'Market-based mechanism for low carbon heat' (<https://www.gov.uk/government/consultations/market-based-mechanism-for-low-carbon-heat>).

⁵²⁷ Welsh Government is also funding the fitting of energy efficiency measures in up to 1,000 existing homes owned by registered social landlords and councils in Wales through their Optimised Retrofit Programme (<https://gov.wales/9-and-half-million-programme-reduce-housing-carbon-footprint>).

Policy/project	Description	Location
Home Upgrade Grant (2022 to 2025)	BEIS plan to introduce this grant in early 2022, which aims to deliver low-carbon heating and energy efficiency upgrades to low income off-gas-grid homes.	England
£14.6 million Electrification of Heat Demonstration project (live)	Innovation project to test the practical and technical feasibility of a large-scale roll-out of heat pumps by installing gas-electric, air-source and ground-source heat pumps in up to 750 homes (mainly on-gas-grid).	GB
£60 million within the Net Zero Innovation Portfolio	Investing £60 million in a Net Zero Innovation Portfolio (NZIP) 'Heat Pump Ready' Programme which will support the development of innovative solutions across the heat pump sector.	To be determined
Reinforcement of electricity networks	Work with Ofgem and DNOs to encourage timely and efficient reinforcement of electricity networks, for example through improving visibility of heat pump installations and engaging with Ofgem on the RIIO-ED2 price control (2023 to 2028) and ensure that heat pumps can be quickly and affordably connected to the network, for example by aligning DNO approaches to connections.	GB

Hydrogen

Policy/project	Description	Location
Hydrogen Trials	Deliver safety and feasibility testing, followed by a neighbourhood trial by 2023, village scale trial by 2025. We launched a consultation on facilitating a grid conversion hydrogen heating trial ⁵²⁸ in August 2021.	GB
Hy4Heat	Funded by BEIS' Energy Innovation Programme, an innovation programme exploring the safety and feasibility of using hydrogen for home heating. It includes development of hydrogen heating appliance prototypes including gas fires, cookers and boilers, the development of hydrogen gas meters, a safety assessment for certain types of houses, and technical studies and standards. Consultation on hydrogen-ready appliances to follow the conclusion of Hy4Heat research programme.	UK

⁵²⁸ BEIS (2021), 'Hydrogen for heat: facilitating a grid conversion hydrogen heating trial' (<https://www.gov.uk/government/consultations/hydrogen-for-heat-facilitating-a-grid-conversion-hydrogen-heating-trial>).

Policy/project	Description	Location
Hydrogen-ready boilers	We are looking to consult on our approach to hydrogen-ready boilers shortly.	Anticipated GB (TBD)
Hydrogen production	<p>We will work with industry to deliver our ambition for 1GW of low-carbon production capacity by 2025, and 5GW by 2030.</p> <p>We intend to launch the Net Zero Hydrogen Fund in early 2022.</p> <p>We will provide up to £60 million under the Low Carbon Hydrogen Supply 2 competition, and further Net Zero Innovation Portfolio (NZIP) competitions for hydrogen R&D will follow.</p> <p>We intend to finalise the design of a UK standard for low-carbon hydrogen by early 2022.</p> <p>We will develop further detail on our production strategy and twin track approach, including less developed production methods, by early 2022.</p>	UK
Hydrogen blending	<p>We are engaging with industry and regulators to develop the safety case, technical and cost-effectiveness assessments of blending up to 20% hydrogen into the gas network.</p> <p>We aim to provide an indicative assessment by autumn 2022, with a final policy decision likely to take place in 2023.</p>	GB

Heat networks

Policy/project	Description	Location
Green Heat Network Fund (2022 to 2025)	Following on from the Heat Network Investment Project, to incentivise the heat network market to adopt low-carbon heat sources and develop low-carbon heat networks. At least £270 million of our Heat Network Transformation Programme investment will be dedicated to the Green Heat Network Fund.	England ⁵²⁹
Heat Network (Metering and Billing) Regulations (from November 2020)	Regulations that ensure that more heat network customers are metered and billed accurately, based on their consumption – thereby enhancing consumer protection and driving energy efficiency.	UK
Heat network zoning	Local data-driven solutions that enable the identification of areas where heat networks are the lowest cost low-carbon solution, backed by legislative	England

⁵²⁹ In Scotland, equivalent schemes include the Low Carbon Infrastructure Transition Programme and District Heating Loan Fund.

Policy/project	Description	Location
	provisions to free up the growth of low-carbon heat networks infrastructure at scale. We are consulting on proposals to provide local authorities in England with powers to put in place heat network zones, requiring that some buildings connect to networks.	
Heat Networks Market Framework	Heat networks are not currently regulated. We will implement a market framework to reach three core outcomes: <ul style="list-style-type: none"> • consumer protection • market growth • decarbonisation of heating networks 	GB
Heat Networks Market Development	Creating the conditions to accelerate growth towards a self-sustaining heat networks market that does not require further government subsidy by: <ul style="list-style-type: none"> • attracting new entrants to the market and enabling market expansion • enabling market competition and effective choices by demonstration through data • helping industry to develop the right skillset across the supply chain and build capacity • linking up market players to form an independent ecosystem through building connections 	UK
Heat Network Skills Programme	A scheme to improve training and skills to build the capacity of supply chain to deliver increased growth.	England
Heat Networks Investment Project Domestic and Non-domestic (2018 to 2022)	Grant and loan investments to fund the development and construction of heat networks which supply both domestic and non-domestic customers.	England and Wales
Accessing low-carbon sources of heat	Working in partnership with devolved authorities and industry to support and develop a range of commercially viable low-carbon sources to come forward and supply heat networks. Examples include energy-from-waste plants, sewage systems and geothermal heat amongst others.	To be determined

Bioenergy

Policy/project	Description	Location
Grow UK biomethane gasification production capacity	<p>A £190,000 UK-funded Advanced Gasification Technologies (AGT) project (May 2020) was established to</p> <ul style="list-style-type: none"> • assess the reasons for the failure of previous AGT projects • identify the risks and barriers to successful development of commercial-scale AGT projects 	UK
Green Gas Support Scheme (2021 to 2025)	Will provide tariff-based support for biomethane injection produced from anaerobic digestion plants, replacing the non-domestic Renewable Heat Incentive for biomethane injection. Will support investment in UK biomethane industry. The scheme is expected to launch at the end of November 2021.	GB
Boiler Upgrade Scheme (from 2022)	Provides upfront capital grants to households and small businesses to support the installation of biomass boilers. Installations will need to be located in a rural area and not have an existing mains gas connection, as well as meet high standards for emissions, to mitigate any negative impact on air quality in line with the government's Clean Air Strategy. Consultation closed July 2020, response published in parallel to this strategy. ⁵³⁰	England and Wales

Using waste heat

Policy/project	Description	Location
Combined Heat and Power (CHP) policy call for evidence	<p>Call for evidence on future combined heat and power policy closed in September 2020.⁵³¹ A summary of responses was published in December 2020. We recently published a further call for evidence on how we support CHP in the future given our decarbonisation objectives, which is open to 20 December 2021.⁵³²</p>	UK

⁵³⁰ BEIS (2021), 'Government response: Future support for low carbon heat' (<https://www.gov.uk/government/consultations/future-support-for-low-carbon-heat>).

⁵³¹ BEIS (2020), 'Combined Heat and Power (CHP): the route to 2050 - call for evidence' (<https://www.gov.uk/government/consultations/combined-heat-and-power-chp-the-route-to-2050-call-for-evidence>).

⁵³² BEIS (2021), 'Combined heat and power: pathway to decarbonisation call for evidence' (<https://www.gov.uk/government/consultations/combined-heat-and-power-pathway-to-decarbonisation-call-for-evidence>).

Improving building energy performance

By delineating between building types, we can tailor policies to address the specific challenges and needs of that type of building. This section is organised into policies relevant to: energy-using products, new-builds, retrofitting and insulation, public sector, large and complex commercial and industrial buildings, and small businesses and small commercial buildings.

Energy-using products

Policy	Description	Location
Energy-related products policy framework, including energy labelling and ecodesign	This will include setting better minimum environmental performance standards for a range of products with high potential for emission reduction and bill savings, and encouraging greater uptake of more energy- and resource-efficient products, for example, through improved consumer information on labels, incentives for purchasing efficient products and other complementary policy levers.	GB (with NI following NI Protocol)
Energy Technology List	A government list of energy efficient products that meet the robust energy saving criteria. BEIS annually reviews the technologies and products that qualify for inclusion.	UK

New-builds

Policy	Description	Location
Future Homes Standard	A 75-80% reduction in carbon emissions from new homes compared to current standards, from 2025, with low-carbon heating and very high fabric standards.	England
Future Buildings Standard	Pathway to highly efficient new non-domestic buildings which use low-carbon heat.	England
Building Regulation Part L and F interim standards	Increase of energy performance standards for domestic and non-domestic buildings ahead of the Future Homes Standard and Future Buildings Standard, effective from June 2022.	England
Consultation on ending new gas connections in new dwellings	Consulting as to whether it is appropriate to end gas grid connections to homes constructed from 2025, in favour of alternative low-carbon heat sources.	England

Retrofitting and insulation

Policy	Description	Location
Local Authority Delivery (2020 to 2021)	Local authorities can support low income households to benefit from low-carbon heating upgrades through the Local Authority Delivery scheme.	England
Home Upgrade Grant (from 2022 to 2025)	BEIS are planning on the basis that the Home Upgrade Grant scheme will commence (after the LAD scheme) in 2022, and will deliver energy efficiency upgrades and low-carbon heating to low income households living in off-gas-grid homes.	England
ECO4 (2022 to 2028)	Support upgrading fuel poor homes and homes of those unable to pay.	GB
Review Decent Homes Standard	Review current criteria and how this could best support decarbonisation and improved energy efficiency of social homes, including the ambition set in the Clean Growth Strategy ⁵³³ .	England ⁵³⁴
Social Housing Decarbonisation Fund and Demonstrator (launched 2020)	The Social Housing Decarbonisation Fund aims to upgrade a significant amount of the social housing stock that is currently below EPC C up to that standard, delivering warmer and more energy efficient homes, and reducing carbon emissions and bills, as well as supporting green jobs.	Demonstrator: UK Main scheme: England ⁵³⁵
Private-rented sector minimum standards	All homes to meet EPC E rating by 2020 and EPC C rating by 2025 for new tenancies and by 2028 for all tenancies. We are aiming to publish a response to this consultation by the end of the year.	England and Wales
Mortgage lender requirements	We consulted on proposals to require mortgage lenders to disclose information regarding the EPC rating of their lending portfolios. We also proposed a voluntary target to reach an average of EPC band C across their mortgage portfolio by 2030, with the option of making this target mandatory if insufficient progress is being made.	England and Wales
Owner-occupied policy	We are also exploring opportunities to improve the energy performance of owner-occupier homes and plan to consult on options to upgrade homes in this sector.	England and Wales

⁵³³ BEIS (2017), 'Clean Growth Strategy' (<https://www.gov.uk/government/publications/clean-growth-strategy>).

⁵³⁴ The Welsh Housing Quality Standard includes a minimum energy standard of EPC band D. Currently over half of social homes are EPC band C or better as a result of this standard.

⁵³⁵ Welsh Government is also funding the fitting of energy efficiency measures in up to 1,000 existing homes owned by registered social landlords and councils in Wales through their Optimised Retrofit Programme (<https://gov.wales/9-and-half-million-programme-reduce-housing-carbon-footprint>).

Policy	Description	Location
Net Zero backstop for homes	We will consider an ultimate backstop date to ensure that all homes meet a Net Zero minimum energy performance standard before 2050, where cost-effective, practical and affordable.	England and Wales

Public sector buildings

Policy	Description	Location
£1 billion Public Sector Decarbonisation Scheme (2020/21)	We have committed to halve direct emissions from public sector buildings by 2032, against 2017 levels, and we aim to further reduce emissions from public sector buildings by 75% by 2037.	England and reserved public services across UK
Phase 2 Public Sector Decarbonisation Scheme (2021/22)	Further funding allocated to ensure our continued commitment to improve schools, hospitals and public sector buildings and reduce emissions.	England and reserved public services across UK
Public Sector Decarbonisation Scheme (2022/3-2024/5)	We are investing £1,425 million for the Public Sector Decarbonisation Scheme over 2022/23 to 2024/25.	England and reserved public services across UK
Greening Government Commitments	A set of sustainability targets for central government departments and their arm's-length bodies, which include targets on greenhouse gas emissions.	UK government departments (and their arms-length bodies)
Public Sector Low Carbon Skills Fund (2020/21)	Up to £32 million in funding in 2020/21 to support public sector organisations that do not have the expert skills to identify and develop projects that are eligible for the £1 billion Public Sector Decarbonisation Scheme. The fund helped them to make applications or deliver funded projects.	England and reserved public services across UK
Public Sector Low Carbon Skills Fund 2021/22	Up to £15m for eligible public sector bodies to develop heat decarbonisation plans for their estates.	England and reserved public services across UK

Large and complex commercial and industrial buildings

Policy	Description	Location
Performance-based framework	Developing and consulting on a mandatory framework for performance-based energy ratings for commercial and industrial buildings over 1,000m ² .	England and Wales, and potentially Scotland

Policy	Description	Location
Non-Domestic Private-Rented Sector Minimum Energy Efficiency Standards: EPC B	Developing amendments to the Energy Efficiency (Private Rented Property) (England and Wales) Regulations 2015 for the non-domestic private-rented sector in order to require increase to EPC band B by 2030, confirmed in our Energy White Paper ⁵³⁶ . Our consultation on setting the EPC band B standard ran from October 2019 to January 2020. ⁵³⁷ We have consulted on how to enforce this target. ⁵³⁸	England and Wales
Best practice specification for the installation of energy efficiency measures – PAS2038	Worked with BSI to establish a new framework specifying requirements for the installation of energy efficiency measures in non-domestic buildings. This was published in August 2021.	To be determined
Energy Savings Opportunity Scheme	A mandatory energy assessment scheme for large UK businesses' energy use and energy efficiency opportunities at least every four years. In July 2021, we published a consultation on strengthening ESOS ⁵³⁹ .	UK
Streamlined Energy and Carbon Reporting (2019 onwards)	Legislation requiring all large or listed UK businesses to report their annual carbon emissions and energy usage in Annual Reports submitted to Companies House.	UK
Climate Change Agreements (2013 to 2025) ⁵⁴⁰ and Climate Change Levy Consultation and Regulation	Voluntary agreements made by high-energy-using UK industry to reduce energy use and carbon emissions. In return, operators receive a discount on the Climate Change Levy, a tax added to electricity and fuel bills.	UK

⁵³⁶ BEIS (2020), 'Energy white paper: Powering our net zero future' (<https://www.gov.uk/government/publications/energy-white-paper-powering-our-net-zero-future>).

⁵³⁷ BEIS (2019), 'Non-domestic Private Rented Sector minimum energy efficiency standards: future trajectory to 2030' (<https://www.gov.uk/government/consultations/non-domestic-private-rented-sector-minimum-energy-efficiency-standards-future-trajectory-to-2030>).

⁵³⁸ BEIS (2021), 'Non-domestic Private Rented Sector minimum energy efficiency standards: EPC B implementation' (<https://www.gov.uk/government/consultations/non-domestic-private-rented-sector-minimum-energy-efficiency-standards-epc-b-implementation>).

⁵³⁹ BEIS (2021), 'Strengthening the Energy Savings Opportunity Scheme (ESOS)' (<https://www.gov.uk/government/consultations/strengthening-the-energy-savings-opportunity-scheme-esos>).

⁵⁴⁰ Environment Agency (2014), 'Climate change agreements' (<https://www.gov.uk/guidance/climate-change-agreements--2>).

Small businesses and small commercial buildings

Policy	Description	Location
Outputs from the Boosting Access for SMEs to Energy Efficiency competition	£6 million competition in 2019 to develop innovative solutions that encourage the take up of energy efficiency and reduce barriers to SMEs. UK business could apply for an energy efficiency assessment through one of the participating projects and apply for funding to install energy efficiency measures anywhere in the UK. Competition has now closed to new applicants.	UK
Non-Domestic Private-Rented Sector Minimum Energy Efficiency Standards: EPC B	Developing amendments to the Energy Efficiency (Private Rented Property) (England and Wales) Regulations 2015 for the non-domestic private-rented sector in order to require increase to EPC band B by 2030, confirmed in our Energy White Paper ⁵⁴¹ in 2020. Our consultation on setting the EPC band B standard ran from October 2019 to January 2020. ⁵⁴² We have consulted on how to enforce this target. ⁵⁴³	England and Wales
Market mechanism for low-carbon heat ⁵⁴⁴	Some of the 20% to 30% of non-domestic buildings that have the same size characteristics and heat profile of domestic buildings will be able to benefit from the domestic market-based mechanism for heat pumps.	UK-wide proposal, subject to consultation
Non-domestic owner-occupied minimum standards	We are aiming to consult later this year on policy options to upgrade owner-occupied commercial and industrial buildings. We are currently considering the potential role of minimum energy efficiency standards at trigger points.	England and Wales

⁵⁴¹ BEIS (2020), 'Energy white paper: Powering our net zero future' (<https://www.gov.uk/government/publications/energy-white-paper-powering-our-net-zero-future>).

⁵⁴² BEIS (2019), 'Non-domestic Private Rented Sector minimum energy efficiency standards: future trajectory to 2030' (<https://www.gov.uk/government/consultations/non-domestic-private-rented-sector-minimum-energy-efficiency-standards-future-trajectory-to-2030>).

⁵⁴³ BEIS (2021), 'Non-domestic Private Rented Sector minimum energy efficiency standards: EPC B implementation' (<https://www.gov.uk/government/consultations/non-domestic-private-rented-sector-minimum-energy-efficiency-standards-epc-b-implementation>).

⁵⁴⁴ BEIS (2021), 'Market-based mechanism for low carbon heat' (<https://www.gov.uk/government/consultations/market-based-mechanism-for-low-carbon-heat>).

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