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FILLING THE GAP – TRANSFORMING ENERGY EFFICIENCY IN BRITAIN'S HOMES

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Summary

The domestic buildings sector is a major contributor to total UK emissions and reducing emissions from this sector is a key priority for reaching Net Zero.[1] In addition to delivering on Net Zero, achieving higher levels of energy efficiency improvements in this sector also offers benefits to households in the form of lower bills and / or warmer homes. Progress to date in the domestic buildings sector has been slow: the Climate Change Committee (CCC)'s 2022 Progress Report highlighted that there had been no sustained progress in reducing emissions from buildings in the last decade, due to low levels of home energy efficiency improvements.[2]

The UK Government has now announced its ambition to reduce energy demand from domestic buildings and industry by 15% by 2030, against 2021 levels (a '15% energy efficiency target').[3] At the same time, the Government also announced an additional public funding commitment of £6 billion to be made available for achieving energy efficiency improvements from 2025 to 2028 ('£6 billion public funding'). Frontier Economics has been commissioned by WWF and ScottishPower to assess the level of energy efficiency measures required to deliver the 15% energy efficiency target in the domestic buildings sector in Great Britain[4], as well as a more ambitious target of a 20% reduction, and to identify where additional policies are required to deliver these.

As part of this work:

- We estimate the level of energy efficiency measures, including a range of insulation measures, heat pumps, connection to heat networks, and solar panels required to deliver a 15% and 20% energy efficiency target, drawing on evidence on the technology mix modelled in the CCC's Sixth Carbon Budget (Balanced Pathway Scenario)[5]. This modelling focuses particularly on deployment of measures across *existing homes*, where the potential policy gap is largest, but we

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1 The buildings sector accounted for 20% of total UK emissions in 2021. Almost 80% of these emissions were from residential buildings. Climate Change Committee (June 2022), 2022 Progress Report to Parliament, Figure 4.1.

2 Climate Change Committee (June 2022), 2022 Progress Report to Parliament, page 156.

3 UK Government (November 2022), Autumn Statement 2022.

4 The Government's 15% energy efficiency target applies across domestic buildings and industry. For the purposes of this work, we focus on the domestic buildings sector, which is the focus of the WWF and ScottishPower partnership. We also assume that the 15% target applies to domestic buildings, rather than making alternative assumptions about the way the target might be split across the domestic and industry sectors (for example, whether a relatively larger target should be met through one sector with a relatively lower target met through the other sector such that the overall target of 15% is met across both sectors combined). We do not consider changes in energy demand used for transport as part of this work. Since DUKES records energy consumption for the domestic and transport sectors separately, we assume that any projected increase in electricity demand in transport (e.g. from the take-up of Electric Vehicles) will be excluded from the Government's assessment of progress towards the 2030 target on the domestic buildings side. This approach is also consistent with the CCC's demand projections for the 6th Carbon Budget which treats energy demand for the buildings and transport sectors separately.

5 The Balanced Pathway can be interpreted as the CCC's central recommendation for meeting Net Zero. The CCC describes it as follows: "*We have developed a Balanced Pathway as the basis for our recommended Sixth Carbon Budget and the UK's NDC. The Balanced Pathway makes moderate assumptions on behavioural change and innovation and takes actions in the coming decade to develop multiple options for later roll-out (e.g. use of hydrogen and/or electrification for heavy goods vehicles and buildings). While it is not a prescriptive path that must be followed exactly, it provides a good indication of what should be done over the coming years*." Climate Change Committee (December 2020), The UK's path to Net Zero, page 24.

also include a qualitative assessment of potential policy gaps in other areas such as for new homes and in non-heating energy use. Throughout this indicative analysis, we make simplifying assumptions on the likely mix of measures that may be deployed, and we take a relatively simplified approach to calculating the energy savings associated with different levels of deployment. To do this, we draw on the CCC's published information on the modelled levels of deployment in its Balanced Pathway Scenario and on the energy savings associated with different low carbon technologies.

- We then compare the required deployment in existing homes to meet the 15% energy efficiency target and the stretch 20% target respectively with the potential level of deployment implied under existing policies, distinguishing between what we refer to as "committed policies" and "planned policies", reflecting the degree of uncertainty around the deployment associated with the policy.

We completed the main part of our analysis before the Government published its 'Powering up Britain' initiative at the end of March 2023, but we have noted the consistency between these publications and the policies previously set out by the Government relating to energy efficiency and heat decarbonisation strategy for domestic buildings. We have updated our analysis to factor in the impact of the following key announcements:

- The confirmation of the Government's plans around a new ECO+ scheme (now branded as the Great British Insulation Scheme);
- The plans to roll forward the existing Boiler Upgrade Scheme for another three years (running until 2028) albeit with no detail on the precise allowances and overall budgeting around this; and
- Additional funding for the existing Heat Networks Transformation Programme.

These changes do not materially affect the results of this analysis. This is because these announcements do not constitute a significant expansion of these schemes, over and above what we already had factored into our analysis.[6]

Our work draws on published scenarios and policy analysis to assess the gap in meeting the 15% target for 2030 (and the 20% stretch target). In several areas, there is a large degree of uncertainty around the future effectiveness of policies and measures. Where this is the case, we err on the side of optimism on the timely implementation and likely effectiveness of policies. For example, we use estimated deployment from the Government's published impact assessments for policies, and do not, for example, make any downwards adjustments to take account of any current evidence of actual ongoing scheme performance under-shooting these projections.[7] This means that we are more likely to have underestimated the size of the gap than overestimated it.

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6 The Great British Insulation Scheme sets out the intention to upgrade c. 300,000 homes and replaces ECO+ which was aimed at upgrading over 410,000 homes. The additional £220m funding for the Heat Network Transformation Programme could translate to c. 126,000 homes connected to district heat, assuming a similar cost per home as the Green Heat Network Fund.

7 For example, we have not adjusted projected Impact Assessment figures on the Boiler Upgrade Scheme for outturn uptake of the scheme in in its initial months.

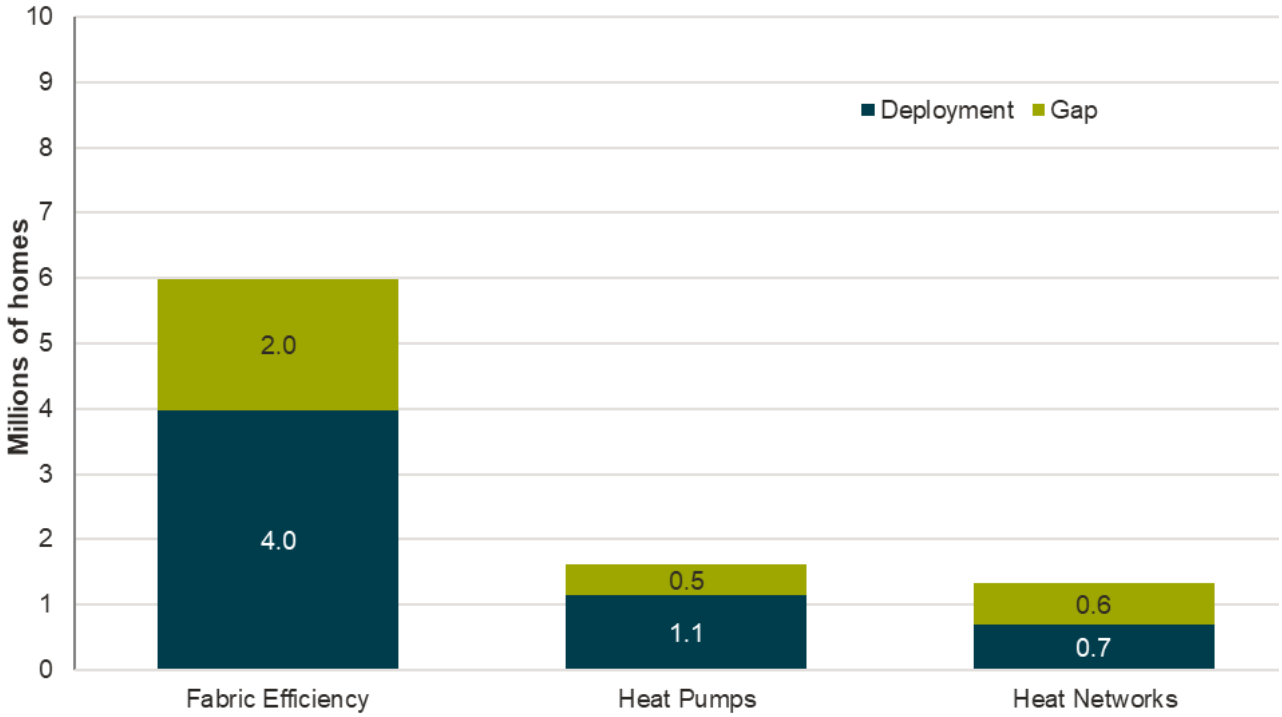
There is also a large degree of uncertainty over the optimal technology mix to meet the targets. We have not assessed this optimal mix as part of this project. Instead, the mix of energy efficiency measures and low carbon heating options is based on the CCC's Balanced Pathway.

Under this analytical approach and these assumptions, we have found that:

- **The 15% energy efficiency target is less ambitious than the CCC's Balanced Pathway Scenario (which would imply a reduction closer to the stretch target of 20%).**
- **There is a material gap to reaching the 15% target based on committed policies.** Focussing on the existing housing stock, achieving the 15% target would require an additional 4.9m fabric efficiency retrofits, 1.5m heat pump installations and 0.6m heat network connections within the existing housing stock.
- **Even if all currently planned policies are implemented (in addition to policies currently committed to) and perform as expected, there is still a significant gap to reaching the 15% target.** Again, focussing on the existing housing stock, we estimate that committed and planned policies together have the potential to deliver 66% of required fabric efficiency deployment in existing homes, 70% of the required deployment of heat pumps in existing homes and 52% of the required deployment in heat networks for existing homes (see Figure 1). In this regard, we would highlight that the category of 'planned policies' takes into the account the additional £6 billion public funding to be allocated to energy efficiency from 2025 to 2028 as announced at the Autumn Statement in 2022. Moreover, for the purposes of this analysis, we have assumed that this entire sum is spent during this period on improving the energy efficiency of the existing domestic housing stock (i.e. with none of it being committed to policies to promote energy efficiency in the non-domestic sector or indeed in the public buildings sectors).[8]

[8] There is uncertainty as to whether and how this funding will be spent so we follow a simplified approach in order to illustrate the potential impact on the policy gap by converting the £6 billion funding to the number of homes receiving energy efficiency upgrades using the average cost to upgrade a home to an EPC C rating, and assuming a similar number of heat pumps are delivered as projected under the ECO4 scheme. We explain our assumptions further under the Methodology section of our report.

Figure 1 Potential deployment gap relative to committed and planned policies – 15% target



- Accounting for the potential additional deployment resulting from 'planned' policies reduces the potential gap. However, there is uncertainty around whether and how these policies will be implemented and in practice, there is also a risk of existing committed policies under-delivering. If committed and / or planned policies are not implemented in a timely way or do not perform as expected, then there is a material risk that the projected delivery levels will not be reached, thereby increasing the size of the gap.

- If a more ambitious target of 20% was to be assumed, and all committed and planned policies were accounted for, we estimate that an additional 5.4m existing homes would require fabric efficiency retrofits, an additional 1.4m existing homes would require heat pumps and a further 1.4m existing homes would require connecting to a heat network.

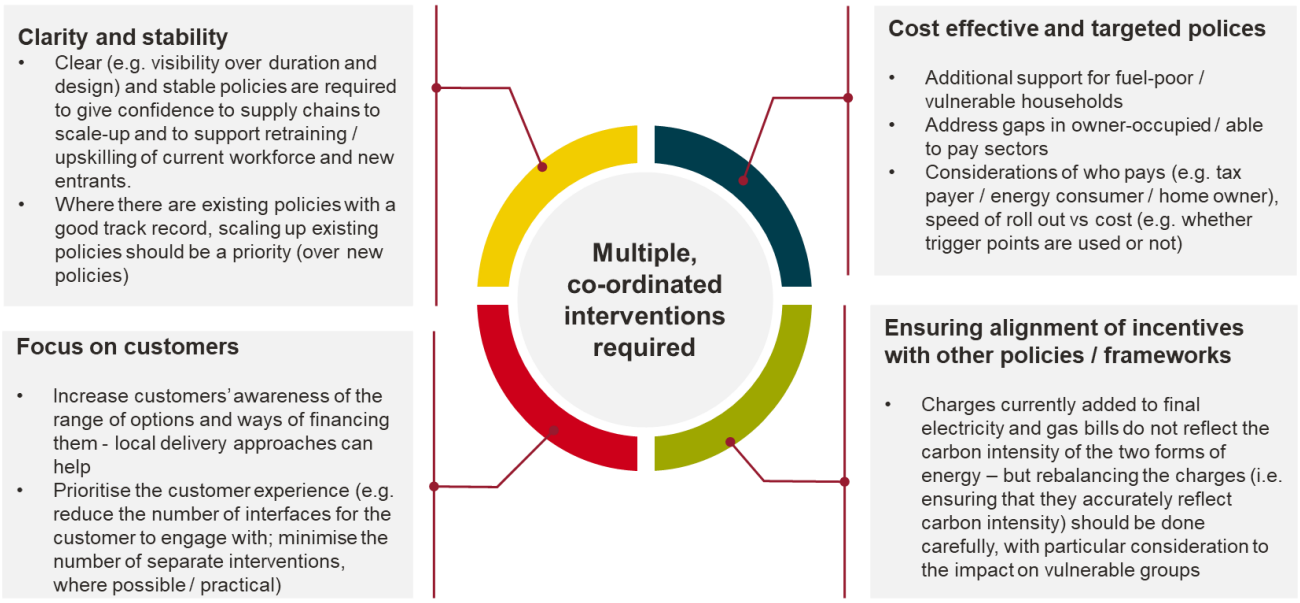
In assuming that all committed and planned policies deliver as modelled / projected we are taking a generous or optimistic approach – for example, early evidence from existing schemes such as the Boiler Upgrade Scheme indicates that actual deployment over the lifetime of the schemes could be lower than projected. In this context, we would note that to be successful a policy programme needs to overcome multiple complex barriers over time, including:

- Supply side barriers (e.g. lack of trained installers);
- Behavioural barriers (e.g. low consumer awareness and confidence from households);

- Economic barriers (e.g. inadequate investment incentives or misaligned incentives in the rental sector between landlord and tenant); and
- Policy barriers (e.g. policy instability over time and /or a lack of long-term certainty around policy frameworks).

Multiple co-ordinated policy interventions will be needed, but it is crucial that these are underpinned by a clear and stable framework. In particular, this is needed to give confidence to supply chains to scale-up and to support a sustained programme of retraining / upskilling of the current workforce, as well as attracting new entrants to the industry. This also needs to be complemented with smarter ways of engaging with households, including developing further incentives for them to improve the energy efficiency of their homes (see Figure 2).

Figure 2 Multiple co-ordinated interventions required



As part of this programme of multiple co-ordinated policy interventions, reaching the target will require all currently planned policies envisaged in the UK Government's Heat and Buildings Strategy (as well as the similar plans of the Scottish and Welsh Governments) to be implemented effectively and in a timely way.[9] In addition, further support and steps beyond planned policies will be required. Where there are existing policies with a good track record, scaling up these policies should be a priority (over creating new policies), but new major policies are likely to be required in some areas. We summarise

9 For example, this includes the proposals to update the Private Rented Sector minimum standards, effective deployment of the £6 billion public funding commitment for 2025-28, the phase-out of fossil fuels in off gas grid homes, the timely introduction of the Future Homes Standard, and the introduction of the Clean Heat Market Mechanism.

in Table 1 below the key policies that could be implemented to help fill the gap.[10] In regard to this table we note that:

- We have not reviewed the detailed design of individual policies, and we are not commenting on whether any individual policy has been optimally designed (for example, in terms of its cost efficiency, effectiveness or distributional consequences). Instead, we are considering each policy's scale and the potential impact it could have on the gap.
- The choice of policies included in the table is driven by our assumption that the target is met in line with the technology mix modelled as part of the CCC's Balanced Pathway scenarios, rather than any Frontier modelling on the optimal technology mix.

[10] This table captures the key policies to fill the gap. More detail on some of the specific early stage proposals that are being considered by Government can be found in Table 4.

Table 1 Policies that could fill the gap

	Committed policies	Gap to 15% target after committed policies	Implement planned policies	Gap to 15% target under committed and planned	Scaling up policies	New major policies[11]
Fabric efficiency	■ Energy Company Obligation (ECO4) ■ GB Insulation Scheme ■ Social Housing Decarbonisation Fund (SHDF) ■ Local Authority Delivery Phase 3 (LAD3) Home Upgrade Grant Phases 1 and 2 (HUG1/HUG2) ■ NEST Warm Homes ■ Scotland's Energy Efficiency policies[12]	4.9m homes	■ Strengthening Private Rented Sector Minimum standards (from 2025 for change of tenancy; from 2028 for all homes)[13] ■ Effective allocation of £6 billion public funding (2025-28)	2.9m homes before £6 billion funding 2.0m homes after £6 billion funding	■ Scaling up support for energy efficiency upgrades, particularly for low-income households (e.g. additional waves of ECO or Social Housing Decarbonisation Fund) ■ Policies targeting lower cost / single or coupled measures for a wide group of households (e.g. a form of scale-up of the GB Insulation Scheme)	■ Additional policies for the owner occupied / 'able-to-pay' segment, (e.g. regulations or incentives at key trigger points such as an Energy Savings Stamp Duty incentive, upfront grants or extensions of the GB Insulation Scheme). ■ Awareness programme to encourage wide-spread take-up of lower cost measures such as draught proofing / hot water tank insulation

11 This also includes significant changes in scope to existing policies.

12 We refer to 'Scotland's Energy Efficiency Policies' to capture the Social Housing Net Zero Fund, Home Energy Scotland (HES) loans, Warmer Homes Scotland (WHS) and Area Based Schemes (ABS) Programme.

13 See DESNZ (September 2020), Improving the Energy Performance of Privately Rented Homes in England and Wales – Consultation Stage Impact Assessment and Scottish Government, Policy actions: Energy efficiency in homes.

	Committed policies	Gap to 15% target after committed policies	Implement planned policies	Gap to 15% target under committed and planned	Scaling up policies	New major policies[11]
						■ Continued work with mortgage lenders on voluntary energy performance standards will be a useful complement to wider policies.[14]
Heat pumps	■ Boiler Upgrade Scheme for 2022-2025[15]	1.5m homes	■ Phase-out installation of fossil fuel heating in off-gas grid homes from 2025 (England / Wales and Scotland)[16] ■ Clean Heat Market Mechanism from 2024	0.6m homes before £6 billion funding 0.5 homes after £6 billion funding	■ Scaling up support for heat pumps (e.g. Boiler Upgrade Scheme)[17] ■ Progress effectively with the Clean Heat Market Mechanism through the decade	■ Rebalancing policy costs on consumer gas and electricity bills / carbon taxing costs from mid-2020s ■ Policies to ensure growth / readiness of supply chain and skilled workforce

14 The Government is considering a voluntary minimum requirement for mortgage lenders, although we note the Climate Change Committee's 2022 progress report recommends a stronger incentive mechanism, such as a policy requiring EPC C from 2028 at the point of sale and/or a mandatory minimum requirement for mortgage lenders (see Climate Change Committee (June 2022), 2022 Progress Report).

15 We note that the *Powering Up Britain* policy papers refer to the intention to use some of the £6 billion funding for 2025-28 (which was previously announced in the Autumn Statement) to extend the Boiler Upgrade Scheme for three years to 2028. However, this announcement does not change this analysis since our analysis includes an assumption about the potential deployment of heat pumps / fabric efficiency measures using the £6 billion funding under the category of 'planned policies'.

16 We note that in Scotland the phase-out of installations of gas boilers in existing homes is planned from 2030.

17 Although the *Powering Up Britain* policy paper announced that the Boiler Upgrade Scheme would be extended by three years to 2028, no detail on the precise allowances and overall budgeting around this has yet been committed to.

	Committed policies	Gap to 15% target after committed policies	Implement planned policies	Gap to 15% target under committed and planned	Scaling up policies	New major policies[11]
			■ Effective allocation of £6 billion public funding (2025-28)			
Heat networks	■ Green Heat Network Fund / Heat Networks Transformation Programme ■ Heat Networks (Scotland) Act 2021, including the Scotland Heat Network Fund	0.6m homes		0.6m homes	■ Scaling up support for heat networks (e.g. Green Heat Network Fund and Heat Networks Transformation Programme in England/ Heat Network Fund in Scotland)	■ Progress proposals for heat network zoning in England as appropriate[18]
New homes	■ Future Homes Standard in England should be implemented from 2025 and strengthened home standards in Scotland and Wales from 2025 at latest, including ending connections to the gas grid for new homes.[19] ■ Policies to ensure growth / readiness of supply chain and skilled workforce are also required.					

18 In October 2021, DESNZ consulted on proposals for the implementation of heat network zones. DESNZ is currently running a Heat Networks Zoning Pilot programme to deliver heat networks in zones where they provide lowest cost (see DESNZ (November 2022), Guidance: Heat Networks Zoning Pilot).

19 See Climate Change Committee (June 2022), Progress Report to Parliament, page 181, 193. The current ambition in Scotland is that new homes must use heating with zero direct emissions and have high fabric efficiency from 2024. In Wales new social homes need to be EPC A and not rely on fossil fuel heating and there are plans for similar standards to apply to all new homes from 2025.

1 Introduction

The domestic buildings sector is a major contributor to total UK emissions and reducing emissions from this sector is a key priority for reaching Net Zero.[20] However, the Committee Climate Change Committee's (CCC) 2022 Progress Report highlighted that there has been no sustained progress in reducing emissions from buildings in the last decade due to low annual levels of home energy efficiency improvements.[21] In addition to delivering on Net Zero, achieving higher levels of energy efficiency improvements in the domestic buildings sector also offers important benefits to households in the form of lower bills and / or warmer homes.

In its Autumn Statement in November 2022, the UK Government announced its ambition to reduce energy demand from domestic buildings and industry by 15% by 2030, against 2021 levels (a '15% energy efficiency target').[22] At the same time, the Government also announced an additional public funding commitment of £6 billion to be made available for achieving energy efficiency improvements from 2025 to 2028.

We have been commissioned by WWF and ScottishPower to assess the level of energy efficiency measures required to deliver the 15% energy efficiency target, as well as a more ambitious target of 20% reduction, and to identify where additional policies are required to deliver these.

In this chapter we set out the scope of the project, as well as the structure of the remainder of this report.

1.1 Scope of this project

We first summarise the scope of this project.

- **Domestic buildings.** The UK Government's 15% energy efficiency target is intended to apply to both domestic buildings and industry across the UK. It could be achieved by some mix of, for example, a 20% reduction in the domestic buildings sector and a 6% reduction across the industry sector.[23] For the purposes of this work, we assume that the target of 15% applies to domestic buildings (rather than considering alternative hypothetical assumptions about whether a relatively larger target should be met through one sector with a relatively lower target met through the other sector). We also do not consider changes in energy demand used for transport as part of this work. Since DUKES records

20 The buildings sector accounted for 20% of total UK emissions in 2021. Almost 80% of these emissions were from residential buildings. Climate Change Committee (June 2022), 2022 Progress Report to Parliament, Figure 4.1.

21 Climate Change Committee (June 2022), 2022 Progress Report to Parliament, page 156.

22 UK Government (November 2022), Autumn Statement 2022.

23 Given the scale of the challenges ahead in the industry sector it might well be anticipated that the Government's 15% target implies over-achievement in the domestic buildings sector to offset a less than 15% reduction in the industry sector by 2030.

energy consumption for the domestic and transport sectors separately, we assume that any projected increase in electricity demand in transport (e.g. from the take-up of Electric Vehicles) will be excluded from the Government's assessment of progress towards the 2030 target on the domestic buildings side. This approach is also consistent with the CCC's demand projections for the 6th Carbon Budget which treats energy demand for the buildings and transport sectors separately.

- **GB-wide analysis.** The scope of this work is focused on Great Britain, given the different policy context in Northern Ireland. We therefore assume that the UK Government's 15% energy efficiency target applies to Great Britain (and do not consider alternative allocations of the target across the UK as a whole).

- **2021 baseline.** The Government has announced that the 15% energy efficiency target will be set relative to a 2021 starting level. We therefore use DUKES data on final domestic energy consumption to derive the 2021 starting level.[24] However, we note that the level of domestic energy consumption in 2021 was significantly affected by the impacts of the COVID-19 pandemic arising from high levels of home working, thereby leading to higher energy consumption in homes compared to the immediately previous years. Setting the target based on the 2021 baseline will imply a more ambitious level of absolute savings to be achieved (relative to setting the target based on the 2019 level of consumption, prior to the COVID-19 pandemic). For example, achieving a target of a 15% reduction based on the 2021 baseline would be equivalent to achieving a reduction of 16% using the 2019 baseline.[25]

- **Technology mix.** There is also a large degree of uncertainty over the optimal technology mix to meet the targets. We have not assessed this optimal mix as part of this project. Instead, the mix of energy efficiency measures and low carbon heating options is based on the CCC's Balanced Pathway.

- **Heating savings from existing housing stock.** The focus of our modelling is on energy savings in the existing housing stock (rather than new buildings) and on energy consumption from heating (rather than non-heating purposes such as appliances, lighting etc), since these areas account for the largest share of the housing stock and energy consumption, and have the highest potential for further demand reduction. However, our analysis includes a high level estimate of the contribution to energy consumption arising

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24 We assume a starting level of final GB energy consumption of c. 449 TWh in 2021, which includes gas, electricity, oil and heat consumption. We do not consider energy consumption from coal / petroleum and bioenergy & waste (c. 4% of domestic UK consumption in 2021 according to DUKES). We have also made an adjustment to the UK-wide DUKES figures to remove Northern Ireland's domestic consumption using data from the CCC on gas, electricity and oil consumption.

25 Domestic energy consumption of gas, electricity, oil and heat in 2019 was c. 418 TWh relative to c. 449 TWh in 2021 (calculated based on data from DUKES (July 2022), Energy consumption by final user (energy supplied basis), 1970 to 2021 (DUKES 1.1.5) and CCC (December 2021), Sixth Carbon Budget - Dataset for data used to make an adjustment to remove Northern Ireland consumption). A 15% saving using the 2021 baseline therefore implies c. 67 TWh of energy savings. If this absolute level of saving were achieved and the target was measured against the 2019 baseline, an overall reduction of 16% (relative to 2019) would have been achieved.

from additional demand from new homes as well as changes in energy consumption non-heating (see Chapter 2 below for a detailed description of our approach).

- **Deployment associated with policies.** Our work draws on published scenarios and policy analysis to assess the remaining gap to meeting the 2030 target. However, we note that:
  - In several areas, there is uncertainty around the future effectiveness of policies and measures. Where this is the case, we have erred on the side of optimism on the likely effectiveness of policies. For example, we use estimated deployment from the impact assessment for policies, and do not make adjustments for actual ongoing scheme performance.[26] This means that we are more likely to have underestimated the size of the gap than overestimated it.
  - We have not reviewed the detailed design of individual policies, and we are not commenting on whether any individual policy has been optimally designed (for example, in terms of its cost efficiency, effectiveness or distributional consequences). Instead, we are considering each policy's scale and the potential impact it could have on the gap.

We completed the main part of our analysis before the Government's suite of publications at the end of March 2023 as part of the 'Powering up Britain' initiative, which set out its plans to enhance energy security and deliver on Net Zero. We have noted the consistency between these publications and the policies previously set out by the Government in the area of energy efficiency and heat decarbonisation strategy for domestic buildings. More specifically, we have updated our analysis to factor in the impact of the following key announcements:

- **The Great British Insulation Scheme.** The Government has confirmed their plans around a new ECO+ scheme (now branded as the Great British Insulation Scheme) which sets out the intention to upgrade c. 300,000 homes[27,28];
- **Extension of the Boiler Upgrade Scheme.** There are plans to roll forward the existing Boiler Upgrade Scheme for a further three years beyond 2025 (running until 2028). However, since there is no detail on the precise allowances and overall budgeting around this, our analysis does not factor in additional heat pump deployment, above what was anticipated to be delivered through this scheme prior to the Powering Up Britain announcement; and

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26 For example, we have not adjusted projected Impact Assessment figures on the Boiler Upgrade Scheme for outturn uptake of the scheme in its initial months.

27 DESNZ (March 2023), Powering up Britain Policy Paper, page 8.

28 The Government Impact Assessment for ECO+ indicated an intention to upgrade over 410,000 homes (see DESNZ (December 2022), ECO+ Consultation Stage Impact Assessment). However, we note that the funding amount of £1 billion allocated to ECO+ (see DESNZ (December 2022), ECO+ Consultation Stage Impact Assessment, page 12) is the same as the funding allocated to the Great British Insulation scheme (see DESNZ (March 2023) Powering up Britain Policy Paper, page 8).

- **Heat Network Transformation Programme:** The Government has announced additional funding of £220m for the existing Heat Network Transformation Programme over 2025/6 and 2026/7. This funding could translate to c. 126,000 homes being connected to district heat, if we assume the same cost per home as for the Green Heat Network Fund.[29]

While these changes are positive, their associated potential deployment (i.e. number of homes upgraded) is small relation to the overall gap.

1.2 Structure of this report

The rest of this document is structured in the following way:

- In Chapter 2, we describe our approach to assessing the required deployment to reach a 15% and 20% energy efficiency target by 2030 in the domestic buildings sector, and potential policy gaps.
- In Chapter 3, we describe our findings in terms of the deployment of energy efficiency measures required and gaps relative to committed and planned policies.
- In Chapter 4, we summarise our conclusions regarding policies that could fill the gaps to deliver a 15% and 20% energy efficiency target.
- In Chapter 5, we summarise our overall conclusions.

Further annexes to this report also provide more detail on the results and methodology.

[29] The Green Heat Network Fund has funding of £288m and is estimated to deliver an additional 1.15 TWh of additional low-carbon heat per year (see DESNZ (November 2020), Green Heat Network Fund Consultation IA, page 10). We estimate that this could serve c. 165,000 homes connected to district heat, assuming c. 7,000 kWh per year average heating requirement per home. The 7,000 kWh per year figure is calculated based on Ofgem data on typical gas consumption for a low-energy use flat (see Ofgem, Average gas and electricity use explained) and CCC data on gas boiler efficiency (see CCC (December 2021), The Sixth Carbon Budget – Charts and Data in the report, tab "Buildings"). Assuming the same cost per home, we estimate that the additional funding of £220m provided under Heat Network Transformation Programme could serve c. 126,000 homes connected to district heat.

2 Methodology

This analysis estimates the required deployment to meet the energy efficiency targets and where additional policies may be needed to meet those targets. As explained above, the purpose of this indicative analysis is to indicate the overall scale of the gap. We therefore make simplifying assumptions on the likely mix of measures that may be deployed, and we take a relatively simplified approach to calculating the energy savings associated with different levels of deployment.

The focus of our modelling is on energy savings in the existing housing stock (rather than new buildings) and on energy consumption from heating (rather than non-heating purposes such as appliances and lighting), since these areas account for the largest share of the housing stock and energy consumption and have the highest potential for further demand reduction. However, our analysis includes a high level estimate of the contribution to energy consumption and savings from other sources such as the additional demand from new homes as well as changes in energy consumption from non-heating.

Our work was structured around two stages:

- **Calculating required deployment to meet the target.** Drawing on published CCC data, we first calculate scenarios in Excel that illustrate the measures required to meet the target. The output of this step is an estimate of the number of retrofit and heating measures that would need to be in place to deliver on a 15% or 20% target for 2030.
- **Identifying gaps where additional policies may be required to deliver the target.** We then summarise the potential deployment of measures associated with policies, based on published material on those policies (including strategy documents and Impact Assessments). We then calculate the 'policy gap', or the difference between the deployment required to meet the target, and the deployment associated with the policies. The output of this step is a quantitative estimate of the gap for existing homes (e.g. expressed as number of homes and as number of individual measures) where additional policies are needed to deliver the required deployment.

We provide a summary of the work undertaken at each stage in more detail below. Further detail on our methodology and assumptions can be found in Annex A.

2.1 Approach to calculating required deployment to reach target

This Section describes our approach to calculating the required deployment to reach the 15% and 20% energy efficiency targets. We set out our approach in three steps as shown in Figure 3 below:

Figure 3 Approach to calculating required deployment

We discuss each step in turn below.

2.1.1 Level of savings required to achieve the target

We first calculate the absolute level of savings in TWh required to deliver a 15% or 20% reduction in energy consumption by 2030, relative to 2021. As explained in Chapter 1 above, we use DUKES data on final domestic consumption to derive the 2021 starting level, which was 449 TWh in 2021. A 15% energy efficiency target therefore implies a reduction in energy consumption of 67 TWh by 2030 (and 90 TWh by 2030 under a 20% energy efficiency target).

2.1.2 Savings associated with a starting level of deployment

There is a wide range of potential technology mix scenarios that could deliver the energy efficiency targets. We use CCC's Balanced Net Zero Pathway, a scenario that reaches Net Zero by 2050, as the starting point for our modelling.[30] We estimate that the CCC's Balanced Net Zero Pathway Scenario implies a reduction in energy consumption of c. 19% by 2030, relative to 2021. [31]

The CCC's Balanced Net Zero Pathway is underpinned by extensive analysis on deployment of low carbon technologies across different households in the UK. We do not have access to the CCC's detailed underlying modelling, and take a simplified approach to calculating the energy savings associated with different levels of deployment, drawing on the CCC's published information on the modelled levels of deployment and energy savings associated with different low carbon technologies:

30 The CCC's Balanced Net Zero Pathway has been developed taking into account considerations such as cost effectiveness (i.e. which technology mixes could deliver lowest lifetime costs), wider benefits (e.g. deployment of energy efficiency measures to address fuel poverty), and consumer preferences. Deployment trajectories were also bounded by assumptions on the deployment constraints for all key technologies and reflecting current UK policy (e.g. plans to phase out installation of new high-carbon fossil fuels and plans to improve energy efficiency of all buildings).

31 We note that the CCC's reduction of c. 19% is calculated relative to the CCC's own demand data for 2021, which is 472 TWh for residential buildings. Given that the CCC's analysis was carried out in 2019, the CCC's 2021 demand figure differs from the baseline used to set the 15% / 20% target, which is based on 2021 domestic consumption from DUKES and implies an energy demand figure of 449 TWh.

- We consider all the key low carbon technology types included in the CCC's Balanced Pathway, with the exception of hybrid heat pumps.[32]
- We adjust the CCC's UK-wide level of deployment to reflect the GB-scope of the work.

The CCC's Balanced Pathway does not publish a breakdown of deployment of solar panels in homes (only a total generation figure is available which captures large-scale solar). We account for an additional reduction in demand due to electricity generated from domestic solar panels, based on National Grid's Future Energy Scenarios.

Our approach to calculating the savings associated with a starting level of deployment can be grouped in the following way:

- Savings from energy consumption for heating in existing homes; and
- Other sources of savings and additional consumption.

We discuss each in turn below.

Savings from energy consumption for heating in existing homes

As part of this work, we model the required deployment of the energy efficiency measures from the CCC's Balanced Pathway, including:

- **Insulation:** This includes cavity wall, solid wall, floor, and loft insulation, as well as measures such as draught proofing and hot water tank insulation (which we refer to as 'other insulation' in line with the CCC's definition).
- **Heat pumps:** This includes both air source heat pumps ('ASHPs') and ground source heat pumps ('GSHPs') which are individually installed in properties.
- **Heat networks:** This includes communal heat pumps and district heating options.[33]

The deployment of additional measures between 2021 and 2030 for existing GB homes according to the CCC's Balanced Net Zero Pathway is shown in Table 2 below.

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32 Following guidance from WWF and ScottishPower, we do not model hybrid heat pumps (15% of heat pumps in the CCC's Balanced pathway are hybrid). We instead assume these are ASHPs. To the extent that hybrid heat pumps are installed instead, this means that we would be overestimating the energy saving associated with overall heat pump deployment and therefore our analysis may slightly understate the remaining gap. CCC (December 2021), Sixth Carbon Budget - Dataset. This is consistent with our general approach of optimism in the modelling.

33 We do not have information on the CCC's definitions of these terms. However, we assume that the CCC's data on communal heat pumps and district heat is broadly consistent with Government definitions for communal heating and district heat which distinguish between the two systems based on scale. Specifically, DESNZ defines 'district heat' as systems that "*supply heat from a central source to consumers, via a network of underground pipes carrying hot water. Heat networks can cover a large area or even an entire city or be fairly local supplying a small cluster of buildings"* (see DESNZ (March 2018) What is a heat network?, page 3) and 'communal heating' as *"[a] system where one source of heat serves all customers in a building*" (see DESNZ (2022), Green Heat Network Fund: Guidance for applicants, page 14). Element Energy also notes that its modelling for the CCC's Sixth Carbon Budget assumes that a typical communal heating configuration supplies ten dwellings (see Element Energy (April 2021), Development of trajectories for residential heat decarbonisation to inform the Sixth Carbon Budget, page 110).

Table 2 Additional deployment in existing homes between 2021 – 2030 in the CCC's Balanced Net Zero Pathway

Measure type	Measure	Number of measures
Insulation	Other (draught proofing and hot water tank insulation)	17,294,618
	Loft	6,333,671
	Floor	2,798,489
	Cavity wall	1,900,023
	Solid wall	2,369,775
Low carbon heating	ASHP[34]	2,103,664
	District heat	1,153,468
	Communal heat pump (GSHP)[35]	755,240
	GSHP	228,790

Source: *Climate Change Committee (December 2020), Sixth Carbon Budget Dataset.*

Note: *Figures are GB-wide. Other insulation comprises of hot water tank insulation and draught proofing. We have grouped together all types of ASHP, GSHP and Communal GSHP from the CCC modelling. All numbers in the table relate to the number of measures, except numbers for district heat / communal heat pumps where numbers reflect the number of homes connected to a communal heat pump loop / heat network, rather than number of individual heat pump loops / networks.*

We calculate the level of savings implied by this level of deployment of energy efficiency measures in the following way:

- We use data from the CCC's Sixth Carbon Budget modelling on energy savings from installing different fabric efficiency measures and information on the relative efficiency of low carbon technologies. Our assumptions are shown in Table 3 below.

[34] This includes 1,639,152 single ASHPs as well as: i) a small number of hybrid heat pumps (464,139); and ii) a very small number of communal ASHPs (373). Regarding i), treating hybrid heat pumps as non-hybrids for the purpose of this modelling means we are more likely to understate the gap. Regarding ii), we do not distinguish in our modelling between communal and non-communal ASHPs but given the small number of communal ASHPs in the CCC's Balanced Pathway (i.e. <0.1%), this is unlikely to materially affect the results.

[35] In the CCC's Balanced Net Zero Pathway, almost all communal heat pumps (>99.9%) are GSHPs.

Table 3 Assumed savings from energy efficiency measures (semi-detached home with gas boiler)

Measure	Energy savings (% reduction in heating demand)
Other insulation (e.g. draught proofing and hot water tank insulation)	5%
Loft insulation	4%
Floor insulation	8%
Cavity wall insulation	10%
Solid wall insulation	13%
ASHP	73%
Heat networks (communal heat pump / district heat)	74%
GSHP	75%

Source: *Efficiency data is sourced from CCC (December 2020), 6th Carbon Budget - Charts and data in the report, tab "Buildings". Insulation savings data is sourced from Element Energy (April 2021), Sixth Carbon Budget Assumptions log, tab "Energy Savings".*

Note: *- ASHP/Heat network/GSHP: Energy savings are calculated based on the relativities between the efficiency of the household's starting technology (e.g. a gas boiler in this example) and the low carbon technology taken up by the household (e.g. ASHP). District heat is assumed to be connected to a heat pump with efficiency that is the average of an ASHP and a GSHP. Efficiencies are based on an average efficiency over 2020-2030 to capture improvements in heat pump efficiency over time.*
- Insulation: We calculate the average energy savings for each type of insulation (e.g. savings from solid wall insulation is calculated as the average savings from external, internal and thin solid wall insulation).

- We develop 18 'packages' of measures which group together different insulation and / or heating technologies (see Table 6 in Annex A).
- We then share the CCC's overall deployment of each individual measure among the 18 packages and 'types' of homes in the GB-population. The output of this step is an estimate of the number of packages taken up by each property 'type', which reflects the home's heating technology (e.g. gas boiler / oil boiler / electric heating), property style (e.g. detached, semi-detached, terraced or flat) and efficiency level. In allocating the CCC's overall deployment, we also accounted for:
  - **Measure eligibility:** Some homes will not take up specific measures either because that measure is not relevant to the property type, does not apply to the property type or because the house is already well-insulated.
  - **Share of the housing stock**: Some home 'types' are allocated larger shares of deployment of certain measures as they make up a larger share of the housing stock. For example, of the homes eligible for package 1, 34% are semi-detached houses

with gas boilers and low efficiency (therefore houses of this type are allocated 34% of the deployment of package 1), while flats with electric heating and a low efficiency make up 5% of all homes that are eligible for this package (and therefore are allocated 5% of the deployment of the package 1). The proportion of deployment by package and house type is shown in Figure 17 in Annex A .

- We calculate the energy savings for different property types, taking into account the number of homes taking up each package (as defined in the previous step) and the savings achieved when each package of measures is installed.

A detailed description of our methodology and assumptions can be found in Annex A.

Other sources of energy savings

Our modelling is focused on the required deployment of energy efficiency measures in existing homes, and the impact on energy consumption for heating. However, in line with the CCC's Sixth Carbon Budget, we also account, at a high level, for the savings and additional energy consumption from other sources:

- **Non-heating savings.** We account for energy savings of c. 12 TWh due to increased appliance efficiency, using an estimate of the percentage reduction in electricity demand due to appliance efficiency assumed in the CCC's Balanced Net Zero Pathway.

- **Impacts of climate warming.** We account for an energy saving of c. 17 TWh by 2030 (relative to 2021), reflecting the net effect of reduced heating demand due to climate warming and additional energy demand required for cooling.[36]

- **Additional demand from new homes.** We account for an additional energy demand of c. 12 TWh by 2030 (relative to 2021) from new homes based on data from the CCC.[37]

- **Savings due to behavioural change.** We account for an additional c. 6 TWh energy saving by 2030 (relative to 2021) based on an estimate of the change in energy demand attributed to behavioural change in the CCC's Balanced Net Zero Pathway.[38]

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36 The CCC assumes that increases in average winter temperatures result in reduced demand for heating, resulting in a 6.6% reduction in heating demand. The CCC also assumes an additional energy demand of 5 TWh annually by 2050. Climate Change Committee (December 2020), The Sixth Carbon Budget Buildings Sector Summary, Box M3.8.

37 The CCC estimates that if all new homes between now and 2050 are built to current standards with air source heat pumps, this would result in an additional annual demand of 43 TWh, and that ultra-high energy efficiency standards could help reduce this by around 4 TWh. We therefore assume an additional annual demand of 1.3 TWh per year, which is an additional 11.7 TWh of annual demand in 2030, relative to 2021. Climate Change Committee (February 2019), UK Housing: Fit for the future?, page 64.

38 The CCC's scenarios consider behaviour change measures such as turning off lights when not in use, pre-heating ahead of peak times, smarter heating management and use (e.g. turning the thermostat down or reducing the amount of time the heating is on), low-flow shower heads and multizone control. See Climate Change Committee (December 2020), Sixth Carbon Budget – Buildings Sector Summary, Box M3.1.

- **Savings due to domestic solar panels.** We account for an additional reduction in demand of c. 6 TWh by 2030 (relative to 2021) due to electricity generated from domestic solar panels, based on National Grid's Future Energy Scenarios.[39]

- **Business-as-usual efficiencies.** The CCC's Balanced Net Zero Pathway also accounts for business-as-usual efficiencies such as increases in boiler efficiency that would take place even without a shift to low carbon heating.[40] We calculate these savings as a 'residual' reflecting the difference between the savings achieved from deployment of all other sources of savings and the savings of c. 19% implied by the CCC's Balanced Net Zero Pathway. This means that we account for business-as-usual efficiencies of c. 2.5 TWh by 2030, relative to 2021.

2.1.3 Calibrate deployment to achieve the savings implied by the target

We then 'scale' the starting level of deployment proportionately (keeping the overall technology mix the same) so that the level of deployment is calibrated to deliver an energy saving (in TWh) in line with the 15% or 20% energy efficiency targets. As the starting point is an energy efficiency saving of c. 19%, this step involves 'scaling up' the starting level of deployment to deliver the 20% target, and 'scaling down' the starting level of deployment to deliver the 15% target.

We scale only the deployment of energy efficiency measures in existing homes and the deployment of solar panels. We assume that the levels of non-heating savings, impacts of climate warming, demand from new homes, savings from behavioural change and business-as-usual efficiencies are fixed, given the focus of this project is on energy savings from heating in existing homes.

2.2 Approach to analysing gaps

In the previous stage we estimate the deployment of measures required to reach a 15% or 20% energy efficiency target by 2030. The next stage involves identifying potential policy gaps to deliver those levels of deployment, as well as the scale of those gaps. Our approach involves two steps:

39 The CCC's Sixth Carbon Budget does not provide a breakdown of the savings from domestic solar installations. We therefore rely on data from National Grid's Future Energy Scenarios (FES). Specifically, we calculate the average capacity of domestic solar panels from the FES Consumer Transformation and System Transformation scenarios for 2021 and 2030 (see National Grid (2022), Future Energy Scenarios Data workbook). We then apply the median load factor for solar PV from DESNZ to obtain an estimate of the total generation from domestic solar panels (see DESNZ (December 2021), Feed-in Tariff load factor analysis).

40 We note that DESNZ are also consulting on increasing efficiency requirements for boilers from 2025 (see DESNZ (February 2023), Improving boiler standards and efficiency consultation). We do not consider the impacts of any changes introduced as a result of this consultation as part of this project.

- **Identifying the level of deployment implied under current policies**. We first identify the key energy efficiency policies (both committed and planned) and estimate their modelled deployment of the energy efficiency measures specified in Table 2.

- **Calculating the potential gap**. To calculate the gap, we then compare the deployment implied by the policies to the deployment required to reach the target.

We discuss each step in turn below.

2.2.1 Identifying the level of deployment implied under current policies

To assess the potential level of deployment implied under current policies, we need to make a judgement regarding the degree to which the policy is committed. We have defined three categories of policies reflecting the degrees of uncertainty around deployment associated with the policy:

- **Committed**: Where there is an existing government policy in place or a well-developed plan for a policy that has been trialled or implemented previously, or builds on an existing policy. These policies have specified levels of funding committed. For example, this includes the Boiler Upgrade Scheme and the Social Housing Decarbonisation Fund.

- **Planned:** Where there is a well-developed policy, but the policy is not yet in place or is still under consultation. In some cases, the level of funding to be allocated is uncertain or the details of the policy design are unclear. The potential number of homes treated under these policies is particularly uncertain given the unproven nature of policies yet to be implemented and the potential for policies to change with new Ministers and Administrations. For example, this category includes the Clean Heat Market Mechanism and strengthened Private Rented Sector Minimum Standards.

- **Early stage proposals:** Where there are policy plans under discussion but the exact policy mechanism, level of funding and / or policy design is not yet specified. Given the high level of uncertainty about these types of policies and absence of available data on their potential impact, we do not attach quantitative estimates of deployment to these policies. For example, this category includes Heat Network Zoning Plans.

Table 4 below summarises the key policies, grouped by policy type (e.g. committed, planned or early stage proposals).[41]

[41] We note that there may be some smaller schemes operating in devolved administrations which we have not considered, as well as the introduction of zero-rate of VAT for the installation of certain energy savings materials in residential homes in Great Britain between 2022 – 2027. Although these schemes will be useful contributors to energy efficiency reductions, they are unlikely to be a major driver in themselves and so would not affect the headline conclusions of this report.

Table 4 Overview of key policies

	Committed	Planned	Early stage proposals
Fabric efficiency	■ ECO4 / GB Insulation Scheme ■ Social Housing Decarbonisation Fund (Wave 1 / 2.1) (England) ■ NEST Warm Homes (Wales) ■ Sustainable Warmth Competition (LAD3 / HUG1) ■ Home Upgrade Grant (HUG2) (England) ■ Scotland's Energy Efficiency policies[42]	■ Strengthened Private Rented Sector minimum standards (England & Wales; Scotland) ■ £6 billion energy efficiency funding from 2025	■ Wales: Consultation on second wave of Warm Homes Scheme; New Welsh Housing Quality Standard to bring all social housing to as close to EPC A as possible by 2023 ■ Scotland: Consultation on requirements for all owner occupied homes to reach EPC C by 2033; Consultation on options for requiring minimum EPC C in mixed tenure homes; Milestone of 2032 for EPC B in social homes; Review of energy efficiency standard for social housing ■ Voluntary energy performance target for mortgage lenders[43]
Heat pumps / fossil fuel phase-out	■ Boiler Upgrade Scheme (England & Wales) 2022-25[44]	■ Phase-out installation of new fossil fuel heating (off-gas grid) – From 2026 (England & Wales) / From 2025 (Scotland) ■ Clean Heat Market Mechanism ■ £6 billion energy efficiency funding from 2025	■ Plans to consult on rebalancing consumer gas and electricity prices (UK) ■ Supply chain policies (e.g. Supply Chain Delivery Plan for markets with zero

42 We refer to 'Scotland's Energy Efficiency Policies' to capture the Social Housing Net Zero Fund, Home Energy Scotland (HES) loans, Warmer Homes Scotland and Area Based Schemes.

43 DESNZ (November 2020), Consultation on Improving home energy performance through lenders.

44 We note that the *Powering Up Britain* policy papers refer to the intention to use some of the £6 billion funding for 2025-28 that was previously announced in the Autumn Statement to extend the Boiler Upgrade Scheme for three years to 2028. However, this announcement does not change this analysis since our analysis includes an assumption about the potential deployment of heat pumps / fabric efficiency measures using the £6 billion funding under the category of 'planned policies'.

	Committed	Planned	Early stage proposals
			emissions heat (Scotland))[45]
Heat networks	■ Green Heat Network Fund (GHNF) / Heat Network Transformation Programme[46] ■ Heat Networks (Scotland) Act 2021, including the Scotland Heat Network Fund		■ Progress proposals for heat network zoning in England[47]
New homes	■ Changes to interim building standards prior to 2025 (can be met without low carbon heat)	■ Future Homes Standard (England) from 2025	■ Early stage proposals for EPC A requirements for all homes (Wales)[48] ■ Zero Carbon Home Standards from 2024 (Scotland)[49]
Energy for non-heating	■ Domestic appliance efficiency standards ■ Energy-related Products Policy Framework		

In the category of 'planned' policies we include an assumption about the potential deployment that could be achieved using the £6 billion energy efficiency funding announced by the Government in the Autumn Statement of 2022. There is uncertainty as to whether and how this funding will be spent, so we follow a simplified approach in order to illustrate the potential impact on the policy gap:

45 For example, in November 2022 Scotland has developed a Supply Chain Delivery Plan with proposals to develop markets with zero emissions heat (see Scottish Government (November 2022), The Heat in Buildings Supply Chains Delivery Plan: Towards an Industry for Green Heat). In March 2023, the UK Government also announced £14m funding allocated to a Heat Training Grant programme and four 'Heat Pump Ready' projects to reduce the costs of low-carbon technologies (see DESNZ (March 2023), News story: £14 million cash boost to accelerate rollout of low carbon heating.

46 The Green Heat Network Fund runs until 2025 but the Powering Up Britain report announced a two-year extension, including additional £220m funding through the Heat Network Transformation fun (see DESNZ (March 2023), Powering up Britain Policy Paper).

47 In October 2021, DESNZ consulted on proposals for the implementation of heat network zones. DESNZ is currently running a Heat Networks Zoning Pilot programme to deliver heat networks in zones where they provide lowest cost (see DESNZ (November 2022), Guidance: Heat Networks Zoning Pilot).

48 New social homes need to be EPC A and not rely on fossil fuel heating, and there are plans for EPC requirements to be extended to all new homes (see CCC (June 2022), Progress in reducing emissions).

49 From 2024, new homes must use heating with zero direct emissions and high fabric efficiency (see CCC (June 2022), Progress in reducing emissions).

- We assume that 100% of this funding is allocated to the domestic sector[50], and that there is a 10% uplift on total funding from the private sector.[51]

- We assume that the funding is allocated towards upgrading the homes to reach an EPC C rating, and that the funding delivers c. 852,550 home upgrades.[52,53]

Our analysis of policy gaps therefore already accounts for the potential impacts of this £6 billion spending, and so any policy gaps would need to be addressed with funding that is *additional* to the announced £6 billion energy efficiency funding.

2.2.2 Calculating the potential gap

We assess the potential policy gap in the following way:

- **Heating in existing homes**: For the committed and planned policies, we attach an estimate of the potential number of homes treated under the policy in the following way:

  - Where available, we use modelled estimates directly from Government Impact Assessments and other published documents.

  - In some cases, the Impact Assessments do not provide direct information about the number of homes and / or measures delivered under the policy but do include information about other metrics of the performance of the scheme. In those cases we use the available information from the impact assessment to calculate an implied number of homes.[54]

  - In some cases, impact assessment data is not available, and so we estimate the modelled deployment by using deployment figures from other similar schemes[55] or

50 This is a conservative approach to estimating the potential gap. We note that the actual level of funding allocated to the domestic sector may be lower which would imply an even larger gap.

51 This is an illustrative assumption, informed by the assumption used in the ECO+ consultation stage impact assessment (see DESNZ (December 2022), ECO+ Consultation Stage Impact Assessment).

52 This assumes an average home upgrade cost of c. £7,700. This is calculated based on government data on costs to bring an average private sector / social rented / owner occupied home to EPC C, weighted by the frequency of each home type in the building stock (see Ministry of Housing, Communities & Local Government (2019), English Housing Survey Private rented sector, 2019-20 report for average home Upgrade cost and ONS (July 2022), English Housing Survey data on tenure trends and cross tenure analysis, table FA1221 for the share of each tenure type.

53 Of the 852,550 fabric efficiency upgrades, we assume that 113,673 of these home upgrades (13% of the total) will also include the installation of a heat pump. The 13% assumption is based on the number on heat pump installations anticipated under ECO4 (i.e. 60,000 heat pump installations, see Table 6 of DESNZ (April 2022) ECO4 Final Stage Impact Assessment) as a proportion of the total number of home upgrades anticipated under ECO4 (i.e. 450,000 homes, see Table 7 of the same document).

54 For example, the DESNZ Impact Assessment for Private Rented Sector Minimum Standards specifies the anticipated proportion of homes meeting the updated standards by 2028, which we use to estimate the number of additional homes meeting the standards (see DESNZ (September 2020), Improving the Energy Performance of Privately Rented Homes in England and Wales: Consultation Stage Impact Assessment, Table 5).

55 For example, we estimate the deployment under Wave 2.1 of the Social Housing Decarbonisation Scheme based on the deployment under Wave 1 of the scheme, scaled for the level of funding.

by applying assumptions about the number of homes that could be treated based on the funding allocated to the scheme (or the anticipated low carbon heat delivered)[56].

We then compare the deployment implied by the committed and planned policies to the deployment required to reach the target to calculate the gap. We do not include early stage proposals when estimating the gap since it is not certain that they will be implemented, or what their impact will be.

- **Other energy consumption:** For energy savings for non-heating purposes and additional energy demand from new homes, we do not model the required deployment or deployment implied under existing policies. Instead we summarise at a high level the potential gap, drawing on the CCC's recommendations in its 2022 Progress Report.

[56] For example, we estimate the number of homes connected to heat networks / communal heating under the Green Heat Network Fund by converting the additional TWh of heat delivered under the scheme to a number of homes using an average heating requirement. For this calculation we use the average heating requirement for a flat, as the CCC recommends heat networks to be rolled out in heat-dense areas like cities, and using anchor loads such as schools and hospitals (see CCC (December 2020), Sixth Carbon Budget paper, page 109) and Element Energy's modelling for the CCC's Sixth Carbon Budget assumes communal heat pumps are typically installed in flats or terraced houses (see Element Energy (April 2021), Development of trajectories for residential heat decarbonisation to inform the Sixth Carbon Budget, page 110).

3 Required deployment and potential gap

In this chapter we summarise the required deployment to reach the energy efficiency targets, and the potential gap relative to currently committed and planned policies.

3.1 Required deployment under the targets

Figure 4 below shows the sources of energy savings that would be required under the 15% and 20% energy efficiency targets, based on the application of the methodology set out in Section 2.1. Savings from the deployment of fabric efficiency retrofits and heat pumps make up around half of the total savings required under the target, contributing to an 8% energy saving (relative to 2021) under the 15% target, and a 13% saving under the 20% target.

Figure 4 Contribution of energy savings by measure type

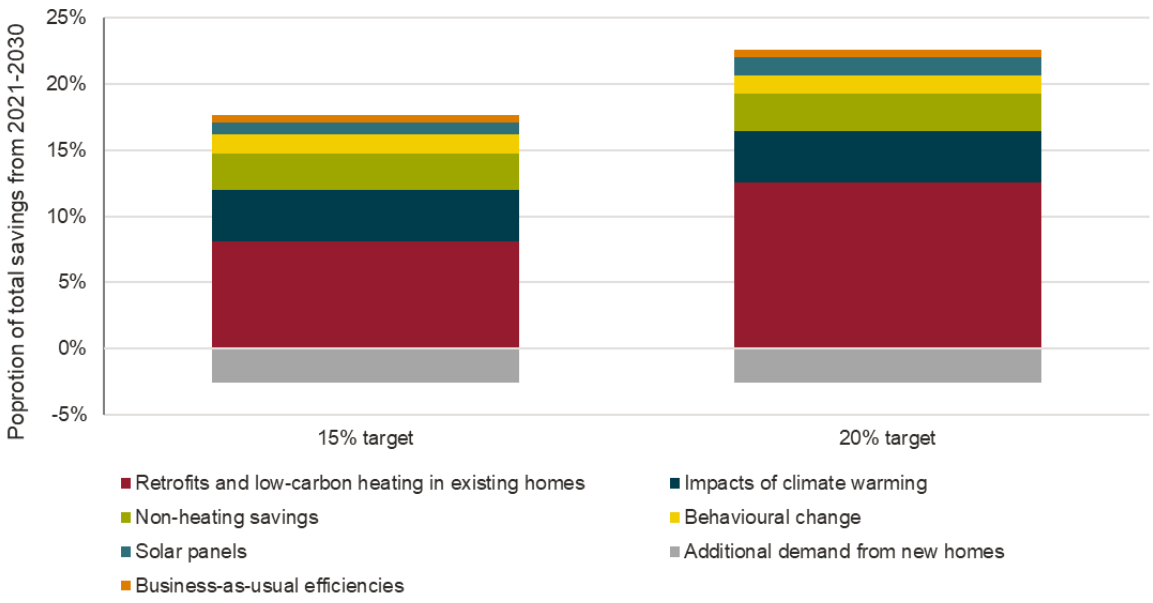


Figure 5 below shows the required deployment of specific measures for energy efficiency in existing homes to meet the targets, using the methodology set out in Section 2.1. For example, between 2021 and 2030:

- An additional 6m installations of **other insulation**[57] are required to reach the 15% target (or 9.3m to reach the 20% target). Other insulation refers to draught proofing and hot water tank insulation which are typically lower cost and require less disruption to install

[57] "Other insulation" refers to draught proofing and hot water tank insulation. We assume that homes taking up one of these types of insulation also takes up the other type as the same time.

relative to other fabric efficiency measures (but are also associated with lower savings). The CCC assumes that draught proofing and hot water tank insulation measures will be widely deployed in the Balanced Pathway.

- An additional 4.4m installations of **loft insulation** are required to reach the 15% target (or 6.8m to reach the 20% target);
- An additional 1.9m installations of **floor insulation** are required to reach the 15% target (or 3m to reach the 20% target);
- An additional 1.6m **solid wall installations** are required to reach the 15% target (or 2.6m installations to reach the 20% target);
- An additional 1.3m **cavity wall installations** are required to reach the 15% target (or 2m installations to reach the 20% target); and
- An additional 1.3m **solar panel installations** are required to reach the 15% target (or 2m to reach the 20% target).

Figure 5 Additional fabric efficiency measures and solar panels required in existing homes

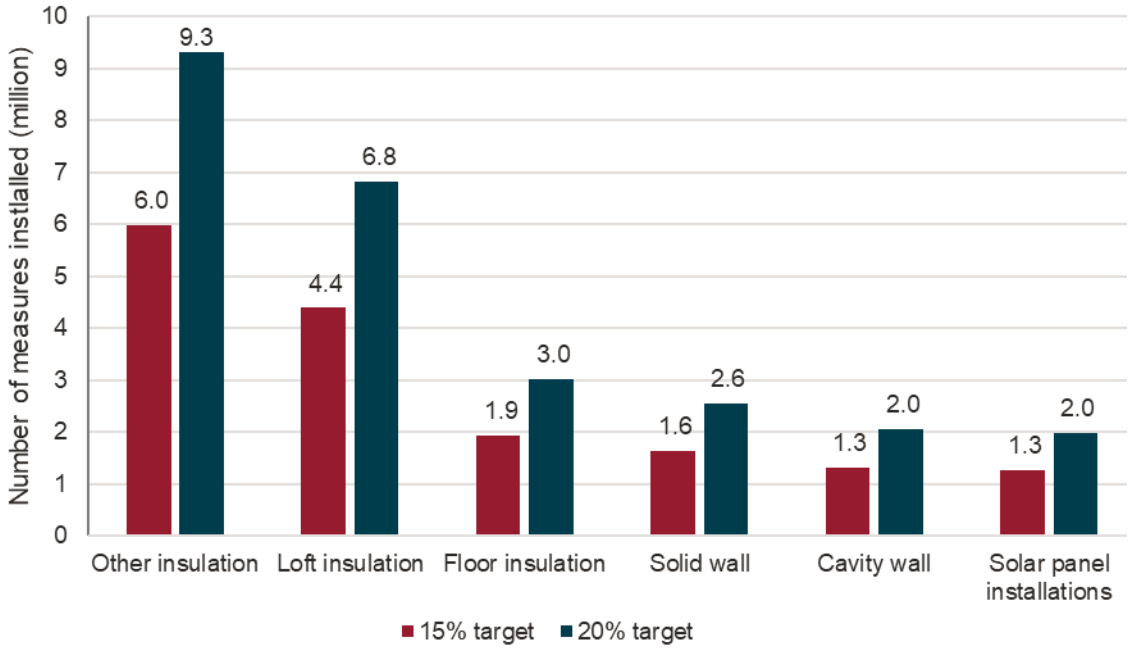
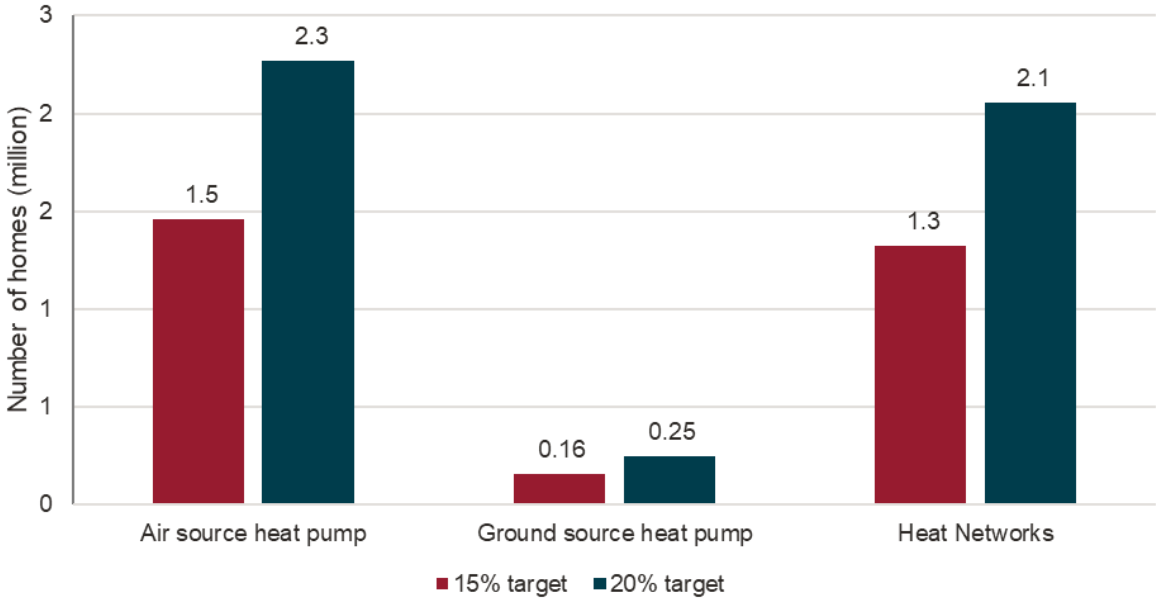


Figure 6 below shows the required deployment of specific measures for low carbon heating in existing homes to meet the targets, using the methodology set out in Section 2.1. For example, between 2021 and 2030:

- An additional 1.5m **ASHPs** are required to reach the 15% target (or 2.3m to reach the 20% target).
- An additional 0.16m **GSHP**s are required to reach the 15% target (or 0.25m to reach the 20% target); and
- An additional 1.3m homes connected to a **heat networks** are required to reach the 15% target (or 2.1m to reach the 20% target).

Figure 6 Additional required deployment of low carbon heating in existing homes



Note: Heat network numbers refer to district heating or communal heat pumps and reflect the number of homes treated, rather than the number of measures installed (since each heat network services multiple homes).

3.2 Deployment under existing policy and the potential gap

As explained in chapter 2 we have estimated the potential gap in deployment by comparing deployment under planned and committed policies to our estimates of the deployment required to reach a 15% and 20% energy efficiency target.[58]

Below we discuss the potential gap, expressed in terms of:

- The number of homes requiring energy efficiency interventions (e.g. a fabric efficiency retrofit and / or low carbon heating technology);

[58] An overview of the modelled deployment of the policies considered can be found in Annex B.1.

- The number of individual measures required (e.g. installations of cavity wall insulation or a heat pump); and
- The targeting and eligibility of existing policies.

3.2.1 Potential gap by type of measure

Gap relative to committed policies

Figure 7 and Figure 8 below shows that there are material gaps in deployment, relative to currently committed government policies across fabric efficiency, heat pumps and heat networks:

- To achieve the 15% target, an additional 4.9m homes would require retrofits, 1.5m homes would require heat pumps and a further 0.6m homes require connecting to a heat network / communal heat pump.
- To achieve the 20% target, an additional 8.2m homes would require retrofits, 2.4m homes would require heat pumps and a further 1.4m homes require connecting to a heat network / communal heat pump.

Figure 7 Potential gap relative to committed policies under 15% target

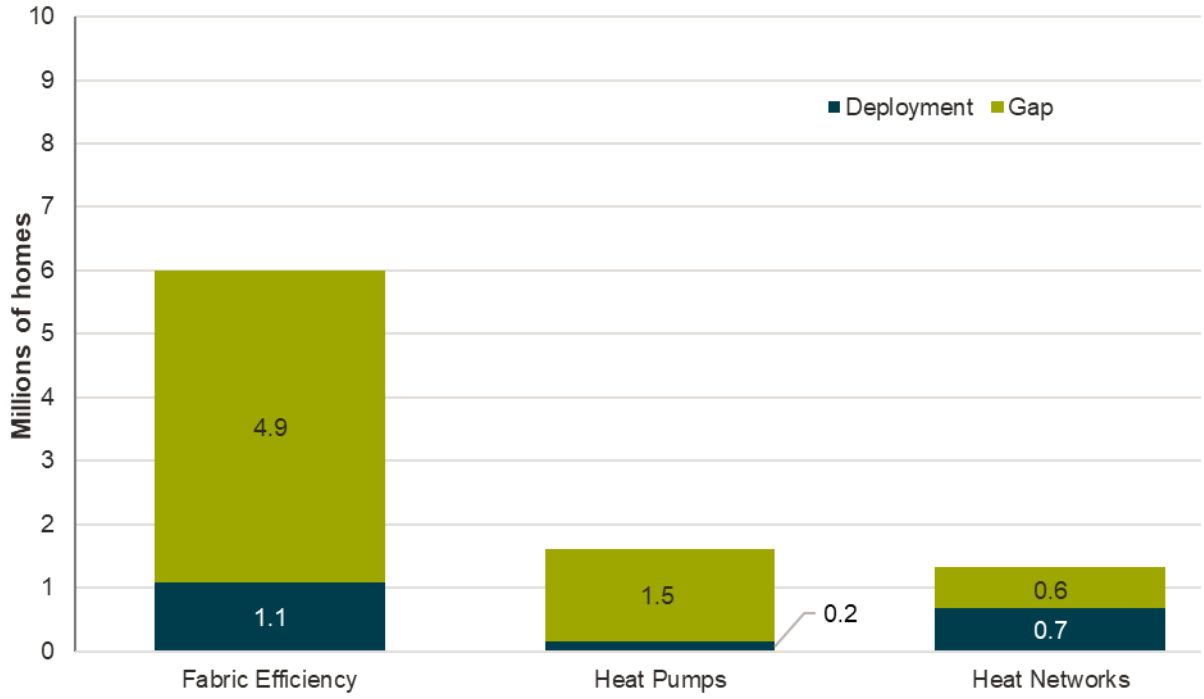
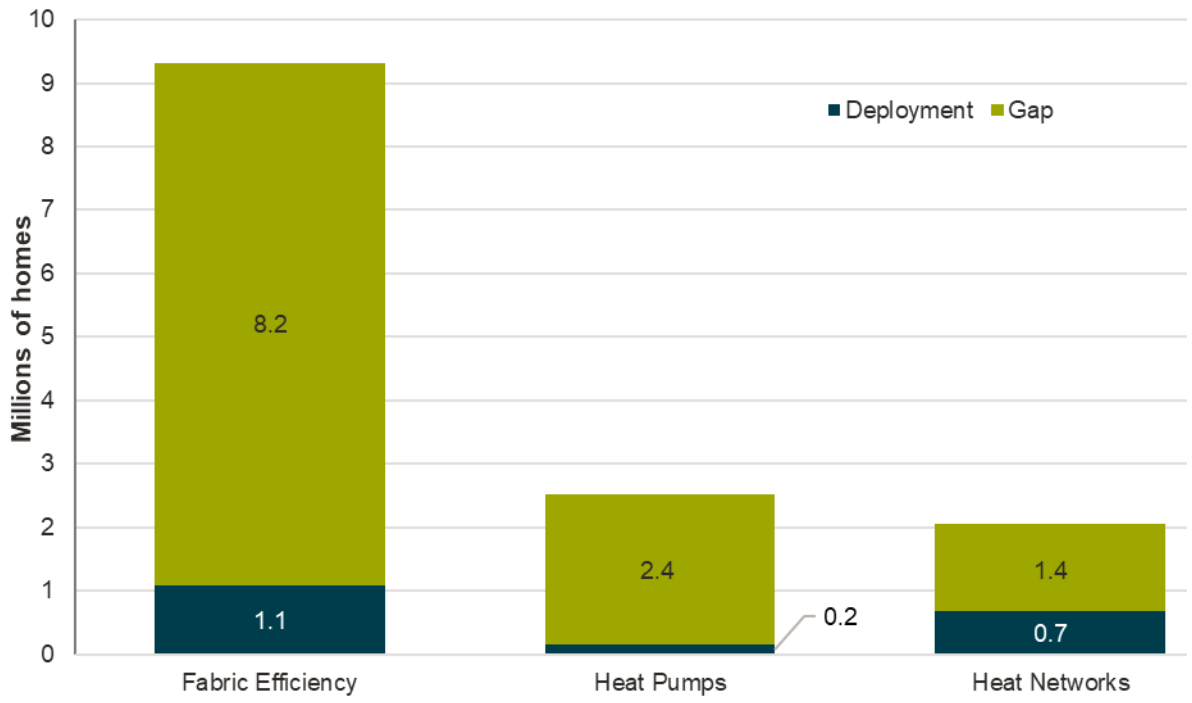


Figure 8 Potential gap relative to committed policies under 20% target



Gap relative to committed and planned policies

We have also tested the impact on the gap when we account for the potential additional deployment from planned policies.

As explained in chapter 2, there is some uncertainty as to whether the planned policies will be delivered in their planned form, and around the levels of deployment that will be achieved under those policies. We also account for the potential deployment that could be achieved using the Government's planned £6 billion funding for energy efficiency from 2025. Figure 9 and Figure 10 below show that even if all committed and planned policies are delivered and perform as expected (including spending the £6 billion funding), there is still a gap remaining to reach the 15% and 20% energy efficiency targets:

- To achieve the 15% target, an additional 2m homes would require retrofits, 0.5m homes would require heat pumps and a further 0.6m homes require connecting to a heat network / communal heat pump.
- To achieve the 20% target, an additional 5.4m homes would require retrofits, 1.4m homes would require heat pumps and a further 1.4m homes require connecting to a heat network.
- Accounting for planned policies reduces the potential gap for heat pumps in particular (in percentage terms), due to the planned policies for phase-out of the installation of new

fossil fuel boilers in off-gas grid homes and strengthened private-rented sector minimum standards, which are associated with relatively high levels of anticipated heat pump take up. This means that a significant part of this gap reduction effect is to be driven by the introduction of new regulatory policies. In this regard, we would note that introducing new regulation in relation to people's homes can be challenging, and therefore this planned policy may be associated with greater risk (relative to policies that do not involve regulation) in terms of timelines for implementation and co-ordination.

Figure 9 Potential gap relative to committed and planned policies – 15% target

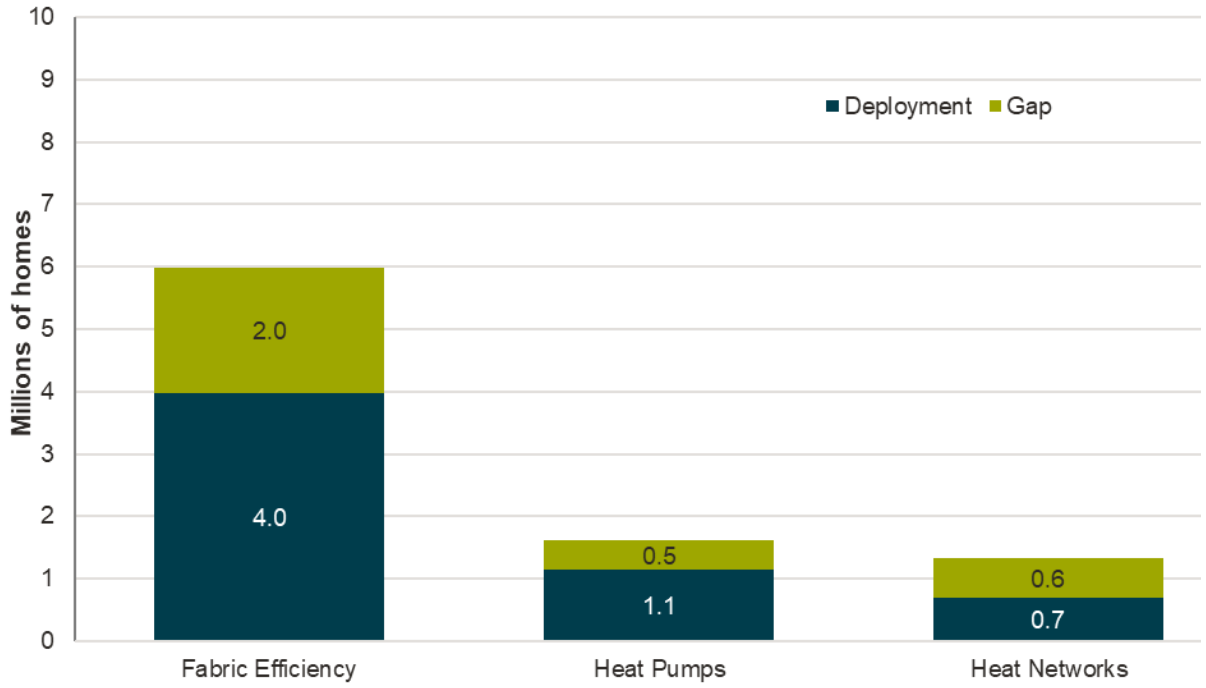
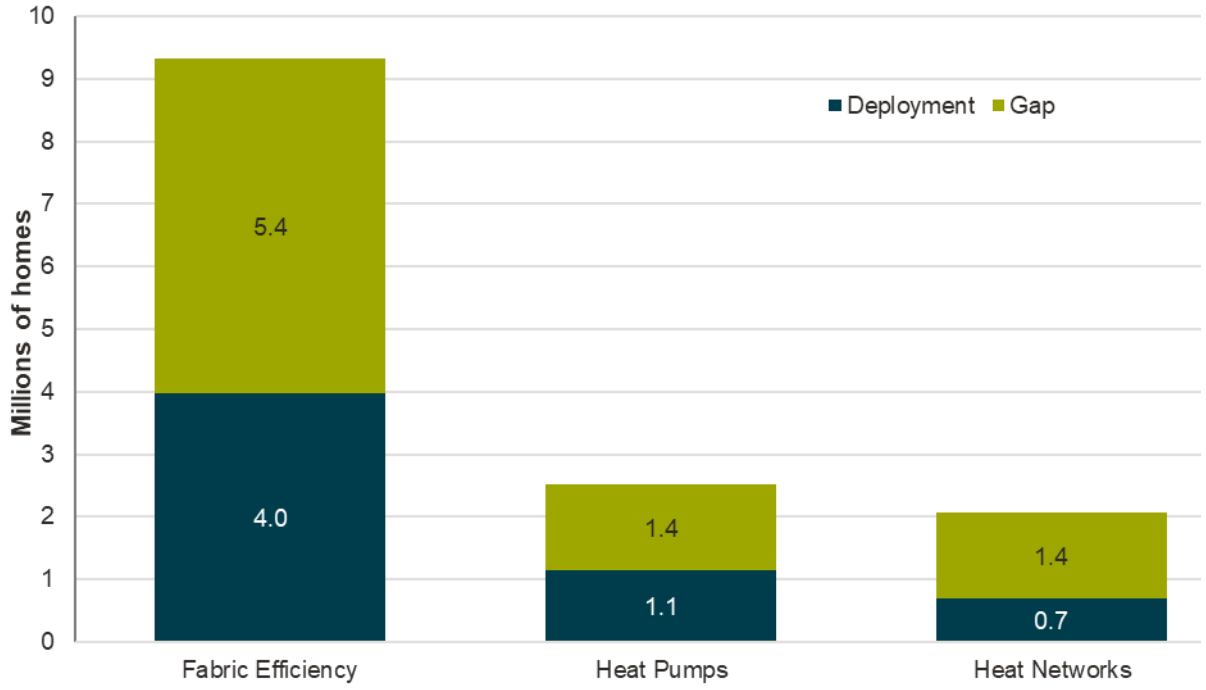


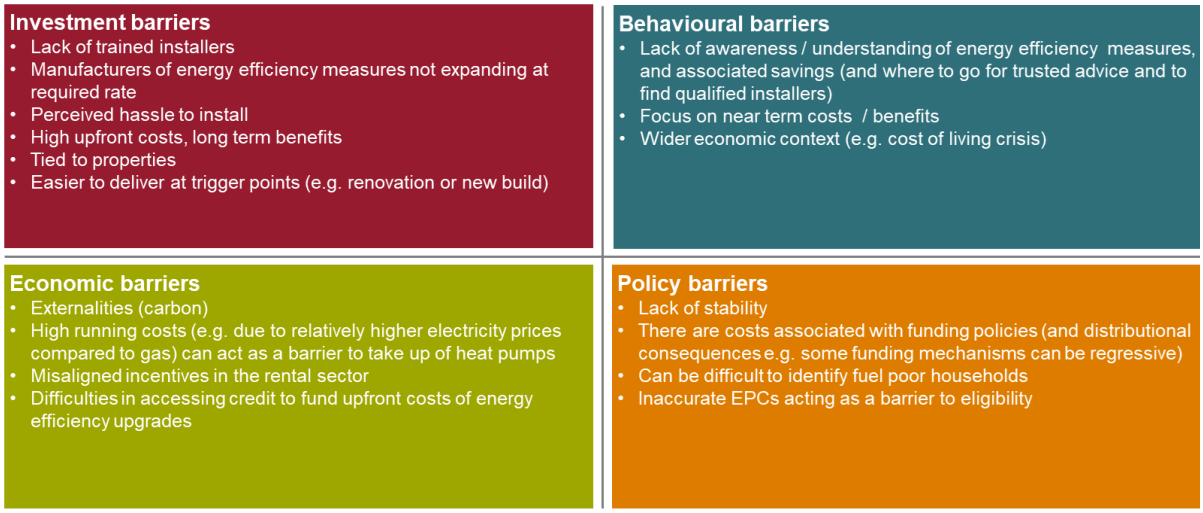
Figure 10 Potential gap relative to committed and planned policies – 20% target



Actual and modelled performance

We note that our analysis assumes that all committed policies deliver as expected (i.e. no delivery or take up issues). In this context, we would note that to be successful a policy programme in this energy efficiency area must overcome multiple complex barriers and market failures, as illustrated in Figure 11 below.

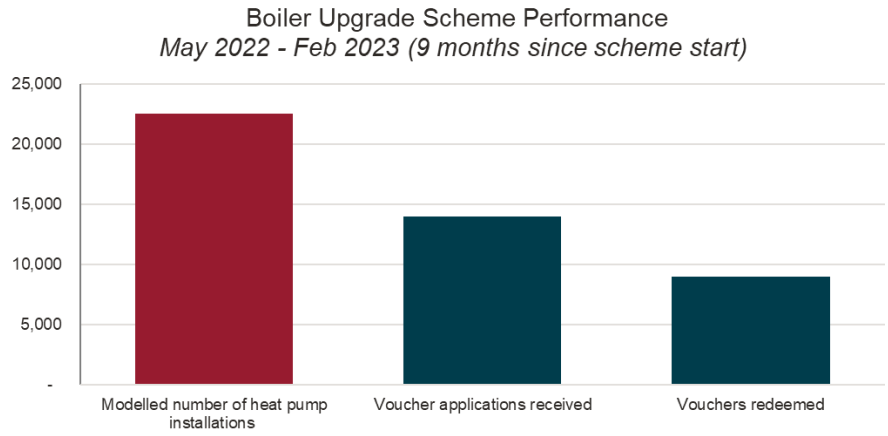
Figure 11 Illustration of delivery barriers and market failures



Early evidence from existing policies (e.g. the Boiler Upgrade Scheme) suggests that actual deployment may sometimes be lower than modelled, particularly at the start of new schemes. This may mean that, for some policies, deployment may be lower than assumed in official policy documents (such as the Impact Assessment), and, therefore, the "gap" in terms of required measures to meet the target may be larger in practice. We discuss this further in Box 1 below.

Box 1: Modelled and actual performance of selected policies

The **Boiler Upgrade Scheme** (originally from May 2022 – March 2025) provides households with a grant for heat pumps (£5,000 grant for an ASHP / biomass boiler; £6,000 for a GSHP). Government has allocated £450m to the scheme to 2025, implying that the scheme has the potential to support retrofits in c. 90,000 households (or c. 22,000 heat pumps every nine months).[59] However, it has taken time for deployment levels to build under the scheme, resulting in lower deployment than anticipated over the first nine months of the scheme, as shown in the Figure below.[60]



Some level of ramp-up is to be expected, especially given that the scheme launched during a period of economic uncertainty, and the number of vouchers redeemed has broadly been rising since the scheme was launched. However, there are actions that the Government could take to help ensure that deployment through the scheme is maximised. As noted by the Environment and Climate Change Committee in the House of Lords, this could include addressing: 1) relatively limited public awareness; 2) a shortage of heat pump installers; 3) heat pump manufacturers not expanding at the required rate; 4) electricity bill costs acting as a barrier to take-up with policy costs falling disproportionately on the electricity side rather than the gas bills side; 5) inaccurate EPCs as barrier to eligibility; and 6) considering levels of low-income support.[61]

59 The Powering Up Britain policy paper announced that the Boiler Upgrade Scheme would be extended by three years to 2028, however no detail on the precise allowances and overall budgeting around this has yet been committed to.

60 The Boiler Upgrade Scheme should support around 90,000 heat pump installations in total over the three year duration of the scheme (see DESNZ (February 2022), Boiler Upgrade Scheme Impact Assessment, page 1 and 10. Data reported by Ofgem indicates that between 23rd May 2022 to 28th February 2023, 14,302 voucher applications were received and 8,689 vouchers were redeemed (see Ofgem (March 2023), BUS Monthly Scheme Update).

61 Environment and Climate Change Committee (February 2023), Letter from Baroness Parminter to Lord Callanan: The Boiler Upgrade Scheme and the wider transition to low-carbon heat.

3.2.2 Potential gap for specific measures

We have also considered the potential gap on a measure-by-measure basis for a sub-set of key policies where data is available on potential deployment by measure. This includes all heat pump and heat network policies and the fabric energy efficiency policies with the largest potential impacts.[62] An overview of the modelled deployment of these policies can be found in Annex B.2.

Potential gap relative to committed policies

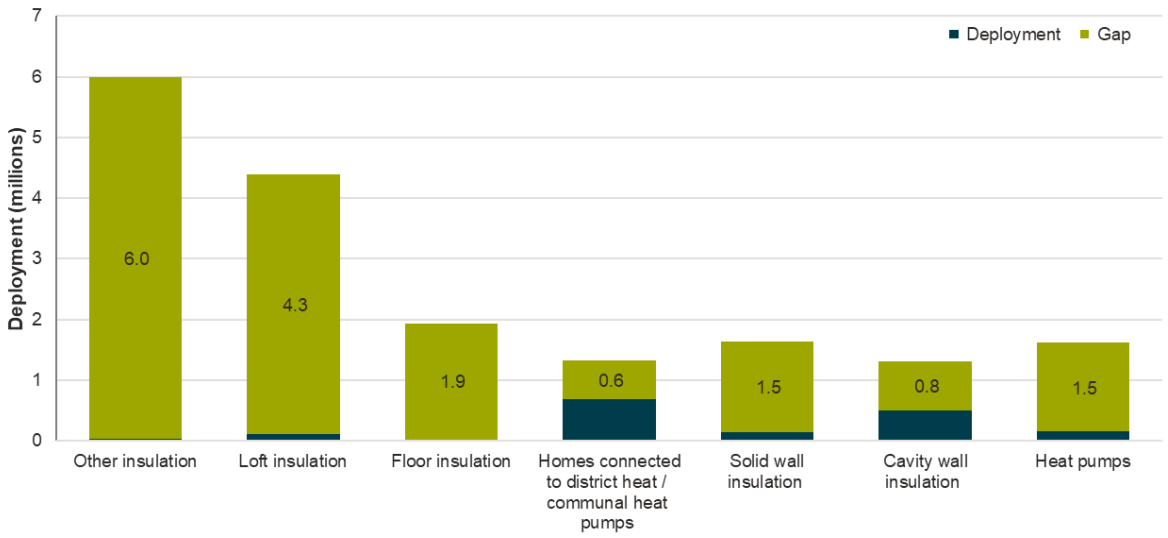
Figure 12 below shows the potential gap relative to committed policies assuming a 15% target. There are material gaps across all areas, but especially in energy efficiency retrofits, including lower cost measures requiring high levels of deployment (e.g. 'other insulation'[63], loft and floor insulation). For example:

- There is a gap in 'other' insulation of 6m installations, in loft insulation of 4.3m installations and in floor insulation of 1.9m installations; and
- An additional 0.6m homes need to be connected to heat networks / communal heat pumps and a further 1.5m heat pumps need to be deployed.

62 This includes ECO4; the GB Insulation Scheme; Private Rented Sector minimum standards; two of the Scottish Government's energy efficiency polices (the Area Based Schemes (ABS) Programme and Warmer Homes Scotland (WHS)) and the impact of the additional £6 billion announced by the UK government at the Autumn Statement last year for energy efficiency measures in the period 2025-28.

63 'Other insulation' refers to draught proofing and hot water (HW) tank insulation, as per the CCC's definition in the Sixth Carbon Budget.

Figure 12 Potential gap relative to committed policies under a 15% target



Note: Solar panels are excluded from this chart, since ongoing and increasing growth in solar panel installation suggests no major gap to reach the additional 1.3m required installations by 2030.

From Figure 12 we observe that further deployment is required across all fabric efficiency measures, but the gap appears to be particularly large in the 'other insulation' / loft insulation categories where very high levels of deployment are required in the CCC's Balanced Pathway. These measures are typically lower cost and require less disruption to install compared to the other fabric efficiency measures[64] and also offer lower savings (see Table 3 above). Actions to address the gap in 'other insulation' measures in particular should prioritise creating public awareness and understanding of the importance of these measures and where to go to obtain advice.

Potential gap relative to committed and planned policies

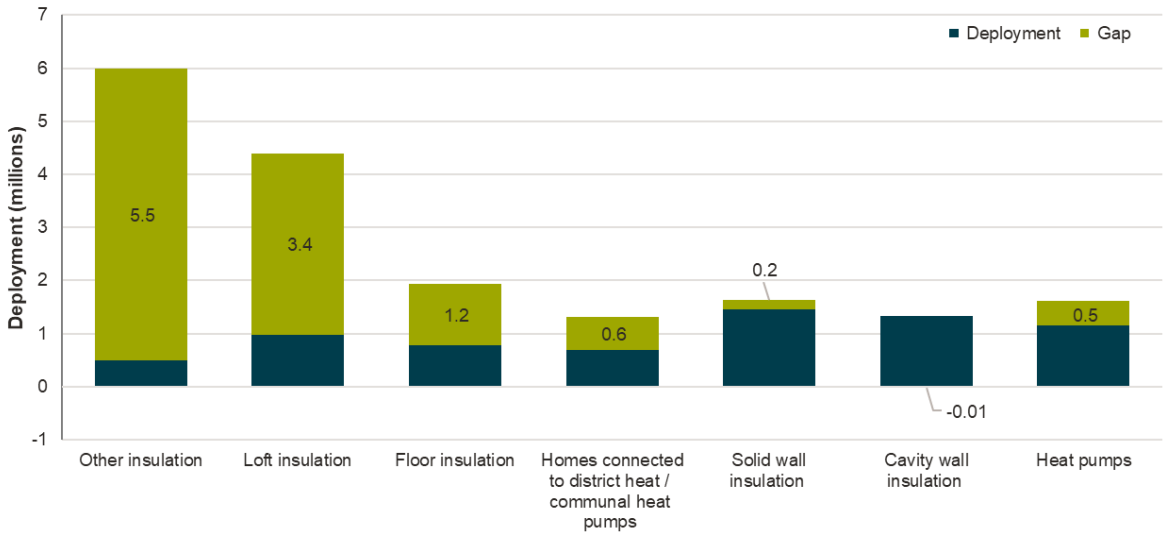
Figure 13 shows the potential gap relative to committed *and planned* policies. As explained above, accounting for the potential deployment under planned policies reduces the size of the gap, but there is greater uncertainty as to the whether this deployment will be achieved. The impact of incorporating planned policies reduces the gap in particular for:

- ASHPs and GSHPs, due to the planned policies for phase-out of the installation of new fossil fuel boilers in off-gas grid homes and private-rented sector minimum standards (as explained above); and

64 See, for example, the illustrative costs referred to recently by the Climate Change Committee in a letter to Chancellor Jeremy Hunt from 9 November 2022 on "Reducing energy demand in buildings in response to the energy price crisis".

- Solid wall and cavity wall (and also floor and loft insulation but to a lesser extent) due to the planned policy for strengthened Private Rented Sector minimum standards. For cavity wall insulation specifically, we note that incorporating the deployment associated with planned policies implies that there is no gap to reaching the deployment required under the 15% target. However, this result relies on all planned policies being implemented and performing as modelled; there is uncertainty around whether this outcome would be reached in practice.

Figure 13 Potential gap relative to committed and planned policies under a 15% target



We provide further detail on the potential gap under the 20% energy efficiency target in Annex B.3.

3.2.3 Potential gap for specific household types

We have also considered the potential policy gap for specific household types under key energy efficiency and heat pump polices.

Figure 14 summarises the policy eligibility (or in some cases, policy targeting) for different home characteristics (e.g. based on tenure, whether the home is categorised as fuel poor and whether the home is connected to the gas grid). This shows that there are particular gaps for energy efficiency policies for those in the owner occupied sector who are not fuel poor. These policy gaps were also highlighted by the CCC in its 2022 Progress Report. [65]

[65] Climate Change Committee (June 2022), 2022 Progress Report to Parliament, pages 178, 194, 196.

Figure 14 Overview of policy eligibility and targeting

			Fabric efficiency							Heat pumps / phase-outs		
✓ Eligible ✓ Eligible with some restrictions			SHDF	ECO4	GB insulation scheme	PRS min. standards	LAD3	HUG1	HUG2	Clean Heat Market mechanism	BUS	Phase-outs installations off gas grid
Owner occupied	Fuel poor	On gas grid		✓	✓		✓			✓	✓	
		Off gas grid		✓	✓			✓	✓	✓	✓	✓
	Non fuel poor	On gas grid			✓					✓	✓	
		Off gas grid			✓					✓	✓	✓
Private rented	Fuel poor	On gas grid		✓	✓	✓	✓			✓	✓	
		Off gas grid		✓	✓	✓		✓	✓	✓	✓	✓
	Non fuel poor	On gas grid			✓	✓				✓	✓	
		Off gas grid			✓	✓				✓	✓	✓
Social rented	Fuel poor	On gas grid	✓	✓	✓		✓			✓	✓	
		Off gas grid	✓	✓	✓			✓	✓	✓	✓	✓
	Non fuel poor	On gas grid	✓		✓					✓	✓	
		Off gas grid	✓		✓					✓	✓	✓

Note: *Eligibility Restrictions:*
- ECO4: Restrictions on eligibility apply depending on factors such as EPC rating of the home and tenure (e.g. owner occupied vs private-rented).
- HUG1/2/ LAD3: Social housing may be included in HUG applications as part of tenure 'in-fill' area-based upgrades – for instance, upgrading a block of flats or adjacent, terraced properties as part of area-based delivery. However, the social housing component of an application cannot exceed 10%.
- GB Insulation Scheme: Includes a broader eligibility pool than ECO4 (i.e. a 'general group' for low efficiency homes in lower council tax bands as well as low-income households). Restrictions on measures apply depending on tenure and whether homes are part of the low-income or 'general' group.

4 Policies to fill the gap

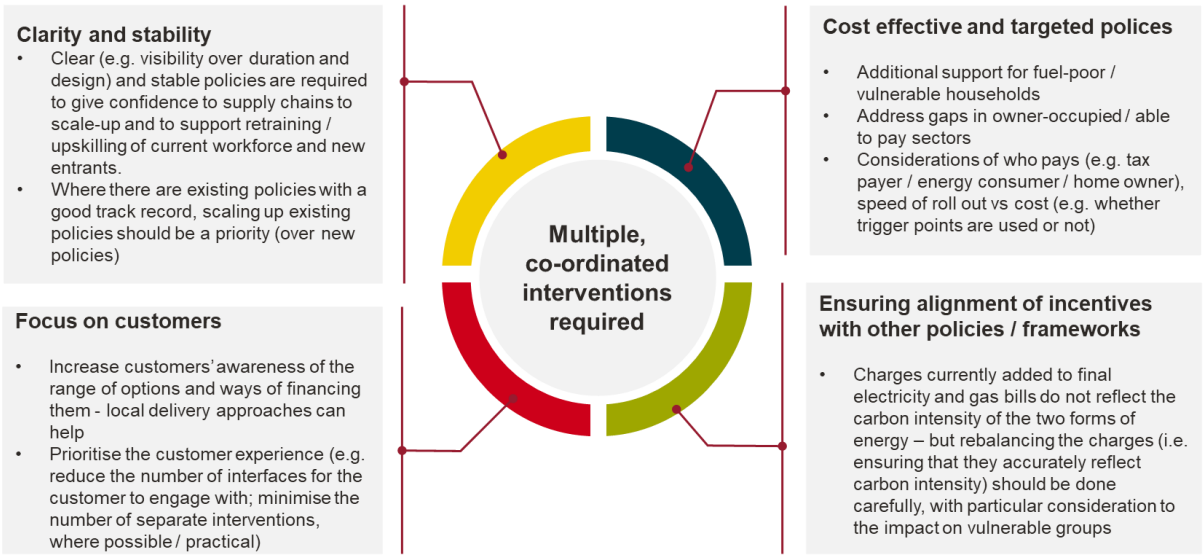
In this chapter, we summarise our conclusions regarding policies that could fill the gaps to deliver a 15% or 20% energy efficiency target.

4.1 Guiding principles for addressing policy gaps

To be successful, any programme of government policies must overcome multiple complex barriers and market failures. Evidence from existing and previous policies suggests that wider barriers and market failures should be addressed simultaneously in order to maximise potential deployment and will require a set of multiple, co-ordinated interventions, with policy stability and clarity as key priorities.

These kinds of co-ordinated interventions are summarised in Figure 15 below.

Figure 15 Approach to developing policies



4.2 Policies to deliver the target

Reaching the energy efficiency targets will require all planned policies to be implemented, scaling up support for energy efficiency, heat pumps and district heat and will also likely require some new major policies. Where there are existing policies with a good track record, scaling up these policies should be a priority (over creating new policies), but new major policies are likely to be required in some areas. In addition, in developing these policies, it will also be important to consider how those policies should be funded and the associated distributional consequences (for example, considering whether the funding of energy efficiency support schemes should be shifted over time away from consumer bills to public

funding to reduce regressive impacts and, in the process, helping to re-balance policy costs between electricity and gas with particular consideration of the impact on vulnerable consumers).

We summarise the policies that could be implemented to fill the gap in Table 5 below. In regard to this table, we note that:

- We have not reviewed the detail of individual policies, and we are not commenting on whether any individual policy has been optimally designed (for example, in terms of its cost efficiency, effectiveness or distributional consequences). Instead, we are considering each policy's scale and the potential impact it could have on the gap.
- The choice of policies is also driven by our assumption that the target is met in line with the technology mix modelled as part of the CCC's Balanced Pathway scenarios, rather than any Frontier modelling on the optimal technology mix.

Table 5 Key policies that could fill the gap

	Committed policies	Gap to 15% target after committed policies	Implement planned policies	Gap to 15% target under committed and planned	Scaling up policies	New major policies[66]
Fabric efficiency	■ Energy Company Obligation (ECO4) ■ GB Insulation Scheme ■ Social Housing Decarbonisation Fund (SHDF) ■ Local Authority Delivery Phase 3 (LAD3) Home Upgrade Grant Phases 1 and 2 (HUG1/HUG2) ■ NEST Warm Homes ■ Scotland's Energy Efficiency policies[67]	4.9m homes	■ Strengthening Private Rented Sector Minimum Standards (from 2025 for change of tenancy; from 2028 for all homes).[68] ■ Effective allocation of £6 billion public funding (2025-28).	2.9m homes before £6 billion funding 2.0m homes after £6 billion funding	■ Scaling up support for energy efficiency upgrades, particularly for low-income households (e.g. additional waves of ECO or social housing decarbonisation fund). ■ Policies targeting lower cost / single or coupled measures for a wide group of households (e.g. a form of scale-up of the GB Insulation Scheme).	■ Additional policies for the owner occupied / 'able-to-pay' segment, (e.g. regulations or incentives at key trigger points such as an Energy Savings Stamp Duty incentive, upfront grants or extensions of the GB Insulation Scheme). ■ Awareness programme to encourage wide-spread take-up of lower cost measures such as draught proofing / hot water tank insulation.

66 This also includes significant changes in scope to existing policies.

67 We refer to 'Scotland's Energy Efficiency Policies' to capture the Social Housing Net Zero Fund, Home Energy Scotland (HES) loans, Warmer Homes Scotland and Area Based Schemes.

68 See DESNZ (September 2020), Improving the Energy Performance of Privately Rented Homes in England and Wales – Consultation Stage Impact Assessment and Scottish Government, Policy actions: Energy efficiency in homes.

	Committed policies	Gap to 15% target after committed policies	Implement planned policies	Gap to 15% target under committed and planned	Scaling up policies	New major policies[66]
						■ Continued work with mortgage lenders on voluntary emissions standards will be a useful complement to wider policies.[69]
Heat pumps	■ Boiler Upgrade Scheme for 2022-2025[70]	1.5m homes	■ Phase-out installation of fossil fuel heating in off-gas grid homes from 2025 (England / Wales and Scotland).[71] ■ Clean Heat Market Mechanism from 2024.	0.6m homes before £6 billion funding 0.5 homes after £6 billion funding	■ Scaling up support for heat pumps (e.g. Boiler Upgrade Scheme).[72] ■ Progress effectively with the Clean Heat Market mechanism through the decade	■ Rebalancing policy costs on consumer gas and electricity bills / carbon taxing costs from mid-2020s. ■ Policies to ensure growth / readiness of supply chain and skilled workforce.

69 The government is considering *a* voluntary minimum requirement for mortgage lenders, although we note the Climate Change Committee's 2022 Progress Report recommends a stronger incentive mechanism, such as a policy requiring EPC C from 2028 at the point or sale and/or a mandatory minimum requirement for mortgage lenders (see Climate Change Committee (June 2022), 2022 Progress Report.

70 We note that the *Powering Up Britain* policy papers refer to the intention to use some of the £6 billion funding for 2025-28 that was previously announced in the Autumn Statement to extend the Boiler Upgrade Scheme for three years to 2028. However, this announcement does not change this analysis since our analysis includes an assumption about the potential deployment of heat pumps / fabric efficiency measures using the £6 billion funding under the category of 'planned policies'.

71 We note that in Scotland, the phase-out of new installations of gas boilers in existing homes is planned from 2030.

72 Although the *Powering Up Britain* policy paper announced that the Boiler Upgrade Scheme would be extended by three years to 2028, no detail on the precise allowances and overall budgeting around this has yet been committed to.

	Committed policies	Gap to 15% target after committed policies	Implement planned policies	Gap to 15% target under committed and planned	Scaling up policies	New major policies[66]
			■ Effective allocation of £6 billion public funding (2025-28)			
Heat networks	■ Green Heat Network Fund / Heat Networks Transformation Programme ■ Heat Networks (Scotland) Act 2021, including the Scotland Heat Network Fund	0.6m homes		0.6m homes	■ Scaling up support for heat networks (e.g. Green Heat Network Fund and Heat Networks Transformation Programme in England/ Heat Network Fund in Scotland)	■ Progress proposals for heat network zoning in England as appropriate[73]
New homes	■ Future Homes Standard in England should be implemented from 2025 and strengthened home standards in Scotland and Wales from 2025 at latest, including ending connections to the gas grid for new homes.[74] ■ Policies to ensure growth / readiness of supply chain and skilled workforce are also required.					

73 In October 2021, DESNZ consulted on proposals for the implementation of heat network zones. DESNZ is currently running a Heat Networks Zoning Pilot programme to deliver heat networks in zones where they provide lowest cost (see DESNZ (November 2022), Guidance: Heat Networks Zoning Pilot).

74 See Climate Change Committee (June 2022), Progress Report to Parliament, page 181, 193. The current ambition in Scotland is that new homes must use heating with zero direct emissions and have high fabric efficiency from 2024. In Wales new social homes need to be EPC A and not rely on fossil fuel heating and there are plans for similar standards to apply to all new homes from 2025.

We do not consider there to be major gaps in the following areas:

- **Energy for non-heating (e.g. appliance efficiency):** The CCC's 2022 Progress Report notes that domestic appliance efficiency standards should contribute to reductions in energy consumption over time, and through a proven mechanism, and that the Energy-Related Products Policy Framework also sets out clear timings for the introduction of new policies. As a result, subject to policies proceeding as planned, there is no major policy gap for reducing non-heating energy consumption.
- **Deployment of solar panels in domestic buildings:** Ongoing growth in solar panels is high and increasing – for example there were c. 61,000 new domestic solar installations in 2021, followed by c. 68,000 installations in January – July of 2022.[75] If these deployment rates continue, there may be no major gap to reach the additional 1.3m required installations by 2030. However, it is worth noting that the solar panel supply chain is subject to some of the same barriers or challenges as other technologies, including a lack of suitably qualified installation engineers, which should also be addressed. In addition, progress on planning and permitted development rights for solar will also help to further facilitate the uptake of solar panels.

[75] MSC Certified (December 2022), Press release: 2022: Solar, so good.

5 Conclusions

We have found that:

- **The 2030 15% energy efficiency target for the domestic sector is less ambitious than the CCC's Balanced Pathway Scenario** (which would imply a reduction closer to the stretch target of 20%).

- **There is a material gap to reach the 15% target in existing homes based on committed policies**. Achieving the 15% target would require policies that deliver an additional: 4.9m fabric efficiency retrofits, 1.5m heat pumps and a further 0.6m heat network connections within the existing housing stock.

- **Even if all currently planned policies are implemented (in addition to policies currently committed to) and perform as expected, there are still gaps to reaching the 15% target in existing homes**. We estimate that committed and planned policies together have the potential to deliver 66% of required fabric efficiency deployment in existing homes, 70% of the required deployment of heat pumps in existing homes and 52% of the required deployment in heat networks for existing homes (Figure 1). In this regard, we would note that the category of 'planned policies' takes into the account the additional £6 billion public funding to be allocated to energy efficiency from 2025 to 2028 as announced at the Autumn Statement in 2022.[76]

  While accounting for the potential additional deployment resulting from 'planned' policies reduces the potential gap, there is uncertainty around whether and how these policies will be implemented and in practice, there is also a risk of existing committed policies under-delivering such as the Government's Boiler Upgrade Scheme aimed at promoting the uptake of heats pumps. If committed and / or planned policies are not implemented in a timely way or do not perform as expected, then there is a much more material prospect of the targets not being reached.

- **If a more ambitious target of 20% was to be assumed, and all committed and planned policies were accounted for, an additional 5.4m existing homes would require fabric efficiency retrofits, an additional 1.4m existing homes would require heat pumps and a further 1.4m existing homes would require connecting to a heat network.**

[76] There is uncertainty as to whether and how this funding will be spent so we follow a simplified approach in order to illustrate the potential impact on the policy gap as follows: i) First, we assume that the entire £6 billion of funding is dedicated to policy delivering energy efficiency improvements in the domestic sector (rather than split between domestic and non-domestic sectors); ii) Second, we convert the £6 billion funding to a number of homes receiving energy efficiency upgrades using the average cost to upgrade a home to an EPC C rating; iii) Lastly, we also estimate the number of homes receiving heat pumps as part of those efficiency upgrades, using the proportion of homes receiving heat pumps (as part of their efficiency retrofit) under ECO4. We explain our assumptions further under the Methodology section of our report.

To maintain effective delivery over the decade, multiple co-ordinated policy interventions will be needed, and it is crucial that these are underpinned by a clear and stable framework. This is needed to give confidence to supply chains to scale-up and to support a sustained programme of retraining / upskilling of the current workforce, as well as attracting new entrants to the industry. This also needs to be complemented with smarter ways of engaging with households, including developing incentives and 'nudges' towards steps to improve the energy efficiency of their homes.

As part of this programme of multiple co-ordinated policy interventions, reaching the target will require all currently planned policies envisaged in the UK Government's Heat and Buildings Strategy (as well as the similar plans of the Scottish and Welsh Governments) to be implemented effectively and in a timely way.[77] In addition, further support and steps beyond planned policies will be required. Assuming the target is met in line with the technology mix modelled as part of the CCC's Balanced Pathway scenarios, this is likely to require:

- a continued strong focus on government support for fabric efficiency upgrades for lower income households; as well as additional policies aimed at the non-fuel poor owner occupied sector;
- a public awareness programme to support widespread deployment of lower cost measures to all households (draught proofing and hot water tank insulation);
- scaling up government support for low carbon heating as part of the gradual phase-out of fossil fuel boilers, rebalancing electricity and gas bills to remove the disincentive effect to take-up of heat pumps arising from policy costs falling heavily on the electricity side, and supporting the development of the wider supply chain; and
- scaling up support for heat networks (e.g. through scaling-up / extension of existing heat network funds) alongside continuing to progress district heat zoning plans.

[77] For example, this includes the proposals to update the Private Rented Sector minimum standards, effective deployment of the £6 billion public funding commitment for 2025-28, the phase-out of the installation of new fossil fuel options in off gas grid homes and successful implementation of the Clean Heat Market Mechanism.

Annex A – Methodology

A.1 Approach to calculating savings associated with a starting level of deployment

As discussed in Section 3.1.2, our approach to calculating the required deployment to reach the target involves using the CCC's level of deployment of individual measures and calculating the associated savings for households taking up those measures.

Our approach can be summarised in three steps:

- **Developing packages of measures:** We develop packages of measures to ensure we account for the interactions between measures on the level of energy savings a household will realise.
- **Allocating deployment to packages:** We allocate the CCC's deployment of each measure across the packages to obtain an assumption about the number of homes taking up each package.
- **Allocating packages to household 'types':** We then allocate the number of packages to different property types to obtain an assumption about the number of packages taken up by each type of home.

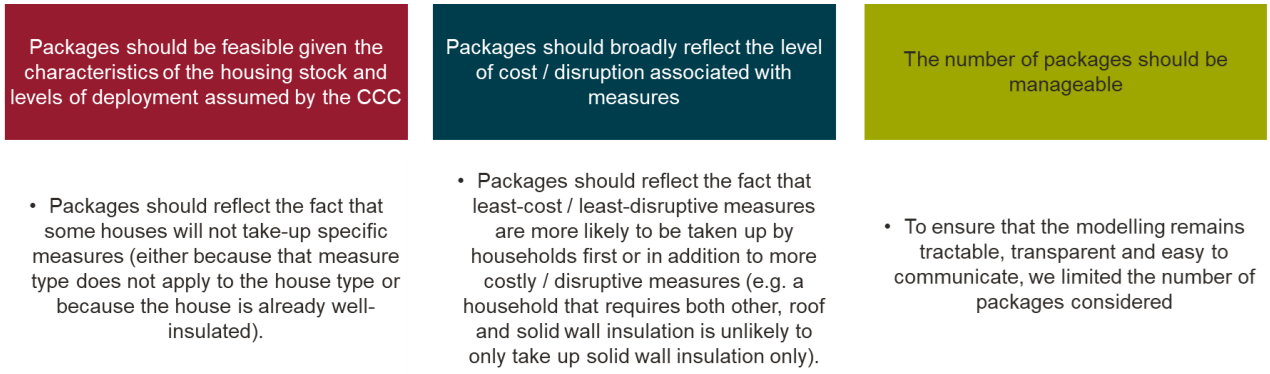
We discuss each step in turn below.

Developing packages of measures

First, we develop packages of measures. Developing packages of measures ensures that we account for the interactions between different measures, and the resulting impact on energy savings. For example, the savings from the first insulation measure installed reduces the household's energy consumption which means that the savings from the second installation will be slightly lower (relative to a situation in which the second measure were installed in isolation). Assuming that measures are taken up by households independently could potentially overstate energy savings achieved if households take up more than one measure in combination.

In practice, there is uncertainty around the exact combinations of measures that will be taken up by different households and so the process of developing packages of measures involves an element of judgement and logical assumptions. We develop packages of measures based on the principles set out in Figure 16.

Figure 16 Principles for package development



Guided by the principles above, we followed these steps to develop our packages:

- **First**, we develop packages of insulation measures.
  - The least-cost / least-disruption package consists only of 'other insulation' (i.e. draught proofing / hot water tank insulation only). These measures are applied to the majority of the homes in the CCC Balanced Pathway.
  - We then create an additional package which added the next lowest cost / disruption measure (i.e. loft insulation).
  - We then create additional packages which added the higher cost / disruption measures, i.e. wall insulation (cavity / solid wall) and floor insulation.
  - We create separate packages for solid wall and cavity wall insulation reflecting that homes generally only take up one of each type of wall insulation.

  We note that this approach follows the same principles as the approach taken by Element Energy for the CCC's Sixth Carbon Budget, where packages of measures were created based on a least-cost / disruption basis.
- **Second**, we create a 'full retrofit + heat pump' package. There are four different 'full retrofit + heat pump' packages to reflect cavity wall and solid wall insulation separately, and also GSHPs and ASHPs separately.
- **Third**, we create a package for those households which take up heat pumps or district heat only (but not insulation). This is for homes which are already well-insulated (which we define as homes which have an EPC rating of C or above).
- **Lastly**, we also incorporate additional packages designed for flats and which exclude floor and loft insulation.

The output of this process is a set of 18 packages, as summarised in Table 6 below.

Allocating deployment to packages

We then allocate the CCC's level of deployment of the measures to these 18 packages. This is done package-by-package:

- We start with the packages that involve the most constraints and measures (i.e. those involving heat pumps and district heat).
- We then work through the remaining packages, starting with those packages with the highest number of measures, and allocate the remaining deployment to these packages.
- We continue this process until we reach the simplest / single measures packages (i.e. package 1 which contains only other insulation).

A detailed description of this approach is set out in the assumptions log accompanying our model. The output of this step is a set of assumptions about the number of homes taking up each package, as shown in Table 6 below.

Table 6 Packages and associated deployment

		Deployment (number of homes)
Low cost / disruption packages		
1	Other	1,479,993
2	Other + loft	2,056,491
Medium cost / disruption packages		
3	Other + loft + floor	841,027
4	Other + loft + floor + solid wall	1,167,749
5	Other + loft + floor + cavity wall	789,713
Full retrofit + heat pump packages		
6	Other + loft + solid wall + ASHP	672,997
6b	Other + loft + solid wall + GSHP	66,349
7	Other + loft + cavity wall + ASHP	672,997
7b	Other + loft + cavity wall + GSHP	66,349
Heat pump only packages		
8	ASHP	688,601

		Deployment (number of homes)
8b	GSHP	96,092
8c	Communal heat pump / DH	1,300,000
Packages suitable for flats		
9	Other + solid wall	123,791
10	Other + cavity wall	32,076
11	Other + solid wall + ASHP	34,535
11b	Other + solid wall + communal heat pump / DH	304,354
12	Other + cavity wall + ASHP	34,535
12b	Other + cavity wall + communal heat pump / DH	304,354

Note: DH = District Heat

Allocating packages to home types

We then allocate the packages to home 'types' in order to obtain an estimate of the number of each type of home taking up a particular package. Each home type differs according to the following characteristics:

- **Building style:** We consider four different styles of buildings (i.e. detached, semi-detached, mid-terraced houses and flats). The number of each style of home is obtained from the National Energy Efficiency Data-Framework (NEED).[78]
- **Existing heating technology:** We consider three main existing heating technologies which are gas boilers, oil boilers and electric resistive heating. Other types of heating (e.g. biomass boilers) make up a very small proportion of households and therefore we have not considered them in the modelling. The proportion of households with each heating technology is taken from data published by Ofgem.[79]
- **Energy efficiency:** We split the households into 'high efficiency' and 'low efficiency' homes. We assume that c. 42% of each property style is rated as 'high efficiency', reflecting the proportion of households in England with an EPC rating of A-C.[80]

78 National Energy Efficiency Data-Framework (NEED) (last updated: 5 August 2021), Additional consumption tables: England and Wales, 2019, Table A.6.

79 Ofgem (December 2015), Insights paper on households with electric and other non-gas heating, Figure 2.

80 Ministry of Housing, Communities & Local Government (May 2021), Energy Performance of Buildings Certificates Statistical Release January to March 2021 England and Wales, Figure 1. We use the proportion of homes in England that have an EPC rating of A-C (rather than in GB) as a simplification. Although there are some small differences in the proportion of homes with an EPC rating of A-C in Scotland and Wales compared to England (e.g. 36% of homes in Wales has an EPC rating of A-C in 2021, as per

We also consider which homes are eligible to take up certain packages of measures. We assume that some packages will not be deployed to certain property types, either because that measure type does not apply to the property type or because the property is already well-insulated. Table 7 below shows the type of houses that are eligible for each package. This is based on the following logic:

- We assume that flats cannot have loft or floor insulation, in line with the data available from the CCC. Packages 9 to 12b are designed to account for flats that take up either solid or cavity wall insulation. We assume that all other property types would take up loft insulation first (given it is relatively lower cost / low-disruption), and therefore take up packages 3 to 7b.
- We assume that only houses that are already well-insulated will take up heat pumps or district heat without also taking up insulation (packages 8, 8b and 8c). We think that assumption is reasonable as the gains from installing a heat pump are highest when a home is well-insulated, and because the cost / disruption from this measure is relatively high, so poorly insulated homes are more likely to take up other lower cost / disruption insulation measures before taking up a heat pump.
- We also assume that highly efficient homes will not take up any of the main types of insulation since they are likely to already have it. Therefore, packages 1-7b and 9-12b are for low efficiency homes only.

Table 7 Eligibility of houses by package

	Package	Which home efficiency types are eligible for the package?	Which building types are eligible for the package?
Low-cost / disruption packages			
1	Other	Low efficiency	All
2	Other + loft	Low efficiency	All except flats
Medium cost / disruption packages			
3	Other + loft + floor	Low efficiency	All except flats
4	Other + loft + floor + solid wall	Low efficiency	All except flats
5	Other + loft + floor + cavity wall	Low efficiency	All except flats
Full retrofit + heat pump packages			
6	Other + loft + solid wall + ASHP	Low efficiency	All except flats

Figure 6 of the same study for England and Wales; 45% of homes in Scotland had an EPC rating of A-C in 2019, as per the Scottish house condition survey: 2019 key findings report) we would not expect these differences to have a substantial impact on the results, given the smaller home numbers in Scotland / Wales, compared to England.

	Package	Which home efficiency types are eligible for the package?	Which building types are eligible for the package?
6b	Other + loft + solid wall + GSHP	Low efficiency	All except flats
7	Other + loft + cavity wall + ASHP	Low efficiency	All except flats
7b	Other + loft + cavity wall + GSHP	Low efficiency	All except flats
Heat pump only packages			
8	ASHP	High efficiency	All
8b	GSHP	High efficiency	All except flats
8c	Communal heat pump / DH	High efficiency	Flats and Mid-terraced only
Packages suitable for flats			
9	Other + solid wall	Low efficiency	Flats only
10	Other + cavity wall	Low efficiency	Flats only
11	Other + solid wall + ASHP	Low efficiency	Flats only
11b	Other + solid wall + communal heat pump / DH	Low efficiency	Flats only
12	Other + cavity wall + ASHP	Low efficiency	Flats only
12b	Other + cavity wall + communal heat pump / DH	Low efficiency	Flats only

Accounting for the eligibility constraints in Table 7, we then allocate the deployment of the packages relative to the number of households of each eligible property type. For example, as shown in Figure 17 below, of the total number of properties that are eligible for package 4, 29% are low efficiency, detached properties with gas boilers. Therefore we assumed that 29% of the deployment of package 4 goes to properties of this type.

Figure 17 Proportion of deployment by package and house type

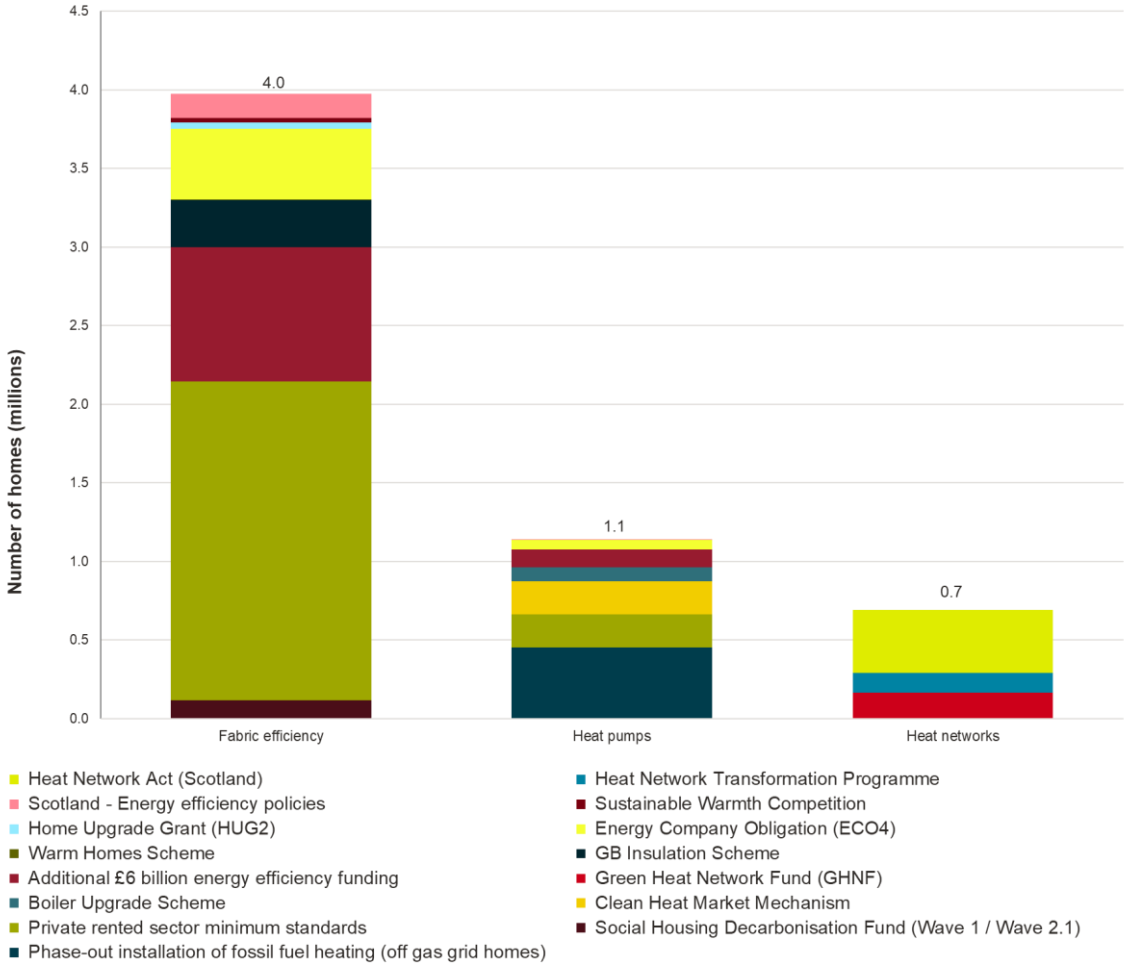
Property	Heating	Efficiency	1	2	3	4	5	6	6b	7	7b	8	8b	8c	9	10	11	11b	12	12b
Detached	Electric	Low	1%	1%	1%	1%	1%	1%	1%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Detached	Electric	High	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%	0%	0%	0%	0%	0%	0%
Detached	Gas	Low	23%	29%	29%	29%	29%	29%	29%	29%	29%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Detached	Gas	High	0%	0%	0%	0%	0%	0%	0%	0%	0%	23%	29%	0%	0%	0%	0%	0%	0%	0%
Detached	Oil	Low	2%	2%	2%	2%	2%	2%	2%	2%	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Detached	Oil	High	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	2%	0%	0%	0%	0%	0%	0%	0%
Flat	Electric	Low	5%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	8%	27%	27%	27%	27%	27%	27%
Flat	Electric	High	0%	0%	0%	0%	0%	0%	0%	0%	0%	5%	0%	6%	0%	0%	0%	0%	0%	0%
Flat	Gas	Low	14%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	22%	73%	73%	73%	73%	73%	73%
Flat	Gas	High	0%	0%	0%	0%	0%	0%	0%	0%	0%	14%	0%	16%	0%	0%	0%	0%	0%	0%
Flat	Oil	Low	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Flat	Oil	High	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Mid-terraced	Electric	Low	1%	1%	1%	1%	1%	1%	1%	1%	1%	0%	0%	1%	0%	0%	0%	0%	0%	0%
Mid-terraced	Electric	High	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	0%	0%	0%	0%	0%	0%
Mid-terraced	Gas	Low	18%	22%	22%	22%	22%	22%	22%	22%	22%	0%	0%	27%	0%	0%	0%	0%	0%	0%
Mid-terraced	Gas	High	0%	0%	0%	0%	0%	0%	0%	0%	0%	18%	22%	20%	0%	0%	0%	0%	0%	0%
Mid-terraced	Oil	Low	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Mid-terraced	Oil	High	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Semi-detached	Electric	Low	2%	2%	2%	2%	2%	2%	2%	2%	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Semi-detached	Electric	High	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	2%	0%	0%	0%	0%	0%	0%	0%
Semi-detached	Gas	Low	34%	42%	42%	42%	42%	42%	42%	42%	42%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Semi-detached	Gas	High	0%	0%	0%	0%	0%	0%	0%	0%	0%	34%	42%	0%	0%	0%	0%	0%	0%	0%
Semi-detached	Oil	Low	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Semi-detached	Oil	High	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Total			100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Annex B Required deployment and potential gap

B.1 Potential deployment under planned and committed policies

We summarise below the potential deployment of measures under planned and committed policies. Figures are expressed as number of homes and are primarily based on the modelled deployment from government impact assessments.

Figure 18 Deployment under committed and planned policies



Note: *Scotland's energy efficiency policies include: Social Housing Net Zero Fund, Home Energy Scotland (HES) loans, Warmer Homes Scotland and Area Based Schemes.*
Clean Heat Market Mechanism: Although the level of the obligation will be set based on a proportion of sales, we expect that this will translate to installations (albeit with some time lag) since the obligation is met by holding low carbon heat pump credits corresponding to the level of the obligation, and these credits are allocated based on the installation of a qualifying heat pump. We also note that actual domestic deployment under the Clean Heat Market Mechanism may be lower than what is assumed in this analysis (which is based on the Impact Assessment). This is because the impact assessment figures exclude hybrid heat pumps, but it has subsequently been confirmed that hybrid heat pumps will contribute towards meeting the obligation. Therefore, a proportion of the deployment associated with the market mechanism could come from hybrid heat pumps (and by extension fewer non-hybrid heat pumps may be deployed). In addition, the obligation may also be met by installing heat pumps (which meet

the capacity and appliance criteria) in non-domestic properties, although the proportion of heat pumps that might be installed in non-domestic properties is unclear.

We note the following:

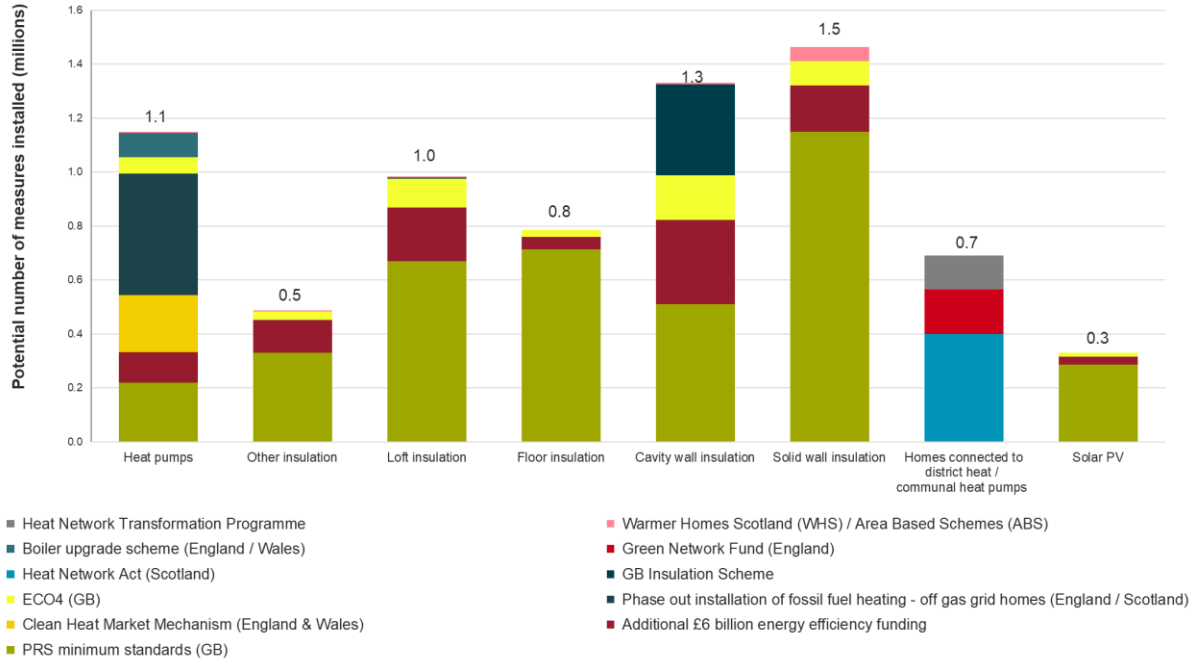
- The numbers of homes across different measure types (e.g. fabric efficiency vs heat pumps) are not additive, since homes can take up measures from more than one scheme (e.g. a heat pump under BUS and insulation under ECO4).
- For policies that deliver both energy efficiency measures and heat pumps, we assume (for the purpose of this analysis) that all homes that receive heat pumps also receive some form of energy efficiency measure. For example, for Private Rented Sector minimum standards, we assume that all 210,000 homes which DESNZ models as receiving heat pumps, also receive a fabric efficiency retrofit. There are some smaller policies (e.g. Social Housing Decarbonisation Fund / Warm Homes) with no information on modelled deployment by measure, therefore we assume that deployment relates to retrofits only.
- The number of homes treated under energy efficiency policies can generally be interpreted as the number of homes upgraded to EPC C, since this is a requirement under most energy efficiency policies. We compare these numbers of homes to our modelled deployment requirements (i.e. the number of homes taking up insulation across the different packages we have modelled). Although our modelling includes packages with different levels of insulation, we assume that homes take up a package which is suited to their efficiency requirements (e.g. to deliver an upgrade to EPC C).

B.2 Potential measures deployed under planned and committed policies

We summarise below the potential deployment of measures under planned and committed policies. Figures are expressed as number of installations and are primarily based on the modelled deployment from government impact assessments.

We show the potential impact of all the heat pump / heat network policies we have considered, as well as the energy efficiency policies with the largest potential impacts. A small sub-set of policies are not shown on the chart below since data on the breakdown of potential deployment of measures is not available.

Figure 19 Deployment of measures under committed and planned policies



Note: *Other insulation: We use the definition 'other insulation' as per the CCC to include draught proofing / hot water (HW) tank insulation. Where policies report modelled deployment of draught proofing / HW tank insulation separately, we take the lower of these numbers as the total "other insulation" installed for consistency with our scenario modelling which assumes that draught proofing and HW tank insulation are taken up together.*

B.3 Potential gap under the 20% energy efficiency target

Figure 20 Potential gap relative to committed policies under a 20% target

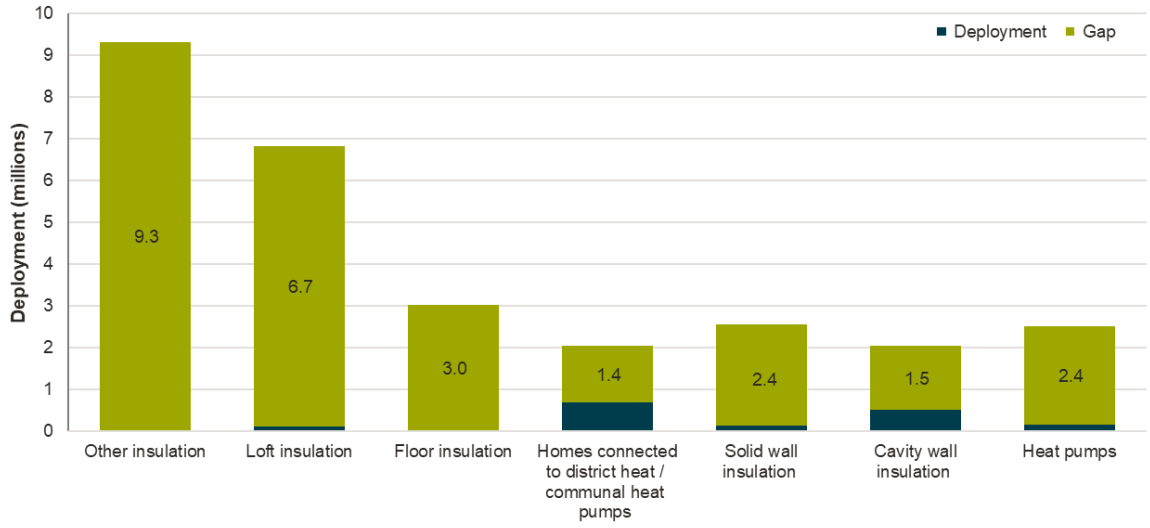
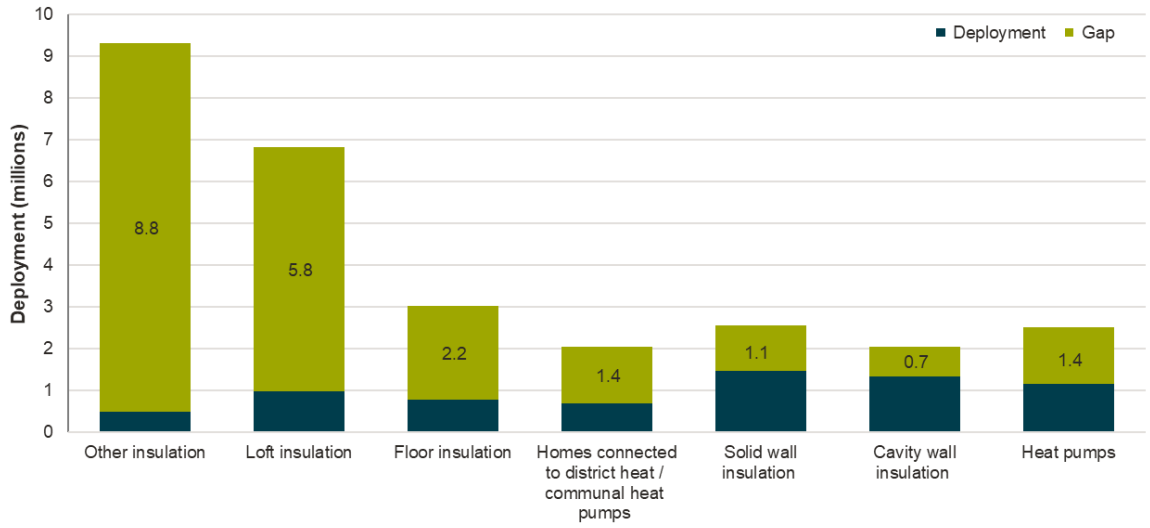


Figure 21 Potential gap relative to committed and planned policies under a 20% target



Annex C Glossary of terms

Table 8 Glossary of terms

Term	Meaning
ABS	Area Based Schemes programme
ASHP	Air Source Heat Pump
BUS	Boiler Upgrade Scheme
CCC	Climate Change Committee
Communal heating	*"A system where one source of heat serves all customers in a building*".[81]
DESNZ	Department for Energy Security and Net Zero
District heat	Systems that "*supply heat from a central source to consumers, via a network of underground pipes carrying hot water. Heat networks can cover a large area or even an entire city or be fairly local supplying a small cluster of buildings."*[82]
ECO4	Energy Company Obligation (4th iteration of the scheme)
GB Insulation Scheme	Great British Insulation Scheme (formerly known as ECO+)
GSHP	Ground Source Heat Pump
HES loans	Home Energy Scotland loans
Heat network	In this report, we use the term 'heat network' to refer to both 'district heat' and 'communal heating' systems.
High efficiency	In this report, we use this term to refer to homes which have an EPC rating of C or above.
HUG1	Home Upgrade Grant (Phase 1)
HUG2	Home Upgrade Grant (Phase 2)
LAD3	Local Authority Delivery (Phase 3)
Low efficiency	In this report, we use this term to refer to homes which have an EPC rating of D or below.
Other insulation	Draught proofing and hot water (HW) tank insulation

81 See DESNZ (2022), Green Heat Network Fund: Guidance for applicants, page 14.

82 See DESNZ (March 2018) What is a heat network?, page 3

Term	Meaning
PRS minimum standards	Private Rented Sector minimum standards
Scotland's energy efficiency policies	In this report, we use this term to refer to the following Scottish energy efficiency policies: 1) Social Housing Net Zero Fund, Home Energy Scotland (HES) loans, Warmer Homes Scotland (WHS) and Area Based Schemes (ABS) Programme.
SHDF	Social Housing Decarbonisation Fund
Trigger points	In this report we refer to 'trigger points' such as boiler replacement, major renovation or home sale.
Sustainable Warmth Competition	Encompasses two schemes: 1) Local Authority Delivery Phase 3 (LAD3); and Home Upgrade Grant Phase 1 (HUG1).
WHS	Warmer Homes Scotland