



REPORT

Decarbonising home heating

Department for Energy Security & Net Zero



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National Audit Office

Decarbonising home heating

Department for Energy Security & Net Zero

Report by the Comptroller and Auditor General

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Gareth Davies
Comptroller and Auditor General
National Audit Office

13 March 2024

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Key facts

18%

of the UK's greenhouse gas emissions in 2021 (the most recent year for which data are available) were from heating homes

55,000

heat pumps sold in the UK in 2022, according to Heat Pump Association estimates

600,000

the Department for Energy Security & Net Zero's (DESNZ's) ambition for the number of heat pumps to be installed per year by 2028

Up to 6%

real terms reduction in the cost of installing a heat pump in UK homes from 2021 to 2023. DESNZ's ambition is for industry to reduce costs by at least 25% by 2025 compared to 2021

£7,500

grant available to households in England and Wales towards the cost of a heat pump since October 2023, with the scheme running to at least March 2028. This is an increase from the £5,000-£6,000 grant that had been available between May 2022 and September 2023

2026

year when DESNZ will take decisions on the role of hydrogen in home heating. In 2023 DESNZ decided to not proceed with a trial intended to provide evidence to support its decisions

£162 billion

Climate Change Committee estimate of the additional investment that will be needed from 2020 to 2050 for installing low-carbon heating in existing UK homes

Summary

Introduction

1 Heating the UK's 28 million homes accounted for 18% of all UK greenhouse gas emissions in 2021, the most recent year for which data are available. The main source of these emissions is from burning natural gas to heat homes. Reducing emissions from heating homes is therefore a key component of the government's overall target to achieve net zero greenhouse gas emissions by 2050.

2 Reducing emissions from heating homes means that households using fossil fuels will need to switch to a low-carbon alternative. The Climate Change Committee has estimated that £162 billion of additional investment will be required to install low-carbon heating in existing UK homes between 2020 and 2050. This could involve installing a heat pump, which uses electricity to generate heat; connecting to a low-carbon heat network – a communal source of heating delivered to multiple dwellings; or potentially using hydrogen instead of natural gas. The suitability of these alternatives depends on factors including regional geography, house type and the heating system currently in use. Emissions from heating homes can also be reduced by improving energy efficiency, for example by improving insulation, to reduce overall energy usage and associated emissions.

3 In October 2021, the government published its *Heat and Buildings Strategy*. The Strategy made a range of commitments aimed at developing markets and consumer choices for heat pumps and heat networks, and stated the government's ambition to end the installation of new fossil fuel boilers by 2035. It committed to:

- growing the supply chain for heat pumps to a minimum market capacity of 600,000 heat pump installations per year by 2028; and
- developing the evidence base to inform strategic decisions in 2026 on the future role of hydrogen in home heating, and therefore the future heating technology mix.

4 The government also committed £6.6 billion from 2021-22 to 2024-25 for schemes to improve energy efficiency and install low-carbon heating, and an additional £6 billion from 2025-26 to 2027-28. This includes the Boiler Upgrade Scheme, which provides households in England and Wales with an up-front grant to help cover the cost of replacing fossil fuel heating systems with a heat pump or biomass boiler.

5 In October 2023, the government clarified that heat pumps and heat networks will be the primary low-carbon technology for decarbonising home heating over the next decade and will play a key role in all pathways to 2050. Also in October 2023, the National Infrastructure Commission, which advises the government on major long-term infrastructure challenges, recommended that the government should not support hydrogen for home heating. The government maintains that it needs to establish the evidence base before taking decisions on hydrogen, but has also stated that no one should hold back on installing a heat pump or connecting to a heat network on the basis that hydrogen might be an option later.

6 The Department for Energy Security & Net Zero (DESNZ) has overall responsibility for decarbonising home heating in England, including meeting interim emissions reductions targets for five-year periods known as carbon budgets. It must reduce emissions while also meeting statutory fuel poverty targets. The Department for Levelling Up, Housing & Communities (DLUHC) also has an important role, given that it oversees building and planning regulations in England, and Energy Performance Certificates, which rate buildings' energy efficiency, in England and Wales.

Purpose and scope of this report

7 This report examines the progress DESNZ has made in decarbonising home heating since the government published its *Heat and Buildings Strategy* in 2021, including whether it has established a clear pathway to decarbonising home heating in a way that is value for money. We have also assessed the progress in rolling out heat pumps, which the government expects to be the main low-carbon technology households use to heat their homes. We have made recommendations aimed at supporting DESNZ to maximise value for money as it develops its approach to decarbonising home heating.

8 The report focuses on the deployment of low-carbon heating and does not consider energy efficiency.¹ The report also does not evaluate the value for money of specific schemes or programmes aimed at decarbonising home heating, such as the Boiler Upgrade Scheme.

¹ Our most recent report covering energy efficiency was: Comptroller and Auditor General, *Green Homes Grant Voucher Scheme*, Session 2021-22, HC 302, National Audit Office, September 2021 (accessed on 19 February 2024).

Key findings

Establishing a pathway to decarbonising home heating

9 Some aspects of DESNZ's plans to test the feasibility of hydrogen for home heating are behind schedule or have been cancelled, meaning it will have less evidence to make decisions in 2026 on the role of hydrogen. DESNZ committed to supporting industry to conduct large-scale trials of hydrogen ahead of strategic decisions on the role of hydrogen in 2026. A gas distribution company plans to start a neighbourhood trial, originally planned for 2023, in 2024. DESNZ is no longer proceeding with supporting a village trial that it originally planned for 2025. DESNZ stated that this is due to issues with identifying a local hydrogen supply. DESNZ told us it is considering alternative plans to address gaps in evidence resulting from the cancellation of the village trial, but that the evidence available will be less than had the village trial gone ahead. Other aspects of its Hydrogen Heating programme are progressing; for example, around half the safety evidence expected from the programme had been submitted to the Health and Safety Executive as at January 2024. DESNZ is still developing an appraisal framework for making its 2026 decisions, which will be based on the costs, benefits and risks of deploying each low-carbon technology, including findings on the safety, feasibility and acceptability of hydrogen. The later the appraisal framework is agreed, the greater the risk that there will be gaps in the evidence base required for decisions on the government's preferred low-carbon technology mix (paragraphs 2.3 to 2.6).

10 Ongoing uncertainty over the role of hydrogen could slow the progress of decarbonising home heating. Some stakeholders told us that the government should provide more policy certainty and stability as a priority, given the substantial capital needed to decarbonise home heating. Without this, it could limit the ability of local authorities and industry to plan and invest on a wider scale. DESNZ has already indicated that it expects hydrogen to play a limited role. Stakeholders from consumer and industry representative organisations and other government bodies have told us the government should bring forward its 2026 decisions on hydrogen, to reduce uncertainty, help strategic planning and stimulate demand for heat pumps (paragraphs 2.7 to 2.10).

11 DESNZ is yet to determine how to decarbonise home heating in around 20% of homes that may be exempt from the 2035 phase-out of new fossil fuel boilers. In September 2023, the government announced it would exempt homes that are not suitable for heat pumps or otherwise warrant exemption. Homes fitting these criteria could include those requiring energy efficiency or electrical connection upgrades, lacking space for a heat pump, or located in zones likely to be connected to a heat network. DESNZ recognises it will need to set out how it expects these homes will be heated, and how it will ensure people living in them are not unfairly penalised. DESNZ intends to consult in 2024 on alternative options for homes not suitable for a low temperature heat pump off the gas grid, such as liquid biofuels. It expects future innovations in heat pump technology and installation practices to enable some of these homes to become suitable for a heat pump by 2035 (paragraphs 2.21 and 2.22).

12 DESNZ is working to develop its understanding of the consequences for gas networks of decarbonising home heating, and how these will be paid for. Parts of the gas network may need to be decommissioned if natural gas is no longer used, and hydrogen is confined to certain areas of the country, although any decommissioning is unlikely to start until the mid to late 2030s. Gas networks are regulated monopolies that depend on private investment to fund ongoing operation and maintenance. There is therefore a risk that investment will reduce if investors expect these assets to be decommissioned. It is also uncertain who will pay for the networks to continue in service with a decreasing customer base, or to be decommissioned, and how the government will ultimately manage the transition for the last remaining customers on a gas network. In June 2023, DESNZ stated that it has limited understanding of the costs and feasibility of decommissioning the gas network and is working to improve this (paragraph 2.20).

13 The government has started establishing roles for local and regional bodies in decarbonising home heating. In December 2023, DESNZ launched a consultation on its proposal for local authorities to play a key role in the planning, delivery and monitoring of heat networks through a new Zoning Coordinator role. In November 2023, Ofgem announced it intends to involve local authorities in energy network planning through Regional Energy Strategic Planners. More broadly, local authorities' understanding of the local housing stock, residents' needs and availability of local suppliers means local authorities could be well placed to support decisions on low-carbon home heating solutions in their local area, though the Local Government Association told us that local authorities need more clarity on their roles and powers. Stakeholders we spoke to told us that they expected the transition to low-carbon heating would require a more regional approach, given variations in local infrastructure, such as energy networks (paragraphs 2.11 to 2.13).

14 DESNZ has developed a campaign and tools to promote heat pumps but does not have an overarching long-term consumer engagement plan for decarbonising home heating. Decarbonising home heating will require almost every household to make a decision that will have a significant impact on their homes. Yet public awareness is low: around 30% of respondents to a government survey in summer 2023 had never heard, or hardly knew anything, about the need to change the way homes are heated to reach net zero. DESNZ has promoted heat pumps as part of its 'Welcome Home to Energy Efficiency' communications campaign, launched in October 2023, and provides information through its online heat pump suitability and energy efficiency tools. Research published by Energy Saving Trust in December 2023 indicated that homeowners were unsure where to get independent, impartial advice on making improvements to reduce their homes' emissions. DESNZ is developing advice tailored to housing tenure, type of installation and the information needed (such as the most suitable measures, available grant schemes, or approved installers). However, it has no overarching long-term consumer engagement plan to support its key milestones for decarbonising home heating, such as the phase-out of the sale of new fossil fuel boilers by 2035 (paragraphs 2.14 to 2.17).

Progress installing heat pumps

15 Uptake of the Boiler Upgrade Scheme has been lower than DESNZ expected, leading it to increase the grant that is available. The Boiler Upgrade Scheme funded the installation of nearly 18,900 heat pumps in England and Wales from May 2022 to December 2023. The original business case budgeted for up to 50,000 installations by this point. DESNZ underspent by £100 million in the scheme's first year. To increase uptake, in October 2023 DESNZ increased the grant value available through the scheme to £7,500 per household, up from £5,000 for an air source heat pump and £6,000 for a ground or water source heat pump. It covers nearly 60% of the average cost of installing a heat pump, based on the average cost in 2023. The grant uplift has enabled some energy suppliers to offer heat pump installations starting at £500. The number of applications to the scheme in December 2023 increased by nearly 50% compared with December 2022, and applications in January 2024 increased by nearly 40% compared with January 2023. Data over a longer period will be required to determine whether the change is sustained (paragraphs 1.9, 3.4, 3.19, and Figure 3).

16 Average heat pump installation costs have fallen, but more slowly than DESNZ hoped, and it has not made the progress it had planned on reducing running costs.

- **Installation costs:** DESNZ considers installation cost a key factor affecting demand for heat pumps. As at December 2023, the average market rate for replacing a gas boiler with a heat pump was around four times higher than replacing like-for-like. In 2021, DESNZ set an ambition for industry to reduce the costs of installing a heat pump by at least 25–50% by 2025 and to ensure heat pumps are no more expensive to buy and run than gas boilers by 2030. Data from MCS (Microgeneration Certification Scheme), a quality assurance scheme, indicate the average cost of installing a heat pump in 2023 reduced by up to 6% in real terms compared with 2021, to £11,287 (in 2021 prices).² Installation costs will need to fall around three times faster over the next two years if they are to reach the minimum 25% reduction ambition. DESNZ told us that costs had not fallen significantly, due to pressures in the global supply chain. This includes, for example, a shortage of semiconductors that are a key heat pump component; manufacturers not being able to keep up with increased global demand for heat pumps; and high energy prices increasing the cost of manufacturing (paragraphs 3.7, 3.8 and Figure 4).
- **Running costs:** Electricity remains more expensive per unit than gas, making heat pumps potentially more expensive to run than a gas boiler. The government has committed to rebalance energy prices over the course of the 2020s, including shifting energy levies and obligations from electricity to gas bills, but its plans around this have been delayed by nearly two years. DESNZ told us that its focus for energy bills in 2022 was tackling the high energy costs since autumn 2021, and that price rebalancing remains essential but politically challenging (paragraph 3.10).

² We have adjusted the MCS cost data to 2021 prices.

17 DESNZ does not have all the information it needs on heat pump installations to monitor whether progress is on track and to identify key barriers to uptake.

DESNZ does not have a single measure of the number of heat pumps installed. DESNZ told us it is considering how it can combine a range of datasets to produce a publishable series. It is planning to monitor uptake of the Boiler Upgrade Scheme grant among different socio-economic groups through an externally commissioned evaluation, for which interim results are due in the second half of 2024. DESNZ's understanding of the key barriers to installation is based on commissioned research, industry insight and qualitative information. However, it tracks progress against some barriers in more detail than others, and does not monitor the reasons why some applications to the Boiler Upgrade Scheme do not progress to heat pump installation. It told us it intends to take a more systematic approach to monitoring these barriers and will gather six-monthly insights through the Boiler Upgrade Scheme evaluation. Regular monitoring of progress in reducing all key barriers would help DESNZ better understand whether it is on track to deliver the anticipated increase in heat pump installations and where further intervention may be required from government or industry (paragraphs 3.3, 3.5, 3.16 and 3.17).

18 DESNZ, along with DLUHC, has developed plans for further measures aimed at increasing heat pump uptake.

In 2023, DESNZ stated it would introduce the Clean Heat Market Mechanism in April 2024. This is an obligation on the manufacturers of fossil fuel heating systems to sell a certain level of low-carbon heat pumps proportional to their fossil fuel boiler sales in the UK market. In February 2024 there were media reports that ministers were considering whether to delay or remove the mechanism. DESNZ has told us that as at early March, no decision has yet been made. From 2025, DLUHC's Future Homes Standard is expected to require all new homes in England to be built to a higher standard of energy efficiency and to have low-carbon heating. DESNZ estimates this will account for 200,000 new heat pump installations a year (paragraphs 3.23, 3.24 and Figure 6).

19 DESNZ is relying on optimistic assumptions about consumer demand and manufacturer supply of heat pumps increasing substantially to achieve 600,000 installations per year by 2028. Heat Pump Association data indicates that 55,000 heat pumps were sold in the UK in 2022. Achieving the target of 600,000 annual installations by 2028 requires an elevenfold increase from 2022 to 2028, using sales as a proxy for installations. DESNZ regards the target as viable given the planned policies and regulation for 2024 onwards. This relies on the Clean Heat Market Mechanism and the Boiler Upgrade Scheme delivering 400,000 heat pump installations per year by 2028, supported by other energy efficiency and low-carbon heating retrofit schemes such as the Social Housing Decarbonisation Fund (SHDF) and the Energy Company Obligation (ECO). A third of respondents to the 2023 consultation on the Clean Heat Market Mechanism reported that the government's targets would be unachievable under market conditions at the time, although this pre-dated the increased grant available through the Boiler Upgrade Scheme. Some of the government's net zero policy announcements in September 2023, such as the delay to the phase-out of fossil fuel heating systems for off-gas-grid homes, make this target more challenging (paragraphs 3.3, 3.6, 3.23, 3.26, 3.27 and Figure 6).

20 DESNZ will have important decisions to make over how it will approach the rollout of heat pumps after 2028 and how to balance costs between taxpayers and households. DESNZ projects that to achieve its 2050 net zero target, heat pump installation rates will need to continue increasing after 2028, with up to 1.6 million installations per year by 2035. Currently, the Boiler Upgrade Scheme and Clean Heat Market Mechanism are only in place until 2028, after which the government will need to decide the relative roles of public engagement, taxpayer-funded grants, obligations on manufacturers and costs incurred by households. By drawing on evaluations of its current schemes, DESNZ can make informed decisions about the combination of policies and regulations that will increase heat pump uptake in a way that achieves value for money (paragraphs 3.28 to 3.30).

21 DESNZ recognises that its overall delivery model for heat pump installations will need to be kept under review. Some stakeholders told us they expect the most efficient delivery model for mass rollout of heat pumps in the 2030s and beyond will be to adopt a ‘street-by-street’ approach to install multiple heat pumps in the same area around the same time, rather than the current approach of demand being driven by individual households. This might enable better planning of upgrades to local electricity networks to carry increases in demand and reduce installation costs. Such a delivery model would require careful planning and public engagement. DESNZ told us it currently expects that the approach of installing heat pumps on a house-by-house basis would endure for the whole rollout, but that it would keep this under review as new evidence emerges (paragraph 3.31).

Conclusion on value for money

22 Decarbonising home heating represents one of the biggest challenges to the government achieving net zero, requiring almost all households to engage in the transition. Aspects of DESNZ’s overall pathway remain unclear, particularly as DESNZ works towards determining the role of hydrogen in home heating. It should not extend this work beyond what is necessary to come to an informed decision, recognising that uncertainty could hamper progress and drive up costs while consumers and businesses wait for further clarity. DESNZ also needs to get to grips with other longer-term challenges, such as the future of the gas networks and plans for reaching harder-to-decarbonise homes, to ensure it has a clear, enduring plan that maximises the value of public and private investments in the transition.

23 Despite these uncertainties, it has become increasingly clear since the 2021 *Heat and Buildings Strategy* that the government’s approach will centre on heat pumps as the main technology. But DESNZ’s progress with encouraging households to install heat pumps has been slower than planned because costs remain high and public awareness remains low. DESNZ must ensure its mix of incentives, engagement and regulations draws on ongoing experience to address these issues, and support the rollout of heat pumps in a way that minimises the long-term costs to both taxpayers and consumers.

Recommendations

24 On establishing a pathway towards decarbonising home heating, DESNZ should:

- a** Establish an overarching long-term consumer engagement plan to support achieving key milestones, such as the phase-out of the sale of new fossil fuel boilers by 2035. This should include clarifying roles and responsibilities for existing organisations in central and local government. DESNZ should also consider introducing a new body with specific responsibility for consumer engagement.
- b** Publish an updated *Heat and Buildings Strategy* by early 2026 at the latest, that takes account of its revised expectations around the relative roles of electrification and hydrogen for home heating.
- c** Consider whether it is possible to provide more certainty on the role of hydrogen in home heating before 2026 to help industry plan and invest. This could include:
 - making some aspects of the decision before 2026. For example, indicating that hydrogen will only be used in locations where certain conditions exist, such as proximity to hydrogen production facilities; and
 - providing clarity on what is in scope for the 2026 decisions, for example whether it will decide on hydrogen as an option for all consumers, or if it will determine hydrogen has a role in specific areas and/or circumstances.
- d** Continue its work to consider the cost implications of a potentially reduced role for gas networks, including how to ensure sufficient investment in their ongoing operation while still in use, and how the costs of decommissioning will be met.

25 On the deployment of heat pumps, DESNZ should:

- e** Accelerate its work to rebalance the costs of energy, for example by moving levies and obligations from electricity to gas bills. As part of this it should ensure households that are unable to switch away from fossil fuel boilers do not experience disproportionate adverse consequences.
- f** Establish a single measure for the number of heat pumps installed regardless of policy, and report to Parliament annually, indicating whether deployment is ahead of or behind DESNZ's expectations and the reasons why.

- g** Ensure it has regularly updated information on all key barriers to heat pump installations, including reasons for Boiler Upgrade Scheme attrition, and use this to inform its approach. This should include key potential barriers such as costs, public awareness, supply chain capacity and others identified through behavioural insights research.
- h** Develop a decision framework for its approach after 2028, particularly the balance of taxpayer-funded grants, manufacturer regulations and consumer costs. This should draw on evidence from DESNZ's evaluation of ongoing programmes. It should consider the thresholds at which government financial support can be reduced, such as the cost of heat pumps and availability of installers.

Part One

Decarbonising home heating overview

1.1 Decarbonising home heating is a key part of the government's plans to achieve net zero greenhouse gas emissions by 2050. Heating the UK's 28 million homes accounted for 18% of all UK greenhouse gas emissions in 2021, the most recent year for which data are available. Buildings are the UK's second-highest emitting sector, after surface transport. The main source of emissions from residential buildings is the use of natural gas for heating.

1.2 This part sets out:

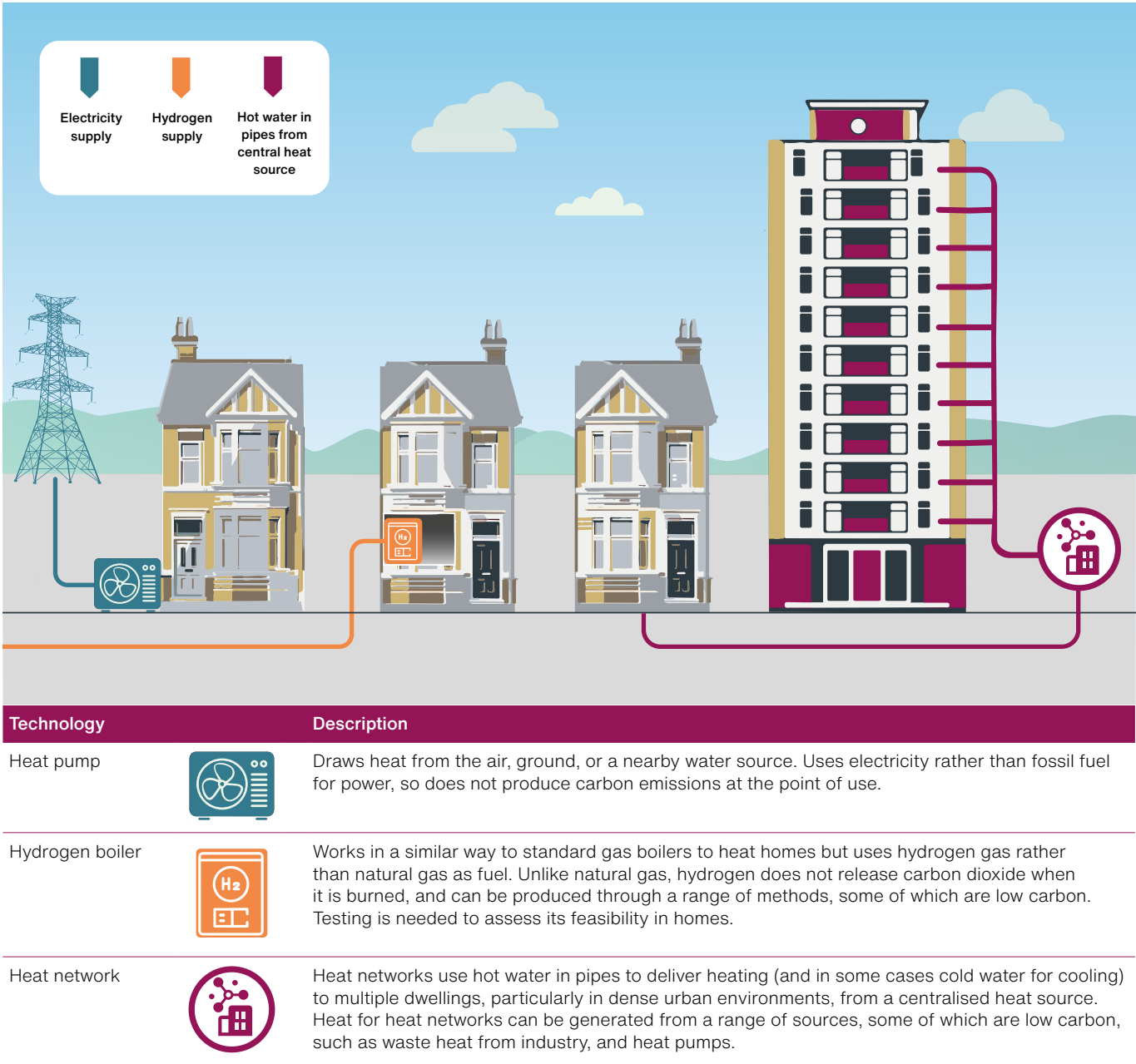
- the government's current understanding of how home heating in the UK can be decarbonised;
- the challenges to decarbonising home heating; and
- the government's approach to decarbonising home heating.

How home heating can be decarbonised

1.3 Reducing greenhouse gas emissions from heating homes will require a combination of reducing energy demand by making homes more energy efficient, and converting heating systems that use fossil fuels to a low-carbon alternative. Most buildings use natural gas for heating, with 86% of homes in Great Britain connected to the gas grid. This must be replaced with low-carbon heating systems such as heat pumps, heat networks and potentially hydrogen (**Figure 1**). The suitability of low-carbon heating technologies depends on factors including regional geography, house type and the type of heating system currently in use.

Figure 1
Low-carbon heating technologies

Low-carbon heating could include heat pumps, hydrogen and heat networks



Note
1 Heat pumps, hydrogen and heat networks are the three main heating technologies considered by the government in its *Heat and Buildings Strategy*.

Source: National Audit Office analysis of the government's *Heat and Buildings Strategy*

Challenges to decarbonising home heating

1.4 Heating is one of the most difficult sectors of the economy to decarbonise, due to its scale, cost and complexity.

- **Scale:** The government will need to support and encourage tens of millions of households to change the way they heat their homes. This will involve large-scale transformation and public engagement, given relatively low awareness of the low-carbon heating transition.
- **Cost:** In 2020, the Climate Change Committee estimated that £162 billion of additional investment would be required from 2020 to 2050 to install low-carbon heating in existing UK homes, compared to the cost of like-for-like replacement of boilers as they reach the end of their lifetime.^{3, 4} The government recognises that the transition to low-carbon heating must be affordable for households to achieve the widespread uptake required, given the rise in energy bills since Autumn 2021.
- **Complexity:** Regions across the UK vary in their geography, physical infrastructure and natural resources. Achieving the scale and pace of low-carbon home heating required to reach net zero by 2050 is likely to require greater coordination to deliver upgrades across streets and regions rather than on an individual household basis.

The government's approach to decarbonising home heating

Roles and responsibilities

1.5 The Department for Energy Security & Net Zero (DESNZ) has overall responsibility for decarbonising home heating in England, including meeting interim emissions reductions targets for five-year periods known as carbon budgets. It must reduce emissions while also meeting statutory fuel poverty targets. The Department for Levelling Up, Housing & Communities (DLUHC) has powers and responsibilities relating to building and planning regulations in England, and Energy Performance Certificate registration for England and Wales.⁵ We cover the role of local authorities in Part Two.

3 The Climate Change Committee, *The Sixth Carbon Budget – Charts and data in the report*, December 2020, 'Buildings' tab (accessed on 4 December 2023).

4 The investment costs for low-carbon heating are related to the energy efficiency investment costs. In general, with less deployment of energy efficiency measures, larger and more expensive low-carbon heating systems would be required. This estimate of investment in low-carbon heating installation is therefore linked to the Climate Change Committee's modelling of energy efficiency investment.

5 An Energy Performance Certificate rates a building's energy efficiency and provides recommendations about how to reduce energy use and save money.

Heat and Buildings Strategy

1.6 In October 2021, the government published its *Heat and Buildings Strategy*, bringing together its work to reduce emissions from buildings in England through improving energy efficiency and transitioning to low-carbon heating, primarily through heat pumps, heat networks and potentially hydrogen.⁶ The government made several commitments in the Strategy to support decarbonising home heating, including:

- Signalling its intention to phase out the installation of new natural gas boilers by 2035.⁷
- Significantly growing the supply chain for heat pumps, to a minimum market capacity of 600,000 heat pump installations per year by 2028.⁸
- Setting a clear ambition for industry to reduce the costs of installing a heat pump by at least 25–50% by 2025 (compared to 2021) and to ensure heat pumps are no more expensive to buy and run than gas boilers by 2030.
- Rebalancing energy prices to ensure that heat pumps are no more expensive to buy and run than gas boilers.
- Accelerating growth of the low-carbon heat network market through a series of complementary measures in the 2020s. In its 2023 *UK Heat Networks Market Overview*, the government stated that its ambition is to increase the proportion of total heat demand provided through heat networks to 20% by 2050 (relative to the size of the existing heat market), up from less than 3% in 2022.⁹
- Developing the evidence base to take strategic decisions on the role of hydrogen for heating buildings in 2026.

1.7 These commitments and other key developments and plans since 2021 are set out in **Figure 2** on pages 18 to 20.

⁶ HM Government, *Heat and Buildings Strategy*, October 2021, white paper, CP 388 (accessed on 19 May 2023).

⁷ The *Heat and Buildings Strategy* also set out the government's intention to phase out the installation of fossil fuel heating systems in homes not connected to the gas grid, including a consultation on whether new installations could be phased out from 2026.

⁸ The government's target to deploy at least 600,000 heat pumps per year by 2028 is for hydronic heat pumps, which draw heat from the air or ground and distribute heat in a building through heated water in a central heating system. The target does not include air-to-air systems, which draw heat from the air and distribute heat in a building through the air. This is because only hydronic heat pumps can supply hot water and can therefore fully decarbonise the heating of a building. When we refer to heat pumps in the context of reaching 600,000 heat pump installations per year by 2028, this means hydronic heat pumps.

⁹ Department for Energy Security & Net Zero, *UK Heat Networks Market Overview*, September 2023 (accessed on 4 October 2023).

Figure 2
Timeline of key funding, commitments and plans for decarbonising home heating since 2021

The government undertook a range of activities from 2021 to 2023; it has fewer plans in place up to 2035

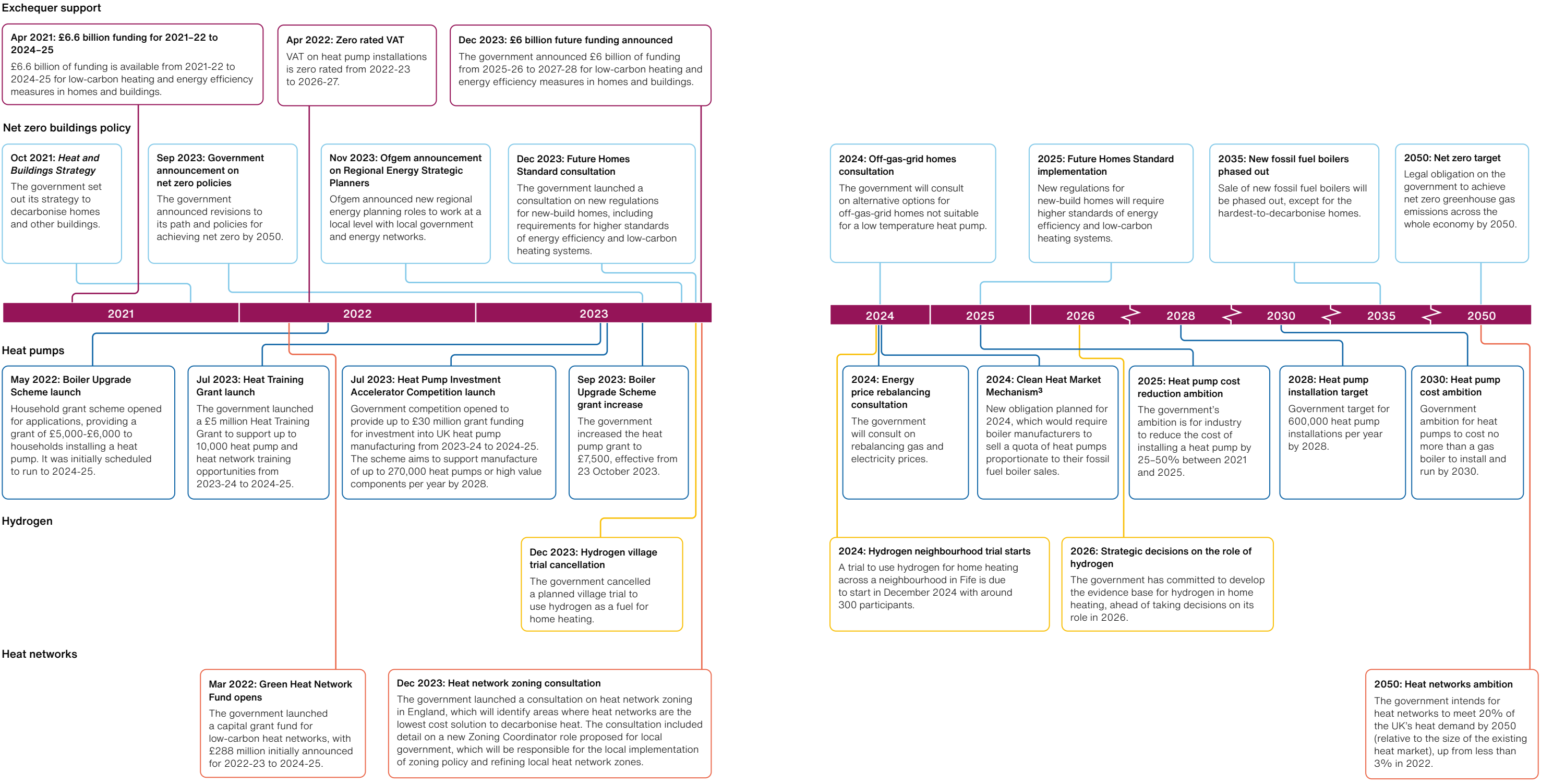


Figure 2 *continued*

Timeline of key funding, commitments and plans for decarbonising home heating since the 2021 *Heat and Buildings Strategy*

Notes

- 1 This timeline presents key developments and plans but is not a comprehensive record of government activity on decarbonising home heating.
- 2 Heat pumps, hydrogen and heat networks are the three main heating technologies considered by the government in its *Heat and Buildings Strategy*. Heat pumps are powered by electricity and draw heat from the air, ground or a water source. Heat networks use hot water in pipes to deliver heating to multiple dwellings from a centralised heat source. Hydrogen could be used to heat homes through a boiler system in a similar way to natural gas. The government is testing whether it is feasible to use hydrogen for home heating.
- 3 In 2023, the Department for Energy Security & Net Zero (DESNZ) stated it would introduce the Clean Heat Market Mechanism in April 2024. However, in February 2024 there were media reports that ministers were considering whether to delay or remove the mechanism. DESNZ has told us that as at early March, no decision has yet been made.

Source: National Audit Office analysis of government documents

Government spending to decarbonise home heating

1.8 The government is investing £6.6 billion over 2021-22 to 2024-25 on low-carbon heating and improving energy efficiency in England and Wales. This includes £450 million in capital funding for the Boiler Upgrade Scheme, which provides households in England and Wales with an up-front grant to help cover the cost of replacing fossil fuel heating systems with a heat pump or biomass boiler. In December 2023, the government announced a further £6 billion for low-carbon heating and energy efficiency from 2025-26 to 2027-28, including a further £1.5 billion for the Boiler Upgrade Scheme.

1.9 The government has underspent on its key schemes supporting the installation of low-carbon heating systems since the 2021 *Heat and Buildings Strategy* (**Figure 3**). In 2022-23, the Boiler Upgrade Scheme underspent by £100 million (66%) and the Green Heat Network Fund, which provides capital grant funding for public and private sector developers of low-carbon heat networks in England, underspent by £50 million (89%). This was the first year of delivery for both schemes. The Hydrogen Heating programme has also underspent each year since 2021-22, albeit on a smaller budget. There remains considerable unspent budget for the last quarter of 2023-24, with 66% of the Boiler Upgrade Scheme budget, 47% of the Green Heat Network Fund budget and 73% of the Hydrogen Heating programme budget unspent at the end of December 2023. DESNZ told us that most of the Green Heat Network Fund has been allocated to projects and DESNZ therefore expects substantial drawdowns from the Fund in the final three months of 2023-24.

Figure 3

Department for Energy Security & Net Zero (DESNZ) capital budget (April 2021 to March 2024) and spending (April 2021 to December 2023) on key domestic low-carbon heating schemes

DESNZ underspent on its key schemes in periods for which it has a full year's worth of spend data

Programme or scheme	2021-22				2022-23				2023-24 ²			
									Full year	April to December 2023		
	Budget	Spend	Difference	Difference	Budget	Spend	Difference	Difference	Budget	Spend	Difference	Difference
	(£mn)	(£mn)	(£mn)	(percentage of budget)	(£mn)	(£mn)	(£mn)	(percentage of budget)	(£mn)	(£mn)	(£mn)	(percentage of budget)
Electrification of Heat programme												
Programme to develop markets and consumer choice for heat pumps												
Boiler Upgrade Scheme: Up-front grant for households in England and Wales installing a heat pump or biomass boiler	–	–	–	–	150	50	100	66%	150	51	99	66%
Heat Networks Transformation programme												
Programme to drive development of a sustainable heat network marketplace and prepare the market for future regulations												
Green Heat Network Fund: Capital grant funding for public and private sector developers of low-carbon heat networks in England	–	–	–	–	56	6	50	89%	74	39	35	47%
Hydrogen Heating programme												
Programme to evaluate the safety, technical feasibility, costs, benefits, impacts and barriers of transitioning to hydrogen for heat												
Hydrogen Heating programme ¹	10	6	4	41%	15	9	6	39%	30	8	22	73%

Notes

- 1 The government is developing low-carbon heating through three key programmes of work: Electrification of Heat (heat pumps), Heat Networks Transformation and Hydrogen Heating. Each wider programme of work has several sub-programmes and projects. We have provided budget and spend data for the whole of the Hydrogen Heating programme because there are no schemes or projects with discrete funding under the programme.
- 2 Budget data for 2023-24 covers the full financial year, whereas spend data covers the first nine months, from April to December 2023. DESNZ told us that most of the Green Heat Network Fund has been allocated to projects and DESNZ therefore expects substantial drawdowns from the Fund in the final three months of 2023-24.
- 3 The Social Housing Decarbonisation Fund, Homes Upgrade Grant and Local Authority Delivery Scheme are key government schemes funding energy efficiency improvements and low-carbon heating installations. We have not included these schemes in this table because they have objectives focusing on fuel poverty reduction as well as carbon reductions, and therefore currently undertake more energy efficiency upgrades than low-carbon heating installations. Only a small proportion of the spend on these schemes has been for installing low-carbon heating. We have not included the Green Homes Grant Voucher Scheme as it closed for applications in March 2021.

Source: National Audit Office analysis of Department for Energy Security & Net Zero data

Structure of this report

1.10 This report focuses on the rollout of low-carbon heating and does not consider energy efficiency:

- Part Two examines whether DESNZ has established a pathway to decarbonising home heating in a way that gives value for money.
- Part Three assesses the progress DESNZ has made since 2021 on the rollout of heat pumps, which it expects to be the main low-carbon home heating technology over the next decade, and its approach to increasing demand for heat pumps.

Part Two

Establishing a pathway to decarbonising home heating

2.1 This section examines how clearly the government has set out a pathway towards decarbonising home heating, including:

- progress establishing the mix of technologies required to decarbonise home heating, particularly how it is determining the role of hydrogen;
- how decisions will be made at the national, regional and local levels;
- how it plans to engage the public in the changes required; and
- how the transition will be funded.

Establishing the technology mix

Determining the role of hydrogen

2.2 The *Heat and Buildings Strategy* committed the government to taking strategic decisions regarding the role of hydrogen for heating in 2026, as part of its work to determine the technology mix. While heat pumps and heat networks are existing technologies, hydrogen heating is not yet commercially available in the UK and its potential use is dependent on a range of factors, such as the extent to which it could replace natural gas in the gas grid, safety considerations and likely costs.

2.3 Progress with establishing large-scale trials of hydrogen for heating has not developed in line with the government's original commitment to support industry to develop a neighbourhood trial by 2023 and a village trial by 2025. A gas distribution company now plans to start the neighbourhood trial in 2024 with around 300 interested participants, and the village trial will not go ahead. DESNZ announced it would not proceed with one proposed site for a village trial in Whitby in July 2023, due to residents' reluctance to change their heating system. In December 2023, DESNZ announced that it would not proceed with the other proposed village trial site in Redcar because the main intended source of hydrogen would not be available.

2.4 DESNZ told us it is considering alternative plans to address gaps in evidence resulting from the cancellation of the village trial; for example, in relation to consumer attitudes and the practicalities of converting from natural gas to hydrogen. It stated, however, that the evidence available will be less than had the village trial gone ahead.

2.5 DESNZ is progressing with other aspects of its programme to develop hydrogen for heating. This includes producing and assessing evidence on the safety, feasibility and acceptability of hydrogen, and other costs and benefits. For example, as at January 2024, DESNZ had submitted around half the safety evidence expected from the programme to the Health and Safety Executive.

2.6 DESNZ is developing an appraisal framework that will set out what information is required to determine the technology mix. This will include information from the hydrogen heating research programme, as well as the costs and benefits of deploying each low-carbon technology to determine the optimal mix. The costs and benefits will be influenced by many factors. These include the feasibility of converting different building types for the technologies and the infrastructure changes required, such as electricity network reinforcement or hydrogen storage. DESNZ is still gathering the evidence it will need to support the decisions. It expects its cost modelling to be complete in 2025. DESNZ set up a team to coordinate the appraisal in autumn 2023. The later DESNZ agrees the appraisal framework, the higher the risk that there will be gaps in the evidence base required for the decisions on the low-carbon technology mix. DESNZ told us it has given sufficient consideration to what evidence will be required to be confident it is not missing anything obvious from its research schedule.

2.7 DESNZ has also not clarified what will be in scope for the 2026 decisions, such as whether it will specify the areas and/or circumstances under which hydrogen might be available for home heating. As a result, it is not clear how much the 2026 decisions will help the gas and electricity network providers and Ofgem, which regulates the gas and electricity markets, to plan.

Implications of uncertainty around technology mix

2.8 Some stakeholders we spoke to said that the ongoing uncertainty about the technology mix for decarbonising home heating had implications that were impacting the transition and the wider energy system.

- Consumer representatives said that some households could be put off installing a heat pump because of uncertainty over whether their area will be on a heat network or hydrogen heating will be available in the future.
- Ofgem and the gas and electricity network operators are not able to effectively plan for the development and potential decommissioning of networks for domestic properties. For example, Ofgem is consulting on potential approaches to managing the depreciation of existing gas investment and future decommissioning costs for the next gas price control period, starting in 2026, to reduce the risks of stranded assets. It will therefore need to decide on its approach before the government has taken a decision on the role of hydrogen.

2.9 Some stakeholders have told us the government should bring forward its 2026 decisions on hydrogen to reduce uncertainty and stimulate heat pump demand. In October 2023, the National Infrastructure Commission, which advises the government on major long-term infrastructure challenges, recommended that the government should not support hydrogen for home heating.

2.10 DESNZ maintains that it still needs to establish the evidence base for hydrogen before taking decisions. However, in June 2023, the then Secretary of State for Energy Security and Net Zero, stated it was “unlikely” that hydrogen would be a major future source of domestic heating. In October 2023, DESNZ indicated a limited role for hydrogen. It stated that heat pumps and heat networks will be the primary means for decarbonising home heating over the next decade, with “the potential for hydrogen to play a role in slower time in some locations.” It stated that no one should hold back on installing a heat pump or connecting to a heat network on the basis that hydrogen might be an option later.

Coordination and decision making

2.11 A value-for-money transition to low-carbon home heating at the scale and pace required to reach net zero by 2050 will require strategic decisions by organisations at local, regional and national levels.

- **Local:** Local authorities have a good understanding of local housing stock, residents’ needs and availability of local suppliers, meaning they could be well placed to support decisions on low-carbon home heating solutions in their area. They can play a key role in encouraging and enabling wider changes among residents to reduce emissions, for example through planning responsibilities and direct engagement with local people. One approach to identifying the change needed to the local energy system and built environment is local area energy planning. Led by local government, local area energy planning includes considering suitable heating technologies for the local housing stock. As at July 2023, 20 local authorities in the UK have local area energy plans.
- **Regional:** Energy networks, both for gas and electricity, are organised regionally. Also, some regions may be closer to sources of hydrogen production, such as industrial clusters. This means some technology choices may need to be made at a regional level.
- **National:** To date, grant schemes to support adoption of low-carbon heat, such as the Boiler Upgrade Scheme, have been administered by central government for England and Wales. Central government will also need to have an overall coordination role, including ensuring local authorities have sufficient capacity to fulfil their role. The government is establishing the National Energy System Operator in 2024, which will have an important role in providing strategic advice on whole-energy system matters.

2.12 Central government has started to determine which organisations will be responsible for which decisions. For example:

- DESNZ intends local authorities to play a key role in the planning, delivery and monitoring of heat networks through a new Zoning Coordinator role. DESNZ opened a consultation in December 2023 on its plans to designate heat network zones, where heat networks are expected to offer the lowest-cost solution for decarbonising heat, and the role of local authorities as Zoning Coordinators.
- Ofgem announced it will create Regional Energy Strategic Planners (RESPs), which will work with local organisations, including local authorities and gas and electricity network operators, to plan energy infrastructure that meets both national targets and local needs. The National Energy System Operator will be responsible for implementing the RESPs across Great Britain. DESNZ and stakeholders told us that local and regional input to network planning will be vital to ensure the networks meet locally specific demands for home heating and other energy needs.

2.13 The Local Government Association (LGA) told us that local authorities still need more clarity on their roles and powers to plan effectively. The LGA told us that the key challenge for local authorities is the lack of certainty on expectations for technology and timings. More certainty would help ensure local authority plans are in line with national priorities. Other stakeholders told us that the government should take a more regional approach to the planning for and delivery of heat decarbonisation.

Public engagement

2.14 Effective public engagement on the transition to low-carbon heating will be crucial, as almost every household will need to make a decision that will have a significant impact on their homes. Around 30% of respondents to a government survey in summer 2023 had never heard, or hardly knew anything, about the need to change the way homes and buildings are heated to reach net zero.¹⁰ However, DESNZ does not have an overarching long-term plan for consumer engagement to support its key milestones for decarbonising home heating, such as the phase-out of the sale of new fossil fuel boilers by 2035. It is unclear who will be responsible for raising public awareness about the transition and ensuring the public makes the necessary changes, particularly as activity ramps up. DESNZ told us it still needs to determine how these responsibilities fall across homeowners, industry and the government.

¹⁰ Department for Energy Security & Net Zero (DESNZ), *DESNZ Public Attitudes Tracker* [Data set], DESNZ, September 2023 (accessed on 4 October 2023).

2.15 The government has stated that the transition to low-carbon heating should be consumer led and follow the natural replacement cycles of household heating systems “to work with the grain of consumer behaviour.”¹¹ Consumers will therefore need information and advice to help them make effective decisions when the time comes to replace their existing heating system.

2.16 DESNZ has promoted heat pumps as part of the ‘Welcome Home to Energy Efficiency’ communications campaign, launched in October 2023, which intends to raise awareness and understanding of low-carbon heating systems. DESNZ also provides information through its online tools on heat pump suitability and retrofit options to make homes cheaper to heat and keep warm, and a phone line service providing households in England with tailored information about how to improve the energy performance of their homes. However, research published by Energy Saving Trust in December 2023 highlighted a lack of impartial, personalised support as a major barrier, with half of homeowners in England unsure where to get independent, impartial advice on making improvements to reduce their homes’ emissions.

2.17 The government plans to provide more tailored advice to households. DESNZ told us that it is developing a new online home energy advice tool, which will provide advice tailored to the user’s housing tenure, type of installation and information needed (such as the most suitable measure for their home, available grant schemes, or approved installers). With the user’s permission, the tool will also provide targeted marketing as information or funding opportunities relevant to the household become available. DESNZ is in the early stages of developing the tool and does not yet have an estimated date for it to be in place.

How the transition will be paid for

2.18 The cost of the transition will be spread between taxpayers, consumers and industry. However, DESNZ’s plan is for the costs of the transition borne by taxpayers to fall over time. To date, DESNZ has provided taxpayer-funded support for energy efficiency measures and low-carbon heat technologies, such as the Boiler Upgrade Scheme. It has also provided support for low-carbon heat networks and intends for these to rely less on government grants and to become more commercially viable over the next decade. DESNZ told us that projects funded via the Green Heat Network Fund are increasingly able to attract private funding, but that it needs to maintain certainty and continue building the pipeline of projects to ensure investor confidence. It told us that more funding for the Green Heat Network Fund, and ensuring the zoning mechanisms are in place, will be key to providing this certainty. DESNZ is also negotiating government support for different types of hydrogen production, which could provide hydrogen for heating.

¹¹ HM Government, *Heat and Buildings Strategy*, October 2021, white paper, CP 388 (accessed on 19 May 2023), page 22.

2.19 DESNZ aims for the cost of low-carbon heating technologies to fall over time. It intends for heat pumps to cost no more than a natural gas boiler to buy and run by 2030. We assess its progress in relation to reducing the cost of heat pumps in Part Three.

The cost to decommission gas networks

2.20 Parts of the gas network may need to be decommissioned if natural gas is no longer used and hydrogen is confined to certain areas of the country, although any decommissioning is unlikely to start until the mid to late 2030s. DESNZ recognises that its work on the costs and feasibility of gas network decommissioning is in its early stages, and that its understanding is therefore limited. Gas networks are regulated monopolies that depend on private investment to fund ongoing operation and maintenance. There is a risk that this investment will reduce if investors expect these assets to be decommissioned. It is also uncertain who will pay for the networks to continue in service with a decreasing customer base or to be decommissioned, and how the government will ultimately manage the transition for the last remaining customers on a gas network.

Harder-to-decarbonise homes

2.21 In September 2023, the government announced that some homes may be exempt from the planned phase-out of new fossil fuel boilers in 2035. This could include homes that are more complex to decarbonise due to physical, locational, or household demographic and behavioural attributes, such as those requiring energy efficiency or electrical connection upgrades, lacking space for a heat pump, or located in zones likely to be connected to a heat network. The government expects that the exemption could cover about a fifth of homes, including off-gas-grid homes. The government also delayed the ban it had planned on installing fossil fuel heating systems for off-gas-grid homes, from 2026 to 2035.

2.22 DESNZ is yet to determine its approach for homes that are complex to decarbonise and how this will be paid for. It expects future innovations in heat pump technology and installation practices to enable some of these homes to become suitable for a heat pump by 2035. It will consult in 2024 on alternative options for homes not suitable for a low temperature heat pump off the gas grid, such as liquid biofuels. DESNZ will also need to consider how to ensure that people living in harder-to-decarbonise homes are not penalised unfairly. For example, there is a risk that households continuing to use natural gas will incur a greater proportion of the costs to maintain gas networks, which are currently borne by all gas customers.

Part Three

Rolling out heat pumps

3.1 DESNZ expects heat pumps to be the main technology that households use to decarbonise home heating over the next decade. DESNZ has set a target for 600,000 heat pump installations per year by 2028, with a much higher installation rate required in subsequent years if there is no mass adoption of hydrogen for home heating.

3.2 This part examines:

- progress to date in rolling out heat pumps;
- measures the government has put in place to increase demand for heat pumps;
- how likely DESNZ is to achieve its 2028 target; and
- DESNZ's approach to supporting heat pump installations after 2028.

Progress to date

Heat pumps installed

3.3 DESNZ does not have a single measure of the number of heat pumps installed. Instead, it builds its understanding from a range of sources, including DESNZ schemes and MCS installations data.¹² DESNZ told us it is looking into how it can combine some of these sources to produce a series that could potentially be published. It is also developing a dashboard that will show the number of heat pumps installed through each government scheme. Heat Pump Association data indicates that UK heat pump sales have increased year on year since 2018, from 27,000 up to 55,000 in 2022.

¹² MCS (Microgeneration Certification Scheme) is a quality assurance scheme. The Boiler Upgrade Scheme requires heat pumps to be installed by MCS-certified installers.

3.4 The government has so far relied on the Boiler Upgrade Scheme, introduced in May 2022, to encourage heat pump installations (see paragraph 1.8); however, the scheme has received lower demand than DESNZ expected. The business case assumed that 70% of installations through the scheme would not have happened if the scheme did not exist. The government announced £450 million of funding for the scheme from 2022-23 to 2024-25, budgeting for 30,000 installations per year. However, the scheme underspent in its first year. The scheme received 31,387 applications from its launch in May 2022 to December 2023, from which 19,064 installations have been confirmed and grants paid out.¹³ Of these, 18,871 installations were heat pumps. The original business case budgeted for up to 50,000 installations by this point.

3.5 DESNZ is planning to monitor uptake of the Boiler Upgrade Scheme among different socio-economic groups through an externally commissioned evaluation. The evaluation will also assess the extent to which the scheme has led to additional heat pump installations that would not otherwise have occurred. DESNZ expects results to become available in the second half of 2024.

3.6 Heat pump installations are also supported through other energy efficiency and low-carbon heating retrofit schemes, such as the Social Housing Decarbonisation Fund (SHDF) and the Energy Company Obligation (ECO).¹⁴ Nearly 15,000 heat pumps have been installed under these two schemes as of November 2023.¹⁵

Installation costs

3.7 DESNZ has identified installation cost as a key factor affecting demand for heat pumps. An online survey commissioned by DESNZ of over 6,000 households from May to June 2023 found that demand increased as up-front costs decreased; a £1,000 increase in up-front costs reduced the demand for heat pumps by approximately 10 percentage points. Households with a higher income and savings were more likely to choose a heat pump. It also identified that up-front costs mattered more to households than running costs when considering whether to install a heat pump.

¹³ Biomass boilers represented less than one per cent of total applications to the scheme over the same period.

¹⁴ The SHDF and ECO have objectives focusing on fuel poverty reduction as well as carbon reduction, and therefore currently undertake more energy efficiency upgrades than low-carbon heating installations.

¹⁵ The SHDF supported 673 heat pump installations out of a total of nearly 23,000 energy efficiency and low-carbon measures installed from March 2022 to November 2023. The ECO supported 14,087 heat pump installations from October 2018 to November 2023, out of a total of 1.4 million measures installed under this scheme.

3.8 So far, the installation costs of heat pumps have not fallen as quickly as DESNZ anticipated. As at December 2023, the average market rate for replacing a gas boiler with a heat pump was around four times higher than replacing like-for-like.^{16, 17} In its 2021 *Heat and Buildings Strategy*, the government set an ambition for industry to reduce the costs of installing a heat pump by at least 25–50% by 2025 (compared to 2021). MCS data indicate the average (mean) cost of installing a heat pump in UK homes increased in real terms from £12,041 in 2021 to £13,396 in 2022 (in 2021 prices) (**Figure 4** overleaf).¹⁸ Average costs have since fallen to £11,287 in 2023 (in 2021 prices), which is an up to 6% real terms reduction compared to 2021.¹⁹ Installation costs will need to fall around three times faster over the next two years if they are to reach the minimum 25% reduction ambition. DESNZ told us that costs had not fallen significantly, due to pressures in the global supply chain. This includes, for example, a shortage of semiconductors that are a key heat pump component; manufacturers not being able to keep up with increased global demand for heat pumps; and increased energy prices affecting the cost of manufacturing.

3.9 DESNZ told us that the high installation costs had been a key factor in the under-delivery of the Boiler Upgrade Scheme, as the £5,000 grant initially provided through the scheme still left households with around £4,000 to pay compared to a like-for-like replacement of a gas boiler. According to DESNZ this would leave a very small pool of people willing and able to make the switch during a cost-of-living crisis.

Running costs

3.10 The government has made little progress on its commitment to rebalance energy prices over the course of the 2020s. Electricity remains more expensive per unit than gas, making heat pumps potentially more expensive to run than gas boilers. DESNZ recognises that rebalancing energy prices, for example by shifting energy levies and obligations away from electricity to gas, is important for increasing the attraction of heat pumps. DESNZ planned to launch a call for evidence on options for fairness and affordability in energy price rebalancing in 2022, but told us that this work is delayed to 2024 when it intends to set out its approach. It said that its focus for energy bills in 2022 was tackling the high energy costs since autumn 2021, and that price rebalancing remains essential but politically challenging. DESNZ told us that it still intends to deliver on its commitment to rebalance energy prices.

¹⁶ Heat pumps have a similar lifespan to gas boilers, of around 15 years.

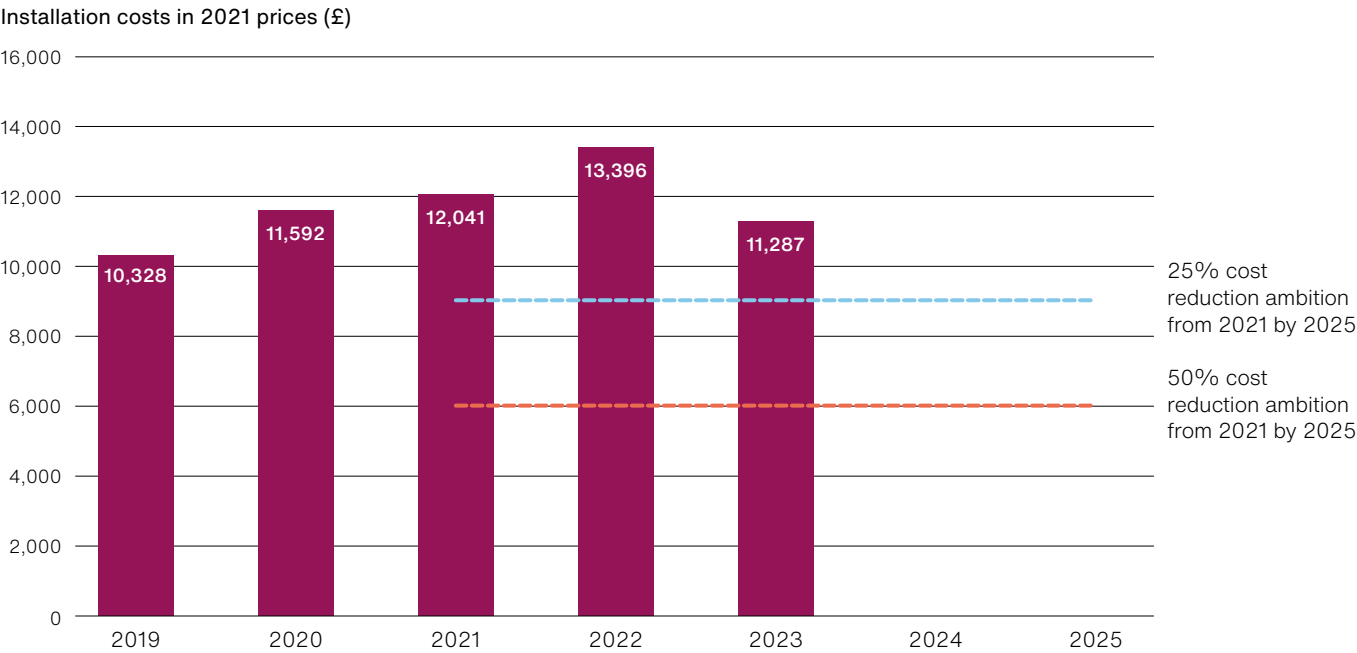
¹⁷ Heat pump installation costs are based on MCS data. The costs are self-reported by MCS-certified installers and should cover “the full cost of the installation that is charged to the consumer”. This includes materials and labour. MCS does not monitor whether grants are deducted from the cost values entered onto MCS certificates, so some cost entries may include the grant value and others may not. DESNZ also relies on these data for the costs in its Boiler Upgrade Scheme statistics. However, Ofgem provides guidance to Boiler Upgrade Scheme installers on what to include and DESNZ therefore expects the vast majority of Boiler Upgrade Scheme installers to be reporting the costs inclusive of the grant.

¹⁸ We have adjusted heat pump installation costs to 2021 prices.

¹⁹ These average costs do not factor in cost per kilowatt capacity, so changes in average cost could also be due to changes in the distribution of heat pump capacities being installed.

Figure 4
Real terms average (mean) cost of MCS-certified UK heat pump installations (2021 prices) in UK homes and the government’s ambitions for cost reductions by 2025

Heat pump installation costs will need to fall at a faster rate over the next two calendar years if they are to reach the government’s cost reduction ambitions



Notes

- 1 MCS (Microgeneration Certification Scheme) is a quality assurance scheme. The government’s Boiler Upgrade Scheme requires heat pumps to be installed by MCS-certified installers.
- 2 This figure presents the average (mean) cost of MCS-certified installations of air, ground and water source heat pumps in UK homes, based on MCS data. The costs are self-reported by MCS-certified installers and should cover “the full cost of the installation that is charged to the consumer”. This includes materials and labour. MCS does not monitor whether grants are deducted from the cost values entered onto MCS certificates, so some cost entries may include the grant value and others may not. DESNZ also relies on these data for the costs in its Boiler Upgrade Scheme statistics. However, Ofgem provides guidance to Boiler Upgrade Scheme installers on what to include and DESNZ therefore expects the vast majority of Boiler Upgrade Scheme installers to be reporting the costs inclusive of the grant.
- 3 Any installations that cost below £1,000 and above £100,000 plus the remaining top and bottom 5% of the data have been excluded. These average costs do not factor in cost per kilowatt capacity, so changes in average cost could also be due to changes in the distribution of heat pump capacities being installed.
- 4 We have adjusted costs for 2019–2022 to 2021 prices using HM Treasury’s Gross Domestic Product deflator. The deflation of 2023 costs to 2021 prices is based on the Office for Budget Responsibility’s inflation forecast.
- 5 A cost reduction of 25% from 2021 by 2025 would put the cost of a heat pump installation at £9,031 (in 2021 prices).
- 6 A cost reduction of 50% from 2021 by 2025 would put the cost of a heat pump installation at £6,021 (in 2021 prices).
- 7 These data indicate average costs fell by up to 6% in real terms between 2021 and 2023. Installation costs will need to fall around three times faster over the next two years if they are to reach the minimum 25% reduction ambition.

Source: National Audit Office analysis of Microgeneration Certification Scheme data

3.11 DESNZ also consulted on reforms to the electricity market in 2022, with a key focus on reforms to make electricity cheaper. It opened a second consultation on an updated set of proposals in March 2024. DESNZ expects to start implementing the reforms from 2025.

Public awareness and confidence

3.12 DESNZ has identified lack of public knowledge about why heat pumps are needed, and their potential benefits, as a key barrier to heat pump adoption. To date, DESNZ has focused on raising awareness through a digital campaign and online tools, as set out in paragraph 2.16. It also piloted and evaluated a digital campaign for the Boiler Upgrade Scheme, which ran from January to March 2023. The evaluation found that the campaign adverts were recognised by around a fifth of 700 households surveyed in March and April 2023.

3.13 DESNZ has also identified disruption associated with the installation of heat pumps as a key barrier. The government-funded Electrification of Heat demonstration project in 2020 and 2021 found disruption to be the key consumer barrier to installing a heat pump. In 2021, the Behavioural Insights Team and Nesta surveyed 1,800 UK homeowners with gas boilers.²⁰ Of the respondents who said they would not replace their gas boiler with a heat pump, even if it cost the same, eight in ten said they were discouraged from heat pump installation by high levels of disruption.²¹ Further research by Nesta has also found that reducing the time and disruption associated with installation would make it easier for households to replace their gas boiler with a heat pump when they reach end of life.²² DESNZ is investing a total of £25 million into a 'Heat Pump Ready programme' from 2022 to 2025 to develop solutions to help improve the ease of installing heat pumps in homes.

²⁰ The Behavioural Insights Team is a social-purpose company. Nesta (formerly NESTA, National Endowment for Science, Technology and the Arts) is an independent innovation agency.

²¹ The Behavioural Insights Team and Nesta, *Estimating the willingness to pay for a heat pump*, March 2022 (accessed on 4 October 2023).

²² Nesta, *Heat pumps: a user survey*, May 2023 (accessed on 4 October 2023).

Supplier capacity and skills

3.14 The skills and capacity of suppliers may be limiting factors on the transition to decarbonising home heating. Stakeholders told us that an energy retrofit research project in early 2023 struggled to install around 800 heat pumps because of limitations with domestic supply. In 2021, witnesses to the Business, Energy and Industrial Strategy Committee²³ and Environmental Audit Committee²⁴ highlighted a skills gap in the sector, in that workers do not have the expertise to install the required scale of low-carbon home heating. A January 2023 literature review commissioned by DESNZ identified instances of heat pumps being installed incorrectly and therefore costing households more. However, DESNZ mitigates the risk of poor installations by requiring MCS-certification for all heat pump installations funded through government schemes such as the Boiler Upgrade Scheme. Also, a 2023 evaluation of the government's Renewable Heat Incentive found that, of the 1,777 heat pump applicants to the scheme who replied to the survey, 66% were 'very satisfied' after two winters with a heat pump and 26% were 'fairly satisfied'.^{25, 26, 27}

3.15 DESNZ is providing a £5 million Heat Training Grant to support up to 10,000 heat pump and heat network training opportunities from 2023-24 to 2024-25. DESNZ told us there should be sufficient places for the number of installers required in 2025, but that it will need to ensure training opportunities continue and expand to reach the number of installers needed in later years.

Monitoring progress against key barriers

3.16 DESNZ does not have all the information it needs on heat pump installations to identify key barriers to uptake. DESNZ told us that it builds much of its understanding of the key barriers to installing heat pumps through commissioned research, industry insight and qualitative information. As at January 2024, DESNZ tracks progress against some barriers in more detail than others. For example, it tracks workforce growth through the number of trained MCS-certified installers. It also holds up-to-date information on the cost of heat pump installations through the Boiler Upgrade Scheme, although it does not know whether this consistently includes or excludes the grant value. It does not track the ease of the heat pump decision and installation process. It also does not monitor the reasons why around 10% of applications to the Boiler Upgrade Scheme do not progress to installation.

23 Business, Energy and Industrial Strategy Committee, *Decarbonising heat in homes*, Seventh Report of Session 2021–22, HC 1038, February 2022, p.28 (accessed on 4 October 2023).

24 Environmental Audit Committee, *Oral evidence: Heat Resilience and Sustainable Cooling*, HC 1671, October 2023 (accessed on 6 November 2023), Qq 85, 91, 95, 132.

25 The Renewable Heat Incentive was a scheme to encourage households and businesses in Great Britain to switch from fossil fuel heating systems to low-carbon alternatives. It was open to applications from 2011 to 2021.

26 Department for Energy Security & Net Zero, *Synthesis of findings from the evaluation of the domestic RHI – Findings report*, Evaluation of the reformed Renewable Heat Incentive, BEIS/DESNZ Research Paper Series Number 2023/005, July 2023 (accessed 1 March 2024).

27 Department for Energy Security & Net Zero, *Synthesis of findings from the evaluation of the domestic RHI – Technical annex*, Evaluation of the reformed Renewable Heat Incentive, BEIS/DESNZ Research Paper Series Number 2023/005, July 2023 (accessed 1 March 2024).

3.17 DESNZ told us it is taking steps to build a more systematic approach to monitoring. The Boiler Upgrade Scheme evaluation will also provide six-monthly insights on key barriers for households, including reasons for dropping out of the scheme, and annual insights for installers. Regular monitoring of progress in reducing all key barriers would help DESNZ better understand whether it is on track to deliver the anticipated increase in heat pump installations and where further intervention may be required from the government or industry.

Increasing demand for heat pumps

3.18 DESNZ plans to increase demand for heat pumps through a mix of grants and regulations. These include:

- measures to reduce the installation cost to consumers of heat pumps, including increasing the value of the Boiler Upgrade Scheme grant; and
- introducing new regulations on housebuilders (for which the Department for Levelling Up, Housing and Communities, DLUHC, is responsible) and boiler manufacturers.

Reducing costs to consumers

Increasing financial support through the Boiler Upgrade Scheme

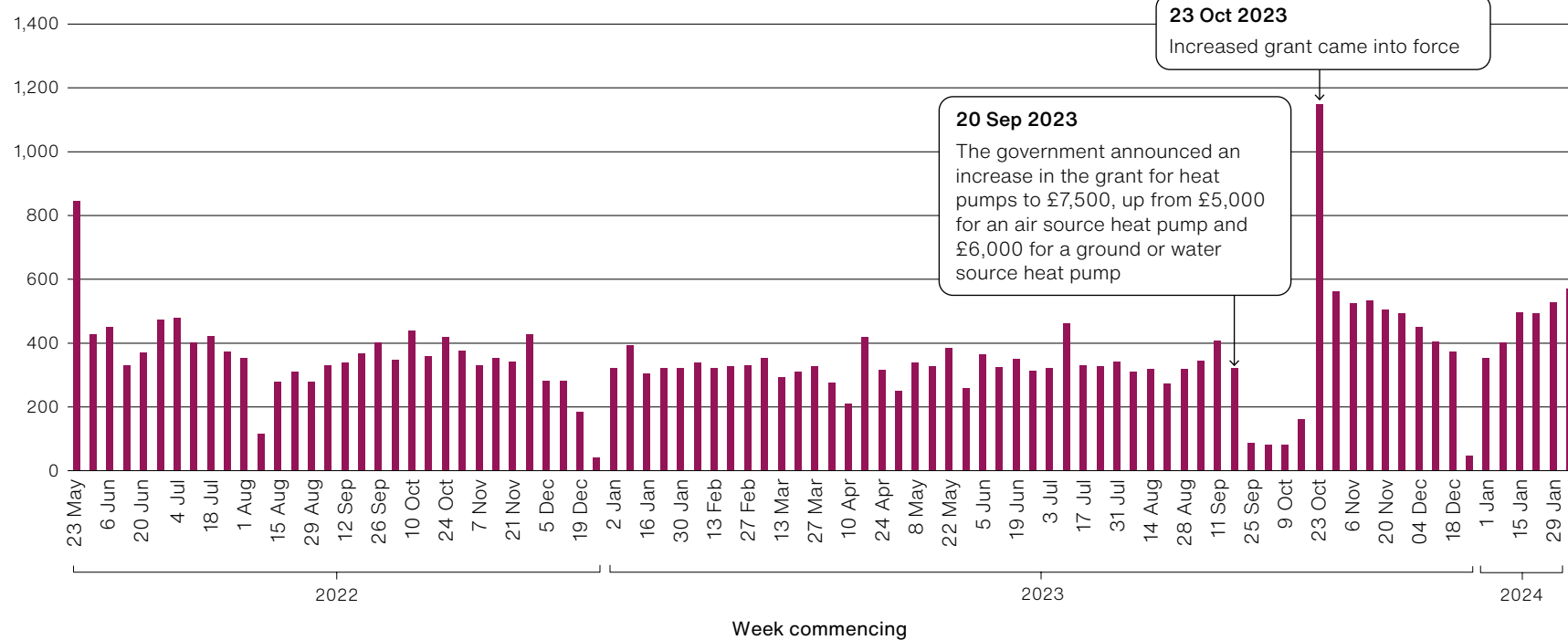
3.19 To increase demand, the government has increased the grant available for heat pumps through the Boiler Upgrade Scheme to £7,500, up from £5,000 for an air source heat pump and £6,000 for a ground or water source heat pump. It covers nearly 60% of the average cost of installing a heat pump, based on the average cost in 2023. The grant uplift has enabled some energy suppliers to offer heat pump installations starting at £500. There was a spike in applications the week after the grant uplift on 23 October 2023, but over half of these were reapplications, since only applications made on or after this date were eligible for the larger grant (**Figure 5** overleaf). The number of applications to the scheme in December 2023 increased by nearly 50% compared with December 2022, and applications in January 2024 increased by nearly 40% compared with January 2023. However, data over a longer period will be required to determine whether the change is sustained.

Figure 5

Weekly Boiler Upgrade Scheme voucher applications, England and Wales, May 2022 to February 2024

There was a large spike in applications the week after the grant uplift in October 2023

Weekly voucher applications received



Notes

- 1 The Boiler Upgrade Scheme provides households and small non-domestic properties in England and Wales with an up-front grant to contribute towards the cost of replacing fossil fuel heating systems with a heat pump or biomass boiler. As at January 2024, more than 99% of applications have been for heat pumps rather than biomass boilers.
- 2 Not all applications will lead to a heat pump or biomass boiler being installed. Ofgem, which administers the Boiler Upgrade Scheme, may not issue a voucher to the applicant if they are not eligible under the scheme regulations, the applicant may not redeem their voucher, or the voucher may expire or be withdrawn later in the process.
- 3 Only voucher applications that were submitted on or after 23 October 2023 could receive the higher grant amount. Vouchers that had not yet been paid prior to 23 October could be withdrawn, and the installer could resubmit an application for the same property on or after 23 October to receive the higher grant amount.
- 4 For the first four weeks of the higher grant, Ofgem monitored whether applications that had been withdrawn between 21 September and 22 October 2023 were then resubmitted on or after 23 October. These reapplications are excluded from this figure. There were 1,914 reapplications during this period: 1,502 reapplications in the week commencing 23 October, 221 in the week commencing 30 October, 103 in the week commencing 6 November and 88 in the week commencing 13 November.

Source: National Audit Office analysis of Department for Energy Security & Net Zero data

Industry support

3.20 DESNZ is supporting industry to reduce heat pump costs in several ways, including:

- An **Electrification of Heat Task Group**, which brings together DESNZ and industry representatives to work towards the target to install 600,000 heat pumps per year by 2028. The Group has a workstream exploring ways to make heat pumps more affordable.
- A **Heat Pump Investment Accelerator Competition**, which will provide up to £30 million of grant funding for investment into UK heat pump manufacturing from 2023-24 to 2024-25. It aims to support the manufacture of up to 270,000 additional heat pumps or 'high value components' a year in the UK by 2028. The government considers that supporting domestic heat pump production could help to reduce costs by lowering dependency on overseas manufacturing and related supply chain delays.

Fiscal measures

3.21 The government has also been supporting lower costs through zero rated VAT on heat pump installations since 1 April 2022, which will continue through to 31 March 2027.

Regulations

3.22 The government intends to support further growth of the heat pump market through regulations it has developed to provide long-term signals to investors, which are yet to come into force.

The Clean Heat Market Mechanism

3.23 The Clean Heat Market Mechanism is an obligation on the manufacturers of fossil fuel heating appliances to sell a certain level of low-carbon electric heat pumps proportional to their UK fossil fuel boiler sales. In 2023, DESNZ stated it would introduce the Clean Heat Market Mechanism in April 2024. The government intends to increase the sales target over time towards its ambition for around 400,000 retrofit heat pump installations per year by 2028. Manufacturers will pay a penalty for missing targets. DESNZ expects to set future scheme targets by considering developments in wider policy and market conditions. However, a third of respondents to a 2023 consultation on the mechanism reported concerns that the targets would be unachievable under market conditions at the time, although this pre-dated the increased grant available through the Boiler Upgrade Scheme. In February 2024 there were media reports that ministers were considering whether to delay or remove the mechanism. DESNZ told us that as at early March, no decision has yet been made.

The Future Homes Standard

3.24 DLUHC is introducing regulations that are expected to require all new-build domestic properties in England to meet higher standards of energy efficiency and have low-carbon heating systems from the outset. The government expects this to result in 200,000 heat pump installations per year once the regulations are implemented in 2025. DLUHC launched a consultation on the Future Homes Standard in December 2023, ahead of legislation planned for 2024 and implementation in 2025.

Achieving the 2028 target

3.25 In 2021, DESNZ set a target for there to be at least 600,000 heat pumps installed per year by 2028. DESNZ understands this to be the minimum market requirement in all potential future heating scenarios. All scenarios other than those with high levels of hydrogen for home heating require much higher heat pump deployment from 2029 onwards.

3.26 Achieving the target requires a steep increase in installations from the current level. Heat Pump Association data indicate that the annual heat pump sales rate doubled over the five years from 2018 to 2022 (**Figure 6**). Using heat pump sales as a proxy for heat pump installations, reaching 600,000 installations would require an eleven-fold increase over the seven years from 2022 to 2028.

3.27 DESNZ regards this target as viable given the current and planned policies and regulation for 2024 onwards. However, some of the government's net zero policy announcements in September 2023, such as the delay to the phase-out of fossil fuel heating systems for off-gas-grid homes, make it more challenging. Our previous work, along with reports from the Committee of Public Accounts, indicate that the government does not have a strong track record on engaging consumers, with optimistic expectations of uptake for its previous energy policies, such as the Green Deal,²⁸ Renewable Heat Incentive,²⁹ and the Smart Meter Implementation programme.³⁰

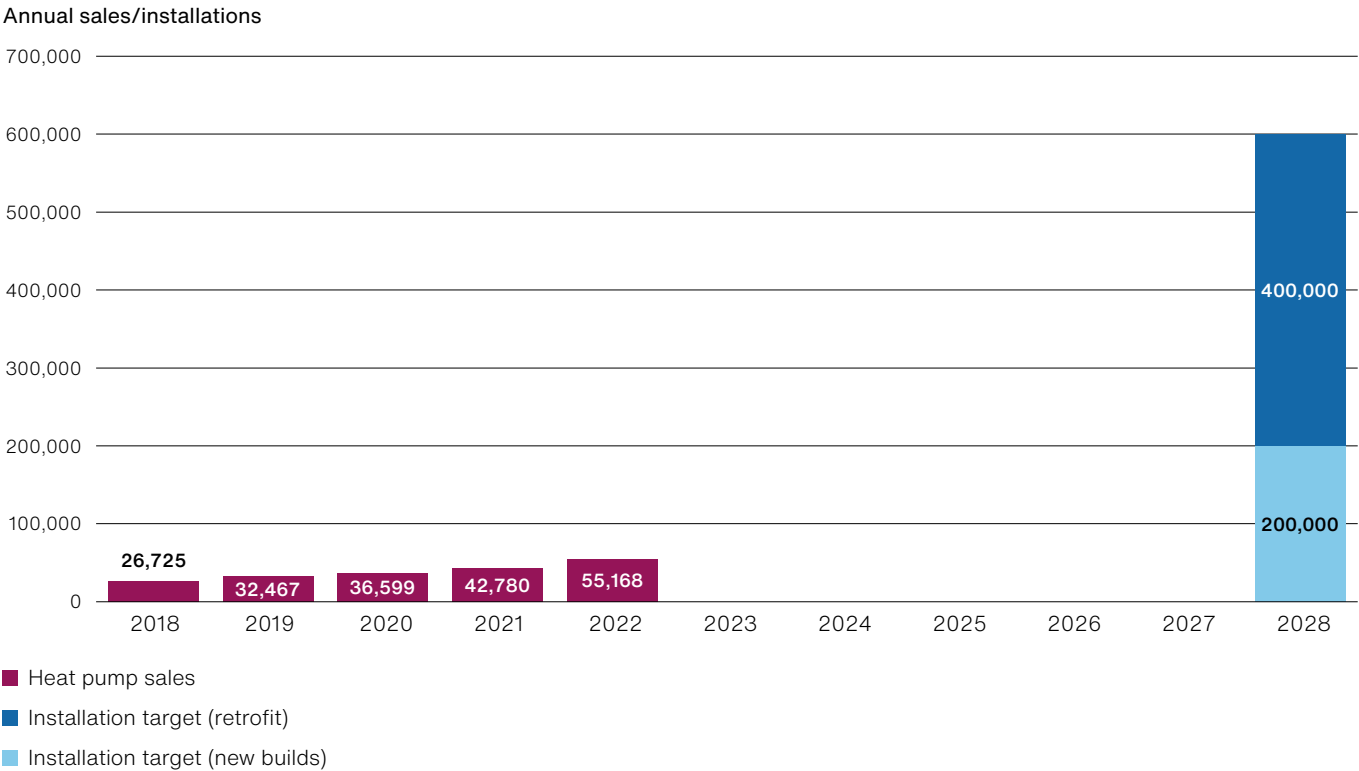
28 Committee of Public Accounts, *Household energy efficiency measures*, Eleventh Report of Session 2016-17, HC 125, July 2016 (accessed on 4 October 2023).

29 Committee of Public Accounts, *Renewable Heat Incentive in Great Britain*, Fortieth Report of Session 2017-19, HC 696, May 2018 (accessed on 4 October 2023).

30 Comptroller and Auditor General, *Update on the rollout of smart meters*, Session 2022-23, HC 1374, National Audit Office, June 2023 (accessed on 4 October 2023).

Figure 6
Annual UK heat pump sales (2018 to 2022) compared to the 2028 heat pump installation target

A steep ramp up in heat pump sales and installations will be required to reach the government’s target of 600,000 installations per year by 2028



- Notes**
- 1 Data from 2018 to 2022 reflect heat pump sales, which are not directly comparable to installations because sales take place before installation and are therefore front-loaded. We have used heat pump sales data because the government does not currently have a single, comprehensive measure of heat pump installations.
 - 2 The government expects the 600,000 heat pump installations per year to be split across new-build homes and retrofit of existing housing stock in 2028. Reaching approximately 200,000 heat pump installations in new-builds by 2028 depends on the number of newly built domestic properties. There are no interim targets or expected milestones prior to 2028.

Source: National Audit Office analysis of Heat Pump Association and Department for Energy Security & Net Zero data

Supporting heat pump installations after 2028

3.28 DESNZ’s policies mostly focus on the short-term actions required for the transition up to 2028, the end of the fourth carbon budget. DESNZ recognises that it needs to determine future policy interventions. By drawing on evaluations of its current schemes, DESNZ can make informed decisions about the combination of policies and regulations that will increase heat pump uptake in a way that achieves value for money. The government identified in its March 2023 *Carbon Budget Delivery Plan* that delivering emissions savings in future carbon budget periods will depend on future government decisions to provide additional funding.³¹

31 HM Government, *Carbon Budget Delivery Plan*, March 2023, HC 1269 (accessed 4 October 2023).

3.29 Given that DESNZ expects heat pumps to be the main low-carbon technology in 2035, policies will need to focus on continuing to increase the rate of installations. The government stated that annual heat pump installations could need to reach up to 1.6 million by 2035. In October 2023, the National Infrastructure Commission highlighted that the number of heat pump installations in existing properties will need to grow by an average of 35% each year to achieve the government's emissions reduction target for 2035.

3.30 The Boiler Upgrade Scheme and Clean Heat Market Mechanism are only confirmed until 2028, after which DESNZ will need to decide the relative roles of taxpayer-funded grants, obligations on manufacturers and costs incurred by households. DESNZ told us that future decisions on the relative cost burden will be guided by the *Heat and Buildings Strategy* principles of prioritising support for the most vulnerable through the transition, and reducing the up-front and running costs of heat pumps. However, it has not set out any milestones or triggers for taking such decisions.

3.31 DESNZ told us it expects that its current approach of installing heat pumps on a house-by-house basis would endure for the whole rollout, with demand driven by individual households. However, some stakeholders told us they expect that the most efficient delivery model for mass rollout of heat pumps in the 2030s and beyond will be to adopt a street-by-street approach to install multiple heat pumps in the same area around the same time. This might enable better planning of upgrades to local electricity networks to carry increases in demand and reduce installation costs. Such a delivery model would require careful planning and public engagement. DESNZ told us it would keep its approach under review as new evidence emerges.

Appendix One

Our evidence base

1 We reached our independent conclusions on whether the government is set to deliver value for money from its progress in decarbonising home heating following analysis of evidence collected from June 2023 to February 2024. We used both qualitative (interviews, document review, self-assessment) and quantitative methods to collect and analyse evidence. Details of the methods are below.

2 We focused on the deployment of low-carbon heating and did not consider energy efficiency. We assessed whether the government is establishing a pathway to decarbonising home heating in a way that is value for money. We also assessed the progress in the rollout of heat pumps, which the government expects to be the main technology that households use to decarbonise home heating. We did not evaluate the value for money of specific schemes or programmes aimed at decarbonising home heating, such as the Boiler Upgrade Scheme.

Interviews

3 We undertook 34 interviews with the Department for Energy & Net Zero (DESNZ), other departments and public bodies, and wider stakeholders. We covered topics based on the focus of our review as set out in paragraph 2, and tailored questions to the responsibilities and expertise of each interview participant.

4 We carried out all interviews online, with each one typically lasting one hour. Interviews took place from June 2023 to January 2024. We took detailed notes of the interviews and reviewed these to identify common themes to inform our findings.

Departmental officials and other public sector bodies

5 We spoke to DESNZ officials responsible for the following areas in decarbonising home heating:

- the net zero buildings portfolio, including cross-portfolio management, strategic decisions and analysis;
- the three key technologies of heat pumps, heat networks and hydrogen for home heating;
- consumer engagement; and
- gas and electricity networks.

6 These interviews focused on progress in decarbonising home heating, how the government oversees its related activities, and how it is establishing its plans for decarbonising home heating.

7 We also met with officials from six other public-sector bodies: Ofgem, the Department for Levelling Up, Housing and Communities (DLUHC), HM Treasury, the National Infrastructure Commission, the Infrastructure and Projects Authority and the Local Government Association. These interviews informed our study approach as well as our findings. Our questions focused on their perspectives on the government's approach to decarbonising home heating, their priorities and challenges in decarbonising home heating, and how DESNZ is working with them and other partners.

Wider stakeholder interviews

8 We met with wider stakeholders, including members of industry and industry representatives, academics, think tanks and consumer representatives, to capture a range of views to inform our findings. We also held external exploratory scoping meetings to gain key insights on the topic and inform the focus of our audit. Our questions focused on their perspectives on the challenges of decarbonising home heating and the government's progress. The stakeholders we spoke to were:

- Centre for Research into Energy Demand Solutions, University of Oxford;
- Citizens Advice;
- Climate Change Committee;
- Energy House, University of Salford;
- Energy Networks Association;
- Energy Saving Trust;
- Energy Systems Catapult;
- MCS (Microgeneration Certification Scheme) Charitable Foundation;
- Octopus Energy;
- Regulatory Assistance Project; and
- independent advisers.

Document review

9 We reviewed more than 250 published and unpublished documents, of which over 230 were provided by DESNZ. We carried out our review from September 2023 to February 2024. Documents reviewed covered the period from October 2021 to February 2024. We reviewed the documents against a framework we developed that reflected the evaluative criteria outlined in paragraph 2 and related sub-questions. We then summarised the findings and identified key themes against our audit questions to inform our conclusions.

10 We reviewed documents from DESNZ to understand how the government is overseeing its work on decarbonising home heating, including progress, funding, scenario planning, governance and evaluation. This included a review of:

- board meeting minutes and papers;
- published government strategies;
- business cases;
- policy and research papers; and
- consultation responses.

11 The other documents we reviewed were provided by interview participants and identified through our own review of key literature. We reviewed these documents to understand the key challenges of decarbonising home heating and the perspectives of wider stakeholders on the government's progress.

Self-assessment exercise

12 In October 2023, we asked DESNZ to provide an update of actions and progress against all 25 commitments in the Heat and Buildings Strategy. We requested supporting evidence to verify its assessment of progress and triangulated this against other sources where possible.

13 We provided a template for DESNZ to provide this information. For each commitment, we asked for an overall judgement of progress towards the commitment (ahead of schedule, on track or behind schedule); a brief narrative of progress with planned or completed actions; measurement of progress against any key dates and milestones; and evidence supporting the commentary and assessment of progress.

Quantitative analysis

Government data

14 We analysed a range of published and unpublished quantitative government data to understand government spending and progress in relation to the Heat and Buildings Strategy commitments. The key datasets were:

- Unpublished budget and outturn data for schemes supporting the decarbonisation of home heating, which we used to understand the levels of funding allocated to schemes and DESNZ's progress in awarding the funds.
- DESNZ's *DESNZ Public Attitudes Tracker, Summer 2023*, which we used to understand public awareness of the transition to low-carbon heating.
- Weekly Boiler Upgrade Scheme application data from May 2022 to February 2024, which we used to monitor the change in applications over time. Data from weeks commencing 23 May 2022 to 13 November 2023 are publicly available from the ad hoc management information publication of Boiler Upgrade Scheme weekly application figures, published on 30 November 2023. Data for weeks commencing 20 November onwards were provided by DESNZ.

Other data

15 We are grateful to MCS (Microgeneration Certification Scheme) and the Heat Pump Association for permission to use their data.

16 We used MCS's heat pump installation cost data, which are publicly available in an online dashboard. We used these data to understand change in heat pump installation costs over time, and to compare these to the target cost reductions set out in the Heat and Buildings Strategy:

- We downloaded data from the MCS Data Dashboard in January 2024, filtering to include only the cost of domestic installations of air source and ground/water source heat pumps in England, Northern Ireland, Scotland and Wales. MCS certification is not a mandatory requirement, so MCS data does not capture all small-scale renewable energy installations in the UK. However, as government schemes will only fund MCS-certified installations, we are confident the data represents a significant proportion of heat pump installations in the UK.
- We used HM Treasury's Gross Domestic Product deflator and the Office for Budget Responsibility's inflation forecast (December 2023) to convert the MCS cost data to 2021 prices.

- The heat pump installation costs are self-reported by MCS-certified installers and should cover “the full cost of the installation that is charged to the consumer”. This includes materials and labour. MCS does not monitor whether grants are deducted from the cost values entered onto MCS certificates, so some cost entries may include the grant value and others may not. Given grants became available through the Boiler Upgrade Scheme in May 2022, the MCS installation cost data may exaggerate the cost reduction since 2021. DESNZ also relies on these data for the costs in its Boiler Upgrade Scheme statistics, with a caveat that the installation costs “should also include the grant value, but this may be subject to interpretation by different installers.” Ofgem provides guidance to Boiler Upgrade Scheme installers on what to include and DESNZ therefore expects the vast majority of Boiler Upgrade Scheme installers to be reporting the costs inclusive of the grant.

17 We used UK heat pump sales data from the Heat Pump Association (2018 to 2022), given there is no central government data source on installations.

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