Committee on
Fuel Poverty

RAF026/2526 How to ensure a successful transition to heat pumps for households at risk of fuel poverty

Report for the Committee on Fuel Poverty

May 2026

Department for Energy Security and Net Zero (2026)

Author

Will Rivers (Carbon Trust)

Research team

Will Rivers, Heather Smith, Jack Adkins, Rosanna Jackson (Carbon Trust),

Rebecca Jones, Kate Mesher, Eve Smith, Lucas Haynes (Ipsos UK), and

John Ewbank (Independent data scientist).

Acknowledgements

Trystan Lea and Glyn Hudson (Open Energy Monitor)

Foreword

The transition to low carbon heating is a central pillar of the UK's approach to enabling net zero. Thank you to The Carbon Trust and partners for this research, which shows that heat pumps, when delivered well, have the potential not only to support a net zero transition but to provide affordable warmth, improved comfort and long-term resilience for fuel poor homes.

However, this research makes clear that pace of deployment alone is not a sufficient measure of success. For households at risk of fuel poverty, the consequences of getting the transition wrong are immediate and severe. Unlike better-resourced households, they have little financial capacity to absorb higher running costs, to fund remedial work, or to navigate complex systems when things go wrong. In this context, a poorly performing installation is not a marginal technical failure: it risks deepening fuel poverty rather than alleviating it. Where fuel poor households find their heat pump system incurs higher running costs than their previous system, the transition risks increasing energy bills - raising a fundamental question of a fair net zero transition.

Heat pumps can work efficiently in any house type with good design, installation and commissioning. However, fabric measures still have a critical role to play in minimising overall bills, increasing comfort and reducing a household's exposure to high bills should their heat pump not be running efficiently. The evidence presented here demonstrates that outcomes are highly sensitive to the quality of design, installation, commissioning and follow-up. Where systems are not well delivered and supported, households can be left paying substantially more than necessary, often without the information or support needed to resolve the problem. This raises important questions of governance, accountability and redress. As deployment accelerates through public programmes, responsibility for quality cannot rest with households themselves. Clear ownership is required across the delivery chain to ensure standards are met, performance is verified, and failures are corrected. Existing frameworks for consumer protection, installer assurance and regulatory oversight must operate coherently and effectively if public confidence is to be maintained.

The Committee is mindful of the lessons from past large-scale retrofit programmes, where inadequate oversight and fragmented accountability led to poor outcomes and lasting reputational damage. This transition must not repeat those mistakes. For fuel poor households, there is little margin for error.

Chair Rt Hon Caroline Flint

Committee on Fuel Poverty

Contents

Executive Summary

Fuel poverty affected 2.36 million households in England in 2025. The Warm Homes Plan commits £15 billion to upgrade up to five million homes by 2030, with an ambition to lift up to one million homes out of fuel poverty. Around £5 billion will fund packages of measures for low-income households, including insulation, solar panels, batteries and heat pumps. The updated Fuel Poverty Strategy for England states that the next generation of fuel poverty policies will focus more on low carbon heating solutions, with a reduced role for fossil fuel heating. Together, these signal a significant shift in focus and increased scale of public investment in heat pump deployment for low-income homes.

Despite this, there is limited evidence on the experience of low-income households living with a heat pump and how the transition to a heat pump has impacted their fuel bills. This research was commissioned by the Committee on Fuel Poverty to address these evidence gaps and understand how to ensure a successful transition to heat pumps for households at risk of fuel poverty. The methodology combined in-depth qualitative interviews with 29 households (including concurrent technical audits in 20 homes), secondary analysis of monitored heat pump performance data from over 1,100 UK heat pump installations, cost modelling, and a wider review of relevant evidence. The findings from this research underpin eight recommendations made to the Committee on Fuel Poverty in their role to challenge and support the government on the delivery on fuel poverty policy and programmes.

What the research found

In the interviews with households at risk of fuel poverty, participants' experiences and overall satisfaction varied widely. For some households, heat pumps had been transformative: homes that were previously uncomfortably cold were now described as being warm throughout, with damp issues resolved and affordable fuel bills. Participants with health issues overwhelmingly reported positive impacts on their wellbeing. These participants typically reported they would choose a heat pump over any other heating system. At the other extreme, some participants reported how their heat pumps had developed major system faults, leading to significant discomfort, with no effective pathway to resolve the issue. This resulted in acute financial and mental distress in households ill-equipped to absorb it. Owner-occupiers were particularly exposed, with a lack of ongoing support resulting in the costs of repairs falling directly on them. Between these two extremes were participants who described the transition to a heat pump as positive, but with caveats about affordability, system responsiveness or installation quality.

Participant satisfaction levels were driven primarily by a comparison with their previous heating systems, many of which were expensive, unsafe or not working. Those whose previous heating systems had been poor or expensive were consistently positive about their transition to a heat pump. In contrast, those who had previously had working gas or oil boilers were more equivocal and more likely to report an increase in bills or lower satisfaction than their previous system. Technical audits revealed that **self-reported satisfaction did not reliably indicate that the system was operating well and delivering low fuel bills.** In some cases, low levels of heat pump efficiency meant that households remained under financial strain and at risk of fuel poverty, when a well-performing system could have removed that risk. Households in our sample were, nearly universally, unaware of the level of efficiency that their heat pump was operating at.

The handover process was the most consistent area of criticism. Handovers were consistently reported as rushed and focussed on providing technical manuals rather than practical guidance. Some participants who had received simple guidance to leave the heating on continuously and not to touch the controls had found that helpful. For others, the same advice had left them lacking in confidence to make necessary adjustments. **Poor or non-existent handovers contributed to overall low levels of understanding and confidence in operating systems efficiently and effectively.** Some participants compensated for the poor handover effectively through self-directed learning online. Participants, typically in social housing, with regular maintenance and servicing arrangements, found these highly beneficial and compensatory for a poor handover.

Technical observations revealed considerable variation in the quality of commissioning of factors such as weather compensation and efficient hot water settings. Third party non-modulating thermostats (which are not compatible with weather compensation controls and therefore can reduce heat pump efficiency) were common in our qualitative sample. Across the systems viewed during home visits, settings consistently remained as commissioned by the installer with households unaware of how to adjust them.

The heating patterns adopted by participants varied widely between fully continuous and highly intermittent heating patterns, but with strategies somewhere in between these two extremes predominant. The use of programmed heating schedules was exceptional in this sample; most participants interacted solely with the room thermostat to make regular manual adjustments. **Participants who adopted continuous heating patterns were consistently highly positive about their experience and levels of comfort.** Participants adopting intermittent heating patterns had more mixed experiences.

Secondary data analysis of over 1,100 monitored installations, building on recently published analysis, identifies a wide performance gap between the highest and lowest performing heat pumps. Systems on the Heat Pump Monitor platform operate, on average, at 39% higher efficiency than systems installed under the Electrification of Heat trial. At current energy prices, this gap is equivalent to several hundred pounds a year in running costs for a typical fuel poor home.

Not all factors influencing performance can be observed in the secondary data, and the observable factors do not fully account for the performance gap. However, of those that can be observed, **the correct commissioning of weather compensation was consistently identified as the factor most strongly associated with high efficiency**. The commissioning of water heating settings was also observed to have a material impact on fuel bills. Lower flow temperatures were strongly associated with high efficiency in systems where weather compensation was set correctly, but the relationship was less clear where weather compensation was set poorly. The sizing of the heat pump relative to property demand also showed a weaker association with performance than weather compensation. The highest performing systems in the dataset were operated continuously but the data was inconclusive on whether operating a heat pump intermittently always carries an efficiency penalty. Levels of insulation and property age showed no meaningful relationship to in-situ heat pump efficiency in this analysis. However, improving the thermal fabric of the building reduces heat demand and fuel bills independently of heat pump efficiency.

Cost modelling in this report shows that installing **solar PV and battery storage, alongside a heat pump, can significantly lower bills in all cases.** Solar PV was consistently viewed favourably by households in the qualitative interviews. However, the combined savings from solar PV and battery storage can be less than additional costs that result from a poorly performing heat pump. Time-of-use tariffs can deliver material savings for households willing and able to flex their heat demand to the lower cost tariff windows. **However, where heating patterns are not well aligned to the tariff, time-of-use tariffs can increase fuel bills**. Participants in the qualitative interviews typically expressed a preference for simple and predictable tariffs.

Recommendations

The findings from this research underpin eight recommendations, directed to the Committee on Fuel Poverty in its role supporting and challenging the government on delivery. They focus on the principal instruments for installing heat pumps in low-income households under the Warm Homes Plan: Warm Homes: Social Housing Fund and Warm Homes: Local Grant but are applicable to the installation of heat pumps in low-income homes in general:

Recommendation 1: Ensure minimum standards of commissioning are met

Of the factors examined in the secondary data analysis, weather compensation showed the clearest relationship with efficiency. Across the systems observed in the qualitative research, non-modulating thermostats (incompatible with effective weather compensation) were prevalent and settings consistently remained as the installer had left them. Weather compensation is not mandatory under current requirements of the Microgeneration Certification Scheme (MCS) and third party non-modulating controls are not prohibited.

The Committee should press for Warm Homes Plan programmes to specify and verify minimum commissioning standards focussing on the correct calibration of weather compensation, no non-modulating room thermostats, and optimised hot water settings.

Recommendation 2: Ensure households are equipped to operate their systems confidently and efficiently

Handover quality was the most consistent area of criticism in the qualitative research and had material impacts on people’s confidence in operating their system effectively and efficiently.

Ongoing support was highly valued and viewed as compensatory for a poor handover, but was exceptional in our sample. MCS specifies handover documentation but not the quality of verbal explanation, household understanding, structured follow-up or ongoing support.

The Committee should press for Warm Homes Plan programmes to embed minimum standards for handover and structured post-installation support, sufficient to enable households to operate their systems with confidence. Provision should be made for a follow-up after the household has lived with the system through an initial heating season and for ongoing servicing and maintenance included as standard.

Recommendation 3: Monitor and verify heat pump performance as standard

Self-reported satisfaction was primarily driven by comparison with previous, typically very poor, heating systems. Satisfaction did not reliably correspond to reasonable levels of system efficiency or lower bills. Heat pump underperformance may not be apparent to the household but represents a material risk of exacerbating fuel poverty. MCS requires installers to provide a design-stage prediction of system efficiency, not verify actual performance.

The Committee should press for in-situ performance monitoring to be a standard feature for installations in low-income households funded through the Warm Homes Plan, with verified efficiency data made available to the household, the delivery body and the funding department, and feeding into ongoing programme evaluation.

Recommendation 4: Establish minimum performance guarantees against design-stage predictions

There is a wide performance gap between the best and worst performing heat pumps. This can result in costs being several hundred pounds higher and means that some households will remain at risk of fuel poverty after the installation of a heat pump. MCS does not require remediation of systems that are underperforming relative to their design.

The Committee should press for minimum performance guarantees to be specified as a default requirement in installations targeting low-income households, anchored to the design-stage efficiency prediction that installers are required to produce under MCS.

Recommendation 5: Monitor the effectiveness of remediation arrangements for households at risk of fuel poverty

System faults were common in the qualitative sample, in some cases leading to significant discomfort, and financial and mental stress. Households receiving free installations were often left without practical recourse, and it was unclear who was responsible for remediation. The redeveloped MCS:2025 scheme is designed to close this gap, with mandatory financial protection and single-point accountability for resolution. For fuel poor households, these arrangements are a critical but unproven safeguard against a negative transition.

The Committee should monitor the effectiveness of remediation for low-income households and advocate for strengthening within Warm Homes Plan programmes if they fall short.

Recommendation 6: Include solar PV and battery storage in installation packages where feasible until heat pumps consistently reduce fuel bills

Solar PV and battery storage installed alongside a heat pump can reduce annual electricity costs substantially, bringing substantial benefit to fuel poor households.

The Committee should press for default inclusion of solar PV and battery storage in Warm Homes Plan packages targeting low-income households, where feasible, until heat pumps routinely reduce fuel bills for low-income households.

Recommendation 7: Recommend time-of-use tariffs only where households are confident managing them

Engagement with tariff choice in the qualitative sample was limited, with a recurring preference for simple tariff structures. Effective utilisation of time-of-use tariffs was confined to households with high technical engagement and there were cases in which a tariff was actively worsening the household's cost position. Cost modelling confirms that, where heating patterns are not optimised to the tariff schedules, time of use tariffs may increase fuel bills in some cases**.**

The Committee should press to ensure that time-of-use tariffs are recommended only where the household has expressed clear confidence in managing the more complex arrangement or where automatic optimisation software or hardware is installed alongside. The financial case for heat pump installations in low-income households should be calculated at standard tariff rates, with time-of-use savings treated as upside rather than a core component of the affordability case for heat pumps in low-income households.

Recommendation 8: Address key gaps in the evidence base on heat pump performance and operation in low-income households

Several evidence gaps were identified as part of this research including the absence of dedicated in-situ heat pump performance data specifically for fuel poor households, the extent to which heat demand changes during the transition to a heat pump and the impact of heating behaviours such as intermittent heating and partial heating on fuel bills.

The Committee could press for these evidence gaps to be addressed through a funded audit and study programme commissioned alongside the Warm Homes Plan.

1. Introduction

1.1 Why this research is needed

Fuel poverty[1] affected 2.36 million households in England in 2025, representing 9.4% of all households.[2]

This research was commissioned by the Department for Energy Security and Net Zero (DESNZ) on behalf of the Committee on Fuel Poverty (CFP). The CFP commissioned the work to address two evidence gaps that have become more pressing as heat pumps move to the centre of fuel poverty policy: the limited understanding of how fuel poor households actually experience life with a heat pump, and the limited understanding of why some installations deliver the running cost savings the technology can offer while others do not.

On the first evidence gap, evaluations of large-scale energy efficiency programmes, including the Energy Company Obligation (ECO), the Social Housing Decarbonisation Fund (SHDF), the Home Upgrade Grant (HUG) and the Local Authority Delivery (LAD) scheme, suggest that satisfaction may be lower, and post-installation problems more prevalent, among households receiving heat pumps through these programmes than in the able-to-pay market, but little is understood about why[3]. Existing evidence also indicates that fuel poor households tend to heat intermittently and partially in response to financial pressure,[4] while heat pumps are generally considered to operate most efficiently when running continuously. Whether and how these patterns are reconciled in practice has not previously been examined in any detail.

On the second gap, well-installed heat pumps can reduce running costs relative to all other heating system types, including mains gas.[5] Recently published analysis of monitored installations, however, points to a wide performance gap between the best and worst performing heat pumps, and to substantial differences in running costs as a result.[6] This research uses a combined dataset of installations from the Heat Pump Monitor (HPM) and Electrification of Heat (EoH) demonstration project to examine what the monitoring data

---

[1] A household is in fuel poverty in England if it meets the Low Income Low Energy Efficiency definition: its equivalised disposable income, after housing and required energy costs, is below the poverty line and it lives in a property with a Fuel Poverty Energy Efficiency Rating of Band D or below.

[2] Department for Energy Security and Net Zero (2025) 'Annual Fuel Poverty Statistics in England, 2025'. Available at: https://www.gov.uk/government/collections/fuel-poverty-statistics (viewed on 27 April 2026)

[3] Department for Energy Security and Net Zero (2024) 'Local Authority Delivery Scheme: phases 1 & 2 Evaluation'. Available at https://www.gov.uk/government/publications/local-authority-delivery-scheme-phases-1-and-2-evaluation (viewed on 27 April 2026)

[4] Zapata-Webborn, E., Hanmer, C., Oreszczyn, T., Huebner, G., McKenna, E., Few, J., Elam, S., Pullinger, M. and others (2024) 'Winter demand falls as fuel bills rise: Understanding the energy impacts of the cost-of-living crisis on British households', Energy and Buildings 2024: volume 305, article 113917. Available at: https://doi.org/10.1016/j.enbuild.2023.113917 (viewed on 29 April 2026)

[5] Rosenow, J., Lea, T. and Boni, G. (2025) 'Bridging the efficiency divide: open-source insights into UK heat pump performance gaps', Energy and Buildings 2025: volume 352, article 116785. Available at: https://doi.org/10.1016/j.enbuild.2025.116785 (viewed on 9 March 2026)

[6] Rosenow, J., Lea, T. and Boni, G. (2025) 'Bridging the efficiency divide: open-source insights into UK heat pump performance gaps', Energy and Buildings 2025: volume 352, article 116785. Available at: https://doi.org/10.1016/j.enbuild.2025.116785 (viewed on 9 March 2026). The implications of this performance gap for running costs are explored in Section 3.10, Table 6.

reveals about the factors responsible for that gap. Neither dataset is necessarily representative of installations under large-scale energy efficiency programmes, nor of households at risk of fuel poverty. Wider evidence, including in-situ monitoring of Renewable Heat Incentive (RHI) installations between 2017 and 2022[7], is broadly consistent with the levels of performance seen in the EoH dataset. The higher levels of performance observed in HPM should be considered more exceptional and indicative of what can be achieved when good practice in design, installation and commissioning is in place.

How heat pumps installed in homes at risk of fuel poverty are performing is itself a critical data gap. If the variation observed in the available data is indicative of the wider population of installations in households at risk of fuel poverty, this poses significant risks for those least able to deal with the financial consequences of low-efficiency systems. Even modest changes in energy costs have a material impact on the ability to afford adequate warmth, and those on low-incomes have limited financial capacity to absorb bill increases or fund remediation of underperforming systems.

1.2 Research questions

The research is structured around three research questions:

Research Question 1: What are the lived experiences of households at risk of fuel poverty with heat pumps?

- What are the experiences of households at risk of fuel poverty living with heat pumps, in terms of fuel bills, comfort and satisfaction?
- How do households at risk of fuel poverty use and manage their heat pump systems in response to their heating needs and daily schedule?
- How did the quality of installation and commissioning shape their day-to-day experience?
- How adequate was the information and support they received before, during and after installation?
- What has been their experience of using additional technology or services, such as solar PV or smart electricity tariffs, alongside their heat pumps?

Research Question 2: What determines whether a transition to a heat pump increases or reduces fuel bills for households at risk of fuel poverty?

- What heat pump design, installation and commissioning factors determine real-world heat pump performance?
- What is the scale of variation in running costs between well performing and poorly performing systems?
- How do property characteristics, heating patterns, household behaviours and control strategies affect performance?

---

[7] RB&M Research (2024) ‘In-situ heat pump performance analysis: Analysis of Ofgem Data 2017–2022’. Available at: https://www.recc.org.uk/pdf/rbandm-research-project.pdf (viewed on 9 March 2026)

- What role can complementary measures such as solar PV, battery storage and time-of-use tariffs play in reducing running costs?

Research Question 3: How to ensure a positive transition to heat pumps for households at risk of fuel poverty?

- What interventions are needed to improve system performance through design, installation and commissioning?
- Which households face the greatest risk in the transition, and how can programmes identify and protect them?
- What does the evidence suggest about minimum standards for post-installation monitoring and support?

The scope of this research is England only, consistent with the statutory framework for fuel poverty and the remit of the CFP.

1.3 Research method

The research employed a mixed-methods approach combining three complementary strands:

Qualitative interviews with households at risk of fuel poverty

In-depth interviews were conducted with 29 households at risk of fuel poverty with heat pumps, across 6 regions of England. Twenty took place in the participant's home using a dual-researcher model: an Ipsos social researcher led a semi-structured interview exploring the household's heat pump journey, while a Carbon Trust technical expert conducted a concurrent system audit covering system specifications, performance metrics, flow temperature and weather compensation settings, and a visual property assessment. Nine further interviews were conducted online following the same topic guide but without a technical audit. Participants completed a 7-day structured heating diary. Data were analysed using a thematic framework methodology. Sample characteristics are presented below.

Sampling and scope. A maximum-diversity purposive sampling approach was used, monitoring diversity across household composition, previous heating system, tenure, property type, heat pump type, household vulnerabilities and geographic region. Participants were required to have lived with a heat pump for at least one full winter. Participation in energy efficiency programmes targeted at low-income households served as the primary recruitment indicator including households who had received their heat pump through publicly funded schemes. Individual fuel poverty status was assessed retrospectively using a dedicated screening questionnaire and the Centre for Sustainable Energy (CSE) fuel poverty calculator,[8] which applies the Low Income Low Energy Efficiency (LILEE) methodology.[9] Values were self-

---

[8] Centre for Sustainable Energy (2025) 'Fuel poverty calculator'. Available at: https://www.cse.org.uk/resource/fuel-poverty-calculator/ (viewed on 29 April 2026)

[9] Department for Energy Security and Net Zero (2025) 'Fuel Poverty Methodology Handbook (Low Income Low Energy Efficiency)'. Available at: https://assets.publishing.service.gov.uk/media/69c3b33b380a2a73a7cf9e43/Methodology_Handbook__2026_Fuel_Poverty_Statistics_Publication_.pdf (viewed on 29 April 2026)

reported and not all participants could be confirmed as meeting the strict LILEE definition. The sample is described throughout as households ‘at risk of fuel poverty’. Full details are set out in the Technical Annex that accompanies this report.

Most participants (18) were owner-occupiers. Nine were in social renting and two were privately renting. The sample reflects a wide range of prior heating arrangements: 15 households had previously relied on electric heating (six on storage heaters and nine on convector heaters, plug-in heaters, electric boilers or wall-hung heaters), six had oil-fired systems, two had mains gas, one had LPG and one used solid fuel.[10] Three participants had moved into properties where a heat pump was already installed, and one was unable to identify their previous system. Full details of the sample are provided in the Technical Annex.

16 participants were aged 65 or over, and 11 households included someone with a health condition or disability. There were 17 female and 12 male participants. 12 lived with a partner, nine alone, five with grown dependants (aged 14 or over), and three with children under 14. The sample was predominantly white and concentrated in the South West (17 households), with smaller numbers across the North West, East of England, North East, Yorkshire and Humber, and South East.

Reported household income was concentrated at the lower end of the distribution: seven households reported under £15,000, eight in the £15,001 to £21,000 range, seven in the £21,001 to £24,000 range and three between £24,001 and £27,000. The remaining four households spanned bands between £27,001 and £42,000. Details of how household income levels relate to fuel poverty for different household sizes and compositions are provided in the Technical Annex along with a full participant breakdown.

Secondary data analysis

The EoH demonstration trial dataset covers 742 installations delivered through 3 contracted partners between 2020 and 2023.[11] The HPM platform dataset covers 383 systems, self-reported by owners using the Open Energy Monitor platform, and predominantly comprises installations delivered by specialist heat pump installers with actively engaged homeowners, some of whom actively work on improving their system.[12] Performance within HPM also varies substantially, and not all HPM installations represent best practice. The HPM mean should therefore be read as an indication of what is commonly achievable under the current standards framework when good practice is followed, not as an upper ceiling.

---

[10] The range of previous heating fuels encountered in our sample is not representative of the fuel poor population at large where 71% of households use mains gas. However, our sample was consistent with heat pump installations in low-income households to date having been installed predominantly in off-gas homes, due to scheme criteria exclusively targeting off-gas homes (e.g. the Home Upgrade Grant) or structurally incentivising the replacement of off-gas heating systems (e.g. the Energy Company Obligation).

[11] Energy Systems Catapult (2024) ‘Electrification of Heat Demonstration Project: Heat Pump Performance Cleansed Data, 2020–2023’ 2nd Edition. UK Data Service. SN: 9050. Available at: https://doc.ukdataservice.ac.uk/doc/9050/mrdoc/UKDA/UKDA_Study_9050_Information.htm (viewed on 9 March 2026)

[12] Heat Pump Monitor (2025) ‘Open-source real-time monitoring of UK domestic heat pump installations’ [public system data and API]. Available at: https://heatpumpmonitor.org/ (viewed on 9 March 2026)

A third source, in-situ monitoring of RHI installations between 2017 and 2022 (approximately 1,700 installations, of which around 1,400 are air source), is referenced where relevant. This sample reports annual SPF only and does not include the system-level operational data used in the primary analysis.[13]

The analysis identifies statistical associations between technical and commissioning factors and SPF. Causal claims are made only where the observational evidence is supported by a mechanistic explanation, by published evidence, or by documented case studies of intervention. The monitoring data captures system-level metrics including SPF, flow temperatures, compressor power and heating patterns, but does not capture all factors that may affect performance. Potential issues such as hydraulic separation, radiator balancing, flow rates, other hydronic issues, and refrigerant charge are not visible in the data, and the analysis cannot therefore quantify their contribution to the performance gap.

Cost modelling

Cost modelling estimated annual running costs for different housing archetypes and system configurations using a two-stage approach, detailed in Section 3.10. The first stage used a dynamic heat pump simulator, developed by Trystan Lea of Open Energy Monitor,[14] to generate half-hourly electricity demand profiles over a full calendar year for each scenario. The simulator runs at a 30-second internal timestep and represents heat pump operation through two control strategies calibrated to the performance gap observed in the secondary data analysis: a modulating strategy reflecting the higher-SPF systems in HPM, and an on/off strategy reflecting the lower-SPF systems in EoH. The second stage used a domestic electricity and cost model, developed by the Carbon Trust, to convert these demand profiles into annual running costs under different tariff, solar PV and battery storage configurations, using the Ofgem Q2 2026 electricity price cap rate of 24.67p/kWh. Five housing archetypes were defined, spanning the fuel poor housing stock from a small insulated flat (8,000 kWh annual demand) to a large solid-wall house (27,000 kWh), with dwelling characteristics drawn from DESNZ Annual Fuel Poverty Statistics 2025.[15] Results for three archetypes are presented in the main report; full results and full methodological details are provided in the Technical Annex that accompanies this report.

Rapid evidence assessments

Rapid evidence assessments synthesised the existing UK evidence base relevant to each research question, covering fuel poor heating behaviours, technical performance factors, delivery contexts and the policy landscape. Sources were identified through academic

---

[13] RB&M Research (2024) 'In-situ heat pump performance analysis: Analysis of Ofgem Data 2017–2022'. Available at: https://www.recc.org.uk/pdf/rbandm-research-project.pdf (viewed on 9 March 2026)

[14] Open Energy Monitor (2025) 'Heat Pump Performance Simulator'. Available at: https://openenergymonitor.org/tools/dynamic_heatpump_v1.html (viewed on 29 April 2026). Full methodological details are provided in the Technical Annex.

[15] Department for Energy Security and Net Zero (2025) 'Fuel Poverty Statistics, England: Detailed Tables, 2025' and 'Fuel Poverty Statistics, England: Supplementary Tables, 2025'. Available at: https://www.gov.uk/government/collections/fuel-poverty-statistics (viewed on 27 April 2026)

database searching, targeted grey literature searches, snowballing from key references, and AI-assisted deep research through Perplexity AI. Findings are integrated throughout this report.

Reporting conventions

Findings from the qualitative research are presented through thematic descriptors such as ‘a consistent theme’, ‘a recurring pattern’, ‘commonly’, ‘typically’ and ‘in some cases’ to indicate the relative weight of findings without implying statistical prevalence. The same conventions are applied to technical observations from the in-home visits, in recognition of the small purposive sample.

Key limitations

Several key limitations of the research and analysis should be considered when interpreting the findings:

- The qualitative sample of 29 interviews was purposively selected to maximise diversity rather than to be statistically representative; findings identify the range of experiences and factors driving variation, but cannot estimate prevalence.
- Fuel poverty status was assessed using self-reported data, meaning not all participants may meet the LILEE definition.
- The completeness of the technical data captured during in-home visits varied depending on each system’s controls. The SPF readings taken during in-home visits relied on manufacturer on-board monitoring rather than full Measuring Instruments Directive (MID) certified metering equipment so should be treated as indicative of higher and lower performance rather than precise measurements.
- The technical and commissioning factors that drive variation (such as flow temperature settings, weather compensation, and system oversizing) are general across household types, but the prevalence of these issues specifically within the fuel poor population cannot be inferred from these data.
- Neither the EoH nor the HPM dataset is representative of the wider installed base or of installations delivered through fuel poverty or wider energy efficiency programmes, for which no equivalent monitoring data currently exists. However, together they are the largest available source of system-level operational monitoring data on UK heat pump performance.
- Not all factors affecting heat pump efficiency can be identified or quantified using the EoH and HPM datasets. The list of factors examined is not an exhaustive list of factors that can impact heat pump performance.

Definitions

A heat pump’s efficiency is measured by its Seasonal Performance Factor (SPF). An SPF of 4.0 means that for every 1 kWh of electricity consumed, the heat pump delivers 4 kWh of heat. A higher SPF means lower fuel bills for the same level of warmth.

See Glossary.

2. The lived experience of households at risk of fuel poverty with heat pumps

This chapter presents insights on the lived experience of households at risk of fuel poverty with heat pumps drawn from in-depth interviews with 29 households at risk of fuel poverty and concurrent technical observations in 20 of those homes.

Chapter summary

- **Comparison of the heat pump to their previous heating system fundamentally shaped people's experiences and levels of satisfaction.** The standard of previous heating systems in this sample was often described as very poor. There was a high prevalence of households transitioning from non-functioning, expensive to run or unreliable electric, oil, LPG and solid fuel systems in this sample. Participants with poor previous systems were consistently positive about the transition to heat pumps. Those replacing generally reliable previous systems were more equivocal. Those replacing previously functioning gas boilers typically expressed a preference for a new boiler over the heat pump.
- **Where the previous system had been inadequate or non-functioning and the installation proceeded well, the heat pump was associated with substantial improvements in perceived comfort, health and quality of life.** Health conditions did not in themselves determine whether a participant's experience was positive or negative, but heightened the, typically positive, impacts on people's health. Participants commonly attributed positive outcomes to the package of measures received which often included solar PV or insulation and ventilation improvements (and in some cases both) rather than the heat pump alone.
- **Self-reported satisfaction did not reliably correspond to measured system performance or to running costs,** and perceptions of energy costs were highly varied. Participants replacing electric heating almost always reported lower bills; those replacing gas boilers reported increases; those replacing oil typically described their cost position as unclear. Some participants reported self-rationing behaviours in response to high running costs.
- **System faults were common within the sample and in some cases caused significant distress.** The critical issue was the absence of a consistently effective pathway to resolution. Participants described being passed between installer, manufacturer, and (for social tenants) housing association, with no single point of accountability for diagnosis and repair. Pathways differed markedly by tenure: owner-occupiers were particularly exposed once warranties expired. While social tenants had a clearer pathway in principle, the effectiveness of that pathway was variable. Faults placed significant financial pressure on households with no buffer to absorb unexpected costs.

- **The quality of handover was the most consistent area of criticism in this sample, and its consequences were significant.** Participants who had not received what they considered an adequate handover were more likely to operate the system intermittently and less likely to be satisfied overall. Handover quality appeared to vary by tenure, with owner-occupiers reporting the poorest experiences on the whole. Where a structured ongoing maintenance relationship was in place, this could compensate for a poor or absent initial handover.
- **Heating behaviour varied across a spectrum, from fully continuous operation to fully responsive on-off use**. Most heating patterns and control strategies fell somewhere in between these two extremes. Behaviours were shaped primarily by prior habits and the quality of guidance received, rather than by occupancy patterns or dwelling characteristics. Participants who had adopted fully continuous operation on the advice of their installer consistently reported high levels of satisfaction and comfort.
- **Understanding of heating controls was typically limited.** Participants typically engaged only with the room temperature set point and were unaware of other functionality such as scheduling, weather compensation and flow temperature settings. Across the systems observed, settings consistently remained as the installer had left them, meaning that the parameters fixed at commissioning effectively determined the ongoing operating characteristics of the system.
- **Engagement with tariff choice was limited and the potential running cost benefits of time-of-use tariffs were typically not being realised.** Effective engagement with time-of-use tariffs was confined to households with high technical engagement or installer-configured integrated packages. A recurring theme was a preference for simple tariffs.
- **Technical observations revealed considerable variation in commissioning quality and system performance.** Indicative SPF values recorded from systems' own monitoring ranged from 1.3 to 5.8. Across the systems where SPF could be reliably calculated, values below 3.0 were a recurring observation. This is well below efficiency levels associated with best practice and the lowest fuel bills. Third-party room thermostats were commonly present in the systems observed. Weather compensation was typically enabled, though in some cases it appeared to be in conflict with third party thermostat control. Water temperature set points were typically not optimised for efficiency, ranging between 50 and 70 degrees, often on a continuous re-heat setting, and auxiliary immersion heaters were observed active in some systems.

2.1 Previous heating systems and baseline conditions

Participants' experiences of their heat pump were shaped, often profoundly, by what heating system they had transitioned from.[16] At the most acute end of the range, there

---

[16] For the purposes of this report, baseline conditions refer to the heating system that the household used before the heat pump was installed, together with the participant's description of its reliability, cost and effectiveness in delivering heat. The thermal characteristics of the dwelling also form part of this baseline where relevant, but the strongest and most consistently discussed influence on participants' experience of the heat pump was the system

were participants who reported previously living with gas wall heaters that had been assessed as unsafe, and a participant who relied solely on a plug-in electric radiator after his gas supply was disconnected. Others had systems that participants reported as functioning but expensive, inefficient or uncomfortable: oil boilers that were old and costly to run, storage heaters that provided heat at the wrong time of day for the household, and LPG and solid fuel systems that required significant effort and cost to operate and maintain.

A subset of participants had previous heating systems that they described as having worked adequately, including both participants with functioning gas boilers and participants with oil systems that, while costly to run, provided reliable heat and hot water.

Comparison with the previous heating system emerged as the most important contextual factor shaping experience and satisfaction, a finding that runs through the sections that follow.

2.2 Impact on comfort, health and quality of life

Where the heat pump replaced an inadequate previous system and the installation was reported as functioning well, participants described substantial improvements in comfort, an increased ability to use all of their home, and a greater sense of day-to-day wellbeing. Participants described homes that had previously been partly unusable due to cold or damp becoming habitable throughout. Being able to use all rooms had implications for daily living, health and dignity, particularly for participants with long-term health conditions or caring responsibilities. One participant, who had previously relied on storage heaters and had lived with low indoor temperatures, described the transformational nature of the change:

> *"I'm just never cold. I used to be shivering, I'd have blankets on me, changing the hot water bottle."* (owner-occupier, previously storage heaters)

Health conditions were prevalent in the sample and could heighten both the positive and negative experiences of the consequences. For participants whose health was affected by cold, a warm and stable home environment was described as essential. One social tenant with a chronic muscular health condition, who had previously spent around a year using a wheelchair, described the contrast with her previous coal-heated home. Under the coal system, once the fire went down the temperature of the whole house dropped significantly, which she reported was severely detrimental to her health. Since moving into a property with a heat pump, she found the constant warmth easier to manage and used her wheelchair less often:

> *"You just put it on and it stays at that level all the time… if the house wasn't warm, I'd be suffering pretty bad really."* (social tenant, coal heated home).

Another participant, whose partner had a long-term health condition, described her house as previously suffering from significant damp and mould issues, as she struggled to maintain

---

it replaced. Characteristics of the sample, including tenure, dwelling type and previous heating system, are summarised in the Technical Annex.

comfortable temperatures with night storage heaters and portable electric radiators. She described the wider impact of the installation of the heat pump, alongside loft insulation, as being critical for her and her partner's well-being, enabling them to maintain a safe and dignified home environment during a period of acute vulnerability.

> *"It just makes a massive difference when you're dealing with somebody who's not well."* (owner-occupier, no previous central heating).

For participants whose heat pump systems were perceived as performing less well, the inability to maintain adequate warmth had consequences for their health management. One owner-occupier living with a combination of conditions that limited her ability to leave the house described the heat pump as an improvement relative to her previous electric heating, but one that still fell short of what her health required:

> *"I'm not warm enough for my medical conditions ideally. But I'm also not worryingly cold either. It's more just like because my circulation is not very good, the sort of discomfort in my extremities sort of thing […] since getting this in, it's been an improvement. It would be better for my health if I could have it warm all the time."* (owner-occupier, previously electric heaters).

Participants frequently attributed their positive experience to the package of measures received rather than the heat pump alone. It was common in our sample that some combination of solar PV, insulation, increased ventilation and new radiators had been installed alongside the heat pump. The qualitative evidence does not isolate the effect of the heat pump from the wider package.

2.3 Satisfaction, system performance and perceptions of energy costs

Self-reported satisfaction in this sample did not reliably correspond either to measured system performance or to running costs. It was common for participants who had replaced electric storage heating, plug-in electric radiators or non-functioning systems to describe themselves as satisfied overall, even where technical observations indicated their system was operating well below the efficiency a well-commissioned heat pump could be expected to deliver. In contrast, participants who had previously had a functioning gas boiler expressed a clear preference for a gas boiler. Where dissatisfaction was expressed, it most often related to the responsiveness of the heat pump compared with a previous boiler, to higher than expected running costs, or to ongoing system faults.

High satisfaction in this sample should be interpreted with care. Where the previous system delivered cold rooms, damp or unaffordable bills, even a heat pump operating below its efficiency potential could be experienced as a substantial improvement. Interviewers also observed that initial responses to satisfaction questions were sometimes brief and positive, with more nuanced views emerging later.

One participant's account clearly illustrated the gap between initial reported satisfaction and underlying reality. At the start of the interview, she indicated she would choose a heat pump again and valued the elimination of damp from her property. However, as the conversation progressed, significant reports of challenges with the system emerged. The system had experienced a fault that had left her without reliable hot water for several months. The initial positive response appeared to reflect both the genuine improvement over her previous system and a reluctance to criticise a free installation, but it did not reflect the severity of the problems she was living with:

> *"we got it for nothing, you can't really complain."* (owner-occupier, previously oil)

However, it is important to note that heat pump systems were typically outperforming previous heating systems in terms of comfort and bills and the underperformance issues represent significant potential upside if issues with system performance can be addressed.

Perceptions of energy costs

Assessing the actual impact on household energy costs from the qualitative evidence alone proved extremely difficult, owing to changed tariff structures, simultaneous installation of other measures, rising unit prices, and the absence of reliable pre-installation baselines. Perceived bill direction nonetheless mapped closely to the previous fuel type. Participants who had transitioned from electric storage heaters, plug-in radiators or bottled LPG almost always reported lower running costs. *"I can put my heating on and I'm not worrying about what it's costing."* (private renting, previously direct electric). Solar PV was viewed very positively by this group and was sometimes described as essential to making the heat pump affordable: participants with solar panels described building up credit over summer months that offset higher winter consumption. Both participants who had previously heated with a functioning gas boiler reported that their bills had increased. Among those replacing oil, bill comparisons were difficult owing to different billing structures, and most described their cost position as unclear.

Heat rationing to reduce bills

Evidence of rationing heating to avoid high bills was common in the sample and took several distinct forms. Some participants reported delaying the daily switch-on until they felt notably cold, or postponing the start of the heating season altogether. Others ran their system at setpoints they described as below their preferred level. One owner-occupier reported that she would like to be able to have the system running overnight, but could not afford to (owner-occupier, previously gas boiler). Some participants described extensive use of supplementary measures, including layered clothing, electric blankets and log burners.

A distinct form of bill anxiety was described by some participants stemming from the visibility of daily heating costs on their smart meter display. With the transition to a heat pump, the cost of running their heating became immediately visible in a way it had not been previously. Some described responding to this visibility by restricting heating. One participant described how the smart meter display shaped her daily decisions about when to turn the heating on:

> *"I delay putting it on until I'm starting to really feel the cold. Simply because I don't want the bill to go up. And then I look at the smart meter in house display and I think 'oh my goodness, I spent that much today."* (owner-occupier, previously electric heaters).

More positive views of the smart meter display were also described, although these were most often associated with households that had solar PV installed. For these participants, the visible feedback allowed them to time energy-intensive activities to periods of solar generation, or to verify that the PV was meaningfully offsetting their daily heating costs. In these cases, the smart meter functioned positively as a feedback tool where the household had something to optimise around it, particularly through PV self-consumption, but in households without that flexibility the same visibility more often drove restriction of use rather than reassurance.

For some, rationing took a different form, shaped by the structure of the household's tariff rather than absolute restriction. One owner-occupier on a time-of-use arrangement described modulating her setpoint to track the cheap windows on her tariff rather than her comfort, reflecting that *"if I had more money available, I would keep the temperature higher"* (owner-occupier, previously electric heaters). In contrast, some participants described rationing behaviours that had been routine under their previous heating system but were no longer necessary after the transition to a heat pump.

Another participant described a similar response, with the smart meter introducing an element of anxiety even where the underlying bill position was manageable:

> *“In the winter months, you know, if you sit and look at your smart meter, you could panic.”* (owner-occupier, previously solid fuel).

Participants with the lowest incomes had no buffer to absorb unexpected increases in costs, either from higher-than-expected bills or unexpected maintenance costs, in some cases leading to an accumulation of debt. In these cases, there was clear evidence of rationing as a response mechanism. One owner-occupier, whose system had developed a fault during her first winter in retirement, described being forced into debt and onto a higher direct debit. She had also reduced her setpoint to 16°C:

> *“I’m £200 in debt with the electrical people, but they’ve upped my payment to £245 a month, so that’s what I’m paying at the moment, which is not great […].I still think I’m paying too much for 16 degrees.”* (owner-occupier, previously oil).

Tariff choice and awareness of cost-saving opportunities

The tariff on which a household purchases its electricity materially affects the running cost of a heat pump, but tariff choice was a peripheral concern for participants overall and engagement with tariff structures was typically limited. Participants in this sample were predominantly on standard variable or fixed tariffs, with a subset on time-of-use or other flexible tariffs, which included Octopus Cosy, other Octopus flexible variants, heat pump specific tariffs, and smart import and export tariffs configured alongside solar PV and battery storage. Awareness of tariff type was uneven. Some participants could not name their specific tariff. One owner-occupier on a fixed dual-fuel tariff had not informed her energy supplier that she had a heat pump at all. A social tenant on a time-of-use arrangement did not know that different tariff structures existed, reflecting that *“no one really told me about that”* (social tenant, previously storage heaters).

Among those on time-of-use tariffs, experiences were mixed and strongly shaped by household capacity to adapt consumption around tariff windows. Participants who used time-of-use tariffs effectively typically had professional or technical backgrounds, or had received an integrated hardware and tariff package from their installer. One owner-occupier, an engineer by background, aligned his schedule to Octopus Cosy ‘cheap windows’ and manually raised the system’s flow temperature during cold snaps. Another had been placed on Intelligent Octopus Flux by her installer alongside solar PV and battery storage. These participants described positive experiences of their tariff arrangement, but the level of technical engagement required to make the tariff work well was exceptional in the sample.

Other participants on time-of-use tariffs described the arrangement as working poorly for their circumstances. One participant on a heat pump specific tariff with an 11am to 4pm cheap window described having to compress domestic activity into that period:

> *“I have to do everything between 11 to 4, and I manage it on a weekend but not in the week.”* (owner-occupier, previously oil).

A social tenant had switched away from a time-of-use tariff because she could not align her household’s usage to the cheap windows, and subsequently found it difficult to find a standard-rate alternative.

A recurring theme was a strong preference for simple, predictable tariff structures over potentially cheaper but more complex alternatives. Some participants who were on standard tariffs had considered time-of-use alternatives and decided against them, citing the additional complexity and the need to monitor timing. One participant described her reasoning as: *“I always like to work things out myself, and it’s just more difficult to work out really”*, noting that the price differential did not appear sufficient to justify the added effort (owner-occupier, previously direct electric). Another, who lived alone and described struggling with apps and digital settings more generally, reflected:

> *“I prefer an on/off switch, but for other people that like messing around with settings, they’re going to love it.”* (owner-occupier, previously gas boiler).

Taken together, this pattern suggests that the potential running cost benefits of time-of-use tariffs were typically not being realised for participants in this sample. Where savings were being achieved, this was most commonly in households with high technical engagement or where the installer had configured tariff and hardware as an integrated package. Where time-of-use tariffs had been adopted without that level of support, there were cases in which the tariff was actively worsening the household’s cost position or imposing lifestyle constraints that the participant described as difficult to sustain.

2.4 System faults and pathways to resolution

Within this sample, system faults[17] were not uncommon and ranged from discrete installation errors that the participant was aware of, to longstanding operational problems that had not been resolved. Reported faults included systems that had lost the ability to heat water to a reliable temperature, systems in which one or more components had failed and not been replaced, hot water cylinders heating repeatedly and with excessive mechanical noise during the night, and a system heating only the hot water cylinder continuously but not the radiators.

Among those whose systems had developed faults, the direct consequences included lost heating and hot water for extended periods, disrupted sleep where the fault produced noise at night, and additional electricity consumption from backup heating or from the system itself operating inefficiently while malfunctioning. The impact of these failures was significant, causing considerable distress particularly among participants with health conditions or caring responsibilities.

The critical issue, as described by participants, was not only that faults had occurred but that there was no consistently effective pathway to resolve them. Participants described being passed between the installer, the heat pump manufacturer, and, for social tenants, the housing association, with no single point of accountability for diagnosis and repair. In some cases, multiple visits from different parties had failed to resolve the problem, with each attributing the fault to a different cause or to another party's responsibility.

Pathways to resolution differed markedly by tenure. **Owner-occupiers in this sample were particularly exposed.** Once an initial warranty period expired, some had limited practical recourse, and the cost of diagnosis and repair fell directly on the household. One owner-occupier discovered that her system had only a 2-year warranty because it had not been installed by engineers employed directly by the manufacturer. When the installation company subsequently went out of business and her system developed a fault, she struggled to find anyone to repair it and was ultimately out of pocket for both a legitimate repair and a sum paid to someone she later identified as a scammer. She described the period without hot water as prolonged and distressing:

"it was so difficult, I was without hot water for 6 weeks because I couldn't find anyone to do it, nobody wanted to touch it… I just felt left high and dry, they never actually said if you need a service contact us, nothing." (owner-occupier, previously electric heating).

The cost of annual servicing was itself a concern for some owner-occupiers, with one participant reporting a figure of £450 per year.

Social housing tenants had a clearer pathway in principle, since housing associations carried an obligation to maintain the heating system, but the effectiveness of that pathway was variable. Some tenants described prompt, organised responses through their housing association's maintenance provider. One participant had built a working relationship

---

[17] System faults were identified through a combination of participants' accounts and, where available, concurrent technical observations during home visits.

with the maintenance company over several years of annual servicing, to the point that she was on familiar terms with the engineers. She described being able to call the housing association helpline and receive *"an instant response within 24 hours"* for routine issues, and that if *"something serious [happens], the engineer comes out immediately on an emergency response."* She was complimentary about the maintenance provider and reflected that renting the property meant she received more assistance than if she had owned it (social tenant, previously electric boiler). Other tenants described repeated visits that did not resolve the underlying problem or long waiting periods during which the system continued to operate with a known fault.

One social housing tenant described how his system had experienced faults that were still unresolved. After he had complained to his Housing Association about higher-than-expected bills, their maintenance team and a manufacturer service engineer had been sent to address suspected installation errors. However, he reported that nobody had been able to fully diagnose and fix the fault. The participant, a retired electronic engineer, reflected on the diffuse accountability he had encountered:

> *"I think there's confusion between the plumbing side of it and the electronic side of it. The [manufacturer] engineer couldn't tell you what because he didn't install it and the plumber can't tell you what because they don't understand the [manufacturer] side of it."* (social tenant, previously storage heaters).

The participant described the home as being comfortable, but he thought that his bills had not reduced compared to their previous storage heaters. The SPF of the system, as reported on the heat pump's controller, was 1.3, by far the lowest observed in the sample.

Faults had material financial consequences. Systems operating with undiagnosed problems sometimes consumed more electricity without delivering adequate heat, with one participant describing the cost of running a faulty heat pump over six months as *"an absolute fortune"*. A further participant was spending in the region of £250 per year on logs for a supplementary wood burner because the heat pump was not heating the property adequately.

2.5 Handover and post-installation support

Handover experiences ranged from comprehensive to non-existent. At the more positive end, some participants described clear, patient explanations, follow-up visits, or ongoing maintenance arrangements through which a knowledgeable engineer returned regularly to check the system and answer questions. More commonly, the information provided at installation fell substantially short of what participants felt they needed, and some described receiving no meaningful handover at all.

Among those who found the handover inadequate, a recurring issue was that it had been rushed, taking place at the end of a long installation day without appropriate time for questions:

> *"it was done so quickly, it was at the end when they were all trying to leave and you were just obliged to say yes that you understood it."* (owner-occupier, previously LPG).

Another participant, a social tenant whose installation had coincided with a difficult period at home, described the experience in similar terms. She reflected that a follow-up visit some weeks later would have been more valuable than attempting to absorb everything on the installation day itself:

> *"it's a whirlwind. You can't wait for them to leave and they're trying to throw so much information you just didn't remember it at all[…]a few weeks after installation, once everything's settled just to see if they're happy with the temperatures, if they need reshowing the temperature gauge."* (social tenant, previously storage heaters).

Where written materials were provided, they were typically the manufacturer's technical manual rather than a user-focused guide:

> *"I did try and read the technical stuff, but some of it passed over my head, it was too technical."* (owner-occupier, previously oil)

Handover quality appeared to vary by tenure, though no tenure group was uniform in its experience. Owner-occupiers in this sample reported the poorest handover experiences, with participants describing the information received as inadequate, rushed or overly technical. One participant described how the commissioning electrician had directed her away from the upstairs controls entirely:

> *"he said, you don't need to bother with any of that upstairs. Here's your controls. Yes, that's it."* (owner-occupier, previously gas boiler).

She also received two manufacturer brochures but no practical guidance on how to operate the system.

Social housing tenants who were present for the installation reported more mixed experiences, from careful explanation through to cases where the installers themselves were reported as not appearing to understand or be able to explain the system. One social tenant, a retired electronic engineer, described the handover at his property as essentially non-existent, with knock-on implications not only for his own use of the system but for less technically confident neighbours:

> *"when the electrician came, they didn't know how to use the controllers, the plumbers also didn't know. The only way I could get to find out is read the information and eventually get the (manufacturer) engineer out to tell me how it works. Which you can imagine for me it's okay as you can tell, I do do that thing. But you can imagine what it's like for a 93 year old lady. As far as she's concerned it's a spaceship. Most people would struggle."* (social tenant, previously storage heaters).

Social housing tenants who had moved into properties with heat pumps already installed received no handover. However, those whose housing association provided an ongoing maintenance arrangement often described this as an effective substitute, with a contracted provider visiting every nine to 12 months to check the system, explain settings and answer questions. These examples suggest that a structured ongoing maintenance relationship can compensate for a poor or absent initial handover.

For participants whose heat pump was installed outside the heating season, the gap between installation and first use meant that any handover information had been forgotten by the time they needed it.

The consequences of inadequate handover were concrete and significant. Participants who had not been given what they perceived to be an adequate handover were, on the whole, more likely to operate the system intermittently and overall less satisfied with the comfort and running costs of their system. This pattern was associated with poorer comfort and satisfaction overall. Inadequate handover also contributed to an ongoing lack of confidence in using and adjusting the system, leaving participants anxious about their heating, with one describing the experience as *"demoralising"* (owner-occupier, previously gas boiler).

Confidence in using the system typically took time to develop, regardless of the quality of the initial handover. One owner-occupier who had received a reasonable handover described her confidence growing over the two years since installation:

> *"…We've had it coming up to 2 years in March and I am more confident now. Was a little bit frightened at the beginning."* (owner-occupier, previously solid fuel).

For some participants, this process of adjustment involved a fundamental shift in how they understood a heating system. One participant who had previously used bottled gas reflected that adjusting had been as much a conceptual change as a practical one:

> *"The radiators are never really hot and that's a mindset thing… as long as the house is warm, it doesn't really matter how hot or cold the radiators are."* (owner-occupier, previously electric methods and bottled gas).

Not all participants arrived at this position, however, and for some the absence of adequate handover left a persistent undercurrent of uncertainty. One owner-occupier reflected that her confidence was limited less by an inability to operate the system than by a continuing doubt about whether she was using it well:

> *"My biggest bug bear is that I don't know if I'm using it properly."* (owner-occupier, previously electric heating).

2.6 Heating behaviours, understanding and control

How participants engaged with their heating systems varied considerably, both in the heating behaviours they adopted across the day and the year, and in the extent to which they understood and used the controls available to them.

The spectrum of heating behaviours

Most participants were at home for most of the day, reflecting the age and retirement profile of the sample. This would in principle suit continuous heating, generally associated with more efficient heat pump operation, but heating patterns varied significantly and did not align neatly with occupancy: some continuously-occupied households heated intermittently, and some who worked outside the home heated continuously. Behaviours fell along a spectrum from fully continuous operation to on-off use in response to immediate need, with most patterns falling somewhere in between. The boundaries between continuous and intermittent were often indistinct and the broad groupings below contain a range of specific control strategies.

Some participants left the heat pump running at a constant temperature and made no routine adjustments beyond seasonal changes. These participants typically described having been advised by their installer to leave the system on and had followed that advice. One social tenant kept his system at a constant 18 degrees and described the heat as *"a very low background heat, it never gets overly hot, it never gets overly cold"* (social tenant, previously electric boiler). Participants who had adopted fully continuous operation consistently reported very high levels of satisfaction and comfort.

Some participants left the system running but made small, regular adjustments, typically reducing the temperature by one to two degrees overnight or increasing it by a degree or two in the evenings for comfort. One household kept the heating at 21 degrees during the day and manually reduced it to 18 or 19 degrees at bedtime, prioritising warmth for children during the day. These participants were generally satisfied and comfortable, though their adjustments were sometimes driven by uncertainty about costs rather than by a clear understanding of how the system would respond.

Some participants had developed more sophisticated approaches, actively managing use against time-of-use tariffs. These participants typically had professional or technical backgrounds and had invested considerable time in understanding the system, programming setpoints around tariff windows and adjusting weather compensation curves. As described in Section 2.3, the level of technical engagement required was exceptional in the sample.

Towards the other end of the spectrum**, some participants used defined schedules with clear on and off periods or manually turned the heating down by 4 degrees or more, meaning that the heat pump was switching off entirely for extended periods.** One participant reduced her thermostat from 17 or 18 degrees during the day to 14 degrees at bedtime, a pattern she described as similar to how she had operated her previous gas boiler. Another used a daily schedule with heating on in the morning, off through the middle of the day, back on in the late afternoon and off again at night (social tenant, previously solid fuel).

Among participants who used large setbacks and expected the system to respond rapidly to temperature increases when they turned the thermostat back up, comfort and satisfaction levels tended to be the lowest. The slow recovery time of a heat pump, compared with a fossil fuel boiler, meant that raising the temperature by several degrees in the morning did not produce the rapid response participants expected. One participant described the system often not reaching 20 degrees until mid-afternoon after an overnight reduction to 15 degrees, and regularly wore multiple layers indoors including 2 coats. Interviewers observed that other factors sometimes contributed, such as thermostatic radiator valves restricting flow to unused rooms, which may have further limited the system's ability to heat the dwelling.

However, large setbacks and scheduled patterns did not universally produce poor outcomes. There were participants using these approaches who reported high satisfaction, typically in smaller, well insulated properties where the thermal envelope maintained reasonable temperatures during off periods. In some such cases, participants were typically not aware of any efficiency penalty that may have been associated with their heating pattern. One participant, a single parent whose system had been set up by the installer to run at flow temperatures up to 55 degrees, on a programmed schedule with heating periods in the morning and evening, described her home as warm and was broadly satisfied. This system had a reported SPF of 2.2, substantially below the level that a well-commissioned system could be expected to achieve. However, this was not something the participant was aware of, and she had not been prompted to investigate strategies for improving the efficiency of the system despite expressing some anxiety about the scale of her pre-payment electricity bills during the winter.

How participants had arrived at their position on this spectrum varied. A number of participants had been advised by their installer to leave the heating on continuously, and had done so, in some cases departing substantially from their previous approach. For these participants, clear advice at handover appeared to be sufficient to prompt a change in behaviour. Others only arrived at continuous operation following independent research, often in response to an initial period of high bills or low comfort prompting them to research advice on how to operate a heat pump efficiently.

Understanding of heating controls

Across the sample, a recurring theme was for participants to have very limited understanding of their heating controls beyond manual adjustment of the temperature set point. Whether the system had been fitted with a third-party room thermostat or was controlled through the heat pump manufacturer’s own interface, participants typically engaged only with the basic temperature setting and did not use any other functionality. In many cases, this was not identified as an issue by participants. However, a lack of understanding of the controls and how to adjust settings was a source of concern for others.

Among the 20 systems observed during home visits, third-party room thermostats were commonly installed as the primary user interface, separate from the heat pump’s own controller. In all cases where a third-party thermostat was present, participants were using only that thermostat and were unaware of the heat pump’s own controller or its settings. However, limited engagement with controls was not confined to systems with third-party thermostats. Among the systems where participants were using the manufacturer’s own controller, engagement was similarly restricted to the temperature set point. Where either type of controller offered additional functionality, such as scheduling, weather compensation settings, flow temperature adjustments and hot water configuration, it was rare for participants to be aware of these features. A common response during technical observations was surprise that these settings existed at all.

Both third-party and manufacturer thermostats typically had scheduling functionality that was not used by participants. Where a schedule had been set, this had typically been programmed by the installer at the point of commissioning. In some cases, the participant was not fully aware of how the schedule was operating. In one case, the system had been programmed by the installer on the heat pump’s own controller, but the participant only used a separate thermostat and was unaware of the programming. In another case, a participant wanted to adjust the schedule on her thermostat but did not understand how to do so, describing the system as *“complicated”* and reflecting that it would be *“so much easier if it was on an app”* (social tenant, previously storage heaters).

A common pattern described by participants was that the installer had advised them not to adjust the controls. This advice was described as reassuring and helpful by some, but left other households feeling anxious that they were unable to make any adjustments.

Confidence in controlling the system varied considerably. Some participants had a set-and-forget approach that worked well for them and described being content not to engage further with the controls provided they were comfortable. Others described feeling unable to use the controls effectively, confused by the interface, or anxious about making changes. For participants whose system was providing adequate warmth, this lack of understanding was not an immediate problem for day-to-day comfort. However, it represented a latent vulnerability: if their circumstances changed, if the system developed a fault, or if they needed to adjust their heating for health reasons, they would not have the knowledge or confidence to respond. One owner-occupier, who had previously heated her home with a gas boiler and had been directed away from the upstairs controls at commissioning (see Section 2.7), found that when the system proved more expensive to run than she had expected she was unable to adjust the settings to bring costs down. She described how the experience had left her feeling distressed:

> *"I didn't feel confident at all, it was demoralising. I consider myself to be quite an intelligent person, but I felt useless. I cried one afternoon to my son. I felt that I'd been duped"* (owner-occupier, previously gas boiler).

She has since developed more confidence through trial and error, learning to plan ahead for the system's slower response, but reflected that this had come at considerable personal cost.

Where participants had developed confidence with their controls, this had typically come through self-directed learning: YouTube, online forums including Facebook groups and Reddit, or trial-and-error experimentation. These tended to be participants with professional or technical backgrounds, or with a strong motivation to understand the system, often prompted by dissatisfaction with its initial performance. One participant spent two months working out how to programme his system after the initial installation left it malfunctioning:

> *"It did take nearly 2 months to get it where we are now"* (social tenant, previously storage heaters).

Another described needing to research online to learn about the controls after her initial lack of confidence: she reflected that she would need to *"watch a video on YouTube to see"* how to adjust them (social tenant, previously storage heaters). These participants were the exception: across the sample, confidence with the controls was largely shaped by the quality of the initial handover, and it was typical that participants had not engaged with any settings beyond the room thermostat.

2.7 System commissioning and technical configuration

Concurrent technical observations at the 20 in-person visits recorded considerable variation in how heat pump systems had been commissioned and configured. This final section of the chapter provides the technical backdrop to the experiences described earlier, setting out the commissioning features with most direct bearing on running costs, efficiency, and how systems behaved in use. The implications of these observations for running costs and efficiency across the wider heat pump population are outlined in Section 3.

Efficiency measurements recorded during home visits were drawn from each system's own inbuilt monitoring data which typically reported heat pump electricity use and heat output. Based on this data, SPFs ranged from 1.3 to 5.8 for the systems in our qualitative sample. Just under half of the recorded system efficiencies were below 3.0. Measurement periods varied depending on each system's monitoring capability, and these figures are therefore indicative of relative performance rather than precise seasonal values.

Third-party thermostats and weather compensation. **Third-party room thermostats were commonly installed as the primary user interface across the systems observed.** Weather compensation, a standard feature that adjusts the heat pump's output in response to external temperature, was commonly confirmed enabled across the systems observed; in some cases it was confirmed not enabled, and in others it could not be reliably determined.

A common control arrangement was for both a third party thermostat to be present and for weather compensation to be enabled. How these two control strategies interacted was not always clear. In some cases, the thermostat appeared to be deliberately set higher than the desired internal temperature by the installer, which would have the effect of allowing the weather compensation to control the flow temperature completely, provided that the weather compensation was well adjusted to the property. In other cases, the weather compensation curve was set at the highest available temperature settings and with weather compensation offset adjustments of several degrees applied, likely resulting in the heat pump operating at high fixed flow temperatures for much of the heating season. In one case, weather compensation had been enabled alongside a schedule for the heat pump to be operational only between 05:00 and 08:00 and 16:00 and 21:00. In this example, the room temperature adjustment setting was enabled (a common control feature that adjusts the weather compensation setting according to the internal room temperature), alongside a high max flow temperature setting of 55°C. In practice this was likely to result in the heat pump operating at the highest flow temperature settings to chase the internal temperature set point during its 'on' period. Therefore, although weather compensation was enabled in most systems, it was clear that some were not calibrated to operate on the most efficient settings.

Water heating set points. Water heating set points observed during home visits were typically around 50°C, with some systems set at 55°C or above. The highest observed set point was 70°C. Higher water set points are associated with lower heat pump efficiency, since the compressor must work harder to reach the target temperature and, above a certain threshold, the system may call on the immersion heater to complete the heating cycle.

Auxiliary immersion heaters left active. On a number of systems, the auxiliary immersion heater was active as part of the hot water cylinder configuration. An immersion heater delivers heat at an effective SPF of 1, so any electricity it draws reduces overall system efficiency proportionally. In at least one of the systems observed, the resident was unaware that the immersion heater had been drawing electricity alongside the heat pump since installation, and it had only been isolated shortly before the visit. In one case, the heat pump was not connected to the cylinder at all and all hot water was provided by the immersion heater.

Thermostatic radiator valves restricting flow. In some properties TRVs were observed to be actively restricting flow to one or more rooms, typically rooms used for storage or perceived as unused. In some cases, participants described closing radiators in unused rooms in response to cost concerns.

One owner-occupier, describing how the heat pump controls had been left unchanged since commissioning, reflected:

> *"the whole lot upstairs is very confusing. There are flashing lights, there are on/off switches. And so on and so forth. I don't know what they're for. [The engineer] has told me not to worry about it."* (owner-occupier, previously gas boiler).

Taken together, these observations indicate that the parameters set at commissioning largely defined the operating characteristics of each system thereafter, since settings were rarely adjusted by participants themselves (Section 2.6). The implications of commissioning quality for running costs and efficiency, across the wider monitored heat pump population, are developed further in Section 3.

3. What determines whether a heat pump transition reduces or increases fuel bills?

This section examines the factors that determine whether a heat pump transition reduces or increases running costs for households at risk of fuel poverty. It draws primarily on secondary analysis of over 1,100 monitored heat pump installations in the UK and on cost modelling undertaken for this project, synthesised with published research and relevant findings from the qualitative interviews with 29 fuel poor households (including technical audits of 20 homes) presented in Section 2.

Chapter summary

1. **The secondary data analysis identified a substantial gap in efficiency between high-performing heat pump systems in the Heat Pump Monitor (HPM) dataset and the lower performing systems in the Electrification of Heat (EoH) trial.** The mean SPF in the HPM data is 3.9 and the mean SPF in the EoH data is 2.8. At current energy prices, the gap between the two is equivalent to several hundred pounds a year in running costs for a typical fuel poor home.
2. **Not all factors influencing performance can be observed in the secondary data and the observable factors do not fully account for the performance gap.** Installation quality factors that may also affect performance, including hydraulic separation, pipe sizing, emitter undersizing, and balancing, cannot be reliably identified from the monitoring data.
3. Of the factors that can be observed in the monitoring data, **the correct commissioning of weather compensation was consistently identified as the factor most strongly associated with high efficiency**. Of 165 Vaillant systems in the EoH dataset, 55% had weather compensation set incorrectly, a configuration associated with cycling and higher-power compressor operation.
4. **Basic third-party on/off thermostats are incompatible with weather compensation because they switch the heat pump on and off in response to room temperature, overriding its modulating logic.** Where such a device is the primary control, non-weather-compensating behaviour is built into the system from the outset. Third-party on/off thermostats were commonly fitted in the systems inspected during the qualitative home visits.
5. **In the HPM dataset, lower weighted flow temperatures are strongly associated with higher efficiency;** the relationship is much weaker in the EoH dataset where the sub optimal commissioning of weather compensation appears to have a stronger bearing on observed efficiency.

6 **The monitoring evidence indicates that a degree of oversizing is still compatible with high performance where the system is otherwise commissioned well.** Conversely, correctly sized systems with poorly commissioned weather compensation tended to perform inefficiently.

7 **Hot water cylinder specification and commissioning can add £66 per year to running costs in the typical case of a standard cylinder,** and over £162 where the immersion heater cycles frequently.

8 **In the HPM data, property age and insulation level do not appear to constrain heat pump efficiency,** indicating that heat pumps can achieve high efficiency across a range of property types when the system is well-designed, installed and commissioned. However, heat demand may still increase in poorly insulated homes.

9 **The evidence from the monitoring data on whether continuous or intermittent operation produces lower overall bills is inconclusive,** although the highest-performing systems in the HPM dataset overwhelmingly operate continuously.

10 **A recent, separate controlled study of TRV use found that moderate trimming of internal temperatures reduced space heating energy consumption marginally** without affecting heat pump efficiency. However, more extensive zoning was not tested.

11 **Cost modelling indicates that the combination of solar PV (4 kW), battery storage (10 kWh) and a heat pump-specific time-of-use tariff substantially reduces total household electricity costs across all dwelling archetypes modelled**. These savings are additive to, not a substitute for, those delivered by a high-performing heat pump. In some archetypes with higher heat loss, the package does not fully offset the running cost penalty of a low-performing heat pump. Time-of-use tariffs further reduce energy costs in some cases, but in homes with higher heat demand, where schedules are not optimised to the time-of-use low-cost tariff periods, fuel bills can increase.

3.1 The performance gap in heat pump efficiency

This secondary data analysis draws on two UK monitoring datasets:

- The EoH demonstration trial dataset covers 742 installations delivered through 3 contracted partners between 2020 and 2023.[18]
- The HPM platform dataset covers 383 systems, and predominantly comprises installations delivered by specialist heat pump installers with actively engaged homeowners, some of whom actively work on improving their system.[19]

---

[18] Energy Systems Catapult (2024) ‘Electrification of Heat Demonstration Project: Heat Pump Performance Cleansed Data, 2020–2023’ 2nd Edition. UK Data Service. SN: 9050. Available at: https://doc.ukdataservice.ac.uk/doc/9050/mrdoc/UKDA/UKDA_Study_9050_Information.htm (viewed on 9 March 2026)

[19] Heat Pump Monitor (2025) ‘Open-source real-time monitoring of UK domestic heat pump installations’ [public system data and API]. Available at: https://heatpumpmonitor.org/ (viewed on 9 March 2026)

Published analysis of these datasets by Rosenow, Lea and Boni (2025) established the scale of the performance gap between high-performing and lower-performing systems.[20] **HPM systems achieve a mean SPF of 3.9, while EoH trial systems achieve a mean of 2.8,** i.e on average HPM systems operate at 39% higher efficiency than EoH trial systems.

Analysis of Ofgem data for approximately 1,400 air source heat pump installations reported a mean SPF of approximately 2.7, consistent with the EoH end of this range.[21]

The analysis below investigates the association between specific commissioning, design and behavioural factors and efficiency, with a view to understanding what can be learned for installations in households at risk of fuel poverty. The analysis is made possible by the open-source availability of these monitoring datasets, which allows the impact of different factors on in-situ heat pump performance to be observed empirically across a large population of systems in operation. Two complementary analytical approaches are used;

1. Statistical comparison of efficiency, flow temperature, sizing and operating patterns across the two datasets identifies the strength of association between each factor and observed performance.
2. Visual inspection of operating signatures across the EoH sample, building on the work of Rosenow, Lea and Boni (2025) on a subset of Vaillant systems, allows the absence of weather compensation to be identified directly in the monitoring traces.

Not all factors influencing performance can be observed in the secondary data and the observable factors do not fully account for the performance gap. Installation quality factors including hydraulic separation, pipe sizing, emitter under sizing, balancing, and refrigerant charge cannot be reliably identified from the monitoring data, and the analysis therefore cannot separately quantify their contribution to the performance gap.

Of those factors that can be observed, **the analysis identifies weather compensation as the factor most strongly associated with the performance gap between the two datasets,** with an association considerably stronger than that of any other observable factor examined. Other factors that influence performance to a lesser or more conditional degree, including flow temperature, room thermostat control, hot water settings, and heat pump sizing, are discussed in turn below. Throughout this section, a well-commissioned system is one in which weather compensation is correctly configured and active, the room thermostat (where present) does not **override the heat pump's internal controls, flow temperatures are set at levels appropriate to the radiator sizing, and hot water settings are optimised for efficient operation.**

---

[20] Rosenow, J., Lea, T. and Boni, G. (2025) ‘Bridging the efficiency divide: open-source insights into UK heat pump performance gaps’, Energy and Buildings 2025: volume 352, article 116785. Available at: https://www.sciencedirect.com/science/article/pii/S0378778825015154 (viewed on 9 March 2026)

[21] RB&M Research (2024) ‘In-situ heat pump performance analysis: Analysis of Ofgem Data 2017–2022’. Available at: https://www.recc.org.uk/pdf/rbandm-research-project.pdf (viewed on 9 March 2026)

3.2 Weather compensation

Weather compensation is a built-in feature of modern heat pumps that adjusts the temperature of the water sent to the radiators (the "flow temperature") according to the temperature outside. In mild weather, the radiators are supplied with cooler water; in cold weather, with hotter water. When weather compensation is missing, switched off, or set up incorrectly, the heat pump instead aims for the same flow temperature whatever the conditions outside, and this is typically set high enough to cover the coldest days of the year.

A fixed flow temperature reduces efficiency through two distinct mechanisms:

Firstly, the wider the difference between the outside temperature and required flow temperature, the more electricity the system uses for each unit of heat delivered. When a system runs at a fixed flow temperature set high enough for the coldest days, it spends most of the heating season producing water hotter than the building actually needs, using more electricity to lift the water further than necessary.

Secondly, the compressor within the heat pump, which is the component responsible for the majority of the heat pump’s power use, is designed to run at variable speeds rather than simply switching on and off. The compressor runs most efficiently when running continuously at a low, steady speed. The compressor's speed is controlled by the difference between the current flow temperature and the target flow temperature. When weather compensation is set up correctly, the target flow temperature is continuously adjusted, enabling the compressor to settle into a pattern of efficient low-output. Without weather compensation, the target is set well above what is needed: the compressor runs at high output to reach it. The heat pump then cycles off and back on rather than holding a steady state. The system spends more of its running time at the high-output end of the compressor's range, and also incurs additional losses each time it restarts.

Correctly commissioned weather compensation addresses both effects together. By keeping the flow temperature no higher than the building actually requires, it minimises the temperature lift the compressor has to provide. By continuously matching the target to demand, it also allows the compressor to settle into steady, low-output running, which is where it operates most efficiently.

Published analysis of a 165-system Vaillant subset of the EoH dataset by Rosenow, Lea and Boni (2025) found that approximately 55% of these systems had weather compensation set incorrectly.[22] Vaillant systems with correctly set weather compensation in this subset achieved a mean SPF of 3.30, compared with 2.69 for systems with incorrect settings.[23] Figure 1

---

[22] Rosenow, J., Lea, T. and Boni, G. (2025) ‘Bridging the efficiency divide: open-source insights into UK heat pump performance gaps’, Energy and Buildings 2025: volume 352, article 116785. Available at: https://www.sciencedirect.com/science/article/pii/S0378778825015154 (viewed on 9 March 2026)

[23] These figures represent the SPF difference between two sub-populations within the Vaillant subset, defined by their visible operating signature. The two sub-populations may also differ in other installation quality factors that the monitoring data cannot separately identify, so the differential should be read as the gap between two clusters of installation outcomes that weather compensation most directly indexes, rather than as a clean isolation of weather compensation alone.

displays differences in the distribution of flow temperatures across the full HPM and EoH datasets that are consistent with the HPM data containing a higher prevalence of systems with well commissioned weather compensation than the EoH data. HPM systems cluster in a narrow, low-temperature band of approximately 26 to 40°C, consistent with correctly functioning weather compensation. EoH systems are spread across a much wider range, with a substantial proportion operating at higher fixed temperatures.

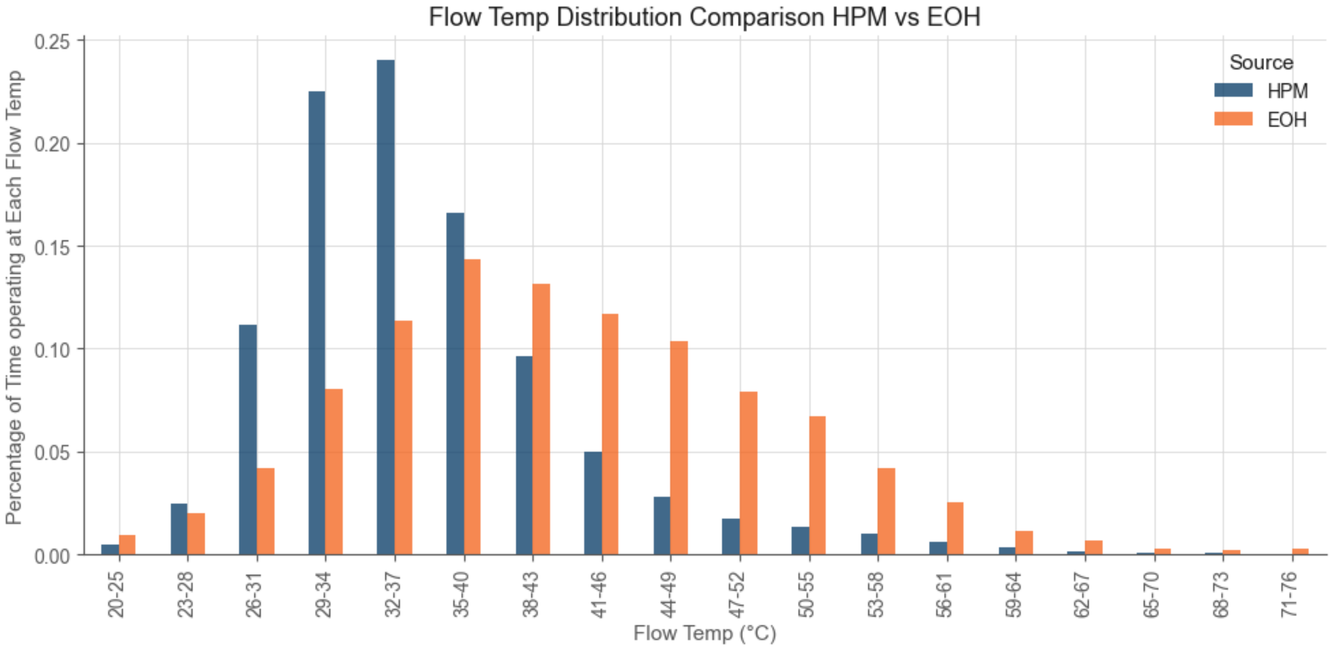

Figure 1: ***Distribution of flow temperatures across both datasets.***

Alt text for Figure 1: Bar chart showing the proportion of operating time spent at each flow temperature band, from 20–25°C up to 71–76°C. HPM systems are tightly clustered between 26 and 40°C, peaking in the 32–37°C band where they spend roughly a quarter of their operating time. EoH systems are distributed much more broadly, with notable proportions of operating time at flow temperatures of 38°C and above and a long tail extending past 60°C.

Where weather compensation is not functioning effectively, the heat pump tends to cycle on and off (the mechanism is described in the next subsection). Figure 2 shows the population-level signature this mechanism predicts. Plotting the proportion of operating time spent at different levels of electrical draw, HPM systems spend most of their operating time at lower power draws, concentrated around 500 to 700W, consistent with sustained low-speed modulation. EoH systems are spread more broadly, with a notable secondary peak around 3,000 to 3,500W, indicating that their compressors spend a higher proportion of operating time at higher, less efficient speeds. This is the empirical correlate of the modulation defeat described above: where weather compensation is absent, the compressor operates predominantly at the high-output end of its range rather than in the stable low-output band where efficiency is highest.

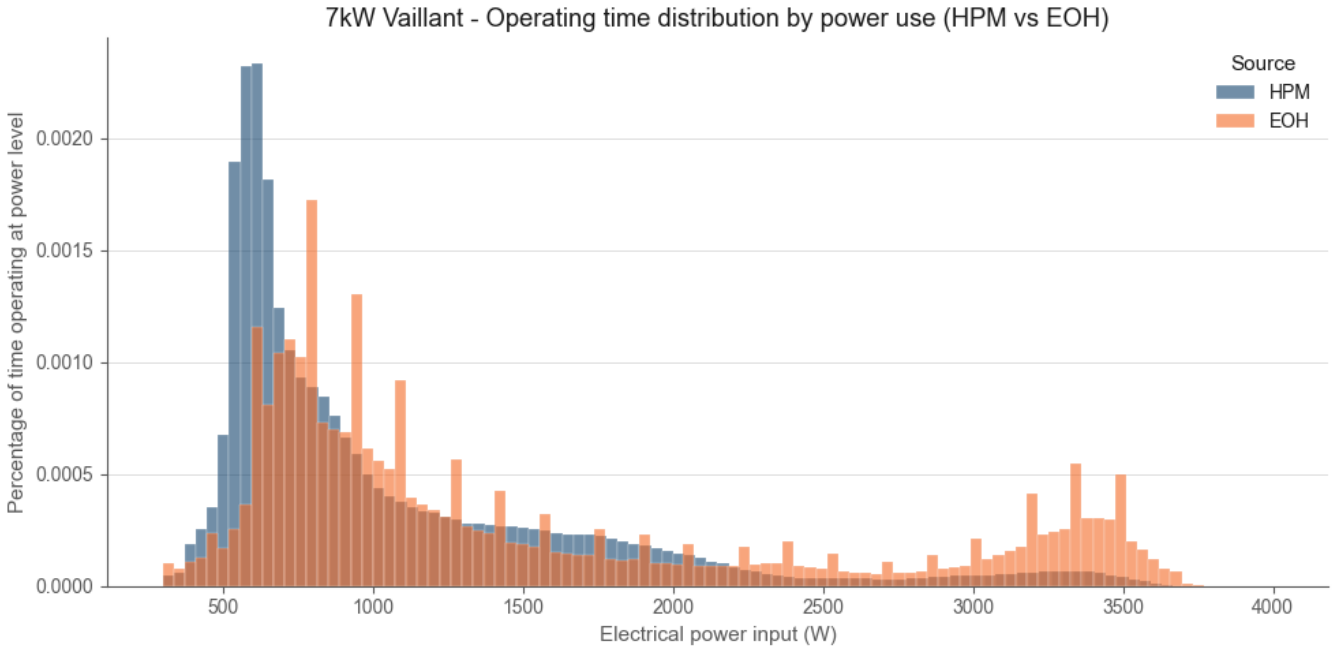

Figure 2: ***Compressor power distribution for 7kW Vaillant systems.***

Alt text for Figure 2: Histogram of compressor electrical power draw for 7kW Vaillant systems in both datasets. HPM systems spend most of their operating time at low power draws of around 500 to 700W, consistent with sustained low-speed modulation. EoH systems are distributed more widely, with a clear secondary peak between 3,000 and 3,500W, indicating that their compressors operate at high-output, less efficient speeds for a meaningful share of the time.

3.3 Non-modulating thermostats and control logic

The cycling pattern described above can arise in two ways, both of which reflect the same underlying commissioning issue. The first is where the heat pump is fitted with its own manufacturer-supplied room thermostat and weather compensation is disabled or incorrectly configured: the heat pump targets a fixed flow temperature and the room thermostat switches it on and off in response to room temperature. The second is where a third-party on/off thermostat is used as the primary control device. Basic on/off thermostats, including devices commonly marketed as ‘smart’ thermostats when operating in their default on/off mode, switch the heat pump on and off based on room temperature alone, regardless of the weather compensation settings on the heat pump itself. The presence of a third-party on/off device as the primary control is therefore both a cause of the cycling pattern and a symptom of a system not set up to run effectively on weather compensation.

A separate category of modulating third-party controllers that can automatically optimise weather compensation settings (including products such as Homely, Havenwise and Passiv) communicate with the heat pump’s internal control logic and can operate alongside, or in place of, the manufacturer’s own weather compensation. These are not subject to the issue described above.

The evidence base on the prevalence of third-party on/off thermostats in the wider EoH dataset is limited, and has not been systematically quantified in any published source identified in the evidence review. From the technical home visits conducted for the qualitative strand of this research (Section 2), third-party thermostats were commonly present across the 20 systems inspected, and participants were consistently unaware of weather compensation settings or how they might be adjusted. The qualitative sample is small and not representative of the wider installed base, but the findings indicate that where these issues are present, they are unlikely to be identified or corrected by the household without external intervention. Cycling produced by any of the mechanisms described here can still deliver stable room temperatures, which means that the household has no obvious signal the system is operating inefficiently.

Where a third-party on/off thermostat is the primary control, correcting the system’s performance involves more than adjusting the heat pump’s own settings. It requires either removing the third-party device, replacing it with a modulating controller, or configuring it in a way that allows the heat pump’s weather compensation logic to operate, for example by setting the room temperature target high enough that the thermostat effectively remains in the ‘on’ state.

3.4 Hot water settings and equipment

Hot water can represent a significant proportion of total heating costs, particularly in smaller or better-insulated homes where hot water accounts for a higher share of total heat demand. Analysis of the monitoring data undertaken for this project found substantial variation in hot water efficiency by cylinder and commissioning configuration (see Table 1).

Table 1: Annual hot water costs by configuration (Source: Analysis of different hot water cylinder configurations and commissioning settings in the EOH and HPM data.)

Configuration	Coefficient of Performance (COP)	Annual cost	Additional cost over optimal configuration
Optimised cylinder, 45°C tank	4.5	£108	–
Standard heat pump hot water (50°C)	2.8	£173	+£66
Heat pump with immersion cycling	1.8	£270	+£162
Immersion only	1.0	£486	+£378

An optimised cylinder designed for heat pump use allows the heat pump to heat water at lower temperatures and higher efficiency. Standard or retained cylinders require higher flow temperatures and produce lower efficiency. The difference between the optimised cylinder vs a heat pump with immersion cycling is over £160 per year. The optimised case (COP 4.5) reflects the top of the range observed in the HPM data rather than typical performance

3.5 Flow temperatures

The temperature of the water circulating from the heat pump to the radiators is known as the flow temperature. The weighted average flow temperature is the average flow temperature the system operates at, weighted according to the amount of heat delivered at each temperature. In well-commissioned systems, lower weighted flow temperatures are strongly associated with higher efficiency. Rosenow, Lea and Boni (2025) report a statistical correlation between weighted flow temperature (minus outside air temperature) and SPF in the HPM dataset of $R^2 = 0.55$, meaning that roughly half of the difference in annual efficiency between HPM systems can be attributed to this single factor.[24] HPM systems achieving SPFs of 4.0 or above had average flow temperatures of approximately 37°C on the coldest days of the year.

Figure 3 shows this relationship across both datasets. In the HPM data, the relationship between flow temperatures and efficiency is clear. In the EoH data the relationship between flow temperature and efficiency is present but much weaker, consistent with the weather compensation commissioning factors discussed in the previous subsection appearing to have a stronger bearing on observed efficiency. Low flow temperatures do not appear to be sufficient on their own for high efficiency: a system can operate at a nominally low weighted flow temperature and still perform poorly where weather compensation commissioning issues are also present.

---

[24] Rosenow, J., Lea, T. and Boni, G. (2025) ‘Bridging the efficiency divide: open-source insights into UK heat pump performance gaps’, Energy and Buildings 2025: volume 352, article 116785. Available at: https://www.sciencedirect.com/science/article/pii/S0378778825015154 (viewed on 9 March 2026)

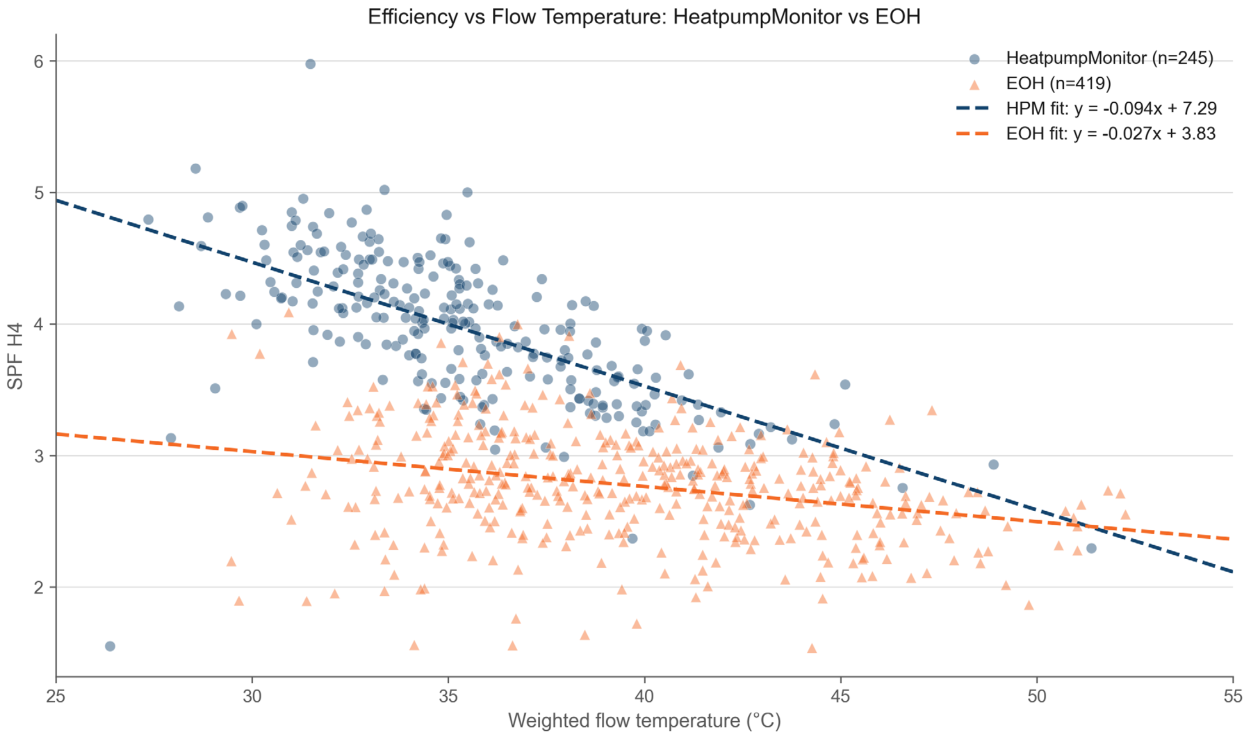

Figure 3: ***Heat pump efficiency by weighted flow temperature across both datasets. Source: project analysis.***

> **Alt text for Figure 3:** Scatter plot of SPF H4 against weighted flow temperature, with linear regression lines fitted to each dataset. In the HPM data the relationship is steep and clear. In the EoH data the relationship is present but considerably weaker. EoH systems operating at low flow temperatures of 30 to 35°C cluster around SPF 2.5 to 3.5, well below the HPM trend line at the same temperatures.

The flow temperature a system can practically operate at depends on radiator sizing: larger, higher-output radiators can deliver the required heat at lower flow temperatures. Technical observations during the 20 home visits conducted for the qualitative strand of this research (Section 2) found that radiators had been upgraded to larger, high-output models across the systems inspected, suggesting that undersized radiators were unlikely to be the limiting factor in the systems in the sample. The sample was small and purposively selected, and is not generalisable to wider populations.

3.6 Heat pump sizing

Oversizing refers to situations where the rated heat output of the heat pump substantially exceeds the peak heat demand of the dwelling, and it can contribute to the cycling pattern discussed above.

The project analysis compared oversizing across the two datasets (**Table 2**). In the EoH dataset, the mean oversizing factor is 2.26, with 54% of systems rated at more than twice the inferred peak heat loss of the property. In the HPM dataset, the mean oversizing factor is 1.52, with 14% of systems exceeding this threshold.

Table 2: Heat pump oversizing in the EoH and HPM datasets

Metric	EoH (n=424)	HPM (n=207)
Mean oversizing factor	2.26×	1.52×
Median oversizing factor	2.07×	1.42×
% systems >2× oversized	54%	14%

The oversizing factor is calculated as the ratio of rated capacity to inferred peak heat loss, derived from a regression of daily heat output against mean external temperature in the monitored datasets. Because many EoH systems operate intermittently and do not heat overnight, their inferred heat loss figures are likely to be understated, inflating the calculated oversizing factor relative to continuous operation. Inferred heat loss calculated for a home heated intermittently would under-represent what the system would need to deliver if the dwelling were held at a stable internal temperature. HPM systems predominantly operate continuously, so the HPM oversizing figures are likely to be closer to the actual oversizing factors. There is, therefore, a degree of uncertainty in the sizing analysis.

Table 3 shows that the efficiency penalty associated with oversized systems is modest compared with the overall efficiency gap between the two datasets. The HPM oversizing bands consistently outperform the EoH bands at every level: the lowest-performing HPM oversizing band (systems oversized by 2 to 2.5 times, mean SPF 3.38) still exceeds the highest performing EoH band.

Table 3: System efficiency by heat pump over-sizing band

Oversizing Band	EoH system count	EoH Mean SPF	HPM system count	HPM Mean SPF
<1.5×	61	2.91	117	3.99
1.5–2×	133	2.96	62	3.90
2–2.5×	110	2.80	16	3.38
2.5–3×	48	2.71	10	3.76
3–4×	49	2.54	2	3.48
>4×	23	2.48	—	—

The UK’s current Microgeneration Certification Scheme (MCS) design standard (MIS 3005-D) requires that a heat pump be sized to deliver at least 100% of the property’s calculated heat loss.[25] Emerging evidence from the HPM data suggests that heat pumps sized at approximately 1.3 to 1.5 times the calculated peak heat loss deliver the highest efficiencies.[26]

3.7 Property age and insulation

Under the Low Income Low Energy Efficiency (LILEE) definition, a household can only be classed as fuel poor if it lives in a property with an energy efficiency rating of band D or below; therefore, all fuel poor households are in EPC bands D–G. Across the wider housing stock, these EPC bands tend to include a high proportion of older properties and properties with lower levels of insulation.

The project analysis examined HPM systems with at least one full year of monitoring data, broken down by property age and self-reported insulation level (Table 4 and Table 5). Property characteristics are self-reported by HPM users rather than independently verified.

Table 4: Heat pump efficiency by property age (HPM data, ≥1 year monitoring)

Property age	n	Mean SPF	Median SPF
Pre-1900	26	3.97	4.04
1900–1939	55	3.92	3.99
1940–1982	73	3.91	3.93
1983–2011	55	3.91	3.93
2012 or newer	37	3.80	3.72

Table 5: Heat pump efficiency by insulation level (HPM data)

Insulation level	n	Mean SPF	Median SPF
Solid walls (uninsulated)	22	4.00	4.01
Some insulation	72	3.92	3.96
Fully insulated	99	3.91	3.86

The data show no meaningful relationship between efficiency and property age or insulation level in this sample. Older homes with solid walls achieve similar or slightly higher mean SPFs

---

[25] MCS (2025) 'MIS 3005-D: Heat Pump Design Standard', Version 3.0. Available at: https://mcscertified.com/wp-content/uploads/2025/12/MIS-3005-D-The-Heat-Pump-Design-Standard-V3.0-Final.pdf (viewed on 15 April 2026)

[26] Lea, T. and Hudson, G. (2024) 'Analysis of Electrification of Heat trial data', Open Energy Monitor. Available at: https://docs.openenergymonitor.org/heatpumpmonitor/eoh.html (viewed on 9 March 2026)

than modern, well-insulated homes. Taken together with the findings on flow temperature and commissioning above, this is consistent with system design (radiator sizing, flow temperature, weather compensation configuration) being the more immediate constraint on efficiency where the system is otherwise well-commissioned.

The HPM analysis cannot test whether property fabric affects efficiency where commissioning is compromised. Insulation nonetheless reduces total heat demand and therefore total bills, and the absolute financial exposure to any given heat pump efficiency level is greatest in homes with the highest heat loss.

3.8 Heating patterns and behaviours

This analysis sought to understand how heating patterns, household behaviours and control strategies affect heat pump performance. Specifically, we sought to understand the impact of running heat pump systems continuously vs intermittently, and whether to heat all rooms or only those in use. Both bear on running costs, both bear on guidance for fuel poor households, and both share a common tension that practices that reduce demand may have a negative impact on heat pump efficiency. Practices that have historically reduced fuel poor households' bills (turning heating off at night, heating only occupied rooms, and accepting lower setpoints) interact differently with heat pump operation than they did with gas, oil or electric systems. Some remain compatible with efficient operation; others may impose efficiency penalties that reduce or eliminate the demand savings they generate. The qualitative research for this project (Section 2) found that intermittent and partial heating were common among the 29 participants.

Continuous versus intermittent operation

Heat pumps are generally advised to be operated continuously or near-continuously during the heating season, both to maintain efficiency and because their lower peak power output compared with a gas boiler means they may struggle to recover internal temperatures quickly after cooling. The HPM dataset supports this position: the highest-performing systems (SPF above 4.0) overwhelmingly operate on continuous or near-continuous schedules, with mean daily operating hours of over 16 hours during the heating season. Rosenow, Lea and Boni (2025) similarly recommend, based on this data, that setbacks in heating schedules be minimised.[27]

The evidence from the EoH dataset is less clear. The project analysis found that systems classified as intermittent achieved a marginally higher mean winter COP (3.04) than systems classified as continuous (2.95). This finding is most likely confounded by the commissioning issues discussed earlier in this section. A direct comparison of continuous and intermittent operation in well-commissioned systems is not possible from the available data, because HPM systems are predominantly operated continuously.

---

[27] Rosenow, J., Lea, T. and Boni, G. (2025) 'Bridging the efficiency divide: open-source insights into UK heat pump performance gaps', Energy and Buildings 2025: volume 352, article 116785. Available at: https://www.sciencedirect.com/science/article/pii/S0378778825015154 (viewed on 9 March 2026)

Whole-house versus partial heating

A controlled study at the University of Salford Energy House, commissioned by heating controls manufacturers (BEAMA, 2026),[28] found that moderate trimming of internal temperatures using TRVs reduced space heating energy consumption by six to eight per cent without significantly affecting the coefficient of performance of the heat pump. This applied to both traditional and smart TRV variants. The study also found that using smart TRVs on all radiators to impose a whole-house setback significantly increased heat pump cycling; the authors conclude that a whole-house setback is better achieved through the heat pump controller rather than through zone-level devices. The study was not designed to test fuel poverty scenarios specifically.

For more extensive zoning, an unquantified mechanism applies. Where multiple rooms are heated only occasionally and radiator valves are closed for extended periods, the total volume of water circulating through the system decreases, and the heat pump may cycle on and off more frequently as a result. The available EoH data does not allow this effect to be quantified because it does not include the required flow rate data.

The implications for guidance are that moderate trimming with TRVs does not appear to compromise heat pump efficiency in a well-commissioned system, and that whole-house setbacks should be programmed through the heat pump controller rather than through TRVs on all radiators. The effects of more extensive zoning, of the kind reported by some qualitative participants who closed off rooms for extended periods, remain a research gap. These operating practices also matter for the bills question addressed in the next section, because they shape both heat pump efficiency and total heat demand after the transition.

3.9 Other factors not visible in the monitoring data

No single factor fully accounts for the performance gap. Figure 4 plots EoH systems against the performance that would be expected, based on HPM data, at the same flow temperatures. If flow temperature were the only factor associated with efficiency, EoH systems operating at low flow temperatures would cluster near the HPM reference line. However, the lowest-performing EoH systems operate at flow temperatures in the 30 to 40°C range, where HPM data would predict strong efficiency.

---

[28] BEAMA (2026) ‘Air Source Heat Pump TRV Salford Energy House Test’. London: BEAMA. Available at: https://www.beama.org.uk/resourceLibrary/beama-technical-bulletin---summary-of-beama-air-source-heat-pump-trv-salford-energy-house-test.html (viewed on 29 April 2026)

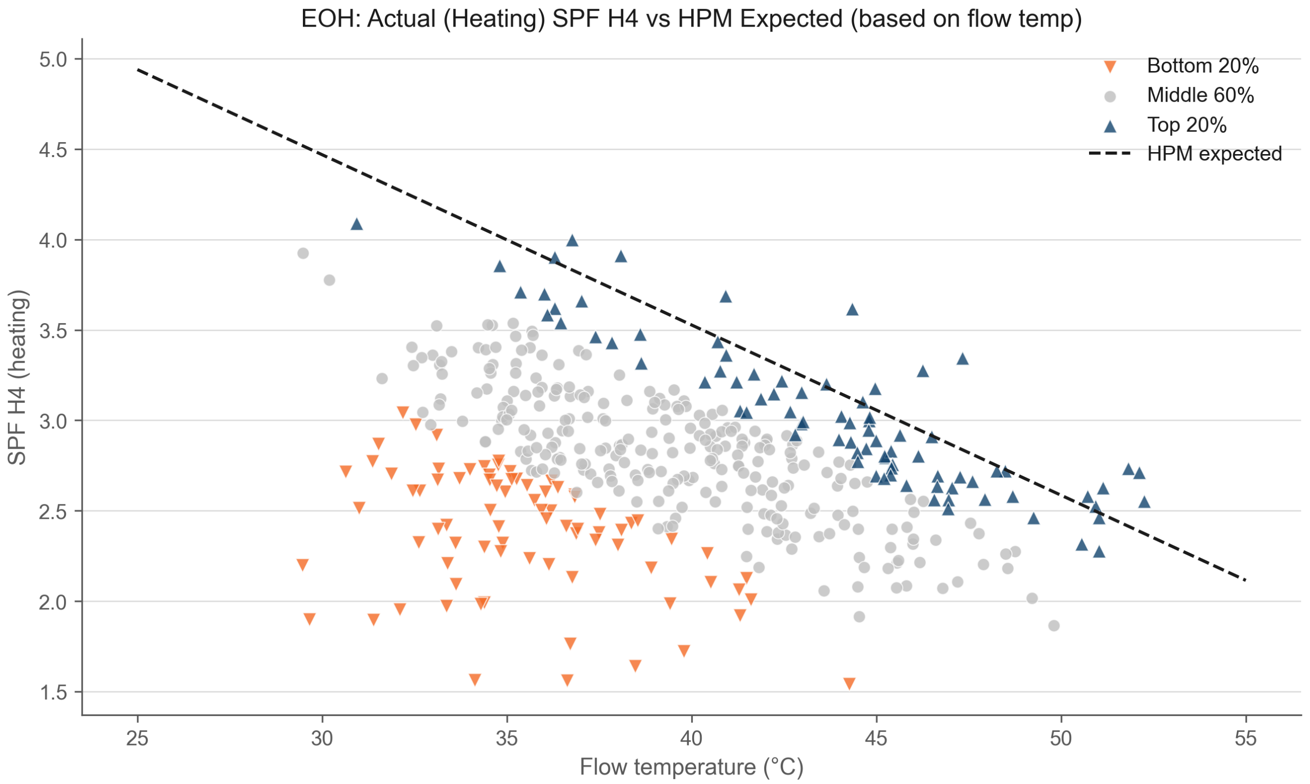

Figure 4: ***EoH system performance compared with HPM expected performance at the same flow temperatures. Source: project analysis.***

> **Alt text for Figure 4:** Scatter plot of EoH systems' actual SPF H4 against their flow temperature, with the SPF that HPM data would predict at the same flow temperature overlaid as a dashed reference line. EoH systems are segmented into bottom 20%, middle 60% and top 20% performance bands. The lowest-performing EoH systems sit predominantly in the 30 to 40°C flow temperature range and well below the HPM reference line: at flow temperatures where HPM systems achieve SPFs of 4 or above, the bottom EoH band records SPFs of approximately 2 to 2.5.

The project analysis found that 36% of EoH systems operate below 40% of their theoretical maximum efficiency, measured as a percentage of the ideal Carnot coefficient of performance,[29] compared with the 45 to 55% of Carnot typically achieved by HPM systems. As noted in the methods, factors such as hydraulic separation, radiator balancing and refrigerant charge are not visible in the data and may also contribute to this pattern.

3.10 Heat pump running costs and the conditions that determine them

Whether a transition to a heat pump reduces or increases a household's fuel bills depends on four interacting factors: the SPF the system achieves in operation, whether the household's

---

[29] The Carnot Efficiency is the theoretical maximum efficiency achievable when the heat pump is operating between a given flow source temperature (e.g. air, ground or water) and sink temperature (heat emitters).

heat demand changes after the transition, the electricity tariff the household is on, and whether complementary measures such as solar PV or battery storage are installed. For fuel poor households, the second of these factors carries particular weight and is the least well-evidenced. This section addresses each factor in turn, then summarises the conditions under which bills are likely to fall, hold steady, or rise.

Static comparison of running costs assuming constant heat demand and standard tariffs

Table 6 compares the total annual fuel cost (heating plus other electricity plus standing charges) of heat pumps at different levels of efficiency alongside other heating systems for the three Ofgem Typical Domestic Consumption Values (TDCVs) used to estimate price cap fuel bills. Table 6 assumes heat demand is held constant when switching between heating systems.[30]

Table 6: Estimated annual fuel costs (heating plus other electricity) for low, medium and high energy use households

Heating system	Efficiency / SPF	Low use	Medium use	High use
Heat pump (HPM upper decile)	SPF 4.7	£987	£1,388	£1,979
Heat pump (HPM mean)	SPF 3.9	£1,056	£1,493	£2,134
Heat pump (gas parity)	SPF 3.3	£1,129	£1,606	£2,301
Gas boiler (condensing)	85%	£1,190	£1,641	£2,302
Heat pump (EoH trial mean)	SPF 2.8	£1,215	£1,736	£2,493
Heating oil	80%	£1,290 to £1,450	£1,852 to £2,097	£2,665 to £3,027
Heat pump (EoH lower decile)	SPF 2.2	£1,368	£1,971	£2,841
Electric storage heaters (Economy 7)	~100%	£1,635	£2,380	£3,446
LPG boiler	80%	£1,649	£2,402	£3,478
Direct electric heating	~100%	£2,226	£3,286	£4,785

Heat demand for each archetype derived from Ofgem Typical Domestic Consumption Values for gas use (7,500 / 11,500 / 17,000 kWh) multiplied by 85% boiler efficiency, giving 6,375 / 9,775 / 14,450 kWh of useful heat. Other

---

[30] The assumption that heat demand will remain the same for different heating fuels and technologies is broadly in line with how fuel poverty is calculated using the modelled heat demand for a property. However, as is discussed in subsequent sections, this assumption may not hold for properties that previously underheated their homes or properties moving from intermittent heating to continuous heating patterns with a heat pump.

(non-heating) electricity included at the Ofgem TDCV figures of 1,800 / 2,700 / 4,100 kWh per year for low / medium / high households. Electricity at 24.67p/kWh and gas at 5.74p/kWh (Ofgem price cap, Q2 2026). Heating oil shown as a range (8 to 10p/kWh) reflecting unregulated market prices. LPG at 12.5p/kWh. Storage heater costs apply an Economy 7 weighted rate of 15.4p/kWh to the heating component; for comparability, other electricity is charged at the single-rate price across all rows. Cost comparisons will differ if a time-of-use tariff is used. Gas boiler efficiency 85%. Oil and LPG boiler efficiency 80%. Standing charges included at Ofgem Q2 2026 levels: electricity 57.21p/day (£209/year) on all rows; gas 29.09p/day (£106/year) on the gas boiler row only. Heat pump and other-fuel rows assume no retained gas connection; households retaining gas for cooking would carry an additional £106/year on those rows.

At the HPM mean SPF of 3.9, heat pump running costs are lower than every other heating system in the table across all three household archetypes. At the EoH trial mean of 2.8, a heat pump is cheaper than direct electric, oil, LPG and electric storage heaters, but more expensive than a mains gas boiler. The absolute cost gap between well-commissioned and poorly commissioned heat pumps widens with home size. A household with a heat pump operating at the HPM upper decile (SPF 4.7) would face annual bills approximately £380 lower in a low-use home, £580 lower in a medium-use home and £860 lower in a high-use home than a household with a system in the EoH lower decile (SPF 2.2).

The potential increase in heat demand after the transition to a heat pump

The modelling methodology underpinning the LILEE fuel poverty calculation assumes a constant level of heat demand for a dwelling, regardless of heating system. This assumption is also used in the analysis in Table 6, i.e. heating demand is assumed to remain constant regardless of heating fuel. However, there is evidence to suggest that this assumption may not hold in many cases where low-income households are transitioning to heat pumps, particularly where their previous heating systems have been relatively expensive to run and where the transition to a heat pump is associated with a shift from intermittent heating to continuous heating.

Empirical analysis by Watson and others (2021)[31] found that homes heated by heat pumps show around 8% higher annual heat demand than gas-heated homes. Simulation modelling by Terry and Galvin (2023)[32] suggests that demand increases of 20% or more can occur following gas-to-heat-pump transitions in high heat loss dwellings. This is explained in the literature by heat pumps tending to be operated more continuously than gas boilers and with smaller setbacks, reducing the periods during which the dwelling cools and thereby increasing overall demand. Our qualitative interviews found evidence of intermittent and partial heating.

In addition to the transition from intermittent to more continuous heating, there is evidence linking heat rationing to increases in energy costs[33] from which we can reasonably infer that

---

[31] Watson, S.D., Lomas, K.J. and Buswell, R.A. (2021) 'How will heat pumps alter national half-hourly heat demands? Empirical modelling based on GB field trials', Energy and Buildings 2021: volume 238, article 110777. Available at: https://doi.org/10.1016/j.enbuild.2021.110777 (viewed on 29 April 2026)

[32] Terry, N. and Galvin, R. (2023) 'How do heat demand and energy consumption change when households transition from gas boilers to heat pumps in the UK', Energy and Buildings 2023: volume 292, article 113183. Available at: https://doi.org/10.1016/j.enbuild.2023.113183 (viewed on 29 April 2026)

[33] Zapata-Webborn, E., Hanmer, C., Oreszczyn, T., Huebner, G., McKenna, E., Few, J., Elam, S., Pullinger, M. and others (2024) 'Winter demand falls as fuel bills rise: Understanding the energy impacts of the cost-of-living

fuel poor households, previously coping with high running costs from expensive previous heating systems, are amongst the most likely to have under-heated their homes in the past. The qualitative research for this project provides direct evidence on this mechanism: significant under-heating was reported under previous heating systems, most notably among households transitioning from the most expensive fuels: electric heating, LPG and solid fuel and these homes now typically heated their home to a comfortable level with the heat pump. For these households, the assumption that demand stays constant when transitioning to a heat pump is least likely to hold. Post-transition demand may be substantially higher than pre-transition demand even before any change in operating pattern.

The implication is that the headline static comparisons in Table 6 may, in some cases, overstate the bill savings actually realised by fuel poor households. Fuel bill savings are most likely to be overstated in the constant demand comparisons for those who previously underheated and now heat adequately and those moving from highly intermittent to highly continuous heating patterns. Although in each of these cases, comfort levels would improve.

3.11 Modelled outcomes for combining heat pumps with solar PV, battery storage and time-of-use tariffs

To understand the impact of solar PV, battery storage and time-of-use tariffs when installed alongside a heat pump, a different modelling approach was required to understand the complex interactions between these technologies and tariffs. Open Energy Monitor’s dynamic heat pump simulator was coupled with the Carbon Trust’s household electricity cost model to estimate annual electricity costs at half-hourly intervals across a range of system configurations. The modelling is structured around three dwelling archetypes based on common characteristics of the fuel poor dwelling stock identified in the DESNZ Fuel Poverty statistics:

- A 4.5 kW semi-detached property with insulated cavity walls, inhabited by a couple with dependent children.
- A 7 kW mid-terrace property with uninsulated solid walls, inhabited by a couple with no dependent children.
- A 10.5 kW detached property with uninsulated cavity walls, inhabited by a retired couple.

These are illustrative cases rather than a representative sample, chosen to explore the range of costs and trade-offs that arise when control strategies, low carbon technologies and tariffs interact with different levels of building performance and energy demand. They do not correspond to the Ofgem low, medium and high cases in Table 6; heat demand and resulting fuel bills are higher than the Ofgem typical values, reflecting the skew of the fuel poor stock toward less efficient dwellings, the assumption of more continuous heat use as system

---

crisis on British households’, Energy and Buildings 2024: volume 305, article 113917. Available at: https://www.sciencedirect.com/science/article/pii/S037877882301099X (viewed on 29 April 2026) efficiency improves (which increased modelled demand by up to 7% in this modelling), and the use of modelled rather than measured consumption.

For Open Energy Monitor's Dynamic heat pump simulator, SPF is derived from the modelled system behaviour, rather than being treated as a fixed input. Each SPF level represents a particular combination of design and operating choices.

Table 7 shows modelled total annual household electricity costs across 3 complementary measures packages: solar PV alone, solar PV plus battery, and the full package adding an Octopus Cosy time-of-use tariff (with no change to demand pattern).[34]

Table 7: Modelled annual household electricity costs by archetype, SPF and complementary measures package

Archetype	SPF	Baseline	+PV	+PV +battery	+PV + battery + time-of-use
Semi-detached (4.5 kW) *Insulated cavity walls* *84m² floor area* *3.5 kWp solar PV* *7 kWh battery*	4.5	£1,494	£822	£629	£491
	3.9	£1,622	£931	£737	£593
	3.3	£1,786	£1,072	£877	£729
	2.8	£1,984	£1,260	£1,039	£944
	2.0	£2,500	£1,728	£1,491	£1,454
Mid-terrace (7 kW) *Uninsulated solid walls* *95m² floor area* *3.5 kWp solar PV* *7 kWh battery*	4.5	£1,981	£1,257	£1,063	£889
	3.9	£2,194	£1,447	£1,255	£1,083
	3.3	£2,448	£1,673	£1,483	£1,322
	2.8	£2,703	£1,924	£1,705	£1,707*
	2.0	£3,474	£2,644	£2,411	£2,558*
Detached (10.5 kW) *Uninsulated cavity walls* *129m² floor area*	4.5	£2,682	£1,655	£1,438	£1,262
	3.9	£3,014	£1,948	£1,736	£1,574
	3.3	£3,265	£2,164	£1,956	£1,813

---

[34] Other tariff structures, including block tariffs (where the per-unit price rises in steps as consumption increases) and alternative time-of-use tariffs, may produce different outcomes for heat pump running costs. The modelling presented here is restricted to the leading heat pump-specific time-of-use tariff currently on the UK market; it is not a general statement about what can be achieved under all tariff structures.

Archetype	SPF	Baseline	+PV	+PV +battery	+PV + battery + time-of-use
5.3 kWp solar PV *7 kWh battery*	2.8	£3,766	£2,658	£2,415	£2,574*
	2.0	£4,922	£3,727	£3,473	£3,896*

*Modelled total household electricity costs at the Ofgem Q2 2026 price cap (electricity 24.67p/kWh standard tariff; time-of-use rates per Octopus Cosy). Figures include solar PV export earnings at 5p/kWh. Excludes standing charges. * indicates cells where adding the time-of-use tariff to PV plus battery increases modelled costs. The simulator assumes households do not shift their heating schedule to align with the tariff's cheaper off-peak periods, so a portion of heating electricity falls within higher-rate tariffs windows.*

Full methodological notes for this analysis are provided in the Technical Annex.

Two observations follow.

- First, heat pump performance is the dominant driver of running costs within each dwelling archetype, and complementary measures do not substitute for it. The difference between SPF 3.9 and SPF 2.0 is around £900 per year for the semi-detached archetype, around £1,300 for the mid-terrace, and around £1,900 for the detached. In every archetype, the lowest running costs are achieved through the combination of a high-performing heat pump and the full package of complementary measures, and in the two poorer-fabric archetypes the cost penalty associated with low SPF is too large to be offset by the fixed package of measures alone.
- Second, the value of a time-of-use tariff is conditional on both system performance and operating patterns. In the four cells marked (*) in Table 7, adding the Cosy tariff (a time-of-use tariff available from Octopus Energy) to PV plus battery increases modelled costs because the modelling assumptions did not optimise heating schedules to the Cosy low tariff periods, therefore the simulated household does not shift a sufficient proportion of its heat demand from peak to off-peak periods.

3.12 Evidence gaps and priorities for further research

The analysis in this section has drawn on the best available evidence to characterise the range of performance and bill outcomes possible under current heat pump installation standards. Several gaps in that evidence base are material to the conclusions drawn, and would benefit from further research to inform guidance to households, installers, and programmes delivering heat pumps to fuel poor households. The gaps fall into two groups.

Monitored performance data on heat pumps installed in fuel poor households is not currently available. The analysis in this section has used the EoH and HPM datasets as the best available evidence on the range of performance possible under current standards, but neither is specifically representative of fuel poverty programme installations. Systematic monitoring of performance and running costs of heat pumps installed under current and future fuel poverty and energy efficiency programmes would allow direct assessment of outcomes for these households.

Controlled comparison of continuous and intermittent operation in well-commissioned heat pumps across a range of property types is not currently available. The existing evidence is limited either to correlational findings in datasets where commissioning is compromised (EoH) or to settings where intermittent operation is rare (HPM). Direct experimental evidence would allow clearer guidance to households on whether continuous operation is required for efficient running, and on the bill implications of different operating patterns.

The effect of extensive zoning on heat pump efficiency is unquantified in the available data. Moderate TRV use has been shown to be compatible with efficient operation in controlled conditions; where more extensive zoning is used, as may be the case in some fuel poor households who close off rooms for extended periods as a cost-management strategy, the effect on efficiency has not been tested.

The interaction between heat pump operating patterns, households' historic partial and intermittent heating strategies, and actual post-transition heat demand has not been characterised in the published literature. This interaction is central to whether bills rise or fall for fuel poor households after transition, and is the strongest single uncertainty in the LILEE assumptions identified by this analysis.

Dataset-wide analysis of third-party thermostat presence in the EoH data has not been undertaken in any published source, and the project analysis did not systematically catalogue this issue across the full dataset. The prevalence of third-party thermostats in installations delivered under fuel poverty programmes is similarly unknown. Both are relevant to the commissioning issues identified earlier in this section, and would inform whether the current EoH performance distribution is likely to be reproduced or improved upon under fuel poverty programme delivery.

4. Recommendations

The recommendations below are directed to the CFP in its role advising government on the effectiveness of fuel poverty policy and challenging government on delivery. They focus on the principal forward-looking instruments for installing heat pumps in low-income households under the Warm Homes Plan: Warm Homes: Social Housing Fund (WH:SHF) and Warm Homes: Local Grant (WH:LG), but are generally applicable to the installation of heat pumps in all homes at risk of fuel poverty. Where relevant, each recommendation highlights how it would interact with the regulatory framework under the Microgeneration Certification Scheme (MCS), which is currently transitioning to a redeveloped scheme (MCS:2025) through 2025 and 2026.

Recommendation 1: Ensure minimum standards of commissioning are met

Of the factors examined in the secondary data analysis, weather compensation showed the clearest relationship with efficiency. Well-commissioned weather compensation was associated with strong performance even where other factors were sub-optimal, while poor commissioning was consistently associated with sub-optimal performance.

In the qualitative sample, third-party on/off thermostats were commonly present across the systems inspected. These devices can override the heat pump’s modulating logic and force inefficient cycling, and in the systems observed appeared in some cases to be in conflict with the weather compensation configured on the heat pump itself. Hot water settings showed a similarly material potential cost penalty: the analysis indicates that poorly configured cylinder settings can add over £160 per year to running costs. Across the systems observed in the qualitative research, parameters consistently remained as the installer had left them at commissioning, and the parameters fixed at commissioning effectively determine the operating characteristics of the system for its lifetime.

Under the current MCS Heat Pump Installation Standard, installers are expected to enable weather compensation where it would improve efficiency, but they are not firmly required to do so: an exception can be documented instead of weather compensation being switched on. Commissioning itself is a mandatory step under MCS, but the standard does not closely prescribe what installers must verify or record at commissioning, and much is left to installer discretion. The compatibility of third-party room thermostats with the heat pump's weather compensation logic is not addressed by MCS.

What the Committee on Fuel Poverty should do

The Committee should press for Warm Homes Plan programmes to specify and verify minimum commissioning standards as scheme-level requirements, going beyond MCS self-certification. As a minimum, scheme requirements should specify that weather compensation is enabled and correctly calibrated; that any room thermostats installed do not operate on a simple on-off basis or otherwise override the heat pump’s modulating logic; and that hot water cylinder settings are optimised for efficient operation.

Recommendation 2: Ensure households are equipped to operate their systems confidently and efficiently

Handover quality was the most consistent area of criticism in the qualitative research. It was commonly rushed, delivered at the end of a long installation day, and supported only by manufacturer technical manuals. Some participants received no meaningful handover at all. Self-directed online learning was the de facto support system, which skewed effective support towards households with technical or professional backgrounds and against digitally excluded households. Where households received structured ongoing support, typically through housing association maintenance arrangements, this often compensated for an inadequate initial handover.

Heating controls were poorly understood across the sample. Participants typically engaged only with the room temperature set point and were unaware of other functionality such as scheduling, weather compensation and flow temperature settings (Section 2.6). Participants who operated their systems continuously, typically on installer advice, consistently reported high comfort and satisfaction, although the secondary data analysis is not conclusive on whether continuous operation is the lowest-cost strategy in all cases (Section 3.8). The combination of limited handover and low understanding of controls means most households cannot make informed adjustments to their systems, and so the parameters set at commissioning effectively determine ongoing performance (Sections 2.6, 2.7).

MCS requires handover documents to include particular content, but does not set requirements for the quality of verbal explanation, the household's actual understanding of the system, or any structured follow-up after the household has lived with the system. The redeveloped MCS:2025 scheme introduces a new Customer Commitment document, which strengthens consumer protection arrangements but does not change the technical handover requirements.

What the Committee on Fuel Poverty should do

The Committee should press for Warm Homes Plan programmes to embed minimum standards for handover and structured post-installation support, sufficient to enable households to operate their systems with confidence and to recognise when something is not working. Provision should include a follow-up touch-point after the household has lived with the system through an initial heating season, with particular attention to digitally excluded households for whom self-directed online learning is not a viable substitute, and to households with health conditions or other vulnerabilities that may require system adjustments. The Committee could also advise on where the MCS handover requirement may need to be strengthened, to address the quality of verbal explanation and household understanding alongside the documentation provided.

Recommendation 3: Monitor and verify heat pump performance as standard

Self-reported satisfaction was primarily driven by comparison with previous, typically very poor, heating systems rather than by an objective assessment of system performance. Satisfaction did not reliably correspond to reasonable levels of system efficiency or to lower bills (Section 2.3). The cost penalty of a system performing at low efficiency falls heavily on a population least equipped to absorb it: a system at SPF 2.8 rather than SPF 3.9 costs approximately £160 to £360 more per year across the Ofgem typical use cases (Section 3.10), and the gap widens further at the lowest-performing end of the observed range. Some participants who had received a funded installation also described feeling reluctant to criticise the system, with the result that satisfaction data on funded installations may further understate performance issues. Satisfaction was therefore not reliable evidence of a successful transition to a heat pump in our sample.

Commissioning issues are typically invisible to the household. Cycling produced by incorrect weather compensation can still deliver stable room temperatures, so the household has no obvious signal that the system is operating inefficiently (Section 3.2).

Under MCS, installers self-certify compliance. Under the redeveloped MCS:2025 framework MCS undertakes site audits of a proportion of installations, but does not monitor in-situ performance.

What the Committee on Fuel Poverty should do

The Committee should press for in-situ performance monitoring to be a standard feature for installations in low-income households funded through the Warm Homes Plan, with verified efficiency data made available to the household, the delivery body and the funding department. Monitoring data should feed into ongoing programme evaluation and into the diagnosis of underperforming systems (see Recommendations 4 and 5). The cost of providing baseline monitoring is small relative to the cost of the installations themselves, and small relative to the running cost penalty of an undiagnosed performance issue persisting for the operational lifetime of the system.

Recommendation 4: Establish minimum performance guarantees against design-stage predictions

Performance monitoring (Recommendation 3) generates the data needed to identify underperformance, but without a defined trigger and consequence, monitoring data alone does not lead to action. A minimum performance guarantee anchored to the design-stage SPF prediction supplies that trigger. The design-stage prediction is the natural reference: it is already produced by the installer as part of MCS compliance and represents the level of performance the installer themselves committed to at specification.

The case for applying a guarantee in low-income households is the stronger one. The financial consequences of underperformance fall on households least able to absorb them, and the evidence in this report shows that fuel poor households are unlikely to identify or correct underperformance themselves (Sections 2.3, 2.6). Households receiving free installations were often left without practical recourse when problems emerged, and owner-occupiers were particularly vulnerable. In the qualitative sample, manufacturer warranties were sometimes as short as two years, and once expired the cost of diagnosis and repair fell directly on the household (Section 2.4).

MCS requires installers to produce a design-stage SPF prediction as part of the pre-sale system performance estimate, but does not require verification of actual in-situ performance against that prediction. Programme-level remediation triggered by underperformance is outside MCS scope altogether, and the redeveloped MCS:2025 scheme does not change this position.

What the Committee on Fuel Poverty should do

The Committee should press for minimum performance guarantees to be specified as a default requirement in installations targeting low-income households, anchored to the design-stage efficiency prediction that installers are required to produce under MCS, with a clearly funded and contracted remediation pathway for systems that fall short (see Recommendation 5). The cost of investigation and remediation should rest with the responsible party rather than the household. The Committee could also advise on where MCS itself may need to be strengthened to require verification of the design-stage prediction in operation.

Recommendation 5: Monitor the effectiveness of reformed remediation arrangements for households at risk of fuel poverty

System faults were common in the qualitative sample, and the critical issue was the absence of a consistently effective pathway to resolution (Section 2.4). Participants described being passed between installer, manufacturer and (for social tenants) housing association, with no single point of accountability for diagnosis or repair. Pathways differed markedly by tenure: owner-occupiers were particularly exposed once warranties expired and faced the full cost of remediation alongside higher fuel bills, in some cases producing significant financial and psychological distress. Social tenants had a clearer pathway in principle, but its effectiveness was variable across the sample.

The financial consequences of unresolved faults were material. Systems with undiagnosed problems sometimes consumed more electricity without delivering adequate heat, placing significant pressure on household finances during the period before resolution. The accountability gap observed in the sample was structural rather than incidental: programme delivery typically ended at handover, with no dedicated mechanism to ensure that subsequent faults were addressed.

The redeveloped MCS:2025 scheme is designed to close much of this gap. Approved financial protection products are now mandatory for every installation, must meet a common MCS standard, and provide at least six years of cover extending to installation defects, design failures and consequential damage, including where the original installer refuses to act or has ceased trading. Complaints are centralised through MCS, and installers are contractually bound to carry out remediation. For households at risk of fuel poverty, who are least able to absorb the financial consequences of a faulty installation, these arrangements are the single most important safeguard against the negative transition this research identifies. They are also new and as yet unproven in practice, and their effectiveness for low-income households specifically has not been demonstrated.

What the Committee on Fuel Poverty should do

The Committee should monitor the effectiveness of the reformed MCS remediation arrangements as they take effect, with particular attention to households at risk of fuel poverty, who are least able to deal with the financial consequences of faulty installations. On the evidence of this research these arrangements are the critical safeguard against a negative transition for this group, and they are new and unproven. The Committee may wish to seek evidence on whether they deliver timely, single-point resolution for low-income households specifically: whether faults are resolved without the household being passed between parties, whether the financial protection responds quickly enough to limit the running-cost burden carried during diagnosis and resolution, and whether the tenure-related differences in access to redress observed in this research persist. Where the arrangements prove insufficient for low-income households, the Committee may wish to advocate for them to be strengthened or supplemented within Warm Homes Plan programmes.

Recommendation 6: Include solar PV and battery storage in installation packages where feasible, until heat pumps consistently reduce fuel bills

At the average performance level observed in the EoH dataset (SPF 2.81), heat pump running costs in the monitoring data exceed those of mains gas (Section 3.10, Table 6), and at the lower end of the observed range they approach those of all but the most expensive previous fuels. For households transitioning from gas, even modest underperformance can eliminate the saving and produce a bill increase. For households transitioning from electric, oil, LPG or solid fuel heating, savings are typically still realised even at lower SPFs.

Cost modelling for this project estimates that adding solar PV and battery storage alongside a heat pump can reduce annual electricity costs by approximately £900 to £1,400 across the illustrative dwelling archetypes modelled (Section 3.11, Table 7). A heat pump-specific time-of-use tariff can deliver further savings on top of this where heating patterns align with the tariff structure, but can increase costs where they do not (Section 3.11; see also Recommendation 7). When installed alongside a well-performing heat pump, complementary measures deliver substantial benefit to households at risk of fuel poverty. When installed alongside a poorly performing heat pump, they offset some, though often not all, of the additional cost from poor heat pump performance: in the larger and less efficient dwelling archetypes that dominate the fuel poor stock, the cost penalty associated with a poorly performing heat pump can exceed the combined annual savings from solar PV and battery storage installed alongside it.

The conditional framing matters. Public funds for tackling fuel poverty are limited, and the most cost-effective long-term intervention is to ensure heat pumps perform consistently well. As performance becomes more reliable, the case for routinely bundling complementary measures becomes correspondingly weaker. In the immediate term, however, the bundling provides a financial buffer against the running cost risk that the wider monitoring evidence indicates is currently present in the installed base. This sits outside MCS scope: it is a matter of programme design.

What the Committee on Fuel Poverty should do

The Committee should press for default inclusion of solar PV and battery storage in Warm Homes Plan packages targeting low-income households, where feasible, until the evidence base demonstrates that heat pumps routinely reduce fuel bills for low-income households. Fabric improvements remain particularly important for larger and less efficient dwellings, where high heat demand compounds the absolute financial impact of any underperformance. The Committee should also encourage government to remain open to revising this position as evidence on consistent heat pump performance accumulates, recognising that the case for bundling weakens as commissioning quality and verified performance improve.

Recommendation 7: Recommend time-of-use tariffs only where households are confident managing them

Engagement with tariff choice in the qualitative sample was limited, with a strong and recurring preference for simple, predictable tariff structures (Section 2.3). Effective use of time-of-use tariffs was confined to households with high technical engagement or installer-configured integrated packages. There were cases in which a tariff was actively worsening the household's cost position, or imposing lifestyle constraints participants described as difficult to sustain.

The cost modelling supports this picture. In four of the modelled scenarios, adding the Octopus Cosy time-of-use tariff to a package of solar PV and battery storage increased modelled costs because the simulated household did not shift a sufficient proportion of its heat demand from peak to off-peak periods (Section 3.11, Table 7). This is a realistic risk for fuel poor households placed on a heat pump-specific tariff without operational support. The withdrawal of OVO Energy's Heat Pump Plus tariff in early 2026, which moved affected customers from approximately 15p/kWh to standard rates of 24 to 30p/kWh, illustrates a separate dimension of risk: tariff dependence transfers to the household the consequences of a future tariff withdrawal.

What the Committee on Fuel Poverty should do
The Committee should press to ensure that time-of-use tariffs are recommended only where the household has expressed clear confidence in managing the more complex arrangement, or where automatic optimisation software or hardware is installed alongside such that the household is not relied upon to align heating patterns with tariff windows. The financial case for heat pump installations in low-income households should be calculated at standard tariff rates, with time-of-use savings treated as upside for the household rather than as a core component of the affordability case for the installation.

Recommendation 8: Address key gaps in the evidence base on heat pump performance and operation in low-income households

Heat pumps are being installed in low-income households at scale without a systematic evidence base on how they perform or what they cost their occupants to run. The EoH and HPM datasets used in this report are the largest available sources of system-level operational data on heat pump performance. Neither these datasets nor the wider RHI in-situ monitoring referenced alongside them is representative of the fuel poor population (Section 3.1). The wide variation in real-world performance evident in those datasets is likely to be reproduced in fuel poverty programme installations unless the recommendations above are acted on, and the resulting cost penalties would fall on those least able to absorb them. Direct monitoring of programme installations would allow the question to be answered for the population the Warm Homes Plan is designed to serve.

Several additional gaps relevant to how low-income households should be advised to operate their heat pumps were identified during the analysis (Section 3.12). The extent to which heat demand increases during a transition from intermittent to continuous heating in fuel poor households is not currently characterised in published research, and is the strongest single uncertainty in the cost modelling underpinning fuel poverty calculations. The performance of well-commissioned heat pumps operated intermittently is not well evidenced, with existing data limited either to correlational findings in datasets where commissioning is compromised (EoH) or to settings where intermittent operation is rare (HPM). The effect of more extensive zoning on heat pump efficiency, of the kind reported by participants who closed off rooms for extended periods as a cost-management strategy, has not been tested in the available data.

What the Committee on Fuel Poverty should do

The Committee could press for a funded audit and study programme to be commissioned alongside the rollout of heat pumps under the Warm Homes Plan, addressing the gaps set out above. This sits within the Committee's remit to monitor the effectiveness of fuel poverty policy and to challenge government on delivery. The findings should be designed to feed back into both programme design (Recommendations 1 to 6) and household operating guidance (Recommendation 2).

Glossary

BEAMA: British Electrotechnical and Allied Manufacturers' Association, the trade association whose 2026 Salford Energy House study is cited in Section 3.8.

Carnot efficiency (or Carnot coefficient of performance): The theoretical maximum efficiency a heat pump can achieve when operating between a given heat source temperature (air, ground or water) and sink temperature (the heat emitters). Used in this report as a benchmark against which observed efficiency is compared.

Coefficient of Performance (COP): The ratio of heat output to electricity input for a heat pump at a given operating point. A COP of 3.0 means 3 kWh of heat delivered per 1 kWh of electricity used. Used in this report for hot water performance (Table 1) and where instantaneous or seasonal-window values are reported.

Committee on Fuel Poverty (CFP): The independent advisory non-departmental public body that advises the UK Government on its strategy to reduce fuel poverty in England, and to whom this report is directed.

Commissioning: The set of activities performed by the installer at handover to configure the heat pump and its controls for the specific property, including setting the weather compensation curve, flow temperatures, hot water settings and control logic.

Compressor modulation: The ability of modern heat pumps to vary compressor speed continuously, rather than only switching fully on or off. Modulating compressors are most efficient when running for extended periods at lower speeds.

Cycling: A pattern of operation in which the heat pump repeatedly switches on and off rather than modulating its output. Cycling is associated with lower seasonal efficiency.

Electrification of Heat (EoH) demonstration project: A government-funded demonstration project that installed and monitored 742 heat pumps across three contracted partners between 2020 and 2023. One of the two primary datasets used in the secondary data analysis.

Energy Company Obligation (ECO): A supplier-funded energy efficiency programme placing obligations on larger energy suppliers to deliver energy efficiency measures to low-income and vulnerable households.

Energy Performance Certificate (EPC): A certificate, required when a property is built, sold or rented, that rates a property's energy efficiency on a scale from A (most efficient) to G (least efficient). Under the LILEE definition of fuel poverty, all fuel poor households are in EPC bands D to G.

Flow temperature: The temperature of the water leaving the heat pump and circulating to the radiators or underfloor heating. Lower flow temperatures are associated with higher heat pump efficiency, provided the radiators are sized appropriately to deliver the required heat at the lower temperature.

Handover: The process by which the installer hands over a newly installed heat pump system to the household, typically including technical documentation, an explanation of the controls and guidance on operation.

Heat demand: The total amount of heat (measured in kWh) required to heat a property to the household's preferred indoor temperature over a heating season. Distinct from electricity demand, which depends on the efficiency with which heat is delivered.

Heat Pump Monitor (HPM): An open-source monitoring platform run on the Open Energy Monitor software, with data self-reported by 383 system owners. The dataset comprises predominantly installations delivered by specialist heat pump installers with actively engaged homeowners. One of the two primary datasets used in the secondary data analysis.

Heating oil: A petroleum-derived liquid fuel (kerosene) used in oil-fired central heating boilers, common in off-gas-grid properties.

Home Upgrade Grant (HUG): A UK Government scheme providing grants to off-gas-grid low-income households for energy efficiency upgrades, including the installation of heat pumps.

Hot water cylinder: The insulated tank that stores hot water for taps, showers and baths. Cylinders designed for heat pump use (typically with larger heat exchanger surface areas) allow water to be heated efficiently at lower flow temperatures.

Immersion heater: An electric resistance heating element inside a hot water cylinder, sometimes used to top up cylinder temperature for hygiene purposes or as a backup. Immersion heating operates at an effective COP of 1, so any electricity it draws reduces overall system efficiency proportionally.

Liquefied Petroleum Gas (LPG): A liquid fossil fuel (typically propane or butane) used for heating in off-gas-grid properties, usually delivered to bulk tanks or bottles on site.

Local Authority Delivery (LAD) scheme: A UK Government scheme delivered through local authorities to provide energy efficiency measures to low-income households in England.

Low Income Low Energy Efficiency (LILEE): The fuel poverty definition used in England since 2021, replacing the previous Low Income High Costs (LIHC) definition. See "Fuel poverty".

Measuring Instruments Directive (MID): European-derived UK legislation governing the accuracy and certification of measuring instruments used for billing and trade. MID-certified meters are required for some statutory metering applications; the SPF readings reported in this study were drawn from manufacturer onboard monitoring rather than MID-certified equipment.

Microgeneration Certification Scheme (MCS): The UK certification scheme for small-scale renewable energy installations, including heat pumps. MCS sets standards for design (MIS 3005-D) and installation, and is the basis for installer certification and government grant eligibility.

Modulating thermostat: A thermostat that communicates with the heat pump's internal control logic to vary the flow temperature continuously, rather than switching the heat pump fully on or off. Modulating third-party controllers referenced in this report include Homely, Havenwise and Passiv.

Non-modulating thermostat (on/off thermostat): A basic thermostat that switches the heat pump fully on or off in response to room temperature. Where used as the primary control device, it can override the heat pump's weather compensation logic and cause inefficient cycling.

Off-gas-grid: A property that is not connected to the mains gas distribution network, and therefore relies on alternative heating fuels such as electricity, oil, LPG or solid fuel.

Open Energy Monitor (OEM): The organisation that operates the Heat Pump Monitor platform and developed the dynamic heat pump simulator used in the cost modelling for this report.

Oversizing factor: In this report, the ratio of a heat pump's rated heat output to the inferred peak heat loss of the dwelling, derived from operational monitoring data rather than from an MCS design heat loss calculation. A factor of 1.5, for example, indicates a heat pump rated at 1.5 times the inferred peak demand of the property.

Photovoltaic (PV): Solar electricity generation, in which sunlight is converted directly to electricity by panels typically mounted on the roof of a property.

Price cap: The maximum unit rate and standing charge that energy suppliers can charge most domestic customers in Great Britain, set quarterly by Ofgem. Cost figures in this report use the Q2 2026 price cap of 24.67p/kWh for electricity and 5.74p/kWh for gas.

Seasonal Coefficient of Performance (SCOP): A standardised theoretical rating of a heat pump's efficiency, calculated in a laboratory and used for product specification. Distinct from in-situ SPF, which is measured in real installations.

Seasonal Performance Factor (SPF): The ratio of heat output to electricity input averaged over a full year of operation in a real installation. An SPF of 4.0 means that for every 1 kWh of electricity consumed, the heat pump delivers 4 kWh of heat. A higher SPF means lower fuel bills for the same level of warmth.

Setback: A reduction in the target room temperature for part of the day, typically overnight. With heat pumps, large setbacks can be associated with reduced efficiency where the system has to work hard to recover from low temperatures.

Smart meter: A meter that measures electricity or gas consumption in near real-time and communicates that data to the energy supplier and (via the in-home display) the household.

Social Housing Decarbonisation Fund (SHDF): A UK Government scheme providing grants to social housing landlords for the retrofit of energy efficiency and low carbon heating measures.

Solar PV: See "Photovoltaic".

Thermal envelope: The insulated outer shell of a building (walls, roof, floor, windows and doors) that separates the heated interior from the outside.

Thermostatic Radiator Valve (TRV): A valve fitted to an individual radiator that controls flow into that radiator based on room temperature, allowing individual rooms to be set to different temperatures.

Time-of-use (ToU) tariff: An electricity tariff under which the unit price varies according to the time of day, with cheaper rates typically available off-peak. Examples referenced in this report include Octopus Cosy, Octopus Intelligent and dedicated heat pump tariffs.

Typical Domestic Consumption Values (TDCVs): Standard estimated annual consumption figures for low, medium and high energy use households, published by Ofgem and used in this report as the basis for the comparative cost analysis in Section 3.10.

Warm Homes: Local Grant (WH:LG): A grant scheme under the Warm Homes Plan, delivered through local authorities, supporting energy efficiency measures and low carbon heating for low-income households.

Warm Homes: Social Housing Fund (WH:SHF): A grant scheme under the Warm Homes Plan supporting energy efficiency measures and low carbon heating in social housing.

Weather compensation: A built-in feature of modern heat pumps that automatically adjusts the flow temperature to the radiators based on outside air temperature: lower when the weather is mild, and higher only when it is cold. Correctly configured weather compensation allows the compressor to run at lower speeds for longer periods, the operating regime associated with the highest efficiencies.

Weighted flow temperature: The average flow temperature at which a system operates, weighted by the amount of heat delivered at each temperature. A more meaningful efficiency indicator than a simple temporal average, since most heat is delivered during the coldest hours of the year.

Zoning: The practice of heating some parts of a property and not others, typically by closing TRVs on radiators in unused rooms. Distinct from moderate "trimming" of individual room temperatures with TRVs, which the BEAMA Salford study found to be compatible with efficient heat pump operation.

This publication is available from: www.gov.uk/desnz

Any enquiries regarding this publication should be sent to the Department for Energy Security and Net Zero.