Mitsubishi Electric White Paper:

Unlocking high temperature heat pump adoption

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Unlocking high temperature heat pump adoption

This paper examines one of the most urgent challenges facing the UK on its path to net zero: how to decarbonise home heating at the scale and pace required to meet legally binding commitments. In its Warm Homes Plan, the government reported that: “As of 2024, building sector direct emissions were responsible for 21% of the UK’s territorial greenhouse gas emissions.”

Much of that is for residential properties that are reliant on gas heating. The Climate Change Committee (CCC) has made clear that large-scale heat pump deployment is essential to achieving the UK’s 2050 net zero target. Yet despite growing momentum, installation rates remain below the government’s ambition.

While the market is expanding, progress is from a low base and significant barriers continue to constrain adoption – particularly in retrofit projects, which will dominate the transition given that four in five homes that will exist in 2050 have already been built.

Homeowners and social housing providers cite high upfront costs, installation disruption, uncertainty over performance, compatibility with existing radiators and pipework, and the electricity-to-gas price disparity as key concerns.

This paper sets out how next-generation high temperature heat pump technology – specifically with R290 refrigerant capable of operating at flow temperatures comparable to gas boilers – can directly address many of these barriers.

By enabling the retention of existing pipework and radiators, these systems can significantly reduce cost, complexity and disruption, unlocking a practical pathway for mass-market retrofit.

However, innovation alone will not deliver the transformation required. Current regulatory frameworks, including Building Regulations, SAP (to be replaced by HEM) and MCS guidance, were developed for earlier generations of low-temperature systems and now risk constraining the deployment of advanced high temperature solutions.

To accelerate adoption, regulatory barriers must be reviewed and updated, and energy pricing structures rebalanced, so that policy enables – rather than inhibits – the transition to low-carbon heating.

Contents

01: The UK's heating challenge

In 2019, the UK government became the first major economy in the world to set an objective of achieving net zero greenhouse gas emissions by 2050 – and to enshrine that goal in law.

The CCC, the independent body established to inform government of progress to net zero and to advise on policy, is pushing hard to keep the UK on track. And changing our heating habits is one of the main pillars of its strategy.

In the CCC's Seventh Carbon Budget, published in February 2025, the Committee set a limit on UK greenhouse gas emissions over the five years from 2038 to 2042. The target is 535 $MtCO_2e$; the government has until June 2026 to respond to that recommendation.

As the CCC notes, it is an ambitious target: "But it is deliverable, provided action is taken rapidly."

The CCC figures show that the UK's provisional territorial greenhouse gas emissions for 2024, including its share of international aviation and shipping, were 413.7 million tonnes of CO_2 equivalent ($MtCO_2e$). And the built environment has a significant footprint. In the 2024 figures, residential buildings accounted for 53.2 $MtCO_2e$ (56.1 $MtCO_2e$ when temperature-adjusted). Non-residential buildings produced 22.4 $MtCO_2e$ (both actual and temperature-adjusted).

Based on the CCC's figures, therefore, buildings accounted for a significant proportion of the UK's total greenhouse gas emissions – and therefore should take a leading role in helping the UK to meet that next CCC carbon budget.

This is no easy task. The CCC is realistic about the speed of change needed, warning that: "The roll-out rates required for the uptake of EVs, heat pumps and renewables are similar to those previously achieved for mass-market roll-outs of mobile phones, refrigerators and internet connections."

The CCC has focused on heat pumps as an alternative to fossil fuel heating such as gas or oil for some time. Back in 2022, the Committee noted[1]: "We cannot reach net zero if we continue to use gas for heat. Changing how we heat our homes and buildings is essential."

The question is, can the UK heating market change at the pace required? In the Warm Homes Plan, published in February 2026, the government set a target of installing **450,000 heat pumps per year by 2030.**

The good news is that heat pump installation numbers are rising.

Figures from the UK Heat Pump Association (HPA) UK[2] show that heat pump sales reached **125,000 units in 2025** – an increase of 27% over the previous year, with a 26% rise of air to water monobloc heat pumps.

However, HPA UK notes:

"Whilst this growth is very positive, the rate of growth has slowed compared to the 56% surge recorded in 2024. To achieve 450,000 heat pumps installed per year by 2030, in line with the target set out in the Warm Homes Plan, the market would need to see 33% compound growth in heat pump sales year on year.[3]"

Whilst the European Heat Pump Association (EHPA)[4] noted that the UK heat pump market was one of only three across the continent to grow in 2024, that growth is from a low base.

Encouraging as these figures are, they are well below what is required to decarbonise domestic heating. The EHPA figures show that UK market is tiny, with only 3.5 heat pumps installed per thousand households. This compares poorly to countries such as Norway (632 heat pumps per 1,000 households) and Finland (524 heat pumps per 1,000 households).

Mitsubishi Electric believes that the technology is already available to meet the UK's heat pump installation target in an efficient and scalable way. Heat pumps are a well-placed, sustainable alternative to gas boilers and address many concerns expressed by householders and social housing providers about switching away from gas.

The introduction of heat pumps that can operate at a high temperature, capable of operating at temperatures comparable to fossil fuel heating systems, can bring the country's heat pump target ever closer. But the industry needs government to assist in the adoption of this solution.

The potential for growth is huge, and the need for low carbon heating solutions is urgent. So, what's holding back the UK's heat pump roll-out?

02: Homeowners and social housing occupants – changing minds

According to a 2025 Energy Security and Net Zero Committee Report to the House of Commons, four in five UK homes that will be occupied in 2050 have already been built[5].

That same report highlights that there are millions of homes in the UK that will need to be retrofitted by 2050 to meet emissions reductions targets. And according to the most recent census data cited in the report, around 74% of households in England and Wales use mains gas central heating.

In a report by the Department of Energy Security and Net Zero (DESNZ)[6] published in December 2025 it points out: "There has been a general upward trend in the number of government -supported installations; in the latest 12 months there was a 19% increase in the number of government-supported heat pumps installed compared to the preceding 12 months (47,507 in the year ending September 2025 compared to 39,777 in the year ending September 2024) and the latest volume is over four and a half times higher than the same period 5 years ago (year ending September 2020)."

Nevertheless, there is a long road ahead. Manufacturers and installers must also be ready to meet the challenge. The 2025 CCC Report to Parliament[7] notes that: "By 2035, the market for low-carbon heating – and its supporting supply chains – needs to scale up to deliver all new and replacement heating installations."

This is the heart, and the scale, of the UK's heat pump challenge – changing how private householders and social housing providers view heat pumps and encouraging them to make the change.

Barriers to heat pump adoption

However, Mitsubishi Electric research shows that there are several perceived barriers to heat pump adoption in both the private and social housing sectors.

Homeowner perceived barriers to heat pumps:

- High upfront cost and installation disruption
- Uncertainty about heat pump performance and instant heat
- Compatibility with existing systems (e.g. radiators)
- Running cost concerns, particularly the current electricity-to-gas price disparity
- Installation time for a heat pump versus a replacement gas boiler

Social housing perceived barriers to heat pumps:

- Pressure to decarbonise at scale, but with tight budgets
- Need for minimal tenant disruption and manageable retrofit cost.
- The importance of system reliability and predictable operating costs
- Tenant concerns about the cost of electricity compared to gas

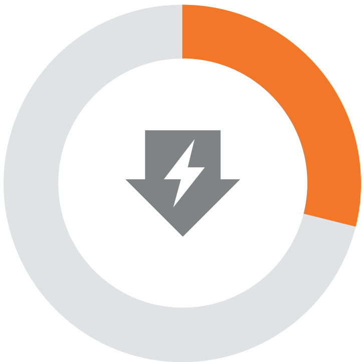
These findings reflect other reports on the residential heat pump market.

A survey by Which? Magazine[8] noted that:

67% of householders said the upfront cost of installing a heat pump was a barrier, either because they were unable or unwilling to pay.

40% said they were unsure whether a heat pump would meet their home's heating needs.

29% had reservations about how much a heat pump would reduce their energy bills.



Social housing providers, i.e. housing associations and local authorities, also face hurdles to implementing heat decarbonisation. Although there are schemes and grants to support this change, there are challenges to delivering against targets.

A 2025 report from the UK Collaborative Centre for Housing Evidence (CaCHE)[9] led by the University of Glasgow, highlights the key issues for this sector. The first of these is financial and funding issues. Despite government financial support, social housing providers face many competing demands for their budgets, particularly rising maintenance costs and major repairs to housing stock.

Although social housing providers are landlords, tenant cooperation is key to making changes to heating systems – heat pumps cannot simply be imposed in occupied homes.

The CaCHE report shows that social housing tenants share the same concerns as other householders when it comes to the ability of heat pumps to provide heating, specifically the loss of 'instant heat' available with gas.

There are also strong objections to the disruption of retrofit which can require tenants to vacate rooms. These issues can lead to high refusal rates among social housing customers.

Changing the minds of the private and social housing sectors needs a new approach – one that addresses the overlapping objections about cost, disruption and performance.

Mitsubishi Electric believes that the new generation of high temperature heat pumps can do exactly that and provide a route to change for the residential heating sector that meets all requirements.

03: New heat pump technology – solving the retrofit challenge

The government has supported the use of air source heat pumps (ASHPs) in homes for many years, as they are a low-carbon, energy efficient alternative to gas boilers. Mitsubishi Electric's factory in Livingston, Scotland, has manufactured and sold over **1.2 million Ecodan heat pumps** since it first started manufacturing them in 2009.

But if we consider the key barriers to achieving higher levels of heat pump adoption, we must address the concerns of householders in the private and social sectors. The gas boiler heating system is familiar, so developing a heat pump that can deliver similar performance is a crucial step in expanding heat pump use in homes.

Some of the biggest barriers to persuading residents to change are installation cost, disruption and time required for the work. Surprisingly, one of the main culprits behind these issues is pipe and radiator sizing in UK homes.

Typically, heat pumps systems are designed to operate with lower water temperatures than gas boilers (35°C to 55°C) as heat pumps operate more efficiently when delivering lower water flow temperatures. In new homes, this is not an issue because they can be designed and built specifically to meet the requirements to optimise lower flow temperatures. But for refurbished homes this can be more challenging, as existing pipework and radiators are unlikely to be able to operate efficiently with these lower temperatures and may require upgrading or replacing causing increased cost, installation time and disruption.

In fact, pipe sizing is a critical aspect of successful ASHP installation. Getting it right can make a significant difference to the system's performance, operating costs and comfort for residents.

Oversized pipes

- Increased installation costs due to larger pipe pipes and fittings
- Reduced heat transfer due to lower flow velocities
- Increased risk of sediment build-up and corrosion due to lower flow velocities
- Increased heat loss and energy consumption due to a larger pipe surface area
- Higher energy bills due to non-optimal system operation

Undersized pipes

- Reduced heat transfer due to higher pressure drop and restriction of water flow rates
- Potential for noise and vibration due to higher flow velocities
- Increased strain and erosion due to higher flow velocities
- Higher energy bills due to non-optimal system operation

Technically, therefore, pipe sizes are critical to delivering good outcomes for heat pump retrofits. The problem is that many UK homes use what's termed as 'microbore' pipework. This is common in houses built in the 1970s and 1980s and according to the Heating and Hot Water Industry Council, is present in around 4 to 5 UK million homes[10].

There has been a long-standing opinion in the residential heating sector that microbore pipework, characterised by pipes with a diameter of less than 15mm, are incompatible with heat pumps, requiring costly and disruptive replacements. But this is not necessarily the case.

Continued research, development and innovation by Mitsubishi Electric into heat pumps has led to a change in the refrigerants used in heat pump products, most critically the evolution from R32 to R290.

R290 has a lower Global Warming Potential (GWP) and is therefore more environmentally friendly. Most importantly, it also unlocks the potential of operating at a much higher temperatures than heat pumps which contain other typically used refrigerants. This addresses the microbore pipework problem and delivers a heat pump that can work successfully with existing residential pipework.

As the name suggests, the Ecodan R290 can operate at temperatures similar to a gas boiler (up to 75ºC) and, crucially it can use the same pipework and radiators as the boiler it's replacing.

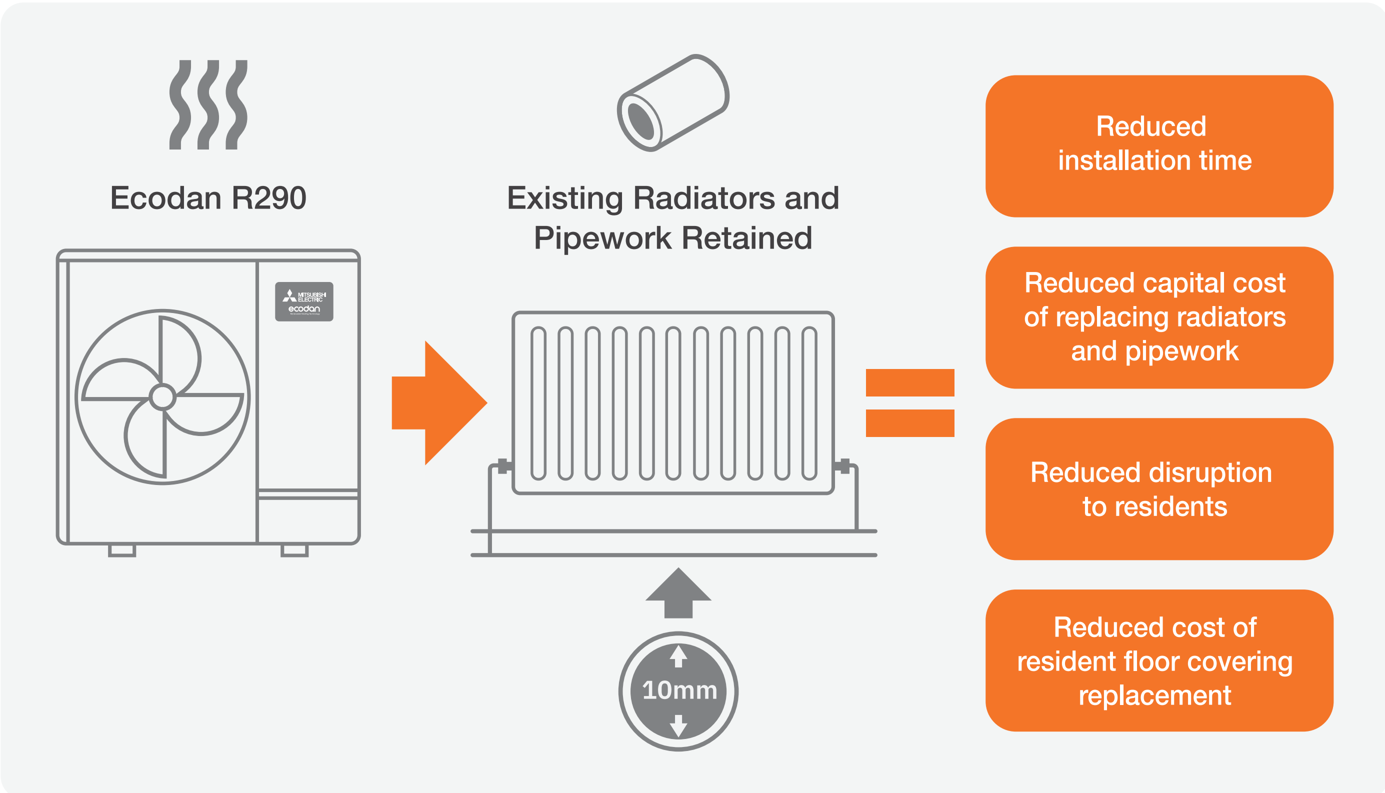
Mitsubishi Electric has tested this approach extensively, using advanced modelling to show that the system works in a range of homes that use microbore pipework.

In addition, Mitsubishi Electric worked with social housing provider, Sovereign Network Group (SNG), which has one of the largest retrofit programmes in the country. It has run a pilot scheme with Mitsubishi Electric to replace boilers in homes with Ecodan R290 heat pumps, using the existing microbore pipework.

The innovative approach has cut installation costs, reduced disruption and opened the opportunity to transform the social housing heating landscape.

Working with Mitsubishi Electric, SNG noted several key benefits, both for itself as a housing provider and for its customers:

- Installation can be reduced to around as little as two days – that's close to 40% quicker than for a low-temperature ASHP system
- Installation savings were reduced by using the existing radiators and pipework (which would have to be replaced for a low-temperature ASHP)
- Improved energy efficiency
- Reduced disruption and a better experience for residents



By examining the barriers to heat pump adoption, Mitsubishi Electric has shaped its technology to meet these challenges head-on. We have also proved the technology by working with one of the largest social housing providers in the UK.

We feel that high temperature heat pumps offer a vital route for growth of heat pump adoption particularly for retrofit projects but there are legislative barriers in the way.

04: What's holding us back? Regulations

In driving heat pump adoption, the UK has established regulations to encourage housebuilders to design for low-temperature residential heating systems. These developments have been useful, but since their introduction several years ago, heat pump technology has moved forward.

As a result, key legislation has effectively been left behind by innovations in heat pump technology. The adoption of low-GWP R290 is a good example, since it lowers the embodied carbon of heat pumps – but its wider adoption in these systems is challenged by current rules.

Three pieces of legislation have the unintended consequence of making it extremely difficult for social housing providers, and installers working with householders on retrofit projects to specify high-temperature heat pumps.

These regulations are Part L of the Building Regulations; the Microgeneration Certification Scheme (MCS); and SAP (the Standard Assessment Procedure). Without government and changes to regulations, they will hinder the roll-out and mass use of the latest high temperature heat pump technology.

Part L of the Building Regulations

Part L (Volume 1) of the Building Regulations covers new and existing dwellings. Its requirements steer designers toward using ASHPs, requiring lower flow temperatures of 55°C or less for space heating systems to ensure energy efficiency.

Section 5: Minimum building services efficiencies and controls – general guidance

1. Requirements for wet heating system flow temperatures

For wet heating systems (such as those using radiators or underfloor heating), the regulation mandates design requirements focusing on a maximum flow temperature:

Maximum Flow Temperature: Where a wet heating system is newly installed or fully replaced in an existing building (including the appliance, emitters, and pipework), all components should be sized to allow the system to operate effectively and meet the dwelling's heating needs at a maximum flow temperature of 55°C or lower.

Exceptions: If it is not feasible to install a system that operates at 55°C (for example, due to insufficient space for larger radiators, or if the system is supplied with higher temperature heat from a low carbon district heat network), the system must still be designed to the lowest design temperature possible that meets the heating needs of the dwelling.

Scope: These low temperature requirements specifically apply to space heating only.

Part L uses a theoretical concept called the 'notional dwelling' to calculate target performance rates for new buildings. The assumed design flow temperatures for this standard specification are:

Standard Notional Dwelling (Mains Gas): The notional dwelling specification assumes a heating system (boiler and radiators) with a design flow temperature at 55°C.

Heat Pump Notional Dwelling: Appendix D, which outlines a good practice specification for a home built with a heat pump, sets the design flow temperature at 45°C for the air source heat pump and radiators.

SAP 10.2 – and beyond

The general principle of the Standard Assessment Procedure is that residential heating systems achieve higher energy efficiency at lower temperatures. SAP 10.2 acknowledges that the thermal efficiency of certain heating appliances, specifically condensing boilers and heat pumps, is significantly higher when they operate at a lower flow temperature. The calculation procedure is designed to account for these efficiency gains in the energy assessment of the dwelling. Section 9 deals with space heating requirements and flow rates.

Standard and design flow rates from Section 9.3.2

Appliance type	Standard design flow temperature (default)	Low flow temperature options for assessment
Condensing boilers (gas, liquid fuel)	70ºC or 80ºC (with a design return temperature of 60ºC)	45ºC and 35ºC for design flow
Heat pumps (wet systems)	58ºC	55ºC, 45ºC and 35ºC
High temperature heat pumps	65ºC	Maximum of 65ºC can be entered

SAP 10.2 states: "The efficiency of condensing boilers and heat pumps is higher when they supply heat at lower temperature. SAP calculations allow for this in the case of a low-temperature heating system." (9.2.10)

And: "Heat pumps operate at higher efficiency with lower flow temperatures." (9.3.2). The SAP methodology, therefore, uses the design flow temperature as a critical variable to assess the heat pump's seasonal performance, effectively providing an efficiency uplift (a "reward") for systems designed and commissioned to run at low temperatures, compared to those running at higher temperatures. In essence, high-temperature heat pumps are accommodated by SAP with their own default operating point (65ºC), but they start the efficiency assessment at a lower calculated performance point than systems designed to run at 55ºC or less, reflecting the opinion that there is an efficiency trade-off associated with generating higher water temperatures. (9.3.1 and 9.3.2)

The government will replace SAP with a new approach: the Home Energy Model (HEM)11. The upcoming SAP 10.3 will act as a stepping stone to the new approach as it is currently being developed. The adoption of HEM will be critical for the wider application of heat pumps in homes, since its calculations take into account a wider spectrum of performance – and a more accurate reflection of modern heat pump technology.

MCS – installation guidance (MCS MIS 3005-D Issue 2.0)

The document steers designers toward lower flow temperatures for efficiency, aligning with the principles of Building Regulations and SAP.

Avoidance of high temperature heat pumps (HTHPs):
The selection of High Temperature Heat Pumps (HTHPs) should be avoided unless the application specifically requires a flow temperature higher than 55ºC. This suggests 55ºC is generally considered the maximum desirable flow temperature for optimal system design. (Section 5.5.3 states: "use of high temperature heat pumps shall be avoided").

Requirement for alternatives: Where a system design proposes a flow temperature greater than 55ºC, the MCS contractor should also provide an alternative design using a flow temperature of 55ºC or lower.

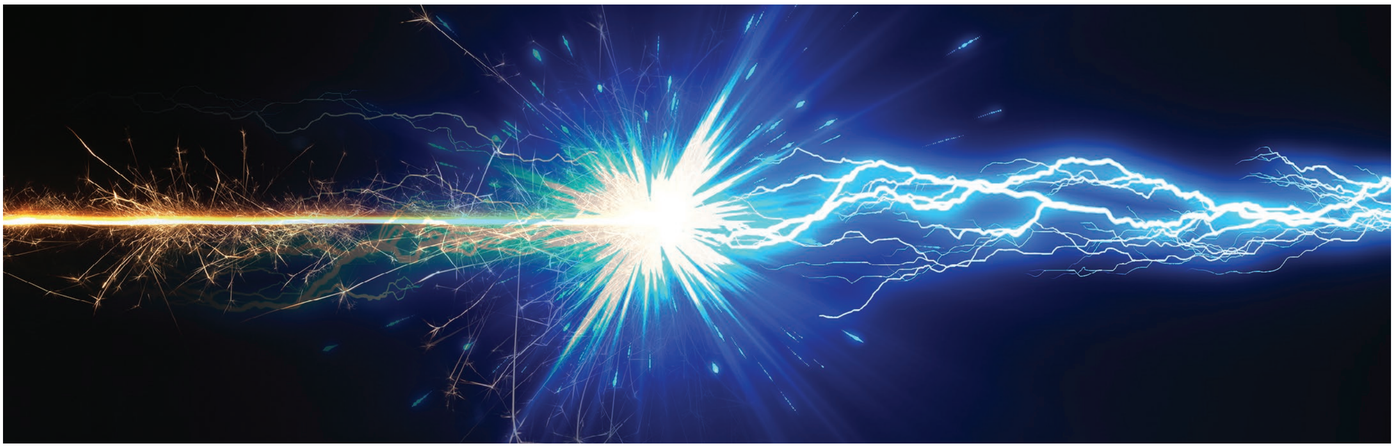
Customer explanation: The differences in efficiency and energy consumption between the high-temperature design and the alternative low-temperature design shall be explained to the customer, allowing them to choose.

It's clear that these three key regulatory documents push designers and installers towards the use of low-temperature heating systems.

While this is understandable, given that these were the only options available to the residential market, it's vital to address these areas with urgency to allow for the use of high temperature heat pumps and to create a more acceptable low-carbon alternative for householders and social housing providers.

05: What's holding us back? The Spark Gap

One of the most important barriers to greater adoption of heat pumps in the residential market is the price difference between gas and electricity for households, often referred to as the 'spark gap.' It is a cost that deters many consumers from switching away from gas heating.



In the 2024- 2025 Energy Security and Net Zero Committee Report to Parliament, 'Retrofitting homes for net zero', this was highlighted as a top priority: "Rebalancing policy costs and reducing the cost of electricity relative to gas is the key recommendation that we make in this Report. We urge the Government to introduce measures that encourage the installation of new low carbon heating systems and that make the installation of new fossil fuel heating systems less attractive in homes."[12]

The policy costs referred to are levied on electricity bills and fund schemes such as the Renewables Obligation, Feed-in-Tariffs and Energy Company Obligation. And while there was some recognition of this by the government, these levies have contributed to the price of UK electricity being almost four times more expensive than gas for consumers. As a result, there are increasing calls to shift this burden more equally across gas and electricity.

Beyond discouraging consumers from switching away from the cheaper fuel, the imbalance of pricing has lead to other unintended consequences. As the Committee Report noted, since EPC (Energy Performance Certificates) scores are based on energy costs, they tend to favour gas heating and typically recommend installing a new gas boiler over a heat pump.

This places a significant barrier in the way of decarbonising the UK's heating systems. However, this should change with the adoption of HEM and a new approach to EPC calculations.

The CCC went further in its 2025 progress report to Parliament, warning: "The ratio of residential electricity to gas prices is significantly off track. Action has not been taken to remove policy costs from electricity prices which would address this, despite it being our first recommendation last year."

The CCC pointed out that, a typical household with a heat pump was paying substantially more every year in policy costs, "which inflated their bills above the underlying cost of the additional electricity used."

The price of electricity compared to gas is a key driver for the successful adoption of heat pumps across Europe. As the CCC highlights, data from comparable countries suggests that the market share of heat pump installations are correlated with more favourable electricity-to-gas price ratios.

06: Meet the industry halfway – a call to action

Mitsubishi Electric recognises that changing regulations and rebalancing electricity costs for consumers are not simple tasks. However, the scale of change required to move the UK from a gas-consuming nation to one that can make the most of its renewable energy supplies will take effort from everyone involved.

As a manufacturer, we focus on delivering products that address market needs. Our role is to listen to end users, examine feasible technologies and deliver solutions. With the Mitsubishi Electric Ecodan R290 heat pump, which can operate at a high temperature, we feel there is now a solution that provides an attractive alternative to gas boilers.

We have made it easier for householders and landlords to retrofit heat pumps with less disruption, lower costs and long-term efficient heating. We have trained our trusted installer base to work with this equipment and proved our technology in the field.

We now turn to government to ask that it takes a long-term view of low-carbon heating and addresses the issues that only it can control – regulation and pricing. **Together, we can achieve decarbonise heating and be one of the nation's leading the way from fossil-fuel dependence into a low-carbon, energy-secure future.**

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Note: The fuse rating is for guidance only and please refer to the relevant databook for detailed specification. It is the responsibility of a qualified electrician/electrical engineer to select the correct cable size and fuse rating based on current regulation and site specific conditions. Mitsubishi Electric's air conditioning equipment and heat pump systems contain a fluorinated greenhouse gas, R410A (GWP:2088), R32 (GWP:675), R407C (GWP:1774), R134a (GWP:1430), R513A (GWP:631), R454B (GWP:466), R515B (GWP:292), R454C (GWP:148), R1234ze (GWP:7) or R1234yf (GWP:4). *These GWP values are based on Regulation (EU) No 517/2014 from IPCC 4th edition. Mitsubishi Electric's air conditioning equipment and heat pump systems contain a hydrocarbon, R290 (GWP:0.02). *These GWP values are based on IPCC 6th edition.

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