EnergisedFutures

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Report

# Decarbonising Cooling in the UK

## An Emerging Challenge for Homes and the Energy System

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# About Energised Futures

Energised Futures, powered by Centrica, is a research and innovation incubator launched to accelerate a new energy future and catalyse Centrica's purpose of energising a greener, fairer future.

Bringing together engineers, data scientists, behavioural scientists and developers across the UK and Belgium, we explore new ideas, test emerging technologies and turn challenges into breakthroughs through pioneering research and collaboration. Our work spans six key areas: Flexibility, Automation, Markets, Connectivity, Engagement and Accessibility.

# Decarbonised Cooling in the UK: An Emerging Challenge for Homes and the Energy System

As periods of sustained heat become more frequent, overheating is emerging as a structural challenge in the UK. Homes designed primarily to retain heat are becoming increasingly vulnerable during warmer conditions, creating growing demand for active cooling and introducing a potentially significant new source of electricity demand.

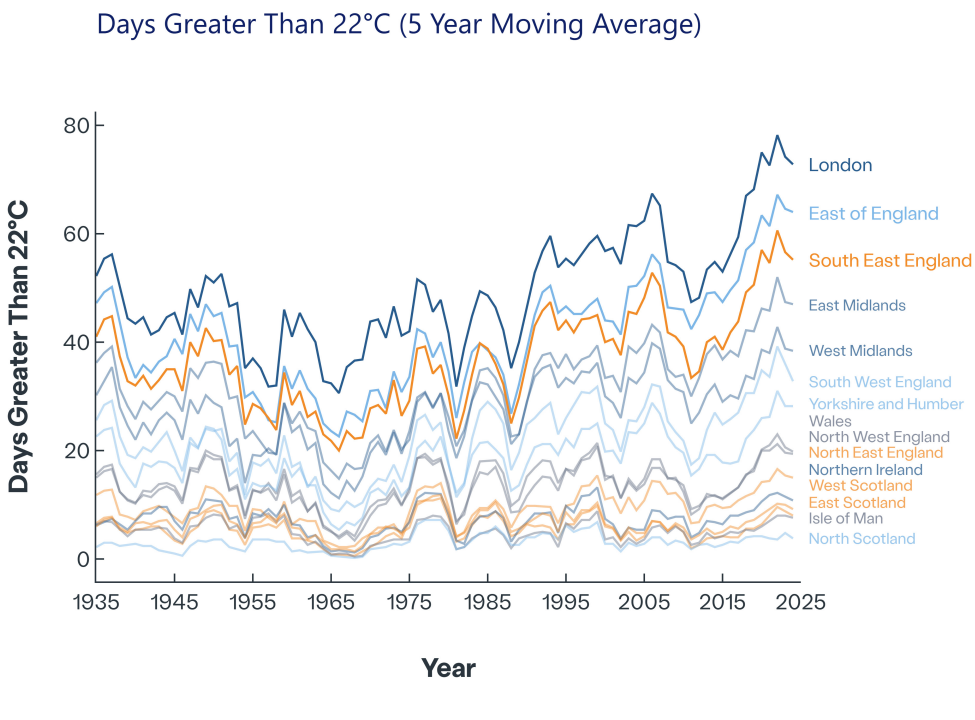


Figure 1 Days Greater Than 22 Degrees Celsius by Region (5 Year Moving Average)

Figure 1 illustrates the UK's increasing exposure to heat, with London and southern England experiencing a growing frequency of hot days and warmer nights. As overheating risk grows, cooling demand is likely to become a more prominent feature of the UK energy landscape.

## A Housing Stock Designed for Heating, Not Cooling

The UK's housing stock is particularly exposed to overheating risk. Around 51% of homes were built before 1965 and much of the stock was designed to retain heat rather than reject it[1]. EPC frameworks have reinforced this focus, rewarding insulation and airtightness while placing less emphasis on overheating, solar gain and ventilation. As a result, highly insulated homes can retain unwanted heat during warm periods. Some overheating risks can be reduced through relatively simple measures such as shading, blinds, reflective window films and improved ventilation, but many homes remain vulnerable to rising temperatures. mand is likely to become a more prominent feature of the UK energy landscape.

## Cooling Demand is Moving Mainstream

Estimates suggest there are currently around 1 million installed residential air-conditioning units in the UK, with projections indicating this could rise to as many as 18 million by 2050[2]. More recent evidence suggests adoption may already be accelerating faster, with approximately 4 million UK homes using some form of cooling technology, including portable air-conditioning units[3]. While temperature and household income remain important drivers, uptake is also influenced by factors such as heatwave frequency, rising night-time temperatures, housing characteristics, home ownership, occupancy patterns and the upfront cost of cooling technologies.

Experience elsewhere in Europe demonstrates how rapidly adoption can increase once certain climate and economic thresholds are reached. In Italy, cooling penetration increased from 29.4% of households in 2013 to 56% in 2024, illustrating the non-linear nature of adoption[4].

1 UK Housing Review (2022), Table 2.2.2: Age of UK housing stock

2 Energy Demand Research Centre (2025), Residential Air-conditioning Demand Futures (RADFutures)

3 Uswitch (2026), Four million UK homes now use air conditioning as temperatures set to reach 26°C

4 Istituto Nazionale di Statistica (ISTAT) (2025), Household Energy Equipment, Year 2024

## *Heat Pumps Alone Are Unlikely To Meet Cooling Needs*

Whilst many heat pumps can technically provide cooling, the UK market is dominated by air-to-water systems, accounting for around 88% of sales[5]. These systems are designed primarily to provide heating and hot water through radiators or underfloor heating, limiting their ability to deliver meaningful cooling.

Air-to-air heat pumps provide both heating and cooling. Most fixed air-conditioning systems sold in the UK are reversible air-to-air heat pumps, but are typically purchased and marketed as cooling products rather than whole-home heating solutions. Despite this, they remain a relatively small part of the UK market due to the prevalence of wet central-heating systems. As a result, the UK's current heat pump pathway remains strongly centred on heating, creating a disconnect between decarbonisation efforts and growing cooling requirements. Recent policy developments have begun to recognise this challenge. As part of the Warm Homes Plan introduced at the start of the year, the government expanded the Boiler Upgrade Scheme to include air-to-air heat pumps, marking the first time cooling-capable systems have been eligible for direct government support[6]. However, for now, air-to-water systems continue to dominate the UK market.

As overheating becomes more common, demand may shift towards integrated comfort systems that combine heating, cooling and hot water in a single solution. This creates an opportunity for air-to-air and hybrid systems to deliver both summer cooling and efficient winter heating, broadening their consumer appeal.

## *A New Electricity System Challenge*

Cooling presents a challenge because demand is weather-driven and synchronised. Under a transition scenario with around 10% cooling penetration, peak electricity demand could increase by approximately 1.3 GW.

5 Heat Pump Association (HPA) (2025), UK heat pump sales reach record high in 2025 but more must be done to meet government targets

6 Department for Energy Security and Net Zero (2026), Warm Homes Plan

Under a higher-adoption scenario of around 30% penetration, cooling could add almost 7 GW to peak demand.

This creates the potential for significant increases in peak demand, electricity price volatility, balancing costs and local network constraints. Recent heatwaves across Europe provide evidence of this emerging dynamic. In several markets, electricity price spikes increasingly occur during evening hours when cooling demand remains high but solar generation has fallen substantially.

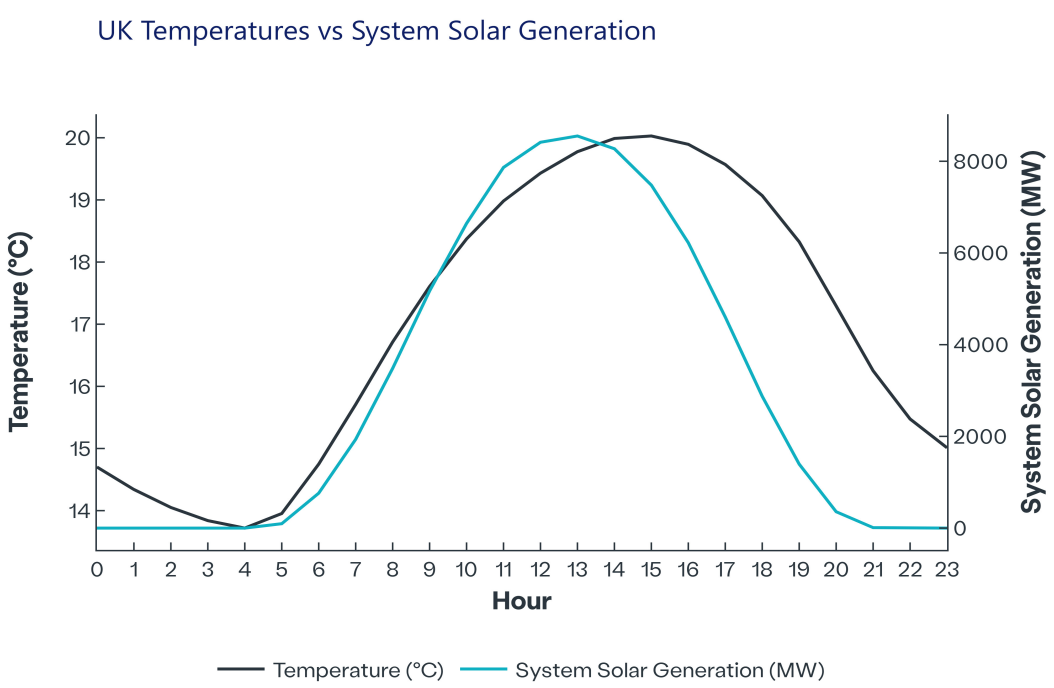


Figure 2 Average UK Temperatures vs Solar Generation by hour, July 2025

Figure 2 illustrates this challenge in the UK, showing that average temperatures in July 2025 remained high well into the evening, even as solar generation fell sharply after sunset.

This suggests cooling may become an increasingly important driver of summer peak demand, even in highly solarised power systems.

## The Opportunity for Smarter Cooling

While cooling demand is often viewed as inflexible, some of it can be shifted. One approach is pre-cooling, where buildings are cooled earlier in the day while system conditions are more favourable. This works as building thermal mass can store cooling in much the same way that it stores heat.

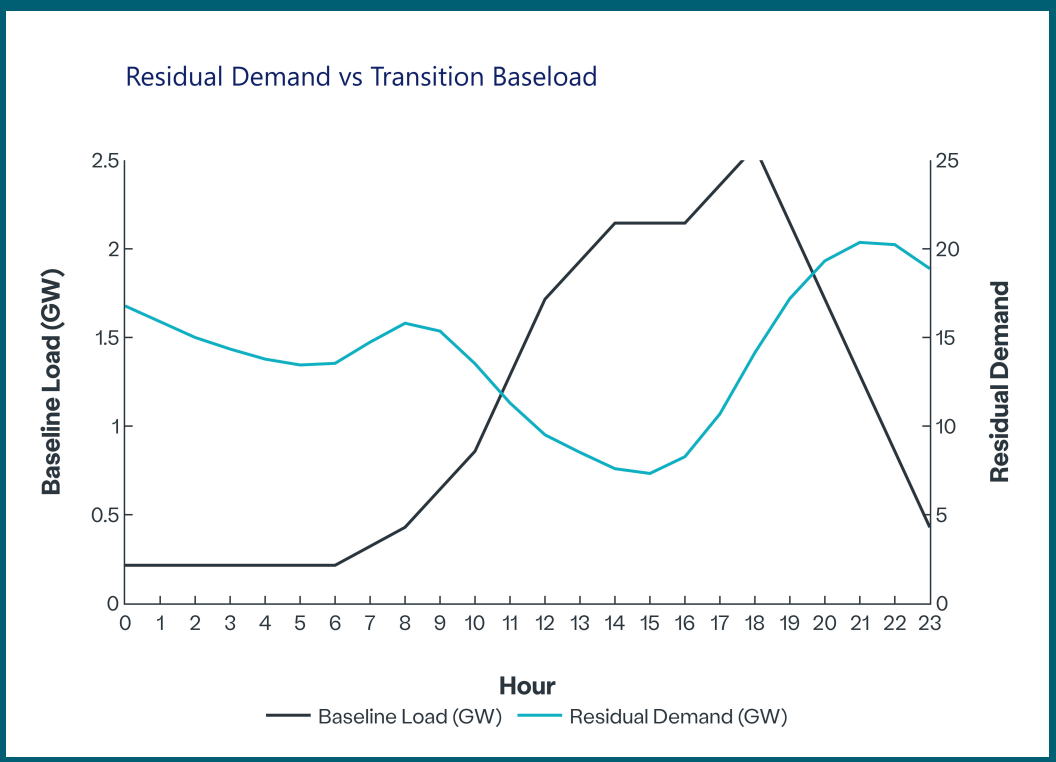


Figure 3 Shifted Cooling Loads

Pre-cooling offers a mechanism to reshape, rather than reduce, cooling demand by shifting a portion of load from the evening peak into solar-rich midday periods.

Modelling based on July 2025 conditions found that while total cooling demand remained unchanged at approximately 26.5 GWh, shifting demand improved alignment with lower-cost, lower-carbon electricity and reduced exposure to peak system stress.

Assuming cooling has been adopted by 10% of households, emissions fall by around 1.6% (54 $tCO_2$/day) when 10% of those households participate in pre-cooling. Increasing participation to 40% raises the reduction to approximately 6.5%. Figure 3 illustrates the impact of shifting 20% of cooling demand into lower-residual-demand periods, reducing demand during the evening hours when temperatures remain high but solar generation has largely fallen away. However, building fabric, occupancy patterns and consumer preferences may limit the proportion of demand that can be shifted, meaning cooling should be viewed as a partially flexible load[7].

## Avoiding a New Form of Energy Inequality

Cooling also presents important consumer challenges. Fixed air-conditioning systems typically cost £1,500–£3,000 for a single-room installation, while portable units cost only a few hundred pounds. Higher-income households are therefore likely to adopt more efficient fixed systems first, while lower-income households rely on less efficient alternatives. Combined with barriers faced by renters, this raises the prospect of a new form of cooling inequality.

Evidence suggests that some of the households most vulnerable to winter fuel poverty are also vulnerable to overheating. In 2024, around 395,000 homes experienced both overheating and an inability to keep warm in winter, with private and social rented households disproportionately represented. This suggests energy vulnerability may span both summer and winter conditions for some[8].

7 Model assumptions. Illustrative analysis is based on average July 2025 GB system conditions and assumes a transition scenario with ~10% AC penetration across the UK housing stock (~28.6 million homes). Cooling appliances are assumed to have an average load of 1.5 kW and a coincidence factor of 5–60% depending on time of day. Total daily cooling demand is held constant (~26.5 GWh), with load shifted between hours rather than reduced. Building thermal characteristics are not modelled; less efficient homes may require evening top-up cooling, reducing practical shiftable load. System data are sourced from NESO/National Grid ESO, with carbon intensity from the GB Carbon Intensity API.

8 English Housing Survey (2026), Weather Resilient Homes Fact Sheet: English Housing Survey 2024 to 2025, Ministry of Housing, Communities and Local Government

## *Looking Ahead*

Cooling remains a relatively small component of UK residential energy demand today, but the drivers of growth are becoming increasingly clear. Rising temperatures, an ageing housing stock, growing overheating risk and increasing electrification are combining to make cooling a more important feature of the future energy system.

The challenge extends beyond the growth of cooling demand to the way that demand develops. Without coordination, increasing adoption could amplify summer peaks, network constraints and energy costs. As cooling becomes more widespread, integrating devices into home energy management systems could enable automated optimisation alongside solar, batteries, EV charging and smart tariffs, helping align household comfort with lower-cost, lower-carbon system conditions.

With smarter technologies and greater connectivity, cooling has the potential to become a more manageable and flexible part of the transition to a low-carbon energy system.