HEAT PUMP READY

Department for Energy Security & Net Zero

Part of the Net Zero Innovation Portfolio

Smart and Flexible Heat Pumps

Learnings from the Heat Pump Ready programme

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1. Introduction

1.1 About Heat Pump Ready

Heat Pump Ready was part of the UK Government's £1 billion Net Zero Innovation Portfolio (NZIP), which provided funding for low-carbon technologies and systems and aimed to decrease the cost of decarbonisation, helping enable the UK to end its contribution to climate change.

Heat Pump Ready, led by the Department for Energy Security and Net Zero (DESNZ), aimed to accelerate heat pump adoption in the UK. The programme supported the development of new tools, technologies and business models to:

1. Improve the customer journey for heat pump adoption
2. Improve the installer journey from survey and design to aftercare
3. Develop smart and flexible home energy systems utilising heat pumps
4. Advance heat pump technology and manufacturing
5. Create innovative finance models for heat pump deployment
6. Develop new approaches to heat pump deployment at high-density

1.2 Report objectives and audience

This report presents findings from the Heat Pump Ready projects, focussing on **smart and flexible home energy systems utilising heat pumps.** It is aimed at smart technology developers, housing associations, energy suppliers, installers, and system designers and contains insights on how to:

- Optimise energy usage and reduce operating costs
- Enable participation in flexibility services
- Integrate heat pumps with other smart technologies
- Improve performance monitoring and aftercare
- Enhance customer comfort and engagement

Similar reports on the lessons learned against the other Heat Pump Ready themes, more detailed case studies on individual projects and programme evaluation reports can be found on the gov.uk website. The Carbon Trust has authored this report as a part of its Heat Pump Ready trial support and learning contract.

1.3 Relevant projects – smart and flexible home energy systems

Table 1: Summary of Heat Pump Ready projects focused on developing smart and flexible home energy systems utilising heat pumps

Company	Project name	Summary
GenGame	Total Home Optimisation Management (THOM)	Developed a home energy management system to optimise heat pumps with PV, battery, and flexible tariffs. Achieved significant running cost reductions and enabled automated participation in flexibility events.
Guru Systems	Guru Smart Heat Pumps	Enabled landlords to remotely monitor and recommission heat pumps, reducing site visits and supporting performance improvements in ambient heat networks.
Passiv UK	Smart Temperature Automation Technology (STAT)	Enhanced the Passiv Smart Thermostat to support participation in flexibility events, reduce heat pump running costs, and enable control without Wi-Fi.
Switchee	Digitising the Customer Journey of Heat Pumps in Social Housing	Used remote diagnostics and tailored feedback through smart thermostats to reduce faults and improve performance in social housing, with no reliance on Wi-Fi connectivity.
Wondrwall	Intelligent Air-Sourcing to Net Zero	Integrated heat pumps with solar PV, batteries, and smart tariffs. Delivered large bill savings through whole-home optimisation and adaptive controls.
Kensa	Highly Flexible Storage Heat Pump (HFSHP)	Developed a heat pump with integrated PCM thermal storage and smart controls to reduce peak load demand and enable cost-effective load shifting.

Mixergy	Making Efficient Systems around Heat-pumps (MESH)	Designed an integrated thermal store and control system to reduce heat pump cycling and simplify installation.

1.4 Key project learnings

1. **Smart heat pump controls can significantly reduce energy bills.**
Several projects demonstrated that automating heat pump operation for weather compensation and time of use tariffs can reduce customer bills by 20% or more without compromising comfort.

2. **Optimising heat pumps with Solar PV, battery storage, and flexible tariffs can lead to even greater savings.**
Heat Pump Ready projects demonstrated that smart controls that integrate heat pumps with Solar PV, battery storage, and time-of-use tariffs can deliver even larger savings, potentially halving household energy bills.

3. **Remote diagnostics platforms can reduce maintenance and improve performance.**
Several projects developed platforms that enable installers, landlords or housing associations to monitor and control heat pumps remotely, demonstrating how this can reduce the need for site visits, identify issues early, and improve long-term system performance.

4. **In-home displays and feedback loops support engagement and behaviour change.**
Projects that used smart thermostats or app-based tools to give residents tailored advice saw measurable improvements in how people used their systems, reducing inefficient behaviour and improving satisfaction.

5. **A lack of common standards for integrating third-party controls with heat pumps is key barrier for developing smart controls.**
Projects highlighted that some of the most effective smart tools cannot connect easily to all brands of heat pumps, because manufacturers use different data formats or limit access to their control systems.

6. **Limited recognition in building performance software and Energy Performance Certificates (EPCs) reduces the commercial case for smart systems.**
Projects highlighted that, without recognition of the benefits of smart and flexible

systems in industry compliance tools, developers and landlords lack a regulatory or commercial incentive to adopt smart technologies.

7. **Connectivity is a prerequisite for heat pump flexibility.**
   Without internet or cellular connectivity, most of the benefits of smart systems cannot be realised. Yet, many heat pumps are still commissioned without connection, especially in social housing.

2. Detailed project learnings

2.1 Smart heat pump controls can significantly reduce running costs

Several projects demonstrated that automatic heat pump controls can deliver significant savings, especially when optimising heat pump weather compensation and heat pump operation in response to time of use tariffs.

- **GenGame** tested its optimisation controls (the Homely thermostat) in the Energy House at the University of Salford. They compared two identical homes: one using a heat pump with fixed settings and a flat-rate tariff, and the other using dynamic weather compensation with a time-of-use tariff. The optimised setup saved 22% on annual heating costs, while still keeping the indoor environment within the homeowners' preferred indoor temperature range. GenGame further tested the system with solar panels and battery storage. When these technologies were included, total savings reached 53% by using stored solar energy and drawing from the grid only during cheaper periods. However, it should be noted that these savings were based on a test case in a laboratory (The Salford Energy House) rather than in-situ field trials.

- **Mixergy** developed a smart control strategy designed to maximise the efficiency of its Aggregated Thermal Inertia system (ATI), which combines hot water storage and a buffer tank into a single unit. The control platform uses machine learning to predict the home's heating demand, optimise the heat pump's runtime, and schedule operation when electricity prices are lowest. This helped reduce unnecessary short cycling of the heat pump, which is known to lower system efficiency and increase wear. Simulations and field trials across 20 homes showed energy savings of 15% to 40% when compared with traditional systems using fixed control strategies.

- **Kensa** developed an advanced smart control strategy to manage its heat pump system, which included a thermal store using phase change material (PCM). The control system was designed to respond dynamically to electricity prices, anticipated heating demand, and the thermal characteristics of the home. It schedules the heat pump to charge the PCM when electricity is cheapest and discharges it during peak times to supply space heating and hot water. The smart controller was tested through hardware-in-the-loop simulations and forecast modelling, which showed annual energy cost reductions of up to 20% when used with time-of-use tariffs.

2.2 Optimising heat pumps with Solar PV, battery storage, and flexible tariffs can lead to even greater savings:

The Wondrwall and Gengame projects highlighted the added value of automation when dealing with more complex home energy systems involving heat pumps, solar PV, batteries and time-of-use tariffs. Both projects demonstrated that significant savings are achievable using controls that optimise the system without daily user input.

- **Wondrwall** built a platform that optimises the complete home energy system, including heat pump, solar PV, battery, and tariffs using a single, intelligent control system. In a year-long trial involving 7 homes (3 new builds and 4 retrofits), the system achieved average total household electricity bills of £685. This represented a **61% reduction in heating bills compared to a modelled counterfactual scenario** in which the same homes relied entirely on grid-imported electricity charged at a flat tariff, without solar, battery or smart controls. However, the very small sample size means that these savings require further verification.

- **GenGame** also tested whole-home optimisation. Its home energy management system (HEMS) controlled heat pump operation in combination with solar panels, battery storage, and time-of-use electricity tariffs. In a series of controlled lab tests at the University of Salford's Energy House and real-world field trials, **the system demonstrated up to 53% savings on space heating costs**. This was achieved by automatically shifting heat pump operation to off-peak periods, storing low-cost electricity in the battery, and using solar generation when available. Compared to a baseline scenario using a standard weather-compensated heat pump with a fixed tariff and no PV or storage, the optimised system reduced costs significantly without compromising comfort. These results highlight the added value of automation, enabling consistent performance improvements without requiring daily user input, particularly when customers have multiple energy technologies that need to be coordinated.

2.3 Remote diagnostics can reduce maintenance and improve performance

Several Heat Pump Ready projects developed smart monitoring and diagnostics platforms which allow housing providers, landlords and service companies to check how heat pumps are performing in real-time. These tools can detect faults early, prevent breakdowns, and help engineers fix problems remotely, reducing disruption for residents and avoiding unnecessary site visits. These platforms are especially valuable for housing associations and large landlords who manage many properties. However, projects highlighted the need for open access to heat pump data and consistent standards across manufacturers to make remote diagnostics easier to scale.

- **Homely** developed the Lifetime platform to monitor the performance of heat pumps remotely and identify inefficiencies over time. The system tracks key metrics such as cycling behaviour, flow temperatures and run hours. Where a heat pump is not operating efficiently, the platform generates a list of recommended actions. In addition to supporting maintenance teams, the platform can provide feedback to manufacturers on common failure modes and areas for performance improvement. Field testing showed the tool was effective in identifying energy waste and opportunities for improved commissioning or control.

- **Guru Systems** created a remote platform that tracks the performance of multiple heat pumps across housing portfolios. Their system shows data including energy use, flow temperatures, and efficiency. If something goes wrong, the platform can flag the issue and even allow the system to be remotely recommissioned. Guru tested the system with 115 homes on heat networks and ambient loops, showing it could identify performance drops and trigger alerts before faults became serious. They also designed the system to meet new regulatory requirements for heat networks due to be introduced in 2025.

- **Switchee** tackled a key problem in social housing lack of Wi-Fi. The project built a system that could communicate with heat pumps using a mobile data connection instead. In a field trial with Daikin heat pumps across 40 homes, Switchee found that 43% of systems had experienced a fault in the first four weeks – many of which were unknown to residents. One common issue was the failure to run essential hot water sterilisation cycles, which can affect health and hygiene. By flagging these problems remotely, Switchee's system enabled faster and more efficient maintenance.

- **Passiv** also developed remote monitoring functionality, which is integrated into its smart thermostat platform. The system collects data on room and flow temperatures, run times, and responsiveness to control inputs. This allows installers and landlords to remotely identify if a system is underperforming, whether due to user behaviour, system configuration, or technical fault. The tool was developed in response to challenges faced by installers and housing providers in identifying problems quickly and cost-effectively.

2.4 In-home displays, feedback loops and automation improve engagement and participation in flexibility services

Several projects found that residents were more likely to use their heating efficiently when they were given clear, personalised feedback about their energy use. Smart thermostats, mobile apps and in-home messages all helped to prompt more efficient behaviour and increase confidence in new heating systems from most residents, particularly when they had received some form of training from the heat pump installer, the smart thermostat installer, or a customer relationship manager.

- **Switchee** used its smart thermostat to group residents into different usage patterns, for example, people who frequently changed the temperature setting, or those who often overrode their heating schedule. They then sent tailored messages with simple advice, like setting up a schedule or reducing unnecessary adjustments. In a field trial, 75% of households changed their behaviour in response to these tips. Many of these changes improved comfort as well as efficiency, for example, by avoiding cold periods caused by manually switching systems off.
  GenGame tested automated and manual participation modes for energy flexibility events through its user-facing app. The platform used push notifications, reminders, and feedback on participation to encourage engagement. When participation was automated, 98% of users took part in events compared to 24% when users had to manually opt-in each time. The events involved temporarily adjusting heating setpoints to shift electricity demand away from peak periods. Users were also shown potential financial savings, helping reinforce continued participation.

2.5 A lack of common standards for integrating third-party controls with heat pumps is a key barrier for developing smart controls

Heat Pump Ready projects highlighted that some of the most effective smart tools cannot connect easily to all brands of heat pumps because manufacturers use different data formats or limit access to their control systems. Projects emphasised that this lack of compatibility makes it harder for innovative products to reach the mainstream and adds time and cost to product development.

- **Passiv, Guru** and **Homely** spent considerable effort working with heat pump manufacturers like Clivet, Ebac and Panasonic to ensure their smart thermostats could control a wide range of systems. While they succeeded in several cases, they reported that reaching agreements with manufacturers took time and required multiple rounds of testing. Projects reported that, without an industry standard, each new integration is bespoke and must be developed and tested separately, slowing innovation, raising development costs, and limiting consumer choice.

2.6 Lack of SAP (Standard Assessment Procedure for the energy rating of dwellings) recognition reduces the commercial case for smart systems

Some projects highlighted that it is essential that standard building industry tools such as SAP (used predominantly for new build housing) and RDSAP (which underpins Energy Performance Certificates) better reflect the benefits of smart controls and flexibility participation. Without recognition of the benefits of smart and flexible systems in industry compliance tools, developers and landlords lack a regulatory incentive to adopt technologies that demonstrably lower carbon and reduce consumer bills.

- **Wondrwall** highlighted that, despite achieving over 60% reductions in household electricity bills through the integration of solar PV, battery storage and smart controls, its system could not be properly credited in EPCs.

- Similarly, **Mixergy's** Aggregated Thermal Intertia cylinder showed strong efficiency improvements but remains unrecognised within SAP, limiting its appeal to housing developers focused on EPC scores. This creates a disconnect between real-world energy performance and official certification.

2.7 Connectivity is a prerequisite for heat pump participation in flexibility

Many of the benefits offered by smart home energy systems, like automatic control, fault detection and participation in energy saving events, depend on having a reliable internet connection. However, projects found that most heat pumps are installed without connectivity, especially in existing homes.

- **Passiv** addressed this by creating a version of their thermostat hub that connects via smart meters instead of home Wi-Fi. This makes it easier to use in homes without internet access, such as in social housing.
- **Switchee** achieved similar results using GSM mobile networks. Both solutions showed that basic connectivity can be provided in most homes, but also that this adds cost, including ongoing costs for mobile connection.

Further information on these and other Heat Pump Ready projects can be found at www.gov.uk.