HEAT PUMP READY | Department for Energy Security & Net Zero

Part of the Net Zero Innovation Portfolio

Highly Flexible Storage Heat Pump (HPSHP)

CARBON TRUST

Project Lead: Kensa Heat Pumps Ltd

Partners: MTC, PNDC University of Strathclyde

Funding:

£1,233,117

Kensa Heat Pumps – A KENSA GROUP COMPANY

mtc Manufacturing Technology Centre

PNDC UNIVERSITY of STRATHCLYDE

The problem: Can heat pumps enable electricity network load shifting?

There have been iterative improvements to heat pump technology since James Harrison patented the highly successful refrigeration circuit design in 1856. Now, peaks in electrical demand from many users plugging in a variety of technologies at the same time, including electrical heating, is causing stress on the electricity grid, requiring a step change in heat pump technology.

The solution

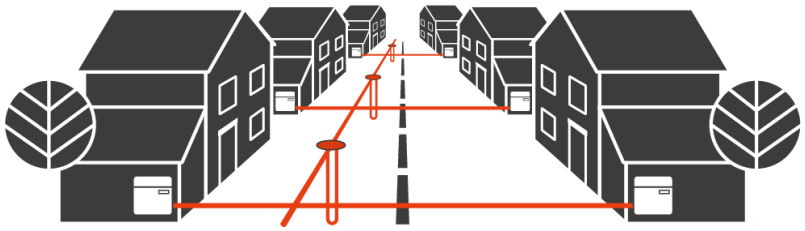
There is a new technology which allows significant flexibility and load shifting, at increased efficiencies, through interruption of the traditional refrigeration circuit that provides opportunities for capital and running cost reduction, space saving, reduced installation time and carbon savings.

This project aims to combine electrically-driven heat pumps with heat storing batteries utilising phase change material (PCM), to shift heat production from times of peak electrical demand on the National Grid. This will enable consumers to ‘charge’ heating systems, to store lower cost and lower carbon heat in anticipation of their peak heating demand. This is achieved by decoupling the times of heating demand in the property from the time of electrical heat production.

> “We are excited to be taking part in Heat Pump Ready; developing a novel solution that will save users money, reduce cost and complexity for installers, and decrease stress on the grid.”

Adam Brann
Principal R&D Engineer, Kensa Heat Pumps Ltd

Enabling electricity network load shifting by heat pumps



What are we going to do?

Two heat pump product designs will be developed and commercialised, both combining electrically-driven heat pumps with heat storing batteries which use phase change material to store heat. Product 1 is for outdoor use, utilising natural refrigerants that offer greatly reduced Global Warming Potential (GWP) but require a high level of venting. Product 2 utilises standard non-flammable non-toxic refrigerant with higher GWP than naturally occurring alternatives but requiring less ventilation.

The project will optimise the design and assess efficiencies for high volume manufacture, assembly, installation, maintenance, supply chain and sustainability. The project will also assess the beneficial impact on the electricity distribution network.

Why is this an improvement on current solutions?

Targets to increase installation of heat pumps will add significant strain on the electrical grid during times of peak load. Heat storage offers an opportunity to decouple the time of heat production from times of peak electricity use. However, previous attempts at integrating Phase Change Material heat storage with heat pumps have failed to provide sufficiently high charge efficiency.

The design of the Highly Flexible Storage Heat Pump (HFSHP) aims to overcome previous problems to allow use of low carbon electricity during times of lower demand to generate heat. As well as ensuring best value for the end user, this will also reduce the need for infrastructure development and help meet national carbon reduction commitments.

What would success look like?

There will be two working prototypes of the HFSHP (for internal and external use). The proposed increase in efficiency and ability to load shift will be demonstrated.

How will this project help towards the target of installing 600,000 heat pumps per year by 2028?

As well as negating some of the challenges faced by the grid from electrifying and decarbonising heat, the Highly Flexible Storage Heat Pump will provide multiple advantages that will help to overcome common barriers to uptake.

These include removing the need for a separate hot water cylinder, providing increased flexibility and efficiency, reduced running costs, and cost neutrality at the point of purchase (compared to conventional ground source heat pumps).

The Optimised solutions development stream of the Heat Pump Ready programme supports the development of innovative tools, technologies and processes to overcome specific barriers to heat pump deployment in the UK. This stream supports solutions aiming to reduce the life time cost and increase the performance of domestic heat pumps, minimise home disruption whilst providing high quality installations, develop and trial financial models to support heat pump deployment, improve the heat pump consumer journey and provide a smart and flexible home energy system.

Heat Pump Ready is funded by the Department for Energy Security and Net Zero through the NZIP programme. The Collaboration & Learning stream is managed by the Carbon Trust with support from Ipsos and Technopolis.

Contact information

Name: Adam Brann

Email: Adam.Brann@kensagroup.com

www.heatpumpready.org.uk

Funded by: Department for Energy Security & Net Zero

Supported by: Carbon Trust, Ipsos, technopolis group

May 2023

Highly Flexible Storage Heat Pump (HFSHP)

Project Progress (Autumn 2023)

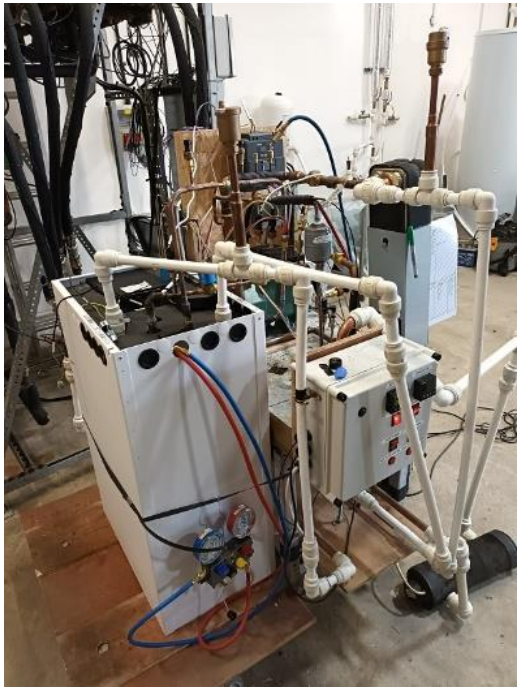
HEAT PUMP READY

Department for Energy Security & Net Zero

Part of the Net Zero Innovation Portfolio

Key Findings

- Phase change material is more efficient than water in storing heat, giving an increased Coefficient of Performance (COP) for the heat pump.
- The highly flexible storage heat pump unit will need two different temperature phase change materials to balance the domestic hot water and space heating needs.
- Phase change materials have specific properties; we wanted to pick two that have sufficiently different heat capacities in order for the two-stage process to work most effectively but are now investigating how two similar PCMs could work.



What progress have we made so far?

We have been working on modelling and simulating the prototype flexible storage heat pump, using an off-the-shelf existing Kensa heat pump as a reference case for comparison. Throughout the project we have investigated phase change components from leading manufacturers PhaseStor and Sunamp.

We started phase change material (PCM) testing at a temperature of 58°C which is higher than planned. Using this higher temperature material means this heat pump design could plug and play into an existing heating system. From initial conversations it seems installers are on board with this higher temperature approach.

Octopus Energy have now invested in Kensa which secures funding for growth and also brings on board an industry partner who have the potential to offer suitable flexible tariffs. This could be a major advantage when implementing the project and gives a louder voice when it comes to discussing the concept of flexible tariffs.

What barriers have we identified, and how has this changed our approach to delivering our project?

The 50°C phase change material we intended to use was withdrawn from the market and the only available alternative turned out to be unsuitable.

We continue our research of the two-stage process, preparing for the expected future availability of 48°C PCMs. The commercial unit providing the benefits of a highly flexible storage heat pump at the end of this project will utilise two 58°C PCMs.

What are our next steps?

Over the next six months we will test and design the HFSHP while continuing researching the two-stage process to develop the ability to control it. We are also continuing our cooperation with Sunamp.