HEAT PUMP READY | Department for Energy Security & Net Zero

Part of the Net Zero Innovation Portfolio

Two stage heat pump with greywater energy recovery

CARBON TRUST

Project Lead: Thermoelectric Conversion Systems Ltd

Funding:

£574,108

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THERMOELECTRIC CONVERSION SYSTEMS

> The Heat Pump Ready programme is the ideal vehicle by which to develop an extremely energy efficient heat pump system for households and small businesses.
>
> **Dr Andrew Knox,**
> Technical Director, TCS

The problem: Can demand side flexibility be improved in heat pumps?

Typical air source heat pump systems require external and internal space for the heat pump and hot water tank, and due to the coefficient of performance, the running costs may be comparable to gas boilers but with higher capital cost. The increased electrical load imposed by the heat pump can also contribute to strain on the electricity grid.

The solution

By utilising otherwise wasted energy from greywater, this solution will improve the operational efficiency of the heat pump system, thereby reducing running costs, and will allow improved flexibility in the time of use.

This project will develop a solution to make energy use more efficient, with a heat pump technology that recovers thermal energy from household wastewater streams to store in the hot water cylinder. A small air source heat pump will also be used to top up the hot water tank temperature to provide the domestic hot water supply. This product will also integrate with a smart controller to control load shifting and allow users to take advantage of time-of-use electricity tariffs.

Using thermoelectric technology to improve heat pump efficiency

What are we going to do?

This project will build and test a two stage thermoelectric heat pump with greywater energy recovery; a water source heat pump will recover thermal energy from household wastewater streams and an air source heat pump will top up the hot water tank temperature to provide the domestic hot water supply.

Both the water source and air source heat pumps will be managed by a smart controller and integrated with demand side management systems to ensure sufficient hot water and heat are available when required, whilst providing users with the ability to customise the heat pump timings to take advantage of smart tariffs.

Why is this an improvement on current solutions?

Current heat pump technologies may have running costs comparable to a gas boiler, whereas using greywater energy recovery technology can improve the efficiency of a heat pump to reduce user running costs. There is also the capability for demand-side management to sync up electricity usage with off-peak electricity hours and make savings through smart tariffs.

Typical heat pump systems also require space for an internal hot water tank and a heat pump on the exterior of a property. This solution is significantly smaller and can be made to fit properties with less available internal space.

What would success look like?

The technology behind this product is being proven in a research setting, so success would be translating this into a real world set up, with higher efficiency and better user experience compared to typical heat pump products.

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

This project aims to overcome several major infrastructural challenges of heat pump adoption, by harnessing demand side management to cope with peak loads, and time-shifting energy use.

This product has the opportunity to make heat pumps cheaper, less grid intensive and applicable in properties with limited internal space – all ways to support heat pump roll out.

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.

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July 2023

TCS Greywater Energy Recovery Project Progress (Autumn 2023)

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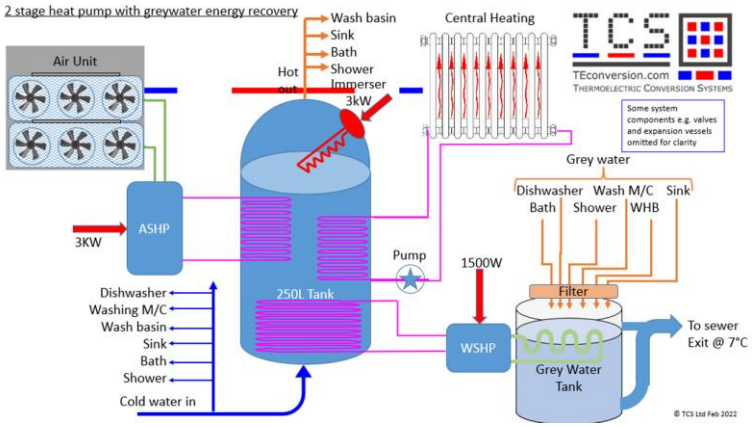
Key Findings

- The full-scale heat pump is performing slightly better than expected, with coefficients of performance (CoP) over 4.
- There is a very pronounced thermal gradient in the hot water tank, which has a bearing on the height and positioning of the heat exchangers and adjoining pipework.
- The grey water tank (CoP 4.5) has a higher coefficient of performance than the hot water tank (CoP 4.0) due to the hot water tank standing losses.



What progress have we made so far?

The project continues to run well and to plan, and the findings so far are very encouraging.

Two different heat pumps with two different sources of energy give the system particular flexibility over a range of heat recovery temperatures. The air source heat pump (ASHP) is performing a lot better than expected and there is a continued focus on the ASHP section of the complete system. We are now re-testing the ASHP with a 250L triple coil tank and external radiator.

Some contacts from InstallerSHOW2023 have expressed an interest in visiting TCS in order to view the prototype in-situ. In total, 35 contacts have registered to be kept up to date with progress on the project.

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

The open system has potential leakage issues if the controller is positioned below the external radiator. We have decided to specify a pressurised system for both loops of the system (air source and water source heat pump) but overall, there is no change to the project delivery approach.

What are our next steps?

The next steps are to further optimise the performance of the ASHP, and then start work on the integration of the ASHP and WSHP into a single unit.

By Easter 2025, we aim to have built a final prototype of the complete greywater energy recovery system, rated at 3kW.

We will also explore a solution in which an immersion coil feeds from a solar thermal system to recover additional heat. The design will need to balance maximising efficiency vs. minimising complexity and cost.