Project Case Study: CUBEX

Project theme:

Innovation in Heat Pump Technology

Project lead:

Mixergy Limited

Partners:

Harlequin Manufacturing Ltd

Contact:

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Funding:

£530,080.20

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2024-2025

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What were the objectives of the project?

The project aimed to develop a new heat pump unit - the **CUBEX modular heat pump,** which:

1. **Provides a low Global Warming Potential (GWP) based heat pump solution for smaller properties** by offering a unit designed to fit in tight cupboard spaces and sit entirely within the property (air is ducted from the outside, meaning there is no need for an external fan unit).
2. **Minimises installation complexity and the cost of repair and maintenance** by developing an integrated heat pump and vented thermal storage solution.

What activities were funded?:

Project funding supported the following activities:

- CUBEX system design specifications for testing, manufacturing and operation.
- Production line design and upgrade for volume manufacturing of the final assembly unit, including producing 10 trial units.

- Whole system performance testing and validation, including real-world trials and lab-based lifecycle testing.
- Commercial exploitation and supply chain development.

What did the project achieve?:

The project successfully completed:

- Design of the CUBEX system.
- 10 trial units manufactured with a production line ready for volume manufacturing.
- Real-world installation at five sites, including private properties, a trade office site, and a social housing property.
- Lab testing, including space heating performance testing and accelerated lifecycle testing of five CUBEX units.

The project successfully manufactured the CUBEX system as designed, allowing it to fit into smaller properties. However, feedback from real-world installations was mixed. One installer gave feedback that the system was too large to be installed in a property's airing cupboard whereas a different installation demonstrated that the CUBEX system can fit into a narrow airing cupboard in a one-bedroom flat.

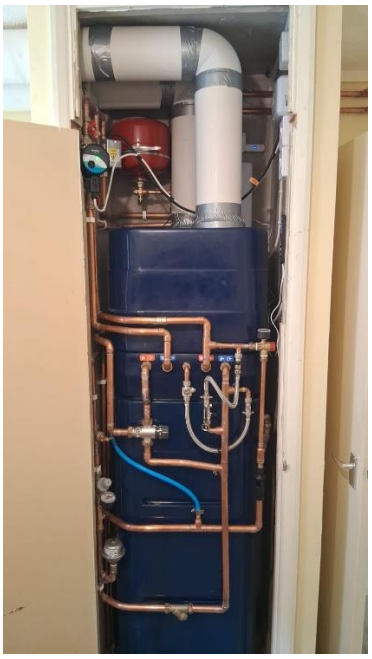

Figure 1: CUBEX installation in a narrow airing cupboard

The project successfully produced an integrated heat pump and vented thermal storage solution. Installer feedback has highlighted that this could simplify installations, but further education about the product is necessary to achieve an efficient installation. Installers reported being unaware of certain requirements for system components.

Project objective 1: Develop a heat pump solution for smaller properties

Why is this important?:

Space constraints can hinder heat pump adoption in smaller homes and flats, as typical monobloc systems need both outdoor and indoor space for their core components. A heat pump with an integrated thermal store that fits in tight cupboard spaces could make these systems viable for smaller properties.

What activities were funded?:

- Mixergy and Harlequin's development of the CUBEX system's design specification for manufacture to ensure it can be efficiently and reliably manufactured at scale.
- Upgrading of project partner Harlequin's manufacturing facility to facilitate the introduction of heat pump head unit integration with Harlequin's existing thermal store.
- Production of 10 trial units, five installed at real-world sites.
- Creation of a life cycle test rig that proved the reliable operation of the system over the course of its warranty period.

What were the project findings and did the project achieve this objective?:

The project achieved this objective to a large extent by completing the development and manufacture of 10 trial CUBEX units, which eliminate the need for an outdoor unit by integrating the heat pump with the thermal store and ducting in air from the outside. Five units were successfully installed at real-world sites, including one in a narrow airing cupboard. However, one real-world installation found that the unit was too big to fit in the airing cupboard of a different property, meaning the CUBEX unit had to be relocated to the loft.

The CUBEX system currently offers a 1.5kW heating capacity and 6kWh of thermal storage capacity (based on a 35°C temperature differential). At present, the heating capacity is constrained by existing safety regulations, which limit the charge of R290 refrigerant in indoor units to 150g. Some in the industry believe that this limit will be increase to 500g, which will allow the heating capacity of the CUBEX system to increase accordingly, covering a wider range of market. Customer feedback from a housing association involved in the real-world installation trial indicated they would prefer a higher heating capacity to cover the heating demand for larger property types. An individual customer also gave feedback that the system performs well for a single, full-capacity shower. However, it struggles to meet demand when two consecutive showers are taken, meaning a larger storage size would be preferable.

No noise concern was reported from the trial sites.

Project objective 2: Minimise installation complexity and the cost of repair and maintenance by developing an integrated heat pump and vented thermal storage solution

Why is this important?

Typical air source heat pump installations require multiple components to be connected on-site, increasing installation time and the risk of post-installation issues. Simplifying heat pump installations is crucial for reducing costs, accelerating deployment, and encouraging adoption. CUBEX has designed the system to be installed by conventional heating engineers, making the process more straightforward and comparable to gas boiler replacements.

What activities were funded?

- Systems integration of the heat pump and thermal store.
- Software integration, whole system performance testing and validation.
- Real-world trials and lab-based lifecycle tests.

What were the project findings and did the project achieve this objective?

The project successfully developed an integrated heat pump and vented thermal storage solution that delivers the following benefits:

- No outdoor unit, as air is ducted to the unit from outside.
- No requirement for a separate buffer vessel on the central heating circuit as the thermal store exchanges heat to both the domestic hot water system and central heating loop.
- Reduced need to install larger radiators and upgrade pipework as the CUBEX unit utilises a high-temperature heat pump head unit with a 3kW direct electric back-up system, which is activated only when the heat pump system struggles to reach target temperature (e.g. during defrost cycles or in extremely cold conditions).
- Eliminates the requirement for legionella prevention cycles (typically required in monobloc heat pump systems with unvented hot water cylinders) and for the installer to have a G3 qualification for unvented cylinder installation, and enables easier and more accessible installation by eliminating the need for a broad range of specialist skills associated with traditional heat pump systems.

The project sought feedback from installers and potential customers (individuals and social landlords) via market research and from feedback resulting from the project's real-world installations. Market research consisted of business development outreach activities to validate market appetite and understand where CUBEX stands to deliver the greatest initial traction in the market.

Installer Feedback

Installers reported that they appreciated the CUBEX unit's ease of installation, enabled by eliminating components not required for a vented system, such as the expansion vessel, the temperature and pressure relief valve and associated plumbing to an external vent. However, one CUBEX unit installed in a home was relocated to the loft as it was too large for the airing cupboard. This significantly increased

the complexity of the installation; it required the loft hatch to be dismantled, significant strengthening of roof trusses, increased pipework and pipe insulation, and the installation of roof vents due to loft height restrictions, which made it impossible to install ducting through the wall for the integrated heat pump. One installer was also unaware that certain components were required for the cold-water inlet and the heating circuit, highlighting that some extra installer training may be required.

Customer feedback
Market research showed that social landlords valued the flexibility of having the option to install only the CUBEX thermal store unit as a direct electric-only replacement for a Hetaerae Sadia Electromax, whilst also being 'heat pump ready' by having the option to also install the CUBEX integrated heat pump head unit on top of the thermal store unit at a later date. This allows social landlords to deliver an incremental retrofit journey towards their EPC targets. The project also contacted social landlords to find homes for real-world installations of the CUBEX unit. Despite the CUBEX system's more straightforward installation process, the project found that a local authority client was apprehensive about the core drilling required to install ducting for the integrated heat pump unit. However, the client was interested in testing the CUBEX thermal store module in their social housing properties.

Potential further research

Opportunities for future research

There are several opportunities for further research:

- **Comprehensive heating season testing**: Mixergy completed performance testing for an ambient temperature of 10°C and system temperature of 40°C, achieving a Coefficient of Performance (COP[1]) of 3.89. Testing the capability of the heat pump across the range of ambient temperatures experienced during the heating season would indicate its Seasonal Coefficient of Performance. Testing at higher system temperatures will also indicate its capability to minimise any radiator upgrades required in a property.
- **Size and heating testing**: Additional testing in real-world properties will demonstrate the proportion of small properties able to fit the CUBEX unit into any available cupboard space. Further real-world installations will also clarify the extent to which potential customers prefer a CUBEX unit with a larger thermal store.

Summary:

What impact could this have on accelerating the heat pump rollout?:

If CUBEX demonstrates its suitability for installation in a high proportion of small homes, it could accelerate the rollout of heat pumps in smaller properties by overcoming the barrier of homes lacking

[1] Coefficient of Performance, or COP, is an instantaneous measure of heat pump efficiency that indicates how much thermal power is delivered per unit of electrical power consumed. A higher COP indicates a more efficient heating system.

space, whilst offering a lower installation complexity that reduces installation costs and the risk of installation errors.

What next?

To support further commercial deployment, Misery is engaging with social housing providers, local authorities, and housing developers to expand the reach of the CUBEX system. An advantage of the CUBEX design is the modular configuration, which separates the heat pump head unit from the thermal store base. This flexibility will enable Misery, in collaboration with Harlequin, to explore alternative base unit form factors—such as shorter, wider, or under-counter cabinet designs—making the system adaptable to a broader range of homes and installation constraints.

Where to find out more

https://www.mixergy.co.uk/solutions/cube-x/

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