CASE STUDY | Christchurch, New Zealand

St John of God Hauora Trust care home

RESIDENTIAL MULTI-UNIT | HEAT PUMPS

Project summary

Location: Christchurch, New Zealand
Facility type: Care home
Consultant: Deta Consulting
Heat pump supplier: Gree
Installer: Hartnell Coolheat

Equipment replaced: 4 x 440L electric cylinders
Water temperature set point: 50 °C
New equipment: 2 x hot water heat pumps
Refrigerant: R410a
Estimated annual energy savings: 129,700 kWh
Estimated annual emission savings: 19%
Total project cost: NZ$163,690

The St John of God Hauora Trust residential care home in Christchurch on the South Island of New Zealand is home to dozens of clients in residential units. When the existing hot water system began to leak and fail, the operators used this as an opportunity to replace the existing technology with a high-efficiency heat pump system.

Existing system

The existing domestic hot water (DHW) supply system comprised four 440 L cylinders located in the roof spaces of each wing of the residential care facility. These hot water cylinders provided gravity-fed hot water to the users, which included showers and sinks. Two of the cylinders had begun to fail and leak, necessitating the installation of a replacement system. The decision to replace it was motivated by both the risk of system failure and the desire to reduce energy consumption on-site.

Heat pump solution

An analysis was conducted to explore various options, including new electric resistance heaters, wood pellet boilers, solar thermal panels and hot water heat pumps (HWHP). This initial analysis concluded that an air-sourced heat pump would be the most attractive replacement for the existing system.

Further analysis carried out by the project consultant, DETA, recommended a centralised system within an existing plant room and the establishment of a ring main for water distribution throughout the site. A centralised system would allow for the installation of two HWHPs with sufficient capacity to accommodate future expansions.

The system was configured to also support an existing gas-heated underfloor heating system, resulting in additional energy savings. The existing gas boilers were employed to provide redundancy to the system and enable load shedding to reduce line charges. The system also featured UV sterilisation to maintain the water storage temperature below the 60 °C threshold required to eliminate legionella from the water storage so further savings could be achieved.

The HWHP system, featuring units from Gree, utilises R410a refrigerant, with all components, including pipes, valves, and accessories, meeting the required pressure specifications. R410a was selected because, at the time of installation, it was the most common and cost-effective refrigerant available. Furthermore, while having a high GWP potential, R410a is a relatively safe refrigerant.

Additionally, the system incorporates controls for automatic heat pump unit shutdown during an Orion (the local electricity distribution company) ripple signal event. The ripple control is used to signal during times of electricity demand and high prices. Therefore, the system can be switched off during these periods and the hot water tanks are used as a buffer.

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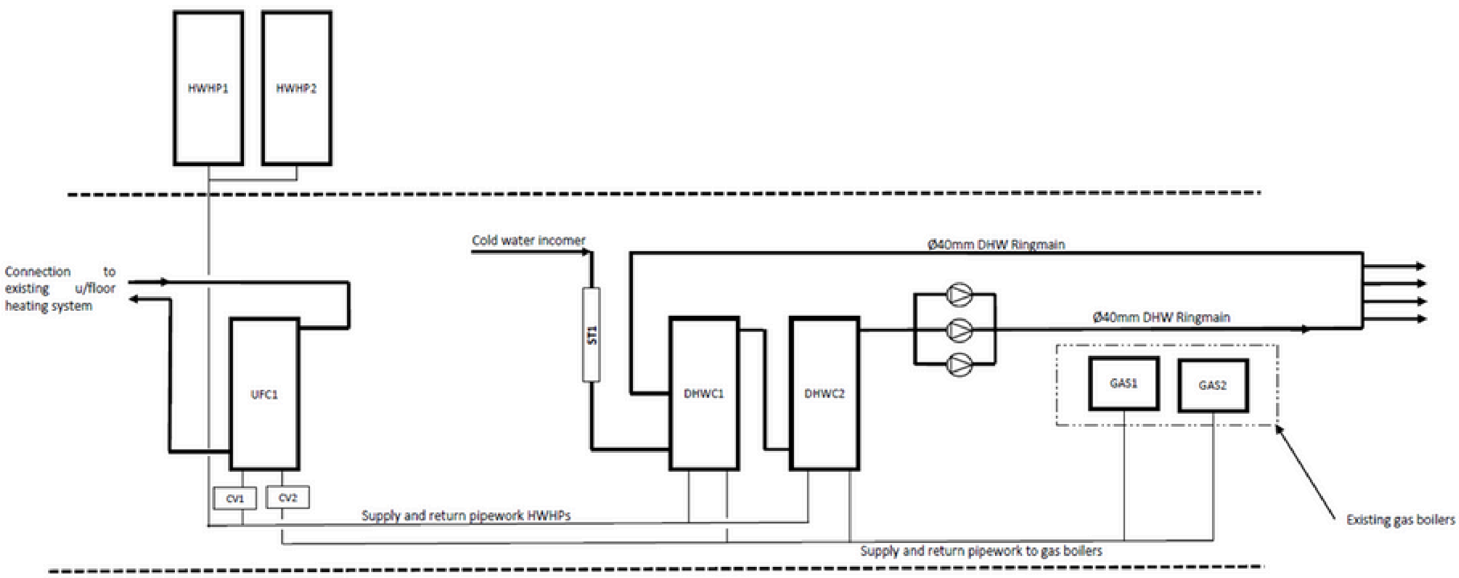

This diagram illustrates the implementation of the heat pumps and the hot water ring main that was installed at the site.

The heat pumps operate by maintaining a set amount of water in the cylinder and maintaining a set temperature by cycling the hot water through the heat pump and into the storage cylinder. Potable water is delivered between 10 °C to 20 °C and boosted up to the set point of 50 °C. The system, shown in the above diagram, is summarised as follows:

- Each hot water cylinder is connected to both the HWHP and gas heating systems.
- DHW1 and DHW2 are stored at 50 °C.
- HWHP1 and HWHP2 are controlled based on maintaining the storage temperature of DHW2 at 50 °C.
- Gas heating is provided if DHW2 drops to a temperature of 43 °C. Gas heating switches off when DHW2 reaches a temperature of 48 °C.
- UFC1 (underfloor system) contains water stored at 40 °C.
- Both HWHP1 and HWHP2 have their own controller at the MCC to receive and act on the Orion ripple signal. During peak load periods, the heat pumps are switched off, and the gas system provides heating to all three cylinders.

DETA worked with the client and contractors, Hartnell Coolheat, to facilitate the installation and conduct monitoring and verification post-installation.

Project cost

The project was estimated to cost approximately NZ$163,690 for a 90 kW system in 2015, which was supplied by Gree and installed by Hartnell Coolheat, with an estimated savings of 129,700 kWh and a 10-year net present value of NZ$180,000.

Within New Zealand, there are no white certificates available for project activities. However, the emissions trading scheme is linked to the carbon emissions associated with the fuel type. Therefore, by gaining efficiency via the heat pump and switching electricity, costs were reduced.

Other system benefits

The following co-benefits were realised in this project:

- Improved social license to operate
- Reduced carbon emissions
- Reduced operational costs
- Increased functionality/hot water production leading to more effective control of building temperatures.

Project outcomes

DETA worked with St John of God Hauora Trust and contractors, Hartnell Coolheat, to facilitate the installation and most importantly conduct monitoring and verification post-installation. The decarbonisation and consumption savings achieved from the project show the impressive results with annual cost savings greater than expected: NZ$40,929 instead of $NZ36,920.

Project observations, findings and challenges

This project represented the first application of a Gree heat pump of this scale in New Zealand, as well as the first heat pump installation in a care home setting. The partnership between DETA and St John of God Hauora Trust was key to the client having trust in the system to operate as expected.

The economics of the project were improved by maintaining the existing gas system in place and providing alternative flexible demand revenue streams. From this project, it is recommended that a holistic approach is taken to heat pump projects to improve economics where possible.

Heat pumps are an ideal application for heat pumps. The temperature range required is easily achieved by heat pumps and with multiple heating demands there are opportunities for integration and diversification of load (with appropriate storage). This project is a great example of how implement heat pumps correctly in this application.