CASE STUDY | South Canterbury, New Zealand

Timaru Hospital (SCDHB)

COMMERCIAL/HEALTHCARE | HEAT PUMPS

Timaru Hospital, South Canterbury District Health Board (SCDHB), is a site that historically has utilised a coal boiler to provide space heating for the various hospital facilities, domestic hot water and to service the on-site laundry.

The hospital team was focused on looking for ways to improve its environmental footprint, eliminate coal emissions and to implement reliable, efficient infrastructure for the future to meet the hospital's heating, hot water and steam sterilisation requirements.

The existing heating system comprised two coal boilers, each with a capacity of approximately 6 MW, which were installed in the 1970s. These boilers provided all the hospital's heat requirements, requiring more than 2,000 tonnes of coal per year and resulting in annual carbon emissions exceeding 4,500 tonnes CO2-e. Their primary function was to supply space heating and domestic hot water across the various hospital facilities, hot water for the on-site laundry and steam for sterilisation.

The system was originally designed to function with a supply temperature of 80 °C and a return temperature of 70 °C. In practice, the system had been operating with a 60 °C supply temperature and there were no reported temperature issues or complaints.

Project summary

Location: South Canterbury, New Zealand
Facility type: Hospital
Consultant: Deta Consulting
Installer: Airtech

Equipment replaced: 2 x 6 MW coal boilers
Water temperature set point: 60 °C
New equipment: 4 x QTON and 6 x hot water heat pumps
Estimated annual reduction in coal: 2,280 tonnes
Estimated annual emission savings: 4,560 tonnes CO2
Total project cost: NZ$4,556,000

The system had been tested successfully at an external temperature of -1 °C, with a heating supply hot water temperature of 60 °C, and it maintained acceptable internal temperatures.

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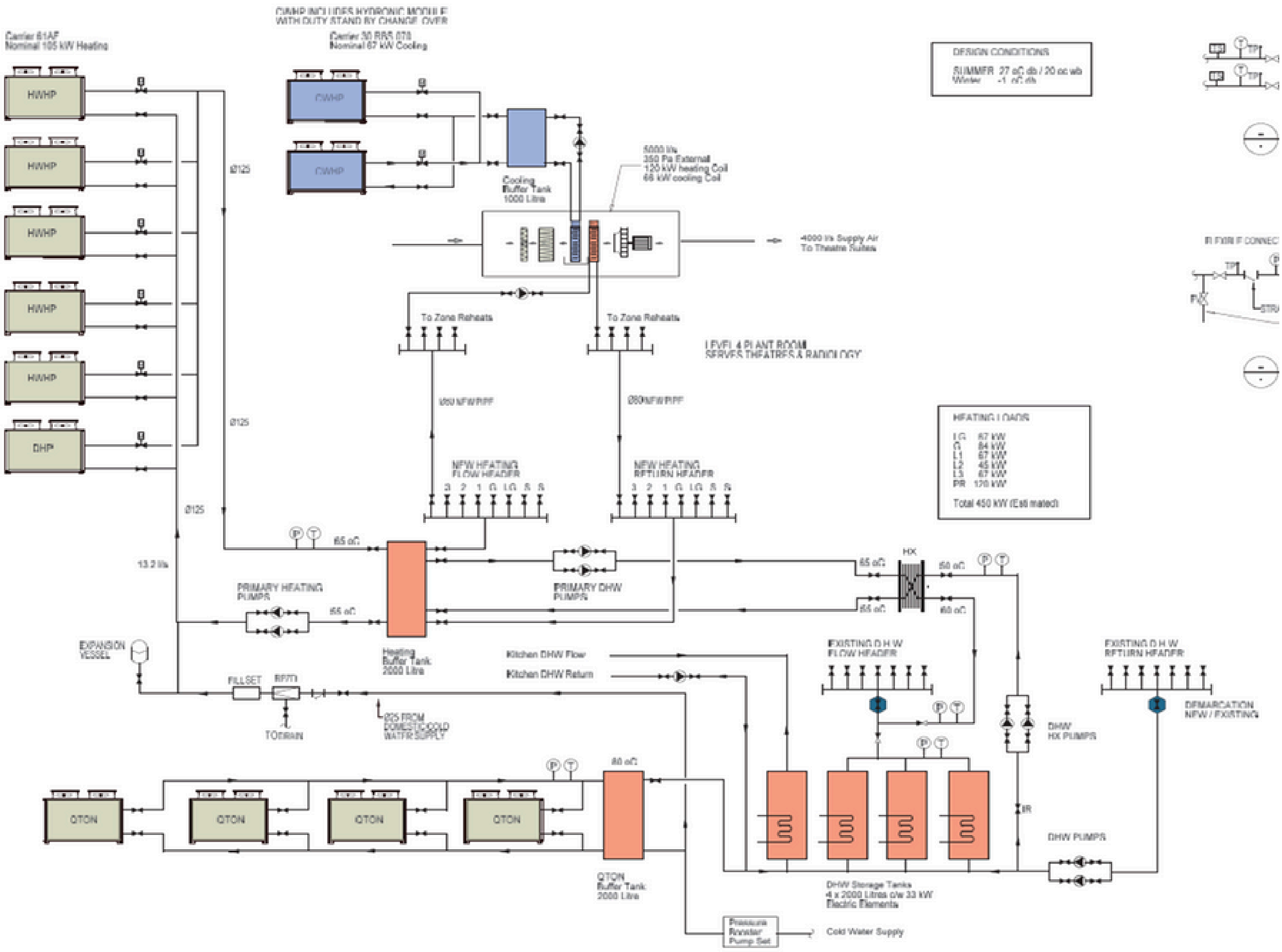

Diagram showing how the new heat pump integration was planned at the site.

Heat pump solution

DETA Consulting initiated the project with an options study, in which DETA pinpointed the following:

- The existing system suffered from significant inefficiencies, resulting in far higher carbon emissions than necessary. Up to 50% of the energy supplied to the site from coal was being lost due to suboptimal combustion and system losses (e.g., non-insulated piping, broken steam traps, and leaks).
- The aging, centralised steam generation and distribution system posed risks related to maintaining services and increased energy and maintenance and operational costs.
- To achieve desired outcomes, it was necessary to first eliminate steam and then to consider implementation toward some level of system decentralisation.

Following a comprehensive review of potential technologies, DETA's initial feasibility options study favoured biomass hot-water boilers to replace the coal-fired steam boilers. This choice was primarily due to the requirements of sterilisation and the high-temperature water required for heating, especially in operating theatres. This choice was also supported by the limited availability of suitable commercial heat pump options at the time. However, both biomass and heat pump options were developed concurrently to ensure a comparative case could be presented to SCDHB, with each case considering practical and cost-effective solutions.

Ongoing collaborative research and evolving technology made the considerations of an air-source heat pump the more favourable option, provided certain challenges could be addressed.

The decision to decentralise the smaller buildings on-site with dedicated heating systems was made early in the process. This allowed for these smaller buildings to be supplied with cost-effective air-sourced heat pump systems and hot water cylinders.

The steam required for sterilisation was removed from the equation by use of a dedicated electric steam generator, which was suitably-sized to allow for existing and future steam demand requirements. The requirement for any steam use for kitchen equipment was also negated thanks to an electrification program in this department.

In summary, a compelling case was established for the use of a suite of electric air-sourced heat pumps to provide heating and domestic hot water services to the main hospital buildings and associated services. Key characteristics of the replacement heat pump system are as follows:

- For heating hot water, a bank of unitary heat pumps was employed, running on R410a refrigerant, and delivering water at 65 °C to the existing radiator network. These units were designed to operate efficiently, even in external ambient air temperatures as low as -2 °C.

- Domestic hot water needs were met by heat pumps with a nominal output of 120 kW, operating on CO2 refrigerant. The water from these heat pumps was stored in cylinders, with electric elements serving as backup and for legionella disinfection cycles. A secondary hot water supply was established through a heat exchanger, utilising hot water from the heating hot water system to provide redundancy.

- The selection of refrigerants was based on their thermodynamic properties, which were well-suited to the specific applications. As the specified systems used commercial-type units with relatively low refrigerant charge, the associated risk was low. Further mitigation measures included proper installation in well-ventilated areas, warning systems, and built-in safety features.

The selected supplier for the main works was Christchurch-based HVAC specialists Airtech. A challenge that was overcome was that a complete transition of the operating theatres over to the new, improved services was undertaken in only four days, minimising disruption to the busy theatre schedules as much as possible. This was achieved using capable contractors and through open and collaborative communication channels in the planning as well as execution stages of this work.

Project outcomes

This project saw 12 MW of coal boilers taken offline and replaced with electrified heating services. The system was designed to mirror the functionality of the existing system condition and has been effectively operating for more than years. The verified decarbonisation and consumption savings show the success of the project:

- Total annual energy savings of 1018 MWh
- Total annual cost savings of NZ$70,800
- Total annual diesel savings of 1308 MWh
- Total electricity consumption increase as a result of the project limited to 290 MWh.

Other project benefits

Some of the additional, and unexpected, benefits for the hospital include:

- Improved standby capacity for critical services (e.g., operating theatres)
- Greater flexibility to cope with peak demands
- A more efficient and reliable heating system
- A significant decrease in total energy used on-site
- Improved future-proofing for an evolving health system
- Siting the new system on the hospital roof has maintained real estate for future development and expansion if required.

Project observations, findings and challenges

The project's timelines required the contractor request for proposal (RFP) responses to be submitted before the end of January and so the contractors had to be notified in December. While interest was identified in December, it was clear that January is a difficult month to receive good responses to RFPs – always consider issuing in January for response in February to avoid this!

Operational hospital environments are always a challenging workplace environment with active care facilities often adjacent to the worksite. Careful attention to contractor selection and planning activities associated with the work are therefore critical to this sort of project's success.

The biomass option was economically viable but there were several factors that scored negatively toward this option, such as the fuel storage and handling considerations. Fortunately, these considerations were picked up, but the encouragement is that appropriate consideration of all non-cost project criteria is essential to ensure consideration of the 'big picture in any project's development.

In this project the creative magic was achieved with all parties taking a collaborative approach and being prepared to test their thinking. This resulted in Timaru Hospital now having a robust, future-proofed system that is more efficient, has reduced waste, and can flex and adapt to the changing needs of the hospital departments. Best of all, when we visited recently to see the finished system (on a typical frosty Timaru morning), the hospital was warm, whilst the old boiler house was cold and silent with not a coal truck in sight.