Wastewater thermal energy mapping

Dunedin City Council worked with Smart Alliances and other suppliers to calculate and map the thermal energy available within one of the city's three wastewater networks. Based on an article originally published in *NZ Local Government* magazine, also published by Contrafed Publishing.

Globally, buildings use about 40 percent of the world's manmade energy. However, in cities, which have high concentrations of buildings, this figure is often higher at around 60 percent and around half of the energy used by buildings is used in heating or cooling systems.

Every house, apartment and building in a city has a hot water system the contents of which go down the drain every day. This makes wastewater a huge energy resource which is currently almost totally ignored.

There are already an estimated 700 to 1000 established systems around the world that recycle thermal energy from wastewater for heating and air conditioning, and this number is starting to rise rapidly.

The first such systems were installed in Switzerland more than 30 years ago and there are at least five wastewater heat transfer systems operating in Australia, including the Hobart Aquatic Centre, which has been running successfully for over 20 years using the city's wastewater heat.

Although the concept is new to this country, technically it's quite simple so long as the systems are designed appropriately.

Nick Meeten (pictured) is buildings, water and sustainability consultant at engineering consultancy Smart Alliances. and an expert on this topic, having worked globally on it for the past seven years.

In 2015, he returned from Germany to New Zealand and is now working for Blenheim-based engineers Smart Alliances.

He says wastewater is an enormous untapped source of thermal energy available in every one of our towns and cities and the potential energy savings are huge.

Independent research from the US shows wastewater energy can lower heating – or cooling – electrical energy use by about 40 percent when compared to conventional air-based solutions and it makes better use of existing wastewater infrastructure.

In June this year, Bloomberg reported that wastewater in London could provide around a third of the city's heat needs (see bit.ly/GreenHeatSource).

"Dunedin City Council recognised this untapped opportunity after hearing my presentation at the August 2016 IPWEA conference in Melbourne," says Nick.

"In late 2016, the Council commissioned Smart Alliances to help it get started by calculating and mapping the thermal energy available within one of the city's three wastewater networks.

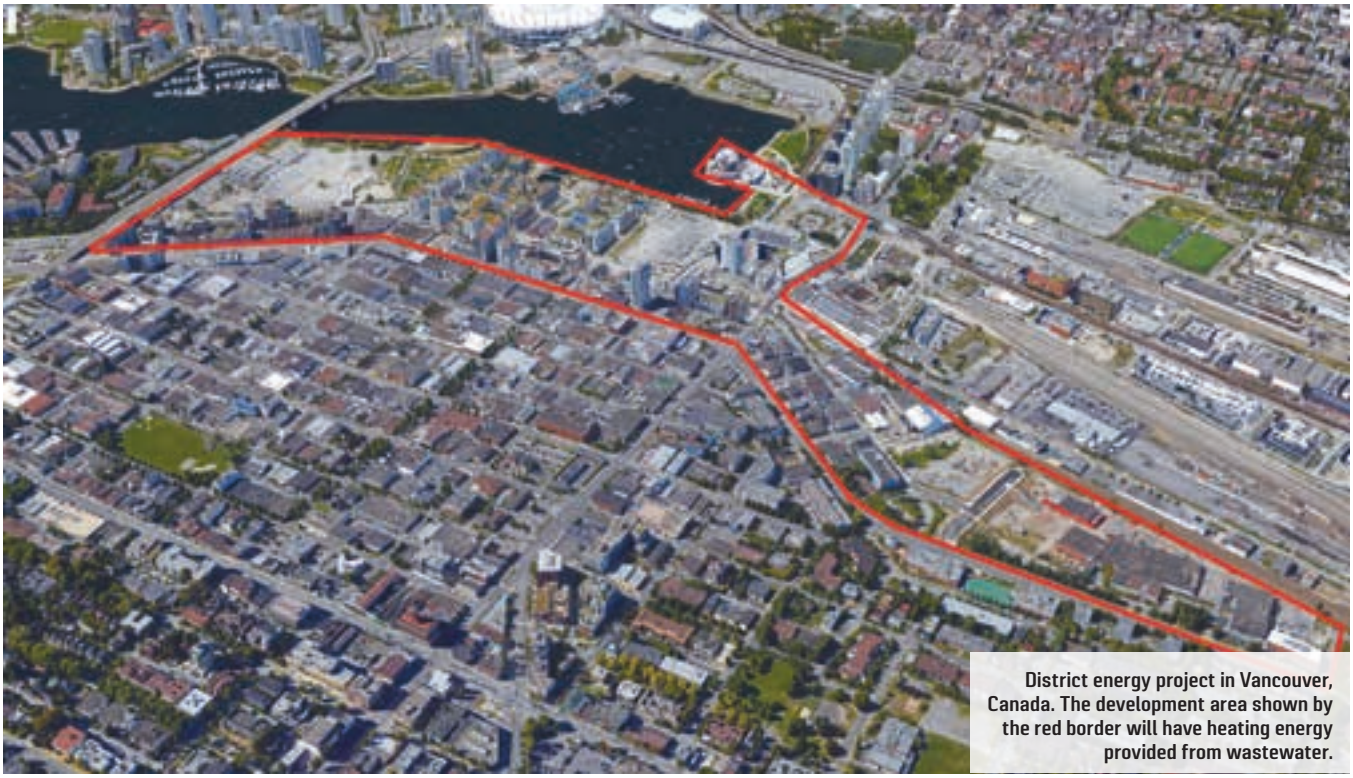
"The project was completed earlier this year and showed up to 10,000kW of thermal energy is available within the network studied. Dunedin has three wastewater networks, but we only studied one of these. So this 10,000kW is estimated to be approximately 60 percent of the overall total, if all three systems were taken into account."

He says the system studied could provide enough thermal energy to heat about 1000 typical houses (or equivalent commercial buildings and industries) and Dunedin City Council now has information and energy maps allowing it to develop a strategy to start utilising this wasted energy.

Nick says that as a thermal source wastewater is stable and neutral in temperature all year round.

This makes it relatively warm in winter and relatively cool in summer compared to ambient temperatures. This temperature stability, together with the excellent energy capacity of water, means buildings' heating and cooling systems do not have to work so much against nature to provide heat or take heat away from buildings.

This simply translates to significant increases in efficiency of the heating and cooling systems, and savings in electricity needed to power these systems.



District energy project in Vancouver, Canada. The development area shown by the red border will have heating energy provided from wastewater.

Wastewater is simply pumped out of a street trunk sewer and put through a special wastewater heat recovery system, before it is pumped back into the sewer. Everything else within the building is conventional heating/cooling equipment.

Other benefits include allowing heavy heat exchanger equipment, which is normally mounted on the roof of a building, to be located down at ground level.

In a seismically active country like New Zealand, removing this weight from high up on a building lightens the load on the building structure.

The Dunedin survey

The project team consisted of Dunedin City Council wastewater manager Laura McElhone as the client, and Smart Alliances in Blenheim as project leader.

Smart Alliances teamed up with collaboration partners Applied Energy also Blenheim based and Kerr Wood Leidal (KWL) engineers in Vancouver, Canada.

Despite the project team being widely distributed geographically, the entire project was delivered smoothly and without requiring any travel, which Nick says kept costs down.

As project leader, Smart Alliances was the single point of contact with Dunedin City. KWL provided the specialist calculations and Applied Energy the mapping skills. KWL had previously developed a specialised calculation model for this purpose for wastewater energy projects it had previously undertaken for Metro Vancouver (a federation of 21 municipalities that collaboratively plans for and delivers regional-scale services for the Vancouver region).

However, before the collaboration started with Smart Alliances, the calculation modelling service had never been provided for other cities outside of Canada.

The Smart Alliances/KWL/Applied Energy team started working together in early 2016 by trialling the calculation and mapping process on Blenheim as a test project, and this ironed out initial teething problems.

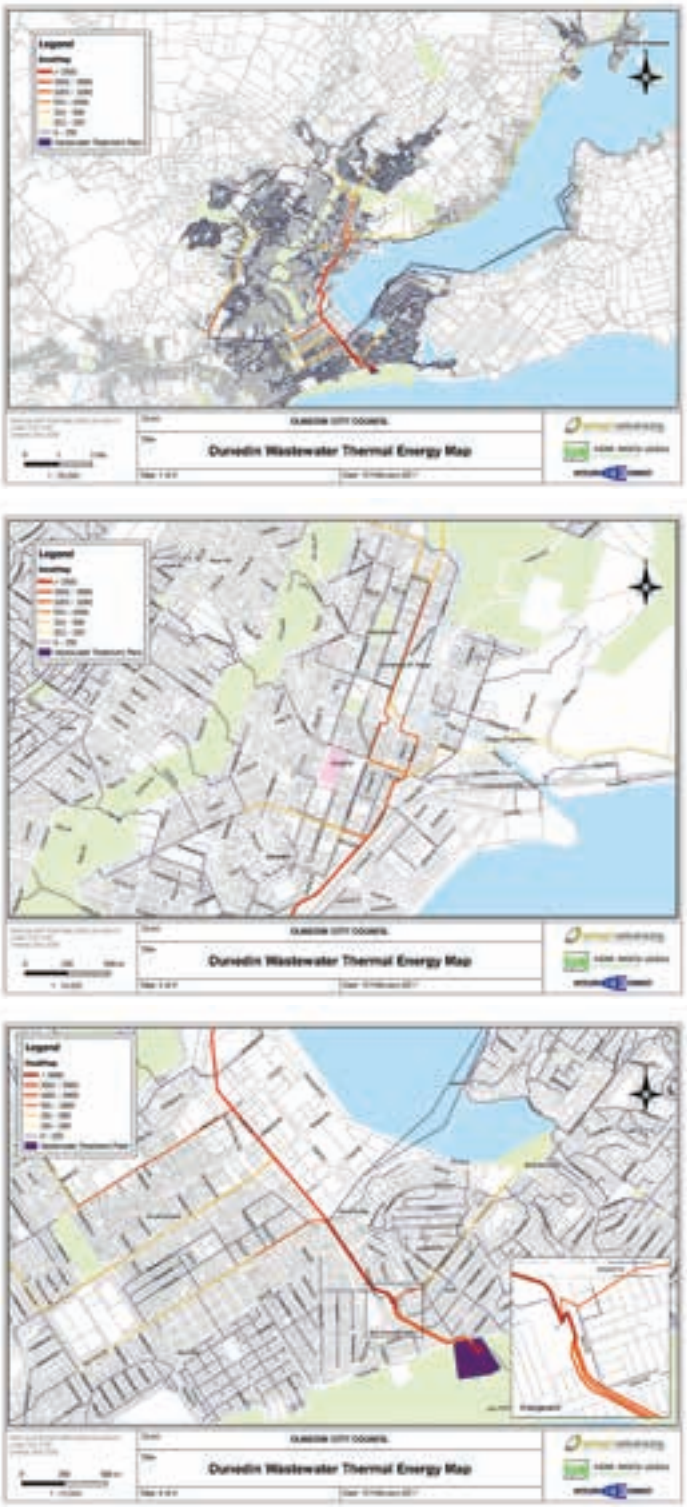
For the Dunedin project, a variety of council data was used such as wastewater infrastructure data, temperature data and hydraulic modelling data. Other criteria required by the KWL calculation model were discussed and agreed.

Revenue generation

The thermal energy available in wastewater could become a new source of revenue for cities which want to utilise it. There are different ways it can be monetised, and at least two different commercial models are being used in other parts of the world. Quebec City charges an annual connection fee for tapping into the energy from its wastewater network.

Scottish Water adopts a different approach by metering the amount of energy withdrawn by a college campus and charging per kilowatt hour of energy.

Other commercial models will evolve and every city should view its wastewater flows as potential energy with a value attached.



Dunedin energy maps.

Once the necessary data and inputs were in place, this was delivered to KWL – which ran its calculation model and delivered the results back to Smart Alliances. This calculation data was sent on to Applied Energy which displayed the data as thermal energy maps for Dunedin City.

A variety of maps were generated at differing scales to provide high-level overviews down to detailed maps for parts of the city.

Once the maps were generated, a number of locations within the city presented themselves as good candidates for potential energy from wastewater projects. These locations ranged from the existing university campus, and the hospital, to areas identified as possible future development sites for the Council itself.

Apart from the maps, a comprehensive report was also provided to Dunedin City. This report covered the topic of using wastewater as an energy source, the agreed inputs used in the calculation model, and discussion of the findings.

A comparison of the wastewater temperatures from Dunedin with a number of other cities was provided to illustrate that the southern city is well within the normal expected range.

The report also covered variations in thermal energy due to daily flow profiles and, for the wastewater plant operators, where the threshold limits are to ensure possible impacts in the wastewater treatment plant's biological processing are managed. A number of example projects from overseas were shown within the report, to give Dunedin City some ideas for what could be suitable candidates within the city.

Now that it has the vital energy maps to guide it, Dunedin City Council is proactively taking the concept forward by approaching suitable site owners who are located close enough to take advantage of the opportunity. The City Council is also alerting new developments to this possibility as they come up.

Since the completion of the Dunedin project, Smart Alliances has also been commissioned by another New Zealand city to assess the feasibility of heating a large aquatic centre using wastewater heat.

Aquatic centres require significant amounts of heat all year around, and are typically one of the most expensive energy using facilities a city has. They are a perfect candidate for using wastewater heat.

It is worth noting that this project was also a finalist in the 2017 Deloitte Energy Excellence Awards – 'Innovation in Energy'. **WNZ**

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