THERMAL POTENTIAL HAILED AS THE NEXT BIG THING

by Yale Carden, Managing Director, GeoExchange

The potential of geothermal as a source of renewable electrical energy in Australia has waned in recent years as technical and financial complexities impede its progress, but another form of 'geothermal' energy has been successfully improving the energy productivity of buildings around the country – geoexchange technology.

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Yale Carden is the Founder and Managing Director of GeoExchange Australia. He has 20 years' experience in the sustainability sector, the past 10 of which have been specifically in geoexchange systems. A member and certified installer with the International Ground Source Heat Pump Association, Mr Carden advises the public and private sector across Asia Pacific.

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Commonly referred to as geothermal heating and cooling or geothermal heat pumps, geoexchange technology is not a function of geothermal heat. Instead, it utilises stored solar energy in the ground or a water body. As these temperatures are closely associated with the average ambient air temperature, geoexchange enables the system to act as a heat source (heating), a heat sink (cooling) or as thermal storage.

To avoid confusion with geothermal electrical energy, this technology is often referred to as geoexchange heating and cooling or ground source heat pump systems – whereas most conventional heating and cooling systems can be considered to be air source heat pumps as they utilise the ambient air as the thermal source.

Rather than producing supply-side renewable electrical energy, geoexchange is reducing energy consumption by producing renewable thermal energy. It was identified as a top 10 energy productivity technology in the 2015 ClimateWorks Australia report titled *Australia's Energy Productivity Potential: Energy's Growing Role in Australia's Productivity and Competitiveness*.

Given that the built environment contributes to 45 per cent of our energy usage, according to a 2012 pitt&sherry report titled *Baseline Energy Consumption and Greenhouse Gas Emissions in Commercial Buildings in Australia*, geoexchange has the capacity to provide significant energy reductions.

THE GEOEXCHANGE APPROACH

Conceptually, the operation of the geoexchange system itself is simple. In much the same way that our ancestors avoided surface temperature extremes by living underground in comparatively moderate temperature caves, a geoexchange system enables individual or connected buildings to access this underground resource for its own heating or cooling needs.

To achieve this, a geoexchange system (Figure 1, page 55) consists of:

- a ground heat exchanger (GHX) that provides the thermal connection through the heat source/sink (usually the ground)
- a ground source heat pump (GSHP), the heat pump or air-conditioning unit that delivers the heat or cooling into the building.

Geoexchange technology has been successfully applied to residential and commercial projects across the country, with pioneering systems at Geoscience Australia, Lithgow Hospital and Wagga Wagga City Council installed in the mid-90s still operating as efficiently today as when they were installed.

Some of these installations are now replacing their GSHPs with modern and more efficient models, while the GHX continues as the foundation of the system's efficient operation and will do so for many generations of GSHPs.

Recent geoexchange installations – such as the Riverina Highlands Building for Tumut Shire Council and the Sustainable Buildings Research Centre for the University of Wollongong – are coupled with on-site solar PV systems. This coupling of technologies further enhances energy productivity through both local renewable energy generation and the high efficiency of geoexchange as a demand-side measure. The end result is that Tumut Shire Council has reduced its annual electricity usage by up to 70 per cent and its peak electrical load by 75 per cent, while the Sustainable Buildings Research Centre is a net exporter of electricity.

FIGURE 1

Figure 1: a commercial building with a vertical borehole ground heat exchanger.

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THERMAL POTENTIAL AND ENERGY PRODUCTIVITY

The unique nature of geoexchange systems is such that the heat source/sink is not always the ground. Successful systems have also used surface water bodies, groundwater aquifers, adjacent buildings with complementary thermal profiles, building foundations, and sewer and water infrastructure. The common feature of each of these is the availability of relatively constant, stable temperatures that are typically associated with desired internal room temperatures.

This introduces the concept of thermal potential as a way of optimising the efficiency of heating and cooling systems. That is, what is the available thermal energy in a given location that can be utilised for heating/cooling a building or a group of buildings?

Thermal potential includes heat sources, heat sinks and thermal storage. It can include a hybridised approach between different thermal sources listed above – comprising conventional systems that utilise ambient air. Such hybridisation, coupled with optimised control strategies, allows a building to select the most appropriate thermal source at any given time to optimise efficiency and reduce operating costs.

Building operating costs can be reduced further with on-site renewable energy generation and either/both electrical and thermal energy storage. That is, produce the heat/cool at an optimum time depending on the cost of power and temperature of thermal source, and then use either or both energy storage systems when energy generation and thermal load do not perfectly align.

In much the same way that energy potential is used to identify the optimal renewable energy project for a specific location, thermal potential enables a system designer to identify the optimal heat source, heat sink or thermal storage for a specific building or buildings.

It is in this combination of on-site renewable energy and the localised use of thermal energy where the greatest benefits to energy productivity exist. This combination enables a building or connected buildings to obtain the most value for each kW produced, while also significantly reducing the carbon emissions associated with each kW generated for that value output. eco