Staying cool in a heating world

As temperatures, as well as living standards, rise, the electricity demand for air conditioning is expected to triple over the next three decades. Signe Hansen looks into the still rarely exploited alternative of using GSHP for cooling

A new shared ground-loop array GSHP system by Kensa Contracting will provide energy efficient heating through Kensa's Shoebox heat pumps in the winter and passive cooling in the summer

Unbeknown to most people, cooling through air conditioners and electric fans, today, accounts for 10 per cent of all global electricity consumption. Moreover, with living standards rising especially in the warmer parts of the world, the global energy demand from air conditioners is expected to triple by 2050. These are facts and predictions presented by the International Energy Agency (IEA) in the report *The Future of Cooling*.

Consequently, the report concludes, increasing the energy efficiency of cooling appliances for both private and industrial use is crucial to limiting electricity consumption and carbon emissions. One way of doing this is by using ground-source heat pumps (GSHP) for cooling.

Robin Curtis, director and GSHP specialist at UK company GeoScience Ltd., explains: "The statistics are horrifying - the IEA estimates that 10 air conditioners will be sold per second for the next 30 years! Properly designed and installed GSHP that make use of ground cooling can be more efficient (and far less unsightly). So, there is the potential to save significant amounts of electricity and reduce carbon emissions."

Unfortunately, in the UK, many people are still unaware of the potential of GSHP, which are mainly used in large-scale commercial and public buildings. Even when the heating potential of GSHP are recognised, the cooling potential might not be, Dr Matthew Trewhella, MD of Kensa Contracting, part of the Kensa Group, the UK's leading provider of ground-source heat pumps, says: "We have even seen ground-source heating and air-source cooling in the same building."

"There is the potential to save significant amounts of electricity"

In other countries such as Sweden, the US and France, the potential of ground- and water-source heating and cooling is being explored and exploited more widely in the domestic, public and commercial sectors.

THE POTENTIAL

When looking at sources of cooling, the ground will always be more efficient than the air. Furthermore, when you combine heating and cooling options, the efficiency increases explains Trewhella. "For example, if you have a block of flats with retail (supermarket) on the ground floor, the annual heating load of the flats could be larger than the annual cooling load of the supermarket. In this scenario, the cold stored in the ground (created by extracting heat from the ground to heat the flats) can be enough to provide all (or much of) the cooling demand without the use of a heat pump at all (or at least minimal use). We call this passive cooling and it is many times more efficient than even regular ground-source cooling."

In the UK, the fact that the decarbonisation of grid electricity will be recognised in Part L of the Building Regulations as of 2020, will also make a significant difference to the measured carbon efficiency of both ground-source heating and cooling. Furthermore, explains Bean Beanland, chairman of the GSHPA (Ground Source Heat Pump

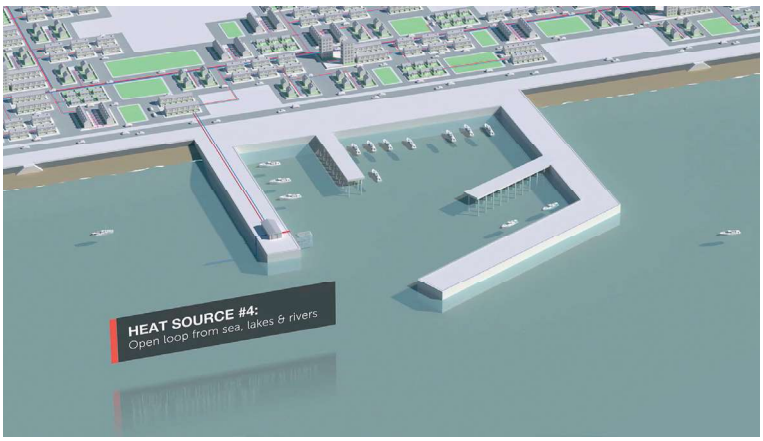
Association), financial viability can be improved by load-shifting ground-source operation into the night when electricity is frequently cheaper and can be accessed using agile tariffs. "Heat or cool generated at night can be stored in thermal stores and released into the building during the day as required," he says.

Where aquifers or surface water sources are present, the potential for cooling via heat pumps or passive cooling becomes even more obvious. This was recognised by Boris Johnson, who, in 2015, as the Mayor of London, came back from a climate event in France questioning why London was not being cooled via heat pumps from the Thames the same way the French were cooling Paris via district cooling from the Seine. "We have been telling people that this was possible for years, but the Environment Agency and Thames river authorities were not, historically, inclined to work with us to make it possible," says Beanland. "I believe that attitudes at all the related agencies are now changing for the better. The cooling (and heating) capacities of the major rivers in our towns and cities are enormous."

THE TECHNOLOGY

For new, highly insulated, often glazed, office type buildings, the demand for cooling is often as great, nearly as great or greater than the demand for heating. Hence (in the UK and similar climates) this type of building is ideal for GSHP as the required size of the ground components (closed-loop or open-loop system) is minimised. This is due to the fact that the use of the heat pump for cooling might increase its efficiency for heating in the winter. "When the pump is in cooling mode, the ground is effectively being recharged with heat that may, subject to geological and soil conditions, improve the efficiency of the heat pump in winter heating mode," explains Beanland.

In the simplest systems, the heat pumps are just reversible and turn from heating to cooling. However, as with any ground-source heating system, it requires a specialist system designer with knowledge of heat pumps and geology to design an efficient system.



The presence of aquifers or surface water can make the benefits of applying GSHP for cooling even more obvious

Things get more complex with bigger, simultaneous systems that deliver both heating and cooling at the same time. "When you add cooling into this, the level of complication increases. It also places a higher level of accuracy required from the building designer to correctly model the heating and cooling loads. The system as a whole works at its most efficient when the cooling load is approximately 50 per cent of the heating load," says Trewhella, "but once the design is complete, the actual physical installation is straightforward."

In both domestic and non-domestic sectors, GSHP used for cooling eliminate the need for the external evaporator units prohibited by planning restrictions in many places around the world.

WHERE CAN IT BE USED?

GSHPs for cooling can be and are installed in various climates and ground conditions. A significant proportion of domestic GSHP for heating and cooling are installed in the US and Canada while GSHP are used extensively for cooling in data centres in Sweden, and water-source cooling for district cooling in, for instance, Paris.

Climates that have continuous all year-round high temperatures, such as Malaysia or Southern India, are more challenging. In those kinds of circumstances, the ground components become much more extensive, unless aquifers are available. "Open-source/loop aquifer systems are capable of providing significant amounts of passive cooling," explains GeoScience's Curtis. "Because the aquifers are generally (in the UK at least) at a very useful temperature for cooling using passive beams or similar, you just need to run the borehole pumps; there's no need to run the expensive high energy compressors. If around, aquifers are useful for larger non-domestic systems where the development costs of a limited number of high-delivery boreholes to deliver multiple MWs is possible."

However, as with regular GSHP, the specifications for heat pumps allow little room for error. "The margin of error is relatively small compared to the conventional approach with fossil fuels and split chillers where everything gets oversized. This sacrifices efficiency, but no one really monitors and measures fossil fuel and split A/C systems, so the levels of inefficiency compared to the manufacturers' quoted data is rarely identified," says Beanland. "So, more care has to be taken with heat pump system design and specification, but, if you get it right, the outcomes are fantastic."

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