Pumping up the heat for a climate-friendly future

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The chaos caused by a volcanic eruption in Iceland April 2010 and the dispersal of its ash cloud across European airspace was a reminder of the tremendous forces of nature that exist below the ground. Not all subterranean heat sources have such sinister power, however. Across Europe, there are plentiful sources of geothermal energy: heat stored in the ground which can be tapped to provide a renewable and inexhaustible energy supply. Using the right technology to access this power at varying depths and temperatures, we can use this heat to reduce our dependence on imported and climate-damaging fossil fuels.

Until recently, the technology to exploit geothermal energy in a cost-effective way has remained under-developed. However, in response to the growing economic and policy pressures to cut CO_2 emissions and improve energy security, one company set out to change this state of affairs, with remarkable results.

The small spa-town of Lendava, Slovenia, draws on a deep geothermal well 1,500 metres below the ground to supply its district heating network. The 70 degrees Celsius water is used to heat schools, sports centres, shops, businesses and apartment buildings. However, once used, the water is still around 50 degrees Celsius: too cool to re-use for space heating but too warm to re-inject into the well (or dispose of in the local environment).

Nafta Geoterm, the firm that manages the well, was convinced it could make better use of its resource and reuse this 'waste' water. The solution, proposed by Professor Darko Goricanec at the nearby University of Maribor's faculty of chemistry and chemical engineering, was to devise a high-temperature heat pump that could reheat geothermal source water from around 40 degrees up to 80 degrees, at which point it could be reused for space heating. While many heat pumps on the market were able to heat water from around 25 degrees to 60 degrees, none could deliver the high temperatures (80-90 degrees) required for the type of heating system that is most common in Europe's older housing stock: high-temperature radiators designed to be run from fossil fuel boilers.

"If it's possible to heat groundsource water from 15 degrees to 50 or 60 degrees, we thought, why isn't it possible to heat water of 50 degrees to reach 60 or 70 degrees?" said Evgen Torhac of Nafta Geoterm.

With support for the cross-border, multi-sectoral partnership from the EUREKA Network, Nafta Geoterm drew together end-users, research institutions and manufacturing companies, based in Slovenia and Serbia. Many had worked together on projects since the days of the former Yugoslavia. As well as developing a heat pump for Lendava, they recognised the broader potential of their project: a new market for the wider exploitation of geothermal energy sources and waste industrial heat.

In Serbia, Zoran Stevanovic, head of the hydrogeology department in Belgrade University's faculty of mining and geology, wanted to be part of the project in order to develop technical expertise and promote green energy locally. Many Serbian towns have centralised heating networks and, although geothermal resources are plentiful and at much shallower depths than in Slovenia, they are largely underexploited. "Ground source heat in Serbia is most typically used for greenhouse space heating or balneology but could also be efficiently integrated into centralised heating systems and industrial processes," he explained.

To succeed, the pump would have to provide heat more cheaply than using fossil fuels, which was Lendava's fall-back option during cold weather periods. Maribor University's Laboratory for Thermal Energy managed the technical research, led by Professors Goricanec and Jurij Krope. They developed software to model the structure of heat pumps and the influence of different temperatures; and conducted simulations to assess the impact of different types of coolant on the pump's running costs and efficiency. This enabled them to specify and simulate the type of compressor and heat exchanger required to achieve optimal efficiency.

One critical factor, resolved on the suggestion of Serbian business partner Klima, was the choice of ammonia as the heat pump's coolant. Project manager Srdjan Andrejevic explains how, as well as beating the competition on safety and environmental grounds - it is not explosive, as isobutane is, and it presents no threat to the ozone layer, as Freon does - it offered the maximum cooling capacity per kilo of coolant used, which brought down the cost of the unit as it meant the pump could use a lower-volume compressor. Klima and its parent company Mayekawa in Belgium designed the compressor, with unexpectedly good results: for each kW of energy consumed, the pump delivers 6.4kW of heat. The project had delivered a world-class result.

The prototype heat pump does not just heat water to 85 degrees Celcius; it can also be used in reverse, to cool water for reinjection into the ground. The technology has already proved its worth in Lendava: "The heat from the heat pump is cheaper than natural gas. People have cheaper heating," said Evgen Torhac;. Rather than relying on a reserve of fossil fuels to supplement the heat supplied from the town's geothermal well, now it can action the heat pump first, and only use fossil fuels as a last resort.

Although the purchase price of the technology is high, the new pump offered a fair return on investment: four years, assuming the heat pump functions for 1,565 hours per year. And with continued policy support, the roll-out of the technology is expected to go from strength to strength.

"Not only is the development and production of the HTH pump an achievement, but indirect benefits are targeting the environment protection sector as well as the building industry," said Zoran Stevanovic. Already, since completing the project, Klima and Mayekawa have tailored the heat pump design for bespoke systems in France and Norway. The new market appears to have opened.

Provided by EUREKA

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