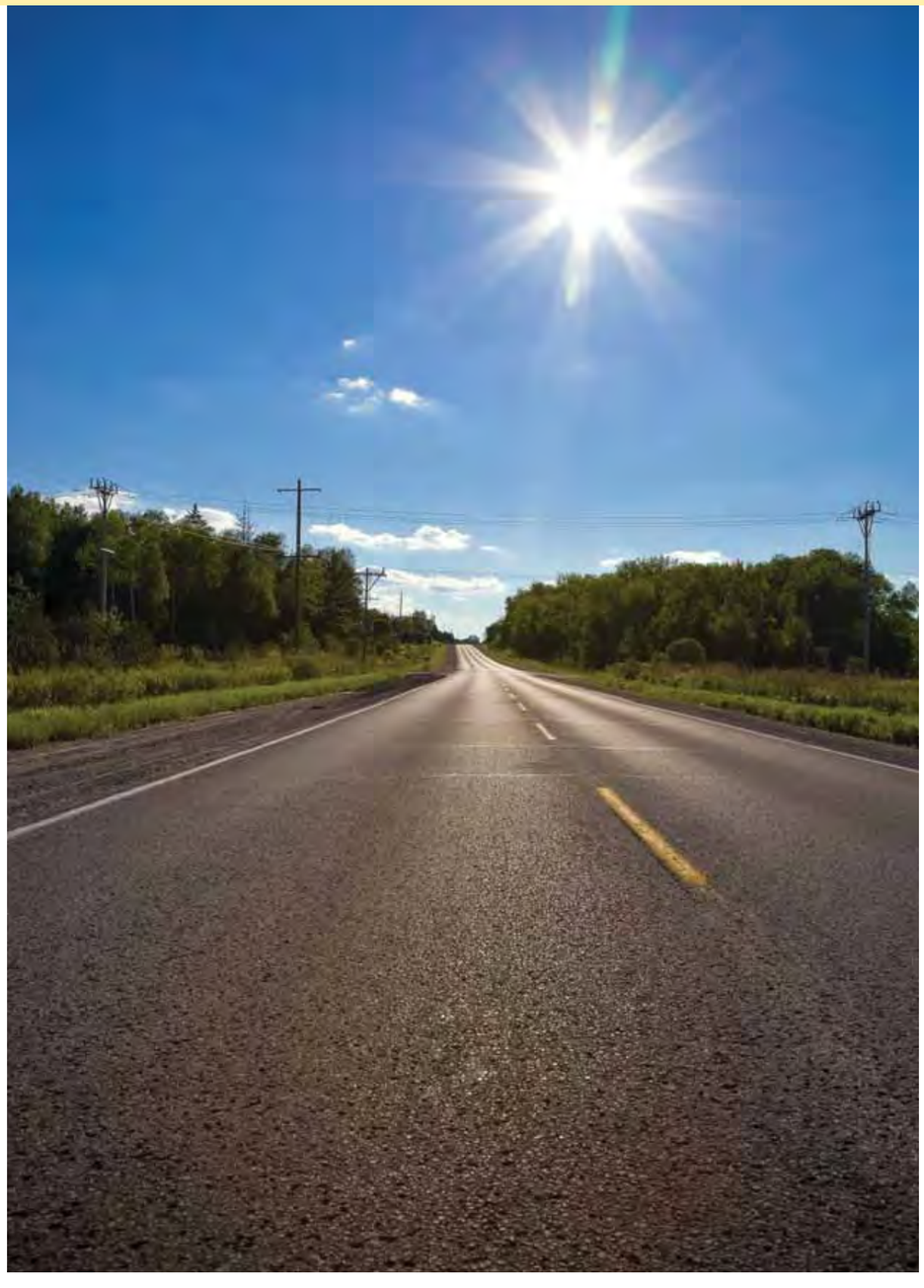
The Answer Beneath our Feet

Alternate energy sources – solar, wind and wave energy – are all becoming more widespread, but if the world's energy needs are going to be met, more innovative low-carbon methods may need to be adopted. Eric Payne reports on a new method for heating roads and buildings.



Throughout human history, mankind has looked to the elements for guidance. Pagan cultures worshipped the sun, the wind and the waves, as gods, and in our technology-led world, scientists have turned to them to solve the world's energy crisis. All of the above have proven potential as alternative energy sources, but all still face significant obstacles which limit their potential adoption, in terms of either economics or efficiency.

Few, however, have thought to look to old mother earth herself, and the ground beneath our feet to provide an answer – until now. Recent technological developments actually make it possible for the earth itself to become a thermal energy store, with the promise of cost-efficient, carbon and pollution-free fuel for the future a very real possibility.

This new method for heating and cooling buildings involves collecting heat energy from existing structures such as roads and car parks, which already cover a significant percentage of our towns and cities. Anyone who has tried to walk barefoot over asphalt on a warm summer's day will known exactly how hot dark, matt surfaces can get. In that sense, storing said energy in groundwater pipes for extraction and practical use in proximate buildings is simply building upon an existing process, which is exactly what makes it so effective.

THE WHOLE PICTURE

The first office building to use heat energy extracted from asphalt concrete was built in 2000 – using Ooms Nederland Holding's 'Road Energy Systems' product, developed in collaboration with WTH and TipSpit. Since then, systems have been refined considerably. One of the leaders in this industry today is UK-based company, ICAX. The company's patented Thermal Bank design promises to be the missing piece of the thermal energy jigsaw, making heat from the sun useful, as part of a sustainable system.

ICAX was founded long before 'environmentally-friendly' became just the latest in a long line of marketing buzzwords, surrounded by hype and obfuscation – back in 1999. The company's stated goal is to help "meet the demand for on-site renewable energy and sustainable development by using interseasonal heat stores, in the quest for zero carbon buildings." A noble quest, no doubt, but how practical is it and what are the costs? I spoke to one of the company's directors, Mr Edward Thomspon, to find out more.

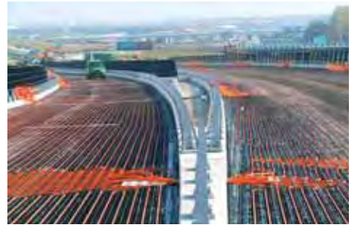
He began by explaining the basics of the ICAX's system and the principles on which it works: "Interseasonal Heat Transfer (IHT) is a new form of renewable energy which combines the strength of solar thermal and ground source heat pumps (GSHP) by connecting between the two, using a thermal bank.

"In renewable energy, all of the various technologies have their own strengths and weaknesses: Solar thermal is a great technology, and it is affordable," Mr Thompson comments. "However, by itself, all it can do is produce a lot of hot water in the summer, which most people don't need. The primary need for heat in buildings is space heating in the winter.

"Another technology, which is very interesting is GSHP, the key merit of which is that you can get four times as much heat out of it as you can from the electricity that you put in – that is four kW of heat for every one kW of electricity input." The reason being that the pump does not have to generate heat, it extracts heat from the ground. However, as soon as you start taking heat out, the temperature of the ground goes down, as does the coefficient of performance. "So, again, a GSHP is a useful piece of technology, but by itself, it is incomplete," Mr Thompson comments.

What ICAX has developed is a mechanism for storing heat to link the two and make them both useful. This system, known as a thermal bank, works on the basis that heat in the ground moves very slowly – just a couple of metres in a matter of months. Mr Thompson elaborates: "Starting with the heat you can quite easily gather with a solar thermal, we use hot water pipes under the soil, to transfer into the ground over the course of the summer months when it is in surplus, for when it is needed in the winter."

The natural temperature in the ground, the world over, is a fairly constant 10ºC at a depth of 10 metres. Over the course of a summer, the system can raise a large volume of ground from 10ºC to about 30ºC. "Now if you match this to an efficient underfloor heating system in a building, typically run at around 40ºC, the GSHP only has to raise the temperature of the water a further 10ºC." A significantly easier task, and one that can cater for 100 percent of a building's heating needs, without the need for fossil fuels.



IMPROVED EFFICIENCIES

With regard to the environmental problems now facing us, Mr Edward Thompson is effusive in his opinion: "We are facing very severe problems related to global warming because we are burning too much fossil fuel. Over 50 percent of the energy used in the UK is used in buildings – largely for heating – and that largely comes from fossil fuels. Providing a way to heat buildings without using fossil fuels is radical, and important, and has a key role to play in reducing our overall dependence on them," he enthuses.

The environmental benefits of the system are without question, promising to lower carbon consumption from heating by 50 percent and for cooling by 80 percent. Then there is the important issues of cost, which still makes so many alternate energy ideas prohibitively expensive. With Interseasonal Heat Transfer (ITH), Mr Thompson assures us, this is not the case: "There is a larger capital cost," he says, "the cheapest way to heat a building is to slam in a standard gas boiler and start releasing CO_2. However, there are also very significant savings for every year of the life of your building."

With regard to maintenance, Mr Thompson is happy to be able to tell us that "a GSHP is a very simple mechanism with very few moving parts. Most refrigerators use a heat pump and refrigerators generally last at least five to ten years, without servicing. A GSHP is an industrial version of that, built to higher standards, so the general maintenance cost is very low indeed." The thermal bank does not require maintenance because it is built into the ground and consists of very high quality plastic piping, designed to last 60 to 70 years. ↘

EFFICIENT COOLING

The system is most effective when it is installed in new build constructions, which are well designed, well sealed and do not 'leak' heat. However, most buildings are old and imperfectly designed. This is a separate issue that will need to be looked at in turn.

With regard to new builds, however, the potential benefits are quite significant. "Particularly if they use air conditioning," Mr Thompson informs. "If you have a modern, well designed building, which is well sealed and doesn't lose heat in winter, it is likely to get too hot in summer and will therefore need air conditioning.

"Air conditioning is a very inefficient mechanism. This is something which everybody knows and accepts because they do not not know of any alternative," he says. "ITH offers an alternative." The reason why IHT is so much more efficient in terms of cooling a building stems from one of the most basic physics principles: air always wants to move from a hotter body to a colder body. Traditional air conditioners use enormous amounts of energy to force hot air outside into even hotter air.

IHT works differently. Operating on the same principle as the heating system, IHT can also collect and store cold in the ground, in the winter, for use in cooling during the summer. Circulating cold water through the underground heating pipes and cooling the ground is a process that, as Mr Thompson puts it, "is in tune with nature."

He elaborates: "When you circulate cold in the ground, the warmth in the building is dying to get to that cold in that ground – it will go there of its own accord, and that is why the energy input is so much less and is also significantly cheaper. It merely requires a circulation pump, which does not use very much electricity."

A GREEN FUTURE

The system also has possible applications on roads. "The first project we did was actually for the Highways Agency in the UK. We built an IHT at the Toddington service station on the M1, which collected heat from the road in the summer, took it down into a thermal bank in the ground and released it into the road itself in winter, to stop the road from freezing – and over the course of two whole winters, no ice formed on the road." Therefore, making the system ideal for use on roads at accident black spots.

As one might expect, thermal banks do perform differently in different geological structures. "Some are more suited to it than others. For example, clay is very good, whereas dry sand is less good. Not to say you could not build one – it would just need to be larger."

The system has already had a successful test in Hiroshima, Japan, proving that it can work outside the UK. As Mr Thompson explains, "Further south, heating becomes less of a problem and cooling becomes a larger one. But, it is actually on cooling that we are most efficient."

The quest to apply the technology in other markets also raises some non-obvious issues. "In the Gulf, for example, where it is very hot during the day and very cold at night, instead of having an interseasonal heat problem to be balanced, you can have a diurnal one – between day and night – and there are things that we can do to balance that as well, because ours is a natural process, working with nature."

Finally, with the need for new 'green' solutions becoming increasingly pressing, the fact that solar thermal technology has advanced to a stage where it can be installed in new-build buildings at a competitive price, bringing increased efficiency, is surely a very positive step in the right direction, for companies, governments and individuals around the world to consider, as we move towards a low-carbon economy. □