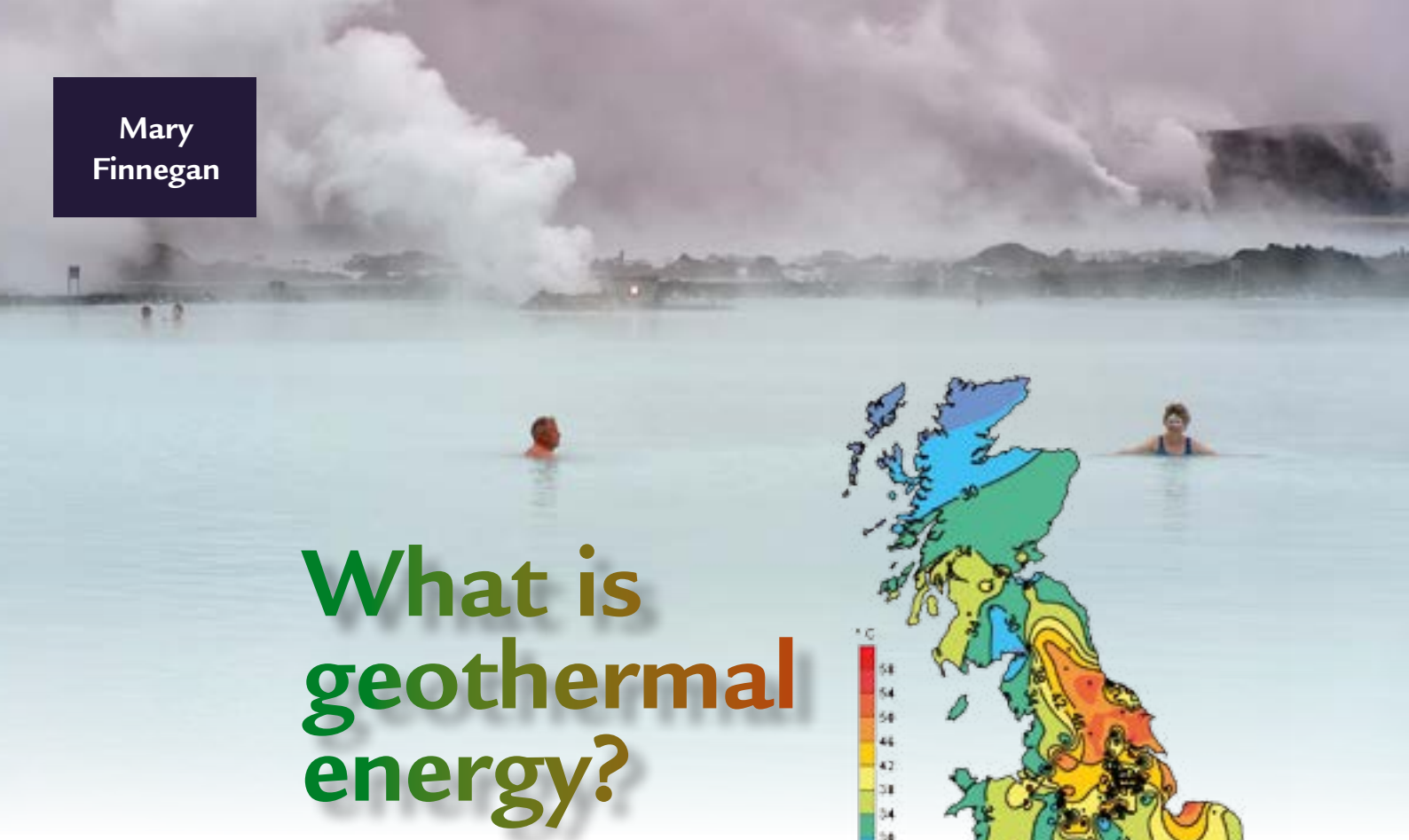
Mary Finnegan



The Blue Lagoon geothermal spa is one of Iceland's top tourist sites.

Key words
geothermal energy
radioactive decay
electricity
power station

What is geothermal energy?

Geothermal energy is the heat is produced by decay of radioactive isotopes deep within the Earth. The temperature at the centre of the Earth is thought to be around 5000 °C, with the temperature reducing toward the surface. It is estimated that 99.9% of the planet is above 100 °C. Geothermal energy is considered a renewable source as the amount available is much greater than the demand.

Hot springs are caused by geothermally heated water rising to the Earth's surface. These have been used for heating since Roman times and humans have been bathing in them since the beginning of our existence.

Temperature and depth

The top 10 to 15 meters of the Earth is heated by the Sun. It warms over the summer and cools during winter. This heat can be concentrated using heat pumps and used to heat buildings, but is not an example of geothermal energy.

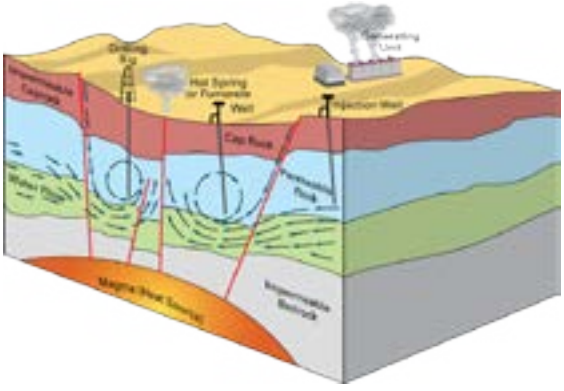
Deeper into the Earth's crust the temperature is not affected by the Sun and remains stable throughout the year. In the UK this is about 9-13 °C. The temperature increases with depth, known as the geothermal gradient. This is caused by heat flow from the Earth's interior and varies in different areas based on the thermal conductivity of the rock.

In the UK the temperature typically increased by around 26 °C every km, but there are hot-spots in the south and north-east of England.

Temperatures at a depth of 1000 m across the UK – black dots indicate measurement points.

Harnessing geothermal energy

Geothermal energy is extracted from the ground using water, which absorbs and stores heat due to its high heat capacity. Hot water aquifers are found when permeable underground materials (e.g. soil, sediment or porous rock) allow water that is geothermally heated deep within the Earth to travel to a relatively shallow depth. Svartsengi and other geothermal power stations in Iceland use hot water aquifers.



A geothermal power plant uses hot water or steam produced deep underground.

Enhanced geothermal systems (EGS) are a new development in geothermal energy. Where a natural aquifer is not present, water is heated by injecting it through into hot, dry rocks. The Habanero EGS power plant in Australia began generating power in May 2013.

Another source of geothermally heated water is decommissioned mine systems which have filled with water over time. The water absorbs and stores heat from the surrounding rocks, which can be extracted and concentrated using heat pumps to heat to nearby towns or cities.

Geothermal electricity and heating

Geothermal power stations use geothermally produced steam to power turbines and generate electricity, much like conventional thermal power stations. Alternatively, lower temperature geothermally heated water can be used to evaporate an organic solvent (with lower boiling point than water), which then drives the turbine. This system is used at the Landau power plant in Germany.

Geothermal electricity production is most suited to countries where the Earth's crust is thin, such as Iceland and the Philippines where around 30% of the electricity is produced geothermally. Geothermal heating requires a less intense heat source and is more efficient than geothermal electricity production.

But just how sustainable is geothermal energy? Despite geothermal energy being considered a renewable resource it is possible for local geothermal heat sources to be affected by high demand and consequently their output reduced. Longevity of geothermal electricity production is demonstrated in Wairakei, New Zealand where power has been generated since 1958. However there has been some localised environmental effects such as subsidence.

Rotorua geothermal power station in New Zealand

District Heating schemes

District heating (DH) schemes distribute heat produced in a central location to residential and commercial buildings in a community. This is popular in many countries in Europe including Sweden and Denmark where DH accounts for over 50% of heating, whereas the UK it accounts for less than 2%.

Geothermal projects in the UK

Heating is responsible for 46% of the UK's energy consumption and is the single biggest use of energy in the UK. The government has set a target of 12% renewable heating by 2020: a big increase from just 1% in 2009.

Southampton district energy scheme: The UK's most established use of geothermal energy began in 1986 in Southampton. A 1800 m deep well extracts water from a geothermal aquifer and uses this to heat fresh water and contribute to the district heating and electricity scheme (see Box above) which provides electricity and heating to a number of public and private buildings in the city centre. The scheme saves a total of 10 000 tonnes of CO_2 each year compared to the annual emissions reported by Southampton City Council of about 27 600 tonnes.

Glasgow Mine Water System: The British Geological Survey recently publicised the results of a study into the geothermal potential of the water in the mines beneath Glasgow, with the conclusion that they could provide up to 40% of the city's heating by extracting around 20 GWh/km^2 each year (about 1% of the total stored energy).

Other projects: The Eden project in Cornwall plans to create an EGS to extract geothermal energy from granite rocks in order to generate electricity. The power will supply the Eden Project and potentially a further 3500 households. Another suggested source of geothermal energy is defunct oil wells in the North Sea. The wells are situated at a point where the Earth's crust is relatively thin (around 10 km thick) and therefore reach high temperatures. Geothermally generated electricity could be produced on the well platform and redistributed to the mainland via undersea cables.

Look here!

North sea geothermal wells: *thinkgeoenergy.com/archives/11618*

British Geological Survey: *www.bgs.ac.uk/research/energy/geothermal/home.html*

Southampton district energy scheme: *www.southampton.gov.uk/s-environment/energy/Geothermal/*

New Zealand Geothermal Association: *www.nzgeothermal.org.nz/nz_geo_fields.html*

Mary Finnegan recently completed a PhD at the Engineering department, University of Warwick.