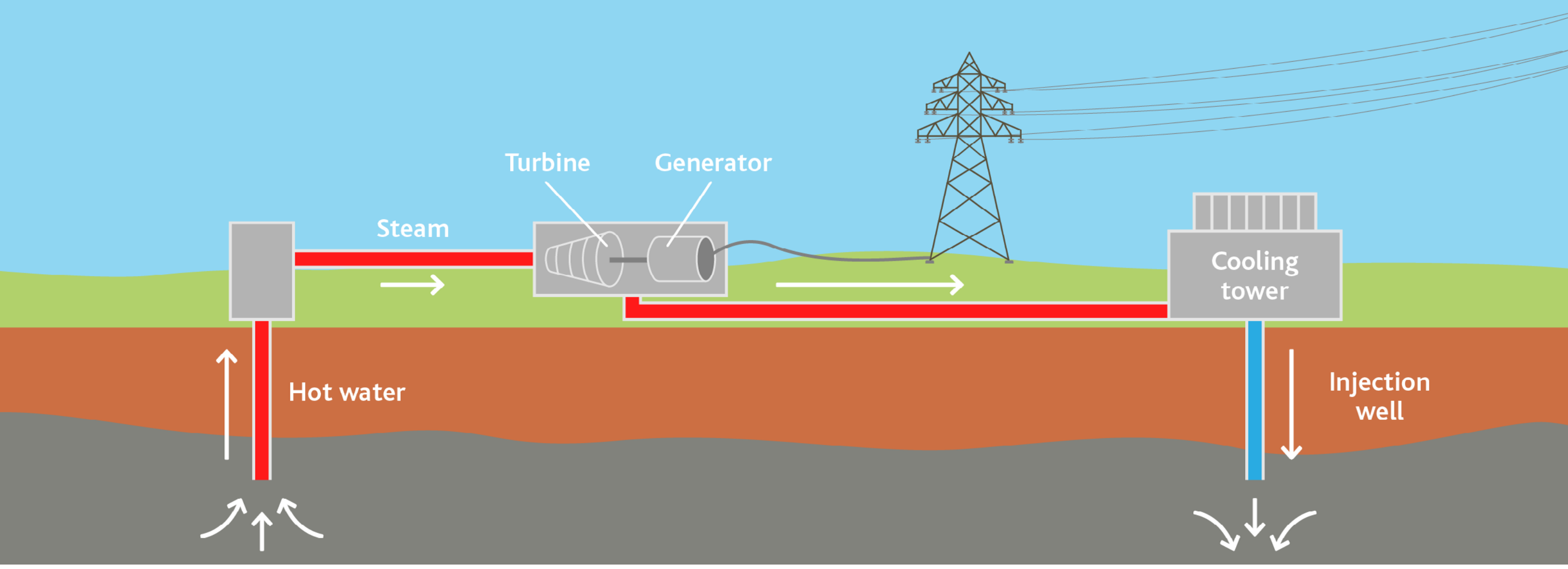

Zero Emission Energy From the Heat Beneath Our Feet

Written by **John M Clegg**
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The world is crying out for plentiful, low-cost, zero emission sources of energy. What if there was a source of energy that could be accessed anywhere in the world to generate heating, cooling, or electricity – that was low cost, zero emissions, and always available?

I graduated with a degree in Engineering Science in 1984, fully intending to carve out a career in aerospace. I was going to design and build new generations of aircraft and the engines that would power them. It only took me two years to realise that my future lay in an entirely different industry: energy. In 1986 I joined a company based in Gloucestershire: it supplied the world with drill bits for oil and gas wells. It might sound very mundane, but it turns out that designing a drill bit that will work under the extreme environmental conditions found deep underground is a significant challenge for mechanical design and materials engineering.

But we took it further

Before I was 30 years old, I was put in charge of a team developing what was effectively a downhole robot. We called it a rotary steerable system (RSS). Our "robot" was able to measure its position and orientation relative to the Earth's gravitational and magnetic fields. It could then use that information to control a mechanical system that would steer the direction of the well. A lot of people think that oil wells are vertical holes drilled from the surface, but this has not been true for a long time. Nowadays, most them start off vertical but end up being drilled horizontally, parallel to oil or gas bearing rocks. Our "robot" made this job significantly easier.

I learned to enjoy working on drilling rigs like the one shown in the (Drilling Rig image.) Working in this industry allowed me to travel all over the world – to thirty-one countries the last time I counted!

< *Image: Drilling Rig Image courtesy of John Clegg*

People drill in these locations to find hot water that is naturally present deep underground. The hot water can be produced as steam and drive power stations to generate electricity.

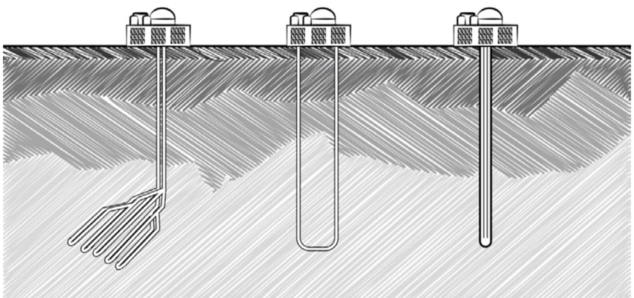
But if we fast forward three decades, to the present day, the world is a very different place. We now have a much better understanding of the impact of carbon dioxide emissions on the global climate. We also know that we need to do everything we can to reduce emissions, ideally at least to zero.

I am now semi-retired, and I've written a couple of books about innovation (which is the introduction of new products or services). I have written about how important it is to meet the needs of all of society when developing new things, and not just think about making profit for a corporation.

I have come to believe very strongly that engineering should do good for society. Now, I've been fortunate to find a way to link these values with the technology I helped to develop all those years ago. I have co-founded a new company, Hephae Energy Technology, to develop the equipment we will need to drill high-temperature geothermal wells.

A handful of countries have been lucky enough to be able to use geothermal energy for heating for thousands of years. In the last hundred or so years they have also used it for electricity generation. These countries are all close to regions of tectonic activity where continents are rubbing against each other. In these places, heat can get very close to the surface – places like Iceland, New Zealand, Indonesia, and Italy. People drill in these locations to find hot water that is naturally present deep underground. The hot water can be produced as steam and drive power stations to generate electricity. And it's worth mentioning that this electricity can be generated all the time, unlike wind turbines or solar panels.

Now, a new generation of unconventional geothermal wells is being proposed. These wells will not require heat close to the surface. Why not? Because if you drill sufficiently deep you can find heat anywhere. They will not require water to be naturally present because they can introduce their own fluids. Using these wells, we will be able to pump cold water into the ground and get steam back, ready to generate electricity. The steam will be created by the natural heat in the rocks below. Even better, water is not the only fluid that can be used for this. In fact, it's very possible that liquefied carbon dioxide will do the job even better. Imagine be able to put carbon dioxide to good use for the environment!



^ *Image: Advanced Geothermal System Image courtesy J. Beard/Pivot2021: Geothermal Reimagined*

The (AGS image) shows a few different proposals for these wells, so-called "Advanced Geothermal Systems" or AGS for short. As you can see, some of the designs are very complex, almost like downhole radiators! Despite their complexity, the "robot" I mentioned earlier is already capable of drilling these shapes. The only challenge when moving to geothermal wells is the temperature.

The sensors and electronics developed for our oil and gas industry drilling "robot" will work up to temperatures between 150° C and 175° C. Although it's possible to drill geothermal wells for local heating and cooling, and even extract a small amount of power, at temperatures like this, hotter is better for geothermal electricity generation. Soon it's likely we will need to be able to drill to temperatures between 300° C and 500° C. At these temperatures, the electronics used in our "robot" will literally melt!

That creates a significant technical challenge, but also an exciting one. I've spent the last two years researching how we can develop the high temperature electronics and sensors that we will need. I've also been looking at what other industries have done. The most exciting part of this research so far, for me, has been talking to the engineers at NASA's Jet Propulsion Laboratory (JPL) in Pasadena, California about their Venus rover. The surface of Venus is close to 500° C. This means that any conventional electrical or electronic system cannot survive there even for a few seconds. NASA has been looking at purely mechanical solutions to this. One of the links at the end of this article will lead you to the results of a recent NASA competition where members of the public could make their own suggestions. But it probably can't all be mechanical because any measurements and images would need to be transmitted back to us. So, NASA has also been looking at how to do it using electronics and developing concepts for electronic systems. These systems might survive for a few weeks or maybe a month at the extreme temperatures on Venus. There's a tantalising possibility that we could work with this team and use electronics developed for Venus to help us to extract the energy that humankind will need from the Earth.

It's just possible that one day our drilling "robot", and a different robot exploring the surface of Venus, could be distant cousins.

My decades in engineering have never ceased to surprise me in terms of the opportunities that have unfolded and what I have found as I turned corners in my career. I never expected it to take me so deep underground or so far out into space. Should you choose engineering as a career, I fully expect that it will surprise and delight you in the same way as mine has for me.

Good luck and reach for the stars!

Glossary

AGS – Advanced Geothermal System

JPL – Jet Propulsion Laboratory

NASA – National Aeronautics and Space Administration

RSS – Rotary Steerable System

Find out more

www.energy.gov/eere/geothermal/geovision

www.jpl.nasa.gov/news/nasas-venus-rover-challenge-winners-announced

www.johnmclegg.com/blog/transition/the-heat-beneath-our-feet/

About the author

John has lived on three continents in a career in engineering in the energy industry spanning more than three decades. Having returned to the UK after many years overseas, John has set up a consultancy in innovation and has co-founded a company that will develop new technology for developing geothermal energy. In his spare time, he used his knowledge to write a book 'Strategy and Innovation for a Changing World' which looks at sustainability through value creation and is available as a paperback.

John was educated in Engineering Science at Worcester College, Oxford University and is an alumnus of Oxford's Saïd Business School. John now lives in Cheltenham with his wife and two dogs.

Key skills: Problem solving, creativity, staying positive and aiming high.