# Going underground for earthly treasures

**The way we exploit, respect and protect our geological resources is changing, finds *Jon Herbert*.**

When it comes to clean energy the future is beneath our feet, says Energy and Clean Growth Minister, Claire Perry.

She points to a secure domestic energy supply that could provide thousands of highly skilled, well-paying jobs. It could also boost the economy while triggering a huge innovative engineering sector with an export potential last seen in the 1960s when North Sea oil first came ashore.

But then her argument becomes more controversial. Natural gas produces lower carbon emissions than oil and fast-disappearing coal-fired power stations. It is currently seen as an interim solution to keep the lights on while the UK moves purposefully towards tough 2050 greenhouse gas reduction targets.

North Sea output is becoming more efficient but is also in long-term decline. Pipelines from Russian gas fields across Europe are politically unreliable. Therefore, the solution the minister refers to is gas extracted by hydraulic fracturing: fracking.

And that opens a whole complex can of carbonated worms.

## Stepping on the gas

Ms Perry says fracking releases gas safely from large reserves hundreds of metres underground and is an essential and indispensable part of the UK's secure energy mix. Like oil, she is convinced that a hydraulic fracturing industry will bring local communities economic growth as part of the Government's contemporary Industrial Strategy.


However, there is huge opposition, which Perry believes is against natural gas as a fossil fuel hydrocarbon. Opponents argue against developing an unwanted resource when the real answer is renewable energy — mainly wind, solar, some biomass and hydropower. Here, production costs have dropped unexpectedly fast as a result of engineering innovation, rigorous design advances that reduce the need for expensive future maintenance, plus the financial clout of economics of scale.

Recent swift progress on largescale battery storage technology is helping to overcome the mainly weather-related problems of renewable interruptability — when the wind doesn't blow on cool cloudy days. That makes renewables truly sustainable and secure, the argument goes.

All of which highlights mankind's complex and often strange relationship with reserves deep inside the earth. Historically, they have been exploited in the name of industry and social progress. Now they are increasingly seen as environmentally flawed, with a few positive exceptions.

## Oil and gas

On 18 June 1975, Energy Minister Tony Benn held up a bottle containing the first North Sea oil to reach BP's Isle of Grain refinery from the Argyll Field. He said, "I hold the future of Britain in my hand." Although the industry has delivered an estimated 40 billion barrels of oil with 24 billion remaining, its monumental engineering activities and economic benefits largely went unseen in an era when most eyes were glued on NASA's efforts to put people on the Moon.

In 1964, the UK Continental Shelf Act was passed. Yet, nothing much happened until the giant Fortes Oil Field was discovered in 1970. Multiple discoveries followed. In July 2015, the North Sea was the world's most active offshore drilling region until the financial crisis struck. But the good times couldn't last. Following bad experiences such as the Brent Spar oil storage buoy debacle, an extensive and thorough decommissioning programme is now in place controlled by the Petroleum Act 1998, where every component has to be accounted for.

The report, *Rigged: How the North Sea Oil and Gas Industry is Undermining Future*

*Generations*, from the Intergenerational Foundation, says future generations could face a £3000 bill per person to do this correctly as Government target costs double from £39 billion to more than £50 billion if oil companies are relieved of their massive decommissioning obligation.

## Optimism with skills warning

A recent oil price upswing has restored North Sea optimism after prices fell from $115/barrel in June 2014 to less than $30/barrel in early 2016. Average operating costs are said to have halved in two years. BP has announced the discovery of Capercaillie and Achmelvich fields. Shell also approved plans early in 2018 to develop Penguin north of Shetland with a floating production and storage vessel with an expected breakeven price of $40/barrel.

However, a major challenge is experienced skill recruitment after the sector's workforce shrank from 450,000 to 330,000 in 2016. Another warning says UKCS operations are missing out on important innovations that could save £240 million annually. The Government is also anxious to identify downstream oil supplying resilience measures.

## Gassy future

According to December 2017 British Gas figures, the UK produced 43% of the natural gas it needed from the North Sea and Irish Sea. A further 44% came by subsea pipeline from Europe. However, 23% of Europe's gas comes from Norway and 35% from Russia. The 13% balance is delivered by LNG (liquified natural gas) tanks from the Middle-East.

Gas is currently significant because it powers 80% of the UK's 25 million homes. Roughly 25% of electricity production comes from gas-fired power stations which can be brought on line rapidly during high demand periods. But North Sea gas supplies are finite; more imports or alternative energy sources will be needed to keep boilers and lights on.

The UK can no longer turn to the Rough gas facility that previously provided 70% of Britain's gas storage capacity due to maintenance costs. Ministers insist market forces will ensure enough gas is available. That leaves the UK with the equivalent of four to five days' winter storage compared to 15 previously. Germany's gas storage capacity at 24 billion cubic metres is some 17 times larger than the UK's.

## Coal

Britain's coal production heyday peaked in 1913 at 287 million tonnes. Some 95% came from 1334 deep mines and 92 surface operations in the early 1950s and coal remained the country's primary fuel into the late 1960s. Modernisation saw output leap from a reduced number of large collieries; Kellingley Colliery in Yorkshire, which was capable of producing circa 700 million tonnes annually, actually mined 404,000 tonnes in a single shift in 1986. However, as the UK's last big pit, it closed in 2015.

Most coal power will come off the grid in the early 2020s with just some 1.3 GW of capacity left; with no form of carbon suppression this is unlikely to still be operating by 2025. Half a decade ago, coal represented 39% of UK electricity production; by the second quarter of 2017 it was down to just 2%. More than 54% of the EU's 619 coal-fired generating stations are now operating at a loss.

Not everyone feels that coal should have had its day. If the North Sea's oil and gas reserves have been huge they are said to be dwarfed by untouched deep offshore coal deposits. One proposal was to gasify coal in-situ and bring the resulting synthetic gas ashore for processing. Synthetic gas contains carbon monoxide, hydrogen, carbon dioxide, methane and water vapour.

Experimental gasification work was planned for Durham in 1912 but thwarted by WWI. The Soviet Union first considered it between 1928 and 1939 "to liberate water from hazardous work in the mines", and actually ended operations in the early 1960s to focus on the extensive natural gas fields that feed the West today. The USA conducted extensive trials in the 1970s and 1980s. New Zealand and Australia ran small-scale trials in the 1990s. China has gasified coal since the 1980s.

One company that wanted to exploit "vast deposits" estimated at some two billion tonnes off the Northumberland's northeast coast was Five Quarter. Its aim was to inject steam through 2km-long boreholes to induce gas from coal; it believed the process could be made carbon neutral while producing other chemical and gases with industrial applications.

However, thousands of people signed a petition against this "experimental" and "dangerous" "deep gas mining". The company closed in 2016, citing financial difficulties and problems securing funding, plus changed global market conditions, declining North Sea activity and uncertainty about government energy strategy.

## Mining

Treating the world as huge treasure box is a cultural tradition, with many small, poorly managed metal and mineral mines resulting in bad environmental impacts the world over.

Big open pit mines come in for criticism too. Many are so large that they generate their own micro-climates. Rio Tinto Kennecott's Bingham Canyon mine near Salt Lake City in Utah at 1.2km deep and 4km wide is the world's largest.

As they go deeper and wider, planning is an increasingly complex balance of grade, slope stability, road access for high-capacity earthmovers, economic flexibility, plus the control of huge amounts of spoil and processing residues returned to the environment where they can erode, weather, leach, enter water systems and are prone to wind dispersal.

Deep level mining depends on innovation and technology; virgin rock temperatures are often high enough to boil water and a constant supply of ice is needed with the "coolth" (un-heat) to maintain workable temperatures.

AngloGold Ashanti's Mponeng gold mine is currently the world's deepest mines at 3.9km (12,800 feet or 2.42 miles) vertically below the surface. Deep gold mines tend to suffer the rock-burst phenomena that kills hundreds of workers each year as ancient rock pressures explosively push up floors as often as they bring down roofs.

Mining environmental impacts include erosion, sinkholes, biodiversity loss, soil contamination, groundwater pollution and surface water, plus chemicals with human health implications. The erosion of sloped, mine dumps, extensive tailing dams can significantly affect surrounding areas, eco-systems, wilderness areas, forests and farmlands. Continuous pumping out of underground water that is often acidic can bring toxic materials to the surface, damaging aquatic biodiversity. The by-products of mineral processing are often undesirable. Heavy metals such as lead and cadmium are particularly adverse; the Colorado River carries huge daily volumes of metal out of the Rockies. Dust from abandoned mines is another problem.

Wildlife habitats can be affected long after mining has ended. Many endemic species are extremely sensitive to environmental conditions. Subtle long-term variations can affect local food chains. Remediation can be a lengthy process that does not result in the exact same conditions before mining began. Some species are quite resistant, others disappear quickly.

But we remain addicted to metals and minerals.

## Good geothermal

Geothermal energy could be positive. The aim is to harness the earth's mid-depth rocks and their intrinsic inner energy derived from volcanism. Research suggests that it is a technology with the potential to generate a fifth of the UK's power. The UK's first commercial geothermal plant could come online by 2020.

Iceland is a world leader in retrieving this energy. Water is pumped into deep holes in hot rocks, is heated and returned to the surface with enough energy to generate electricity or provide heating. Cornwall's hot granites could also be a cost-effective geothermal energy source.

In January, Geothermal Engineering Ltd's United Downs/DEEP Geothermal Power project launched a new website outlining small but scalable plans to target a permeable geological structure called the Porthtowan Fault Zone with two deep wells. A 2500m depth borehole will inject water and a second at 4500m will extract water, which at well-bottom could be circa 190°C. Continuously recycled hot water will supply a 1MW demonstration power plant.

Meanwhile, in another experiment due to start in 2020, scientists on the Krafla Magma Testbed, who are planning to drill more than 2km into a molten magma lake to yield "supercritical steam", say the UK could use energy from Iceland's volcanoes in 20 years' time. This would be delivered by a costly 1000km-long sub-sea electrical interconnector. A quarter of Iceland's power is geothermal. Like wind and solar, globally geothermal power is scalable but has been held back by high development costs. Technical innovation could produce the vital breakthrough.

The UK already has a hidden geothermal energy jewel. In the 1980s the then Department for Energy wanted to examine the potential of geothermal aquifers. Initial drilling of a well in the Wessex Basin was successful but deemed too small to be commercially viable. Southampton City Council decided to create the UK's first geothermal power scheme in a plan to become a "self-sustaining city" in terms of energy.

Pumping began in 1986 at a depth of 1800m and temperature of 76°C. The energy provision was expanded gradually to serve more than 1000 residential properties, a shopping centre, hospital, university, business offices and district heating scheme.

A Renewable Energy Association report in 2012 calculated that deep geothermal resources could provide 9.5GW of UK baseload renewable electricity — equivalent to nearly nine nuclear power stations. But the support regime is uncompetitive compared to other European countries.

## Perry's case

Meanwhile, Perry is adamant that shale gas has a future. She says that those opposed to it are "using the most colourful and scaremongering language they can find and intimidating local communities and decision-makers." She added recently, "In my experience, most of these arguments are made by people who actually just don't want us to use gas at all — now or ever."

Her view is that the UK cannot meet its "energy and heat needs now, or for many years to come, at a price we can afford, without using the gas that geography has gifted us". Planning and regulation regime changes are being made to support the sector's development.

In April, Cuadrilla completed drilling of Britain's first horizontal shale gas well at its Preston New Road exploration site in Lancashire. ■

Jon Herbert was, until early 2009 Director of ISYS International. He is a former communications manager and investment advisor. He has written on environmental issues for many years.