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and the Royal Academy of Engineering have reviewed the scientific and engineering evidence on hydraulic fracturing. They concluded that the health, safety and environmental risks can be managed effectively in the UK by the use of operational best practices enforced by strong regulation. They reported that fracture propagation is an unlikely cause of contamination and that the seismic risks are low. They also noted that robust monitoring of well integrity is vital.

In terms of environmental impact and effects on the local community, shale developments are spread over a wide area with minimal impact on the surface. They are generally the size of a football field and are silent in operation. The drilling and fracturing stage creates a building site, but takes only about six months. Once that is completed, we have a site that will produce gas for 20 years.

Scotland does have shale gas resources. Whether they are commercially viable is still open to question, but the potential is there. If they can be developed, there could be a significant boost to jobs, GDP and energy security. The potential of shale needs to be proven and in order to do that we need to drill and fracture some wells. Although supply chains are currently expensive, if the shale industry develops the supply chains will become more viable.

I support the Scottish Government's moratorium on hydraulic fracturing as an opportunity to engage the public in a dialogue about shale gas extraction, although I am not certain that the extension of the moratorium to 2017 is necessary.

It is vitally important that the period of the moratorium is used to engage in a steady programme of dialogue. The emotional reaction that people have about hydraulic fracturing has to be addressed with a rational analysis of the risks. Public acceptance will only be gained through a wider understanding of the need for shale gas and its potential value to communities, backed up with objective, scientific evidence about the level of risk it presents. ❐

Balancing our energy portfolio

Rebecca Lunn

Professor Rebecca Lunn FRSE FREng is Head of Department, Civil and Environmental Engineering, and Professor of Engineering Geosciences, at the University of Strathclyde. She is an expert in ground engineering and energy geosciences. She is also a member of the Scottish Government's Geothermal Energy Expert Group and was a member of the UK Government's Advisory Committee on Radioactive Waste Management from 2008-2015.

Over the coming years Scotland will lose over half of its current capacity to generate electricity. Currently Scotland's electricity is supplied by gas (10%), nuclear energy (35%), coal (20%) and renewables (35%). By 2016 coal will have been shut down, and by 2023 both of Scotland's nuclear power stations will be decommissioned. That will mean that Scotland will be a significant net importer of power from the rest of the UK. This power will be generated by gas-fired and new-build nuclear power stations.

Electricity is only 21% of Scotland's energy consumption. 55% goes on heating, and that is met almost entirely by gas. Lowering coal consumption to meet carbon targets (by closing coal-fired stations in Scotland and the rest of the UK) will increase gas consumption still further. A 'greener' low-carbon future looks more gas-dependent.

In the Royal Society of Edinburgh's report Options for Scotland's Gas Future[1], we looked at four options: reducing demand, increasing offshore gas production, increasing onshore gas production and increasing imports. We considered factors such as safety, energy security, health and well-being, the environment, climate change, as

SUMMARY

- Scotland is set to lose over half its current electricity generating capacity due to closure of the coal-fired and nuclear power stations.
- Scotland will then become a net importer of electricity generated from England and Wales.
- Under current UK policy, Scotland's imported power will come from the proposed new fleet of nuclear power stations and from existing gas-fired power stations.
- Reducing Scottish and UK coal consumption to meet carbon targets may increase gas consumption for power production.
- The options for meeting future demand are: reducing demand, increasing onshore energy production, increasing offshore production; and increasing imports.
- Decisions have to be made on how to meet future energy requirements and what level of energy security risk is acceptable.
- Public education and debate is essential to avoid crisis decision-making.

Encouraging a resurgence in North Sea exploration activity is likely to require Scottish Government investment

well as economic factors affecting not only the industry but also the consumer.

Reducing demand

In Scotland over an eight-year period, demand for heat has been reduced from 60,000 gigawatt hours (GWh) to 48,000GWh. This has been achieved through improvements in insulation and by using heat pumps. The major barrier is the cost to Government as it is principally achieved through grants. Reducing demand for heat is a capital investment priority for the Scottish Government.

Increasing offshore gas production

Existing oil and gas fields in the North Sea are mature and, as the remaining volumes of gas diminish, are increasingly uncompetitive. Increasing offshore gas production requires exploration to discover new gas fields and may involve production from less conventional sources, such as deep water reservoirs, tight gas and high pressure/high temperature reservoirs. Exploration activity in the North Sea has diminished to almost nothing over the last two decades and encouraging a resurgence is likely to require Scottish Government investment.

Importing energy

Importing energy is relatively cheap and is the most cost-effective option for the consumer. Yet gas production and transportation still has environmental and social impacts. Importing our energy results in those impacts being outside Scotland's regulatory control. It also raises issues of social justice, since environmental and health impacts often fall on the local population and the local workforce, who may not be receiving the benefits of energy production and consumption.

A significant issue with increasing energy imports is Scotland's energy security. In 2014, 53% of our gas was imported, some from regions that are politically unstable, such as Qatar, Russia and North Africa. Disruption to energy production in these regions could lead to UK energy shortages and, hence, to social unrest.

Increasing onshore gas production

There are three forms of unconventional onshore gas that Scotland could develop: shale gas, coalbed methane and underground coal gasification. There are significant resources of coalbed methane.

There is media hysteria about unconventional gas and the public is confused about hydraulic fracturing. For example, there is talk of hydraulic fracturing for coalbed methane, which is incorrect; hydraulic fracturing is not required for coal-bed methane production. There have been significant problems with pollution in the USA, but these are due to poor regulation. For example, groundwater contamination is not caused by hydraulic fracturing or by extracting methane, but because the water that is produced with the gas could pollute ground water.

In the USA, product has been stored in open surface ponds, which can leak and pollute drinking water aquifers. This is a simple problem to solve, but the process has been very poorly managed. In

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the UK, all of the independent expert panels have concluded that if the industry is well regulated, unconventional gas production can be safe.

Energy storage and transmission

If Scotland is to decrease its carbon footprint, we either need to increase our power and heat generation from renewable sources or invest in nuclear power. The Scottish Government has opted for increased renewable production. Most renewable sources are climate dependent and cannot be relied upon to produce a steady supply.

Once Scotland's existing nuclear power stations are closed, we will rely on the rest of the UK to maintain a stable baseload power supply. Hence, to have a sustainable long-term policy based on renewables, new technologies are required to enable significant power storage. This will require investment in technology development for power storage.

Renewable energy sources are primarily in remote locations. The current national power grid is not designed for transmitting power from its extremities; increased renewable production will also require significant capital investment in the national grid.

There is an urgent need to increase Scotland gas storage capacity in Scotland and the rest of the UK. The UK currently has one of the lowest gas storage capacities in the world (as a percentage of consumption), which leaves us highly vulnerable to disruptions in supply.

In combination with our high percentage of gas imports, this results in poor UK energy security. Technology exists to store gas in the subsurface, but there is a need for increased capital investment, and issues of planning permission and public acceptability are inhibiting progress onshore.

A publicly-informed decision

It is clear that there are no easy options. There are some difficult decisions to be taken. Sticking our heads in the sand and relying on imports will put our energy security at risk. We already import over 50% of our gas and that proportion is set to rise.

The question is not simply 'Should we produce shale gas?' because the answer from the public and politicians is likely to be 'No'. We need to ask ourselves how we want to source the UK's future energy requirements, what balance of energy portfolio we want, how much storage capacity we should invest in and how much security risk we are prepared to accept.

In our report we recommended participatory decision-making. Citizens' panels could be used to educate people and help shape policy. We need to change the public attitude of 'not in my backyard' and help people understand that if they say no to domestic production they are, by default, saying yes to something else if their energy needs are to be met. At the moment I do not think there is an adequate understanding of that.

Social justice also comes into this debate. The UK imports over half of its gas energy – in other words, we do not shoulder the environmental impact of the energy we consume. Instead, that impact is borne by people a great distance away. If we produce our own, we can ensure the industry is well regulated and reduce any impacts to an absolute minimum. It is critical that we raise the level of debate and discussion on energy. If we do not, we are likely to end up in crisis. In 2013, the UK was one day away from not meeting its gas demand. Crisis-led policy making leads to poor decisions and poor regulation. ❐

[1] www.royalsoced.org.uk/cms/files/BriefingPaper15-01.pdf

POLITICS, SCIENCE AND MARKET FORCES

Ben Ritchie is a Senior Investment Manager for Pan-European Equities at Aberdeen Asset Management. He gave a short response to the speeches at the beginning of the discussion period.

The energy debate seems to me to be circumscribed by the trinity of politics, science and market forces. Leadership from politicians will be crucial to align these three. Investors obviously want the prospect of returns, but in a context of stability and consistent policy-making. This applies whether we are supporting governments, corporations or individuals. At present, policy is being driven by politics. Scientific evidence and market global market trends are being ignored.

Fracturing shale to release gas is an example of this. The word 'fracking' is quite emotive, and good policy leadership is critical. Having a general moratorium on fracking is fine in terms of politics but may not result in the right kinds of policies. Blanket bans on fracking also cover the use of unconventional recovery techniques offshore, but these are needed to support growth and production in an industry already facing significant pressures. Policies need to take into account scientific logic and market forces, as well as political influences.