Can **Fracking** Revolutionise the **UK Energy Market?**

The controversial topic of fracking has been gaining headlines recently. *Lawyer Monthly* benefits from an article by Amy Comer, Partner and Anna Nerush, Associate of the London Business & Finance Practice of Global Law Firm, Morgan Lewis explaining in detail the topic of fracking.

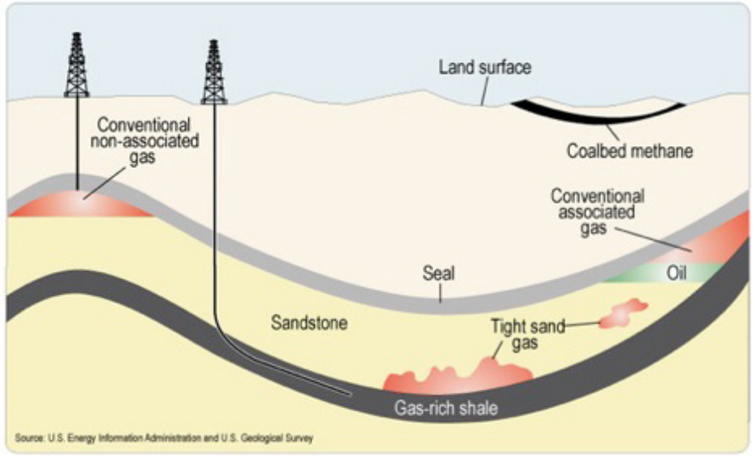
Natural gas has always played an important role in the UK energy mix. According to the BP Statistical Review of World Energy 2013, natural gas accounted for approximately 35% of the UK's primary energy consumption in 2012. The decline in North Sea production of conventional gas has resulted in the UK transitioning from self-sufficiency as recently as 2004 to importing around 50% of its annual gas intake in 2012. Furthermore, recent events in Ukraine and the seemingly growing cleft in relations between Russia and Europe have threatened the stability of the supply of Russian gas, forcing Europe, including the UK, to rethink their reliance on imported gas. Although there has been an increase in coal-generated power in the UK, consumption of gas remains high, as it plays a key role in domestic heating, industrial feedstock and heat processing. If the UK is to diversify its sources of gas supply and reduce its dependency on imported gas, it must look to its domestic gas producing industry. Given rapidly declining conventional gas reserves, this means serious investment in, and development, of unconventional gas sources.

The rise in production of unconventional gas, particularly shale gas, has revolutionised the US energy market, transforming the US from an LNG importer to a major LNG exporter in less than five years. There has been much discussion recently as to whether this success can be replicated in the UK. However, despite David Cameron recently stating that Britain has a "duty" to frack, there is much controversy surrounding fracking and production of non-conventional gas in the UK. Setting aside prevailing negative public opinion and a legal and regulatory framework for unconventional gas extraction that is only at a nascent stage, there are key operational and technical challenges associated with commercial production of a resource that is contained within low porosity and low permeability rock formation. Whilst the term "unconventional gas" encompasses coal-bed methane, tight gas and shale gas, this article examines in particular the nature of, and process for, the commercial production of shale gas and the associated challenges facing the shale gas industry in the UK.

Unconventional gas and fracking

Unconventional gas has the same chemical composition as conventional natural gas, but the reservoirs' characteristics are more complex, meaning that unlike conventional gas, unconventional gas does not flow and is not easily captured (fig 1). Shale gas is trapped within shale

Fig 1.



formations, which are fine-grained sedimentary rocks. Because of the low permeability of the reservoirs, production of shale gas at commercial rates requires a high number of production wells stimulated by hydraulic fracturing of the rocks. Hydraulic "fracking" as it is commonly known, involves drilling into the rock formation and injecting water, sand and chemicals into the rock formations to force out hydrocarbons. The extraction of shale gas from rock with low permeability at economically viable flow rates relies on the use of two technologies: fracking, which increases the surface area through which gas molecules can escape and horizontal drilling, which allows for multiple fracking zones in each well drilled. It should be noted that fracking is not unique to shale gas and has been used in conventional oil and gas production since 1940s.

What differentiates shale gas extraction from other hydrocarbon techniques is that it is done on a larger scale, with a greater number of wells that are often drilled more deeply in order to access the resource. Due to the depth of the wells and lack of natural fissures in the rock formation, extraction of shale gas also requires high pressure and a high volume of water and chemicals.

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Technical and operational challenges

Land access and public opinion

Practical access to private land and the sheer physical scale of shale gas operations should be considered. Shale gas formations typically cover a much wider area than conventional reservoirs and require multiple surface entry points. Drilling and high volume fracking surface installations require an area of approximately 3.6 hectares per pad, compared to 1.9 hectares per pad for conventional drilling, creating sizeable gas fields, which it may not be possible to restore to their original natural or agricultural value following the abandonment or completion of wells. The US experience shows that that well flow-rates can vary significantly within the same shale play and many exploratory wells need to be drilled to identify shale play "sweet spots" with highest flow-rates. The characteristics of shale reservoirs mean that although the well has a longer producing life than a conventional gas well (as it continues to produce tight gas, which bleeds through the low permeability rocks beyond the fracture), it also rapidly declines in production, typically within the first year, as free gas is depleted. High drilling intensity is, therefore, required to achieve meaningful production levels. The UK is much smaller than Australia or the US with simply less land available, meaning that shale gas operations may be nearer to ➜

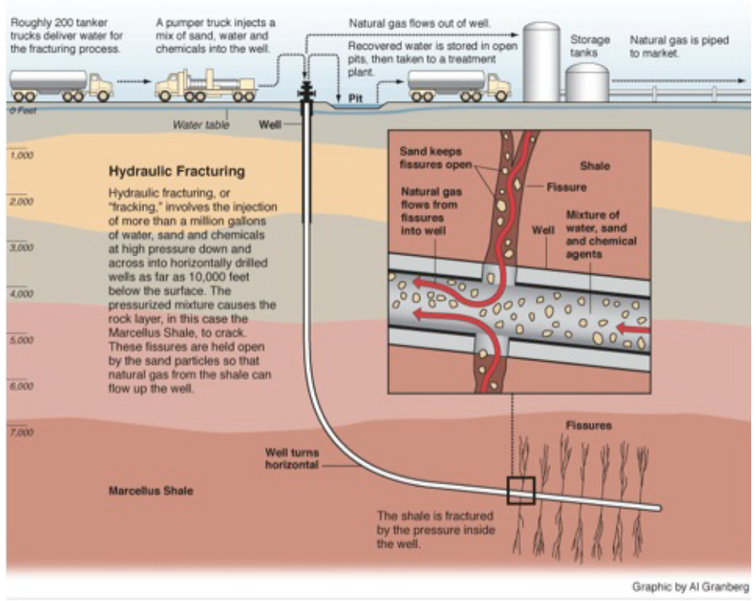

Figure 2: Typical hydraulic fracturing operation.
Source: ProPublica http://www.propublica.org/special/hydraulic-fracturing-national

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densely populated areas, creating a much more noticeable impact on the local community and environment. Fracking operations also involve considerable industrial activity, including trucking, rigs, storage and treatment facilities, all of which require land.

There has been much public opposition to fracking in the UK, presenting a major barrier for operators during the planning process, administered by local authorities. Unlike in the US, where in many states, individual landowners own the mineral rights and receive up to 20% of production revenues, in the UK, mineral rights vest in the Crown and unless and until an attractive compensation package is put in place, there is little incentive for private landowners to support exploration or production within their local community. An incentive package has been put forward by the United Kingdom Onshore Operators Group ("UKOOG") and the Government, comprising a payment of £100,000 for communities in the vicinity of exploration operations as well as 1% of revenues from production, with the local authority retaining 100% of the business rates collected from the sites. However, whether this is sufficiently attractive to overcome objections by local communities remains to be seen. Furthermore, local authorities considering planning applications must implement appropriate systems to avoid potential conflicts of interest.

Equipment and resources

High intensity drilling operations require development and environmental approvals and also a significant number of equipment and skilled personnel. Mobilisation of rigs and personnel incurs time, cost and availability. According to research published by the Oxford Institute for Energy Studies, to produce 1 trillion cubic feet of gas (approximately enough gas to heat 15 million homes for one year), 100 to 200 rigs would need to be working simultaneously. However, according to Baker Hughes, as of January 2014 there were only 126 active rigs in Europe of which just 87 were onshore. Furthermore, few of the existing fleet of rigs are suited for horizontal drilling at depth, therefore, in reality the number of rigs available in Europe for shale gas exploration is considerably fewer. This means that the UK must import rigs from, for example the US, or manufacture new rigs in Europe. Importing high-spec rigs that meet UK specifications requires significant outlay, whilst rig-manufacturing capacity in Europe is limited, as there are only a few land rig builders, with limited annual capacity. Therefore, sourcing equipment for large-scale rapid development remains challenging.

Given the nascent stage of the European shale gas industry, there is likely to be a significant shortage of skilled personnel with fracking knowledge that are qualified to operate complex equipment. Whilst the growth of the domestic shale gas industry will undoubtedly create jobs, workers will need to be appropriately trained, requiring time, money and expertise. The extent to which a workforce can migrate between countries to service projects depends on local content requirements, which may require a certain percentage of the workforce to be local.

Water use

Drilling and fracking require significant amounts of fresh water. Published estimates of water use per well during drilling and fracking operations range between 250-400 cubic metres for drilling and 7000-23,000 cubic metres for fracking. Cuadrilla recently stated that during operations at Preese Hall, near Blackpool, it used 8,400 cubic metres of water for fracture treatments and around 900 cubic metres of water for drilling. Operators can source water through utilities providers or directly from the environment under a licence granted by the Environment Agency (the "EA"). There is scope to recycle water used in fracking operations, however this requires construction of onsite treatment facilities and expensive technologies. According to the February 2014 policy statement by the Chartered Institute of Water and Environment Management (the "CIWEM"), the UK as a whole has sufficient volumes of natural water to support the shale gas industry, however, there may be greater pressures in water stressed catchments, especially as the industry becomes more established.

Environmental challenges

Water and air pollution

Contamination of groundwater is a frequently cited concern associated with shale gas operations. The concern is that groundwater may become contaminated as a result of a catastrophic structural failure of the well or from the flowback of hydraulic fluid, large volumes of which are pumped into the well bore. The typical composition of hydraulic fluid is approximately 99% water and 1% sand and chemical additives. Once a well has been drilled and fractured, a significant volume of fracturing fluid returns to the surface. These are, nevertheless, similar risks to those encountered in conventional gas operations and ensuring well integrity, especially in relation to drinking water aquifers, is a requirement for all hydrocarbon developments. The same construction regulations (the Offshore Installations and Wells (Design and Construction) Regulations 1996) apply to shale gas exploration wells as they do onshore and offshore conventional wells. Unlike in the US, where the composition of chemical additives is not disclosed, use of chemical additives in the UK is subject to assessment and approval by the EA, which has published permitted additives as well as a methodology for their use. Robust wastewater management and treatment systems will need to be implemented to avert any adverse impact on the environment. The CIWEM's conclusion was that there is sufficient capacity at existing industrial wastewater treatment works in the UK to treat returned waters during the exploration stage.

There are a number of ongoing studies into greenhouse gas emissions from shale gas. It is a complex area. Whilst there is research suggesting that shale gas emissions exceed those from conventional gas and coal, further research is required to determine the amount of methane emitted in the course of shale gas production. In October 2013, Public Health England produced a review of the potential public health impacts of exposure to chemical and radioactive pollutants as a result of shale gas extraction, in which it concluded that the risks to public health are low if operations are properly run and regulated.

Earthquakes

The larger of the two earthquakes experienced at Cuadrilla's Preese Hall site in April/May 2011 measured at magnitude 2.3. Whilst it was linked by the British Geological Survey (the "BGS") to fracking activities, the BGS concluded that "the tremors were too small to cause any damage". This was confirmed in a review commissioned by the Department of Energy & Climate Change ("DECC"), which concluded that the earthquake was a result of a "perturbation of pre-existing stress" and although "further small earthquakes cannot be ruled out, the risk from these earthquakes is low, and structural damage is extremely unlikely".

Shale gas in the UK and regulatory regime

The unconventional gas sector in the UK is still in the early stages with only modest levels of exploration. Commercial production is not anticipated until 2030 at the earliest, a view supported by Sam Laidlow, CEO of Centrica who stated in January 2013 that "it would be at least a decade before the UK saw any shale gas production and that, even then, it would not be the game changer we've seen in North America". Unlike in the US or Australia where the shale gas production industry is well established, the UK is lacking key analysis and data on the nature and volume of its technically recoverable resources and the practical impact of fracking on the local geography and environment. This lack of factual information has fuelled media speculation as to the potential impact of the shale gas production industry on the UK economy, and pollution levels.

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It is generally believed that the UK has significant shales at depth, however their geological characteristics and gas storage compositions are not known. Whilst the Government has commissioned a number of studies to estimate total volumes of shale gas, including by the BGS with respect to the Bowland shale in Lancashire, such studies cannot accurately predict technically and commercially recoverable reserves; these can only be established by exploration drilling and testing. The suspension on drilling imposed by the DECC following seismic activity near Cuadrilla's Bowland drilling site in spring 2011 was lifted in December 2012, giving hope of renewed exploration activity by existing licensees, such as Cuadrilla and Centrica. Centrica announced in July 2013 their exploration and appraisal programme for the Bowland play, comprising six wells over an eighteen month to two-year-period, with an additional three wells to be drilled (but not fracked) to obtain samples. The delayed 14th Onshore Licensing Round, is expected later this year, in which the DECC will be offering licences covering more than 37,000 square miles of currently unlicensed areas in England, Scotland and Wales.

Shale gas exploration is regulated by the DECC, the EA and the Health and Safety Executive. It is subject to planning requirements through the Department for Communities and Local Government and local authorities. A UK Petroleum Exploration and Development Licence allows a company to pursue a range of exploration activities, including exploration and development of unconventional gas, subject to necessary drilling and development consents and planning permissions. Within DECC, the Office of Unconventional Gas and Oil was established to coordinate activity of the regulatory bodies, and published a Regulatory Roadmap "Onshore Oil and Gas Exploration in the UK: Regulation and Best Practice" (17 December 2013) setting out the process operators should follow when carrying out drilling activities in the UK. An industry code of practice has also been developed by UKOOG. However, much of the regulatory framework and guidance has been established in the context of an industry which is at a limited stage of exploration and as such, is not equipped to deal with a high volume of permitting applications or production stage activities.

The UK shale gas industry faces many challenges, some of which are inherent to the UK in particular given its geology and prevailing public policy, and many of which are more generally reflective of the European unconventional gas industry as a whole. The greatest hurdle to overcome in the UK at this stage is the public perception of, and broad resistance to, fracking.

Many of the environmental concerns can be addressed through further studies that will help create a more nuanced understanding of the impact of fracking on the environment when set against its benefits for resource extraction, and which can be managed via tailored industry regulation and technology. In the meantime, the economics of domestic shale gas production and its potential impact on the price of gas have generated much discussion and comment. There is clearly a need for comprehensive cost analyses to ascertain whether economic realities justify the perceived impact of large-scale fracking on local communities, amenities and farmland. **LM**