Geo Factsheet

www.curriculum-press.co.uk Number 357

Fracking – What's the Problem?

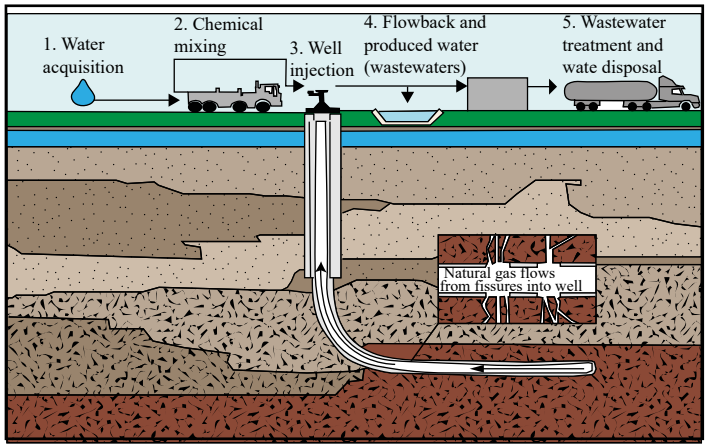
In the 1960s and 70s, elements of the public protested against the nuclear threat and the risks of nuclear power. In the 1980s and 90s it was apparent that the threat to our environment from the expansion of major road links prompted reaction. Since the millennium, there has been a response to land development and climate change issues. Suffice it to say, there is a clear temporal and spatial pattern to protest in the UK, and one current focus of vociferous attention from environmental activists is undoubtedly the process of **Fracking**.

How Does It Work?

Fracking is the term commonly used for **hydraulic fracturing**, which is a method of drilling employed when there are deep deposits of oil and/or gas underground. This can be undertaken vertically or, quite frequently, along horizontal planes to access the relevant rock layer. Pre-existing channels can be extended where expedient. This hydraulic process was tested in the 1940s and thus cannot be seen as innovative, but the horizontal drilling has only been undertaken with any degree of frequency since the 1990s (according to www.livescience.com).

It is accepted that what the UK government refers to as **conventional oil and gas deposits** (Developing Onshore Shale Gas and Oil – Facts about 'Fracking' DECC Dec 2013) are taken from sedimentary strata of permeable rocks such as sandstone. Shale, an impermeable sedimentary rock, also contains gas of a similar chemical structure to North Sea gas. It can, therefore, be accessed from a **vertical well** as with other oil and gas deposits. In the case of shale gas, drilling occurs to a depth of approximately 1.5- 3.2 kilometres, according to where the gas holding rock layer is to be found. At this point the well is directed along a **horizontal plane**, which can extend to a distance of up to1.6 kms. The well is cased in steel or cement to prevent leakage into groundwater systems. The deposits are exploited by injecting a **high pressure mixture** of water, sand, and chemicals, called **slickwater** (at up to 9,000 pounds per square inch). Such pressure is sufficient to cause **fracturing** to the rock into which it is injected, so cracks are generated and the oil and gas is thus released. The sand (and some ceramic particles) allows the system to prop open the fissures created, even after the pressurised injection is reduced. These are called **proppants** and once successfully in situ the reserves of oil and gas can be pumped back to the surface combined with much liquid.

Figure 1. Illustration of hydraulic fracturing and related activities



Once the rock is fractured, some of the previously injected fluid returns to the surface, but it is held in containers prior to specialised treatment.

Why Do We Need It in the UK?

Approximately one third of UK energy demand is supplied by natural gas. According to the government's report of December 2013, a quarter of the gas is used to produce electricity, a fifth by industry, and 2 fifths for domestic cooking and heating. Gas, therefore, already plays a fundamental role in the UK's energy provision. As coal use is reduced, gas will be increasingly important in filling the gap between the development of nuclear and renewable supplies. The government forecasts that in 2030 our reliance on gas will be of the same level of importance as it is currently. A recent report (July7th 2016) in the Financial Times commented that the UK obtains 50% of current gas supplies from imports, mainly via a pipeline from Norway, and by liquefied natural gas tankers. Up to 70% will have to be imported (indeed gas imports have surpassed domestic production since 2011) if we do not use shale gas, especially given that North sea gas production is in decline.

Figure 2a. UK fuel sources of electricity generation 2013

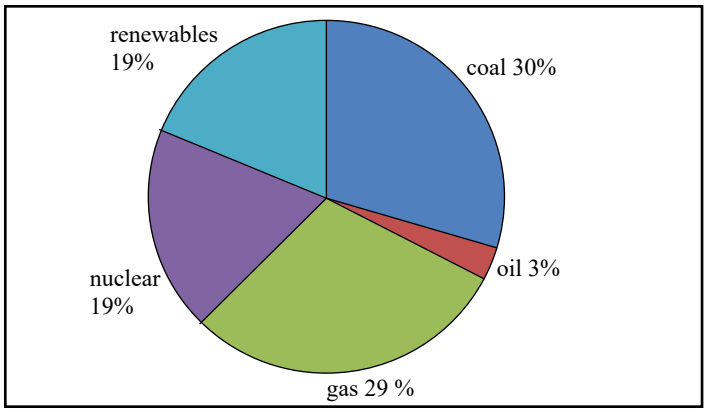
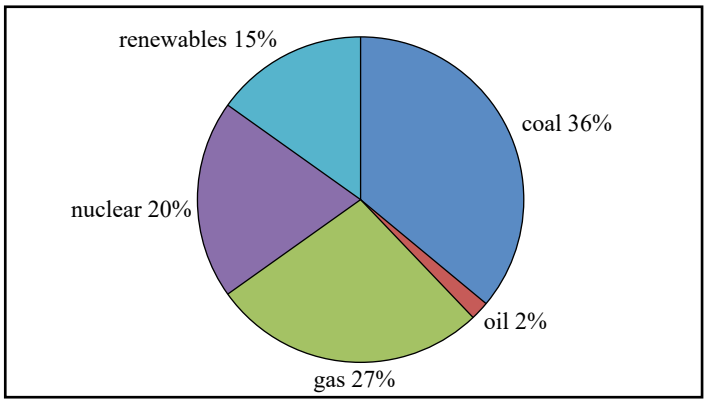


Figure 2b. UK fuel sources of electricity generation 2015



Exploitation of these sources is being considered in order to reduce reliance on imports as well as, of course, a means of boosting tax revenues. The UK Energy Research Centre also stated in a report of 2014 that "*Gas could play an important role as a 'bridging fuel' to a low-carbon economy.*"

Added to these economic and environmental arguments is the practical one – we can now access these resources efficiently with new technology.

Pros and Cons for UK

What's good about it?

- The shale has revealed vital gas resources that will be needed to ensure economic security for the countries with adequate reserves for years to come. The US group, www.energyfromshale.org/americas-energy (an alliance of oil and gas industry groups) claims that '*supplies ....increase our country's energy security and improve our ability to generate electricity, heat homes and power vehicles for generations to come'*

  Indeed, it is true;
  - That in the US the process has led to a boost in domestic oil production and a fall in the price of gas. Importing gas supplies puts the UK at the mercy of regions of great political instability, which can then lead to inherently volatile energy markets. Stephenson et al (2012) describe natural gas as 'a key transition fuel … towards a less carbon intensive economy.' It has been estimated by the government that Britain may have 26 trillion cubic feet (737 billion cubic meters) of natural gas in its shale basins, which would fulfil domestic demand for a decade. This would help in assuring vital energy security. Brexit would appear to suggest that having one's own internal energy resources would equally aid economic growth

- Jobs are created both on the fracking system and through the ensuing energy production. This also guarantees the security of some employment already in the energy industry. An industry funded body in the UK called the Task Force for Shale Gas is reported by the BBC as claiming that thousands of jobs would be generated by investment in shale technology (http://www.bbc.co.uk/news/uk-14432401) and a report by the Institute of Directors in 2013 stated that the figure would be as high as 74,000 jobs.

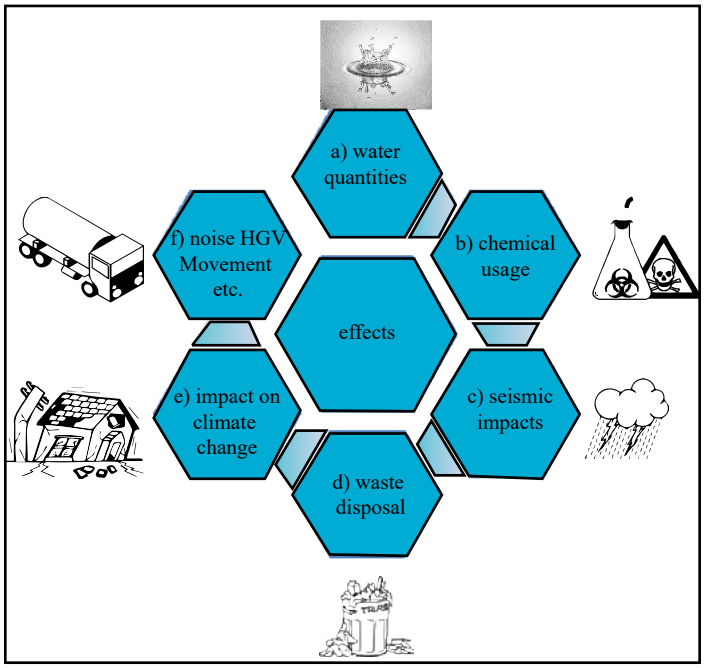
- Significant tax revenues, which the government claim can be reinvested to the benefit of the British people. Domestic supply has fallen 66 percent since 2000 while UK oil and gas operators paid 330 billion pounds ($433 billion) in tax between 1970 and 2014, according to an industry report. It is self-evident that gas extraction generates a basic tax revenue.

- Those who advocate fracking contend that the environmental impacts are not as severe as the opponents suggest. The former claim that it's a safe and clean method of securing vital energy supplies. The UK government contends that 'shale gas acts as a bridge to a low carbon future'. As the 2008 Climate Change Act committed the UK to reducing CO_2 emissions by 50% in 2030, and by 80% by 2050, replacing coal with shale gas would be one possible solution as it has a greenhouse gas equivalent value of about half that of coal.

What is not so good?

A wide range of concerns have been expressed in relation to exploitation of shale oil and gas. A document published by Hants County Council, in relation to exploitation in Hampshire, identified a comprehensive set of issues around on-shore oil and gas development, conventional, and unconventional shale oil and gas (see **Figure 3**).

Figure 3. The Negatives of Shale Gas



a) There is a potential impact on both **water quantities and quality of supplies**. Gas extraction is usually undertaken at a level well below the water bearing rock (the aquifer) and the risk of fractures extending into those rocks during the fracking process is minimal. There are issues related to potential contamination from the released gas or the chemicals used in fracking. In addition, wastewater from fracking has been shown to increase the hazard for river and other water bodies. In the UK, any returned fracking fluid is stored in specially designed tanks. It has been observed in the USA that large volumes of water are required, both during the establishment of the fracking process and subsequent to it, thus compromising local river levels during the fracking process (various estimates put it at 12-19,000cu metres for each fracking event with 1000 cubic metres for drilling). In the UK, the Environment agency will only grant a licence if they deem the supplies sustainable. However, research has shown that 90% of the water used is left deep underground and is therefore no longer available for use in any context. The DECC estimate that in the UK the greater depths demanded, with several lateral extensions for successful extraction, will potentially involve higher volumes of water. Statton, Brown, and Hayes (see source 11) refer to an estimate from the Chartered Institute of Water and Environmental Management, which states that 'in order to meet 10% of UK gas demand from shale gas over 20 years, water demand would be in the order of 25-33 million cubic metres of water' .

b) As some water and its associated additives will be returned to the surface (**flowback)** it is possible that **chemical contamination** will occur. Critics state that we cannot know the long term consequences of even small amounts of chemical leakage, for as with agricultural nitrates, it may take some time for the effects to become apparent

c) Fracking acts as a catalyst to **seismic events**, which have become one of its most frequently quoted adverse effects. Continued exploration of the first drill sites in the UK operated by Cuadrilla near Blackpool was suspended subsequent to two significant seismic events at 1.2 and 2.2 magnitude. New controls have been implemented by the DECC (Department of Energy and Climate Change). Cuadrilla's own report referred to similar events in the USA. Media articles have pointed out these links too, for example the Guardian reported in January 2016, '*The USGS linked a 2011, 5.3-magnitude earthquake on the state's border with New Mexico to such practices (waste water disposal), and has warned that*

earthquakes are 100 times more likely to occur now than in 2008 in areas subject to fracking and wastewater disposal.'

d) **Waste** is generated from drill cuttings and from flowback water – all of this requires careful disposal and adds to management issues.

e) Air pollution and the associated impact of extraction of a fossil fuel are cited as a significant disadvantage of shale gas extraction. It is largely constituted of methane, which is a potent **greenhouse gas.** Some gas is flared if it is uneconomic to recover. This is preferable to venting as it reduces greenhouse gas emission by 80%. The process of Green Completion – a technology that separates the gas from other elements – means that any emissions occurring when the frack fluid is returned to the surface are kept to a minimum. A combination of flaring and green completion is said by government to reduce emissions by 95%. Most CO_2 emissions are derived from the final use of the gas as a fuel and not through the fracking process. The UK has access to carbon capture technology and has invested hugely in its development, but its use is restricted by cost. Public health England also referred to potential radon release in a recent study (2013). They believe this could contaminate both air and water. The US congress commissioned a report that suggested that 650 fracking ingredients held chemicals that are potential carcinogens.

f) Trucks, generators, and other associated machinery and infrastructure will create **dust, noise, and safety issues.** Vehicle emissions are of course dependent upon the distance from any materials, including water supply.

g) In addition to these contentious problems there have been observations made about **the number of wells required at one site**. Fracking wells are grouped together into one small site, reducing surface land use by up to 90%. Many wells are required, as gas does not seep from one area to another, since the shale in which it is found is impermeable. According to anti fracking campaign group Frack Off in 2013, which states its interest as an extreme energy action, '*Well spacings of 8 wells per square mile (or even higher) are common in the US and Australia, where large areas have been coated in wells and supporting infrastructure. Over 45,000 shale gas wells and 55,000 coal-bed methane (CBM) wells have been drilled in the US and over 5,000 CBM wells in Australia.'* However, keeping all wells in one specific area may reduce the need for access roads. Objections to a site in North Yorkshire, within a national park, cited that fracking could lead to 'the industrialisation of the countryside!'

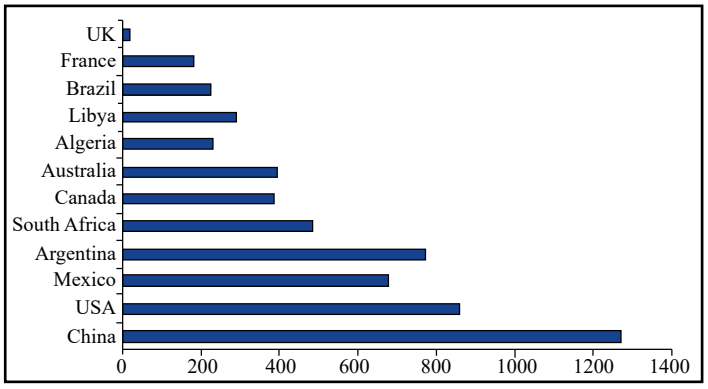
Where Is Fracking to Take Place?

Shale gas 'plays' (i.e. areas of recoverable reserves) are spread all over the world, but as yet only the USA has engaged in full scale commercial extraction.

UK experience in this field is subsequent to its development as a technology in the USA and Canada. As can be seen from the accompanying graph, the national recoverable reserves are considerably less than many other countries. Outside of the USA, shale gas is produced at a commercially viable level only in China and Argentina. Obstacles to development include many of issue already alluded to and can be classified into four main categories:

economic environmental social technological

Figure 4. World recoverable shale gas resources (trillion cubic feet)



Data was not available for some countries (e.g., Russia) so this is not a definitive list *(USEIA 2011a; Bickle et al. 2012)*. Fracking has already been banned or suspended in some EU nations including France, Germany, and the Netherlands, as well as in Scotland and Wales.

UK

The BGS (British geological survey) has produced a survey of regions with significant reserves of shale gas:

1. The Bowland shale of the Pennine basin.
2. Kimmeridge clay of the Weald in Surrey and Sussex.
3. Oil-shale group in the Midland Valley of Scotland.

The following website allows access to maps of UK oil and gas exploitation sites:
https://www.gov.uk/oil-and-gas-onshore-exploration-and-production

Shale Gas Exploration. Near to Hundred End, *Lancashire, Great Britai*

In 2013 there were 176 Petroleum Exploration Development licences out for onshore oil and gas in the UK. A licence is not sufficient to allow drilling, as there are planning permissions and a range of permits from the Environment agency, the Health and Safety Executive, and the DECC. Applications have been submitted for sites in Lancashire, Yorkshire, and Nottinghamshire. Lancashire County Council rejected the plans put forward for 2 sites in June 2015, but the company concerned, Cuadrilla, appealed, and the drilling will go ahead. According to the CPRE, a small number of planning applications to explore for shale gas and oil were made, including for sites in Sussex and Lancashire.

Anti-fracking protests took place in Balcome in the High Weald AONB in West Sussex, where one company, Cuadrilla, had been given permission to carry out exploration using conventional techniques, rather than fracking. Two other applications for exploration by Celtique Energy – at Wisborough Green, just outside the South Downs National Park, and at Fernhurst (in the national park) were turned down. The former mainly because of concerns about disruption from lorries to and from the site, and the latter because the necessary exceptional circumstances to justify drilling within the National Park could not be demonstrated.

In May 2016, North Yorks planning committee agreed to plans to frack a site near Kirby Misperton by Third Energy and it is anticipated it will start drilling next year. Campaigners against Fracking anticipate challenging the decision. However, a viability test, lasting approximately 7 weeks, will be undertaken at the site, and full extraction will take place for 9 years if it proves economically and technologically possible.

The Daily Telegraph reported that the UK would have 68 gas wells in the next 5 years and at least 14 of the new sites are expected to be fracked.
Some of the designated areas include the North York Moors and the Peak District **national park.** Rigs are banned on the surface of the parks but drilling is allowed horizontally underneath park land from outside of the protected areas, as MPs voted for this in December 2015.

One County: Hampshire

Hampshire has a long history of extracting conventional oil and shale, but shale gas is regarded as unconventional as it is not formed in traditional trapped reservoirs.

Typically, the shale gas lies at far greater depths than conventional gas and thus the level of viable reserves in the county is, as of yet, uncertain, although the BGS has suggested massive reserves lie beneath Hampshire. Reports in 2014 pointed at approximately 4.4 billion barrels worth of oil under the Weald Basin.

Oil and gas resources are located in many parts of Hampshire, including within Hampshire's two national parks – the New Forest and The South Downs.

However, extraction has not traditionally taken place within the boundaries of the New Forest National Park. There is one permitted site for conventional extraction at Avington, within the South Downs, but the site was exploited prior to the designation of national park status. Elsewhere, conventional fields were exploited at Stockbridge (north of Winchester) Humbly Grove, near Alton and Horndean.
See source 12 for maps
.
In 2013, the local paper the Daily Echo reported that 8 licences had been granted (though the county report/study concludes that there is no shale oil or gas exploration occurring in Hants at present).
In the south of Hampshire, resources are located in various locations:

- North of Southampton, stretching east from North Baddesley to the A3051 at Fairthorne.
- North of Winchester, from Kings Worthy west almost to Stockbridge.
- Further north, reaching from Chilbolton west to Amport.
- East of Winchester, underneath Hampage Wood.
- Stretching west from Hinton, in the New Forest.
- From east of Fareham, stretching further east.
- East from the Hambledon area (two licences).

It is unlikely that all the sites would be fracked, even if drilling went ahead, because many have the potential to generate conventional gas instead.

In July 2013, the then UK Prime Minister David Cameron claimed that, "fracking has real potential to drive energy bills down", presumably assuming that it would thus have populist appeal. It may be thought that the Paris agreement on climate change would focus minds as countries try to limit the global temperature increase to 1.5 °C. To achieve this, some scientists have suggested that zero emissions will be required by between 2030 and 2050. This is an indication that the energy policies must aim for radical reduction of greenhouse gas emissions.

A report by the Committee on Climate Change, a statutory body that advises ministers on keeping greenhouse gases in legal limits, has stated that 3 conditions should be met if climate change targets are to be met:

- Shale gas production must displace imports rather than augment use,
- Methane leaks must be dealt with,
- Greenhouse gas emissions in other areas of industrial production should be cut in order to compensate for the impact of shale gas on the atmosphere .

However, as indicated in the introduction to this study, it has become clear that fracking will remain a highly contentious practice. Much of the literature related to fracking is highly charged in content and some claims made about its impacts have been severely contested on both sides of the debate. The fact that, as yet, there are no operating wells in the UK and that the 2 experimental ones have been suspended is indicative of the current uncertainty around the industry.

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4. The film Gasland (2010 Josh Fox) can be watched on Youtube. It is an American documentary focusing on communities affected by natural drilling, specifically fracking. Gasland 2 has since been produced.
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Acknowledgements: *This* ***Geo Factsheet*** *was researched and written by* ***Sue Chamberlain*** *and published in January 2017 by* ***Curriculum Press****, Bank House, 105 King Street, Wellington, TF1 1NU.* **ISSN 1351-5136**