



Shale gas and fracking

Standard Note: SN/SC/6073

Last updated: 2 November 2011

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Section: Science and Environment Section

This note is intended to update the Energy and Climate Change Committee's [Fifth Report "Shale Gas"](#) (May 2011), to which the Government has now [responded](#), and [POST Note 374 "Unconventional Gas"](#) (April 2011).

The recent rapid development of unconventional gas resources (notably shale gas) in North America has transformed the World gas-market outlook. In September 2011 the company Cuadrilla announced the results of test drills that indicate substantial reserves in the UK.

Concerns have been raised regarding, for example, resource use, net effects on greenhouse gas emissions and risk of groundwater contamination, although the Government has declined to place a moratorium on drilling and the Committee was supportive of the industry.

Following small seismic tremors near Blackpool in April and May 2011 however, drilling is temporarily suspended while a geomechanical study takes place, although Cuadrilla has just (October 2011) published a full [economic assessment](#) of the potential for shale gas exploration and production in Lancashire and the UK.

Update: On 2 November 2011 a *Geo-mechanical Study of Bowland Shale Seismicity* was published. Cuadrilla's [Executive Summary](#) says it is 'highly probable' that fracking triggered the seismic events, and if this happened again, events at around magnitude 3 on the Richter scale would be a worst-case scenario.

The Government's reaction, and whether drilling will resume, may be discussed during a Westminster Hall debate on Thursday 3 November, on the Committee's shale gas report and the Government response.

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1 UK and World energy demand and outlook

UK Continental Shelf production of natural gas has been declining and in 2010 was about half that in 2000. The UK has been a net importer of gas since 2004, with imports in 2010 accounting for just under half of the UK's gross (consumption plus exports) demand.¹

Natural gas is the only fossil fuel for which global demand is set to be higher in 2035 than 2008 under all scenarios in the OECD/International Energy Agency's (IEA's) [World Energy Outlook](#) (2010).

Around 35% of the global increase in gas production is predicted to come from 'unconventional' sources (shale gas, coalbed methane and tight gas; see next section) in the US and, increasingly, from other regions, notably Asia-Pacific.²

The rapid development of shale gas in North America has transformed the gas-market outlook. As early as 2009, announcing the 2009 World Energy Report, the IEA [stated](#) that the boom in North America was expected to prolong the US 'glut of gas supply' and the share of unconventional gas in total US gas output was expected to reach 60% in 2030;

Unconventional gas is unquestionably a game-changer in North America with potentially significant implications for the rest of the world.

According to the *New Scientist*, the EU has said that reserves from proven and conventional sources will run out in 2068 but that unconventional reserves, such as shale gas, could add another 60 years at the current rate of consumption.³

¹ [Digest of UK Energy Statistics 2011](#) Chapter 4 Gas

² World Energy Outlook 2010 p. 50

³ "Wonderfuel gas; plans are afoot to solve our energy crisis with an overlooked fuel" *New Scientist*, 12 June 2010

2 Unconventional gas reserves

The ECC Committee's report explains what 'unconventional' gas is in detail, but in short, it is natural gas from unconventional reservoirs or sources, and there are three main types. 'Shale gas', as the name suggests, is found within shale beds (as opposed to being within a conventional reservoir capped by shale beds). 'Coalbed methane' is natural gas found within coal seams, and 'tight gas' is found within other low-permeability rocks.

Shale has not previously been considered a hydrocarbon reservoir rock in the UK, because being in essence 'trapped' within low-permeability rocks, unconventional gas cannot be extracted by simply drilling a few boreholes into a large reservoir. But with advances in drilling and wellsite technology, production of gas from these less permeable formations is now commercially viable.

3 Fracking

Gas held within shale beds is accessed through a technique called hydraulic fracturing or "fracking", and can use horizontal drilling. Horizontal drilling is not the main issue; the technique is not new and is used increasingly at conventional wellsites to access harder to reach reserves. Indeed, Cuadrilla's wells in UK shales currently use vertical drilling⁴. According to the [British Geological Survey \(BGS\)](#):

Gas exploration companies drill boreholes down into the gas-bearing shales, thousands of metres below the surface. Then, the drilling continues horizontally for thousands of metres.

The borehole is lined with a steel and concrete casing. A 'perforating gun' is lowered into the borehole to make small holes into the concrete casing; explosive charges from the gun create perforations in the borehole casing.

A mixture of water, chemicals and sand is pumped — at very high pressure — along the borehole and through the perforations which fracture the shale. The water opens up cracks in the rock, and the sand grains lodge into the spaces and keep them open, allowing the released gas to flow out of the rocks and to travel back up the borehole casing.

[...]

High volumes of water — up to a million gallons — are required to fracture, and hold open, the shales. About a third of the 'waste' water, containing treatments, sands and other chemicals, is returned to the surface.

4 Shale gas reserves in the UK

[Figure 1](#) of the ECC Committee's report shows the UK outcrops of formations with shale gas potential. The Committee was told that the sites with best prospects are likely to be close to the formations that yield conventional oil and gas reserves. In the UK these include the Upper Bowland Shale (the source rock for the Irish Sea conventional fields, and where Cuadrilla are exploring, see below), and both the Kimmeridge Clay and Lias of the Weald Basin (source rocks for the North Sea and English Channel fields).

The BGS estimated for the ECC Committee and in a [report](#)⁵ for the Department of Energy and Climate Change (DECC) that, by analogy with similar producing shales in the US, the UK's shale gas reserve potential could be as large as 150 billion cubic metres (bcm). This

⁴ <http://www.cuadrillaresources.com/what-we-do/technology/> accessed 9 October 2011

⁵ DECC 2010 <https://www.og.decc.gov.uk/upstream/licensing/shalegas.pdf>

compares to a 2-6 bcm estimate of undiscovered onshore conventional petroleum. However, while broadly supportive of the industry, the Committee concluded that shale gas was unlikely to be a 'game-changer' to the same extent as in the US, or perhaps countries like Poland.

A company called Cuadrilla started drilling shale gas exploration wells near Blackpool in August 2010.⁶ Cuadrilla says it is a UK company headquartered in Litchfield, although it is owned by Australian drilling company AJ Lucas and private equity firm Riverstone LLC.⁷

At the time of the Committee's inquiry the company was in exploration phase and declined to disclose too much information of a commercially confidential nature concerning its finds. Under licence terms, the results of its wells will be held confidential for four years from the well completion date.⁸

However, on 1 October 2011 the *Economist*⁹ reported that on September 21st Cuadrilla estimated that 200 trillion cubic feet of gas lie in the Bowland shale under Lancashire, nearly 40 times previous projections of all of Britain's shale resources and, in theory, four times as much gas as is still recoverable from the North Sea. This was downplayed in the same article by the BGS which pointed out the difficulties in extracting the full reserve, with possible recovery rates of only 10-20%.

On 21 September 2011 Cuadrilla published an upbeat [economic assessment](#) which predicts that test well activity could support some 250 FTE jobs across the UK, peaking at some 5,600 FTE jobs in the period 2016 through to 2019 if it moves to a commercial extraction phase. Cuadrilla has just (October 2011) published its [full economic assessment](#) by Regeneris Consulting.¹⁰

5 Regulatory regime

Shale gas drilling is covered by the normal UK regime for all oil and gas exploration and development activities. A UK Petroleum Exploration and Development licence (PEDL) allows a company to pursue a range of oil and gas exploration activities (including exploration and development of unconventional onshore gas), subject to necessary drilling/development consents and planning permission.¹¹

The last (13th) Onshore Licensing Round was run in 2008 and following the grant of planning permission, consent was given to drill for shale gas in five locations. Of these, consent for fracking of the shale has been given to Cuadrilla at two sites at Poulton-le-Flyde. In addition, a number of companies awarded licences in earlier offshore rounds are re-assessing the shale potential of older licences.¹² An [environmental assessment](#) has been published for the 14th Onshore Round, on which DECC is considering comments and will publish a government response as soon as practicable. Following this DECC will invite applications for the 14th Round.

⁶ <http://www.cuadrillaresources.com/what-we-do/locations/>

⁷ "Doubts raised about giant UK shale gas find", *Reuters News*, 23 September 2011

⁸ <https://www.og.decc.gov.uk/upstream/licensing/shalegas.pdf>

⁹ "What the Frack?" *The Economist*, 1 October 2011 p.34

¹⁰ *Economic Impact of Shale Gas Exploration & Production in Lancashire and the UK* September 2010 published 5 October 2011

¹¹ See http://www.decc.gov.uk/en/content/cms/meeting_energy/oil_gas/shale_gas/shale_gas.aspx#7 for more links to information on the regulatory regime

¹² HL Deb 6 October 2011 c213WA

As well as holding the necessary PEDL, all drilling operations are subject to notification to the Health and Safety Executive and each site is assessed by the Environmental Agency (SEPA in Scotland) who regulate discharges to the environment (through the environmental permitting system) as well as being a statutory consultee in the planning process.¹³

6 Environmental considerations

6.1 Climate change

Some commentators argue that generating electricity from natural gas is relatively clean, relative, that is, to coal fired generation. It has even been suggested that more gas could help bridge the gap to cleaner renewables or more nuclear generation. Equally, there are fears that plentiful gas may increase energy use and divert investment from more pricey (up-front) alternatives, weakening the case for reducing reliance on fossil fuels. The former Director of the Tyndall Centre for Climate Change Research, Professor Kevin Anderson, has said that “From a climate-change perspective this stuff simply has to stay in the ground.”¹⁴

A [letter to the Guardian](#) (27 September) has said that lower CO₂ emissions are countered by methane releases of up to 10% of production. However, in a [letter in response](#) (6 October 2011), a petroleum engineer has said that methane leakage with frac fluids can be either captured or flared; leakage of 10% would not be tolerated by any commercial company.

6.2 Ground and surface water contamination

In January 2011 the Tyndall Centre for Climate Change Research published a report, [Shale gas: a provisional assessment of climate change and environmental impacts](#) commissioned by the Co-operative Group. The report set out concerns about ground and surface water contamination, possibly even affecting quality of drinking water and wetland habitats, depending on factors such as the connection between ground and surface waters.

The depth of shale gas extraction gives rise to major challenges in identifying categorically pathways of contamination of groundwater by chemicals used in the extraction process. An analysis of these substances suggests that many have toxic, carcinogenic or other hazardous properties. There is considerable anecdotal evidence from the US that contamination of both ground and surface water has occurred in a range of cases.¹⁵

Evidence in the US remains anecdotal to date, but some states have put in place moratoriums on fracking. The US Environmental Protection Agency (EPA) issued guidance last year that no company could frack with diesel in the mixture without a permit. The EPA has also sued one company for alleged water contamination in Texas although the industry counters that most wells are well below aquifers and problems are caused by faulty drilling or surface operations¹⁶ An EPA study in 2004 on hydraulic fracturing for coal bed methane concluded that there was no significant evidence that drinking water aquifers were being affected. But given public concern and the proliferation of fracking, the EPA has embarked on further studies over the next two years.¹⁷

¹³ HC Deb 1 February 2011 c669w and <http://www.environment-agency.gov.uk/business/topics/126689.aspx>

¹⁴ “What the Frack?” *The Economist*, 1 October 2011 p.34 and “Natural Gas: Should fracking stop?” *Nature* Volume 477, pp 271–275 15 September 2011

¹⁵ Tyndall Centre for Climate Change Research at Manchester University, [Shale gas: a provisional assessment of climate change and environmental impacts](#), January 2011, p5

¹⁶ “Fracking”, *Financial Times*, 29 September 2011 p.2

¹⁷ <http://www.environment-agency.gov.uk/business/topics/126689.aspx> accessed 5 October 2011

According to a parliamentary answer, the fluids used to date by Cuadrilla comprise: fresh water and sand—99.96% and polyacrylamide friction reducers—0.04%. Other potential additives include hydrochloric acid, typically at a concentration of 0.125%, or biocide at a concentration of 0.005% if required to purify the local water supply.¹⁸

The ECC Committee found no evidence that fracking poses a direct risk to underground water aquifers provided the drilling well is constructed properly. The Committee concluded that, on balance, a moratorium in the UK was not justified or necessary at present, while urging DECC to “monitor drilling activity extremely closely in its early stages in order to assess its impact on air and water quality”.¹⁹

In its response to the Committee, the Government gave an undertaking to do this, and noted that

The technologies used in shale gas operations are not generically novel or unfamiliar. Hydraulic fracturing, water injection and lateral drilling, individually or in combination, are all familiar techniques that DECC and the other regulators have had to deal with robustly for a long time.²⁰

When asked whether it would consider delaying shale gas extraction in the UK in view of the concerns raised by the Tyndall Centre and while the US EPA investigated, the Government said that with a robust regulatory regime in place DECC saw no need for a moratorium on shale gas activities in the UK. The UK's geology and regulation differed from the US so US experience would not necessarily be equally relevant to UK conditions or to the UK regulatory framework.²¹ The Environment Agency also describes fracking as an established technology.²²

6.3 Resource use

The Tyndall Centre highlighted excessive water use for fracking as a particular problem “given that water resources in many parts of the UK are already under pressure”²³ although the *New Scientist* reports that the industry has started to recapture water to reuse for another fracturing process and to use waste water from conventional gas production plants.²⁴ For the current exploration sites Cuadrilla anticipate using approximately 1,600 m³ of water for each hydraulic fracture operation.²⁵

Because shale gas reserves are more diffuse than conventional reservoirs, productivity at each well falls relatively quickly. The IEA considers that, apart from local community buy-in, the most important above-ground considerations for unconventional gas developments are the availability of sufficient land and water. Shale gas drilling leaves “a large and comparatively invasive footprint on the landscape” because of the large number of wells needed to produce a given volume of gas. The IEA also notes that access to water may be a

¹⁸ [HC Deb 29 June 2011 c853w](#)

¹⁹ Committee Press Release, *Shale gas gets support from MPs in new report*, 23 May 2011 <http://www.parliament.uk/business/Committees/Committees-a-z/commons-select/energy-and-climate-change-Committee/news/new-report-shale-gas/>

²⁰ Energy and Climate Change - Seventh Special Report Shale Gas: Government Response to the Committee's Fifth Report of Session 2010-12 19 July 2011

²¹ HC Deb 1 Feb 2011 [c769W](#)

²² <http://www.environment-agency.gov.uk/business/topics/126689.aspx>

²³ Tyndall Centre for Climate Change Research at Manchester University, *Shale gas: a provisional assessment of climate change and environmental impacts*, January 2011, p6-7

²⁴ Ibid

²⁵ [HC Deb 29 June 2011 c853w](#)

barrier to unconventional gas developments, although technology is starting to reduce the amount required.²⁶

In its [response](#) to the ECC Committee, the Government said that “Adverse effects on water resources as a result of possible expansion of the shale gas industry in the UK are not expected.”²⁷

7 Seismic tremors and current suspension of drilling

At around 2.30 am on 1 April 2011 there was a 2.3 ML local magnitude (ML) earth tremor near Blackpool and a further, small 1.5 ML event at 0.48 am on 27 May 2011.²⁸ The BGS has concluded:²⁹

We are unable to conclusively say if the magnitude 2.3 earthquake was related to ongoing hydrofracturing at the Preese Hall drill site. Our epicentre places the earthquake approximately 2 km from the drill site, which falls within the area of error.

However, our depth of 3.6 km is poorly resolved as the nearest station is 80 km away from the epicentre. This means that the depth errors are large.

Instrumentation much closer to the site, as well as a detailed record of dates and times of injection are required to identify any relationship between the injection process and any seismic activity in future.

Cuadrilla issued a [statement](#) on 31 May 2011 saying it was postponing fracking operations at Weeton, near Poulton, while it interpreted seismic information received from monitoring information located around the site.

In its July 2011 response to the Committee report,³⁰ the Government said that DECC had had discussions with the operator, Cuadrilla, and agreed that a pause in hydraulic fracturing operations was appropriate so that a better understanding could be gained of the cause of the seismic events experienced. A geomechanical study was being undertaken, funded by Cuadrilla, along with further work by the BGS and Keele University, and the implications would be reviewed before any decision on resumption was made.

In June 2011 the Government said that the work was expected to take between 30-60 days and upon completion, the operator's study would be published.³¹

This was published on 2 November 2011. Cuadrilla's [Executive Summary](#) of the *Geomechanical Study of Bowland Shale Seismicity* says

The report concludes that it is highly probable that the fracking at Preese Hall-1 well triggered the recorded seismic events. This was due to an unusual combination of factors including the specific geology of the well site, coupled with the pressure exerted by water injection. This combination of geological factors was rare and would be unlikely to occur together again at future well sites. If these factors were to combine

²⁶ IEA [World Energy Report 2009](#) Chapter 11, p.415

²⁷ Energy and Climate Change - Seventh Special Report Shale Gas: Government Response to the Committee's Fifth Report of Session 2010-12, 19 July 2011

²⁸ “Gas drilling on hold after earth tremor”, *Daily Post (Liverpool)*, 1 June 2011 p.14

²⁹ <http://www.bgs.ac.uk/research/earthquakes/blackpoolApril2011.html>

³⁰ Op cit.

³¹ [HL Deb 27 June 2011 c363WA](#)

again in the future local geology limits seismic events to around magnitude 3 on the Richter scale as a worst-case scenario.

Cuadrilla's water injection operations take place over 3km below the earth's surface. This significantly reduces the likelihood of a seismic event of magnitude 3 or less on the Richter scale having any impact at all at the surface.

DECC does not appear to have commented on the report yet (as of 2 November 2011). However, a Westminster Hall debate on Thursday 3 November 2011 (on the Committee's report on shale gas and the Government's response) may shed some light on the Government's reaction and whether drilling will resume.