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**Friends of
the Earth**

Briefing

Shale gas: energy solution or fracking hell?

Shale gas is being promoted as a safe, clean energy source that can help the UK in the transition to a low carbon economy. But there are serious environmental concerns around shale gas drilling including climate change emissions, threats to groundwater quality and water resource needs.

Friends of the Earth believes that until these issues are satisfactorily addressed, there should be a moratorium on shale gas exploration and drilling in the UK.

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“Because of shale gas, the air in Beijing will be cleaned up as the air in London was cleaned up sixty years ago. Because of shale gas, clean air will no longer be a luxury that only rich countries can afford. Because of shale gas, wealth and health will be distributed more equitably over the face of our planet”.

(Freeman Dyson, in foreword to ‘The Shale Gas Shock’)¹

Introduction

In recent years, shale gas production in the United States has grown enormously, changing the US from being potentially a net importer of gas, to being the world’s largest gas producer.

Geological surveys and initial findings from the one company that has drilled test wells show that the UK could have significant shale gas reserves potentially providing, in the view of its proponents, a secure supply of natural gas. Reserves elsewhere in Europe could be even greater. With claims of lower greenhouse gas emissions than coal, shale gas is being touted as a possible transition fuel as we move to a low carbon economy, and as a source of energy security, reducing reliance on imported gas.

But serious doubts have been raised in many areas: are carbon emissions from shale gas extraction as low as is claimed? Will burning shale gas jeopardise our climate targets? Does shale gas extraction risk contamination of drinking water supplies? Are reserves as large as has been claimed? Will investment in shale gas take money away from renewable energy?

What is shale gas?

Shale gas is a form of ‘unconventional gas’ which is extracted from shale rock formations, usually located at depths of 1000 – 4000 metres. It is chemically effectively the same as natural gas, being mainly methane. ‘Unconventional’ refers to how the gas is extracted.

Other forms of unconventional gas include coal-bed methane (which is extracted from intact coal seams), coal gasification (converting coal to a high-energy gas mixture) and methane hydrate (a type of ice containing methane found in deep oceans and in permafrost).

How is shale gas extracted?

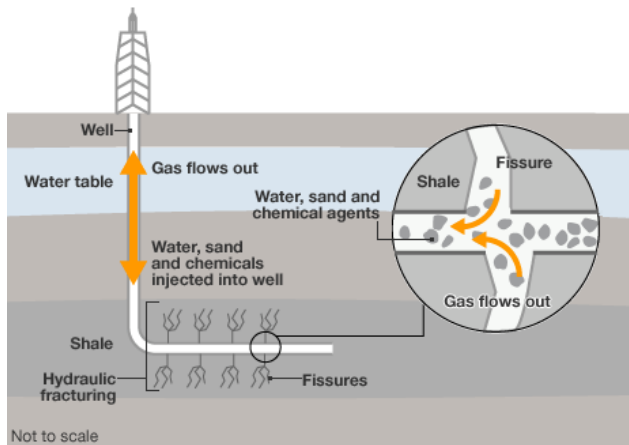
Similarly to conventional gas, extraction is via a well. As is shown in the graphic below², the well is drilled vertically to above the shale, then the drill is steered until it is horizontal and drilling continues. This is because the reservoirs are wider than they are tall, so horizontal drilling accesses more of the reserve. To allow the gas to flow, fractures have to be created in the rock. This is done by hydraulic fracturing (fracking). The concrete casing of the well is cracked with small explosive charges and fluid (approx 99% water and sand, 1% chemicals) is injected down the well and into the shale gas rocks at high pressure. The sand props open the new fractures allowing the gas to flow into the well and be collected at the surface.

UK resources and reserves – how much shale gas is there?

Cuadrilla Resources, which has drilled test wells in Lancashire (see below), estimate that the area where they have the drilling licence contains 5,660 billion cubic metres (bcm) of shale gas. This is theoretically enough to supply Britain’s annual gas needs for 56 years, though only 10-20% of this is likely to be recoverable³.

The British Geological Survey estimates UK reserves at 150 billion cubic metres (bcm) – about 1½ years of UK gas consumption or 10 years of current LNG imports⁴. The US

Shale gas extraction



Department of Energy has estimated UK technically recoverable reserves as 560bcm – about 5½ years of UK gas consumption or 56 years of current LNG imports⁵. This uncertainty reflects a lack of detailed geological knowledge and difficulties with making predictions⁶.

These figures are for onshore reserves only – estimates of UK offshore shale gas reserves (in the North Sea) could be 5 to 10 times higher than onshore reserves⁷.

EU and global resources

According to the US DOE, there are substantial shale gas reserves in Poland and France: Poland's reserves represent over 300 years of current gas consumption⁸.

The US DOE report estimated that shale gas could increase global technically recoverable gas resources by 40%⁹. IEA say unconventional gas reserves are equivalent to 123 years of current production¹⁰. Countries with significant potential reserves include China, South Africa and Australia.

The US experience

Exploitation of shale gas reserves such as the Marcellus Shale (in the Appalachian Basin in the North-East United States) and the Barnett Shale (in the Fort Worth Basin in Texas) mean that production of shale gas in the United States has grown twelve-fold since 2000. The US has moved from having to consider importing gas to being the world's leading gas producer. Shale gas has been described in the Wall Street Journal as *"one of the hottest investments in the energy sector"*¹¹.

What is happening in the UK?

In contrast to the US, shale gas exploration in the UK is at a very early stage. The only test drilling that has taken place to date is in Lancashire, where Cuadrilla Resources has drilled two wells east of Blackpool. Further testing was suspended earlier this year due to concerns about the drilling triggering minor earthquakes - this is currently being investigated.

Applications for drilling have been made or interest expressed in several other locations, including the Mendips¹², Kent¹³, Vale of Glamorgan¹⁴ and near Falkirk¹⁵. There is also reported interest in Ireland, including at sites near the border between Northern Ireland and the Republic of Ireland¹⁶.

Gas industry experts generally think it unlikely that there will be significant shale gas production in the UK or elsewhere in Europe until at least the end of the decade, due to a series of constraints including lack of detailed geological knowledge, cost and operational and regulatory challenges¹⁷. Growing concerns about the environmental and human health impacts of shale gas drilling are another serious obstacle.

Costs

The commercial viability of shale gas will be partly determined by costs. Extraction costs have fallen in the US in recent years, and coupled with rising gas prices, this has made shale gas more competitive. However costs are likely to be higher in Europe for a range of reasons, including the lack of an established supply chain and service industry, as exists in the US.

Environmental and human health concerns

Shale gas extraction poses many actual and potential environmental and human health concerns. The main concerns are:

- impact on climate change
- groundwater pollution
- air pollution
- demand for water

However there are also other local concerns such as noise, additional traffic and the potential link with earth tremors.

Climate change

Shale gas drilling poses two connected problems related to climate change:

- Comparative emissions compared to conventional gas and other fossil fuels
- The impact on overall emissions of using up shale gas reserves

The key difference between shale gas and conventional gas in terms of emissions is in the extraction process. Respected climate change experts at the Tyndall Centre have concluded that there are *'relatively low levels of additional emissions'* compared to conventional gas which *'suggest that there would be benefits ... if shale gas were to substitute for coal'*¹⁸.

Another study by Cornell University¹⁹ found that 4 – 8% of a well's total production is emitted as methane via routine venting and equipment leaks and with fracking fluids as they flow back. This is 30-100% more than from conventional gas. This means that the greenhouse gas footprint of shale gas is 20-100% greater than that of coal on a 20-year horizon. Unsurprisingly this research is strongly contested by the industry²⁰.

Burning shale gas could put meeting the UK's climate targets at risk. As respected climate expert Professor Kevin Anderson of the Tyndall Centre told a recent House of Commons Select Committee inquiry: *"there simply is not the emission space available in the timeframe that we have to utilise shale gas"*²¹. Advocates of the continued use of gas as a key part of our energy mix say that the use of Carbon Capture & Storage (CCS) technology would allow us to use shale gas. However recent reports suggest that the development of CCS has slowed down significantly²².

Investment in shale gas could also have a negative impact on investment in renewable energy. As one expert has said: *"in a world where there is the serious possibility of cheap,*

*relatively clean gas, who will commit large sums of money to expensive pieces of equipment to lower carbon emissions?*²³

Groundwater pollution

Shale gas extraction poses serious risks of contamination of groundwater. by either the fracking fluid or by methane. This can happen either through cracks in the well, or or via natural fissures in the rock or fractures created by the fracking process. It is estimated that 20-85% of fracking fluid remains underground²⁴.

There is considerable evidence of problems with methane, as seen in the film *Gaslands* where people living close to shale gas wells near Dimock, Pennsylvania are shown setting light to their tap water. A recent study by scientists from Duke University found methane levels in shallow drinking water wells were 17 times higher near active gas drilling areas than elsewhere²⁵.

Contamination with fracking fluid is potentially more harmful to human health because of the nature of the chemicals used. Exact information on the composition of fracking fluids is hard to obtain because US Federal law excludes fracking from regulation by the Environmental Protection Agency²⁶. However research has found that:

- 25% of fracking chemicals could cause cancer
- 37% could disrupt the endocrine system
- 40-50% could affect the nervous, immune and cardiovascular system
- more than 75% could affect the skin, eyes and respiratory system²⁷

One study found that some fracking fluids “contained up to 93 times more benzene than diesel. The amount of benzene from a single fracked well could contaminate more than 100 billion gallons of drinking water”²⁸. Benzene is a known carcinogen.

Much of the fracking fluid (15-80%) returns to the surface via the well in wastewater. As well as the fracking chemicals, it has been reported that in the US, this wastewater can contain high levels of radiation: a study by the New York Times of 240 wells in Pennsylvania and West Virginia found “*at least 116 wells with levels that were hundreds of times the EPA’s drinking water standard, and at least 15 wells with levels thousands of times the standard*”²⁹

Concerns about the impact of shale gas fracking on drinking water led the US Environmental Protection Agency to launch a major study of the environmental and human health impacts of shale gas. This study is due to report in 2014³⁰.

There have been concerns about the ability of treatment plants in the US to deal with this waster water but, in the UK, the Environment Agency has told the House of Commons Energy & Climate Change Select Committee that the issue is satisfactorily addressed by current regulations³¹.

Air pollution

There is evidence of higher levels of air pollution near gas wells in the US, and of associated health problems. In Texas, levels of benzene near shale gas wells have been found to be more than five times permitted levels³². Emissions from shale gas wells can also cause photochemical smog: levels of ozone in Sublette County in rural Wyoming where there is a high concentration of gas wells have been recorded as higher than in Los Angeles³³. And there is also evidence of health impacts: “*a Texas hospital serving six counties near drilling*

sites reported asthma rates three times higher than the state average; one quarter of young children in the community had asthma”³⁴.

Demand for water

By its very nature, shale gas extraction needs a lot of water. The volume of water needed is not significant at a national level: one report has found that *“development of shale reserves at levels sufficient to deliver gas at a level equivalent to 10% of UK gas consumption would increase industrial water abstraction across England and Wales by up to 0.6%”³⁵.*

However there could be local and regional problems. For example, the Cuadrilla drilling near Blackpool is within the River Wyre catchment - the Environment Agency’s Catchment Abstraction Management Strategy for the Wyre identifies that all zones are classified as either ‘over licensed’, ‘over abstracted’ or ‘no water available’³⁶.

The Environment Agency, which is responsible for water resources in the UK, has said that it would not license unsustainable abstraction³⁷.

The Government’s view

The Government is supportive of shale gas drilling. In its official response to a recent House of Commons Select Committee inquiry, the Government said *“we will continue to encourage industry to invest in exploration and development, but recognise that the full potential for commercial shale gas production in the UK remains to be proven”³⁸.*

Energy & Climate Change Secretary Chris Huhne has described the film Gaslands as *“a bit of a wake-up call”* but has expressed confidence in the ability of UK environmental regulations to deal with fracking³⁹.

Friends of the Earth’s view

Friends of the Earth believes that there are serious concerns about the environmental impact of the extraction of shale gas. Key among these are greenhouse gas emissions, potential contamination of groundwater, air pollution and water demand.

For these reasons we believe that there should be a moratorium on further shale gas extraction and exploration, at least until the US EPA completes its study into the environmental impacts of these processes. This will also allow further consideration of the impact of shale gas extraction and use in the UK on meeting climate change targets.

Calls for a shale gas moratorium are also supported by the Labour Party, the Green Party, and WWF. Some backbench Tory and LibDem MPs have also expressed concerns⁴⁰.

Moratoriums of some form on shale gas extraction or exploration are already in place in New York State, Pennsylvania, France, North-Rhine Westphalia, Quebec and South Africa.

The UK has abundant resources of renewable energy, from wind, wave, tidal, solar and geothermal power. Friends of the Earth believes that the Government must focus on developing these resources, alongside a major energy-efficiency programme to cut energy waste. As well as cutting emissions this will also create new green businesses and jobs. A second ‘dash for gas’, supported by the promise of supposedly clean and safe shale gas, would seriously affect the chances of the UK meeting its climate change targets, and could cause other local environmental problems.

Shale gas: energy solution or fracking hell?

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- ¹ Global Warming Policy Foundation 'The Shale Gas Shock' http://www.thegwpf.org/images/stories/gwpf-reports/Shale-Gas_4_May_11.pdf
- ² Taken from <http://www.bbc.co.uk/news/uk-wales-14352989>
- ³ Financial Times 21st September 2011 'Lancashire yields huge gas find' <http://www.ft.com/cms/s/0/3b59d762-e465-11e0-844d-00144feabdc0.html#axzz1YfjnPxBT>
- ⁴ House of Commons Energy & Climate Change Select Committee 'Shale Gas' Box 1 <http://www.publications.parliament.uk/pa/cm201012/cmselect/cmenergy/795/795.pdf>
- ⁵ House of Commons Energy & Climate Change Select Committee *op cit* para 19
- ⁶ The estimates are partly based on comparisons with and extrapolations from the US, and it is not clear how whether the shale gas plays (fields) these extrapolations are based on are typical.
- ⁷ House of Commons Energy & Climate Change Select Committee *op cit* para 45
- ⁸ VTB Capital 'Shale Gas in Europe – A Slow Burn'
- ⁹ House of Commons Energy & Climate Change Select Committee *op cit* para 19
- ¹⁰ House of Commons Energy & Climate Change Select Committee *op cit* para 33
- ¹¹ "Reliance spends \$1.36 billion on shale gas stake" Wall Street Journal 28th June 2010
- ¹² UK Methane and Eden Energy are interested in exploratory drilling – see <http://www.bbc.co.uk/news/uk-england-somerset-13748284>
- ¹³ Coastal Oil and Gas has applied to Kent CC for permission to drill exploratory wells at Woodnesborough, near Sandwich – see <http://www.bbc.co.uk/news/uk-england-kent-13666638>
- ¹⁴ Coastal Oil and Gas applied for permission to drill at Llandow in the Vale of Glamorgan. The application was withdrawn temporarily, but is considered ongoing and is likely to return.
- ¹⁵ See <http://www.heraldsotland.com/news/home-news/shale-gas-plan-condemned-1.1104198>
- ¹⁶ See <http://frackingfreeireland.org/politics-related-info/northern-ireland/>
- ¹⁷ See for instance Paul Stevens 'The Shale Gas Revolution: Hype and Reality' <http://www.chathamhouse.org/publications/papers/view/109468> p17
- ¹⁸ House of Commons Energy & Climate Change Select Committee *op cit* Ev 91
- ¹⁹ Howarth et al 'Methane and the greenhouse gas footprint of natural gas from shale formations' <http://www.sustainablefuture.cornell.edu/news/attachments/Howarth-EtAl-2011.pdf>
- ²⁰ See <http://www.energyindepth.org/2011/05/five-things-to-know-about-the-cornell-shale-study/>
- ²¹ House of Commons Energy & Climate Change Select Committee *op cit* para 151
- ²² See <http://www.guardian.co.uk/environment/2011/sep/22/carbon-capture-and-storage-energy?newsfeed=true>
- ²³ Paul Stevens *op cit* page vii
- ²⁴ Tyndall Centre for Climate Change Research 'Shale gas: a provisiobnal assessment of climate change and environmental impacts' http://www.tyndall.ac.uk/sites/default/files/tyndall-coop_shale_gas_report_final.pdf page 57
- ²⁵ Osborn et al "Methane contamination of drinking water accompanying gas-well drilling and hydraulic fracturing" <http://www.nicholas.duke.edu/cqc/pnas2011.pdf>
- ²⁶ This is known as the Halliburton loophole, after the company who were one of the early users of fracking. The loophole was negotiated by then US Vice President Dick Cheney, a former chief executive of Halliburton.
- ²⁷ Colborn et al 'Natural Gas Operations from a Public Health Perspective' <http://www.endocrinedisruption.com/files/Oct2011HERA10-48forweb3-3-11.pdf> and referred to in Food & Water Watch 'The Case for a Ban on Gas Fracking' <http://www.foodandwaterwatch.org/reports/the-case-for-a-ban-on-gas-fracking/>
- ²⁸ Environmental Working Group 'Drilling Around The Law' <http://static.ewg.org/files/EWG-2009drillingaroundthelaw.pdf>
- ²⁹ Food & Water Watch 'The Case for a Ban on Gas Fracking' <http://www.foodandwaterwatch.org/reports/the-case-for-a-ban-on-gas-fracking/> p10
- ³⁰ See <http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/index.cfm>
- ³¹ House of Commons Energy & Climate Change Select Committee *op cit* para 131
- ³² Food & Water Watch 'The Case for a Ban on Gas Fracking' <http://www.foodandwaterwatch.org/reports/the-case-for-a-ban-on-gas-fracking/> p7
- ³³ Food & Water Watch *op cit* p8
- ³⁴ Food & Water Watch *op cit* p8
- ³⁵ Tyndall Centre 'Shale gas: a provisional assessment of climate change and environmental impacts' http://www.tyndall.ac.uk/sites/default/files/tyndall-coop_shale_gas_report_final.pdf section 4.3
- ³⁶ Tyndall Centre for Climate Change Research *op cit* p69
- ³⁷ House of Commons Energy & Climate Change Committee *op cit* para 124
- ³⁸ House of Commons Energy & Climate Change Select Committee 'Shale Gas – Government Response to the Committee's Fifth Report of Session 2010-2012' <http://www.publications.parliament.uk/pa/cm201012/cmselect/cmenergy/1449/1449.pdf> p4
- ³⁹ The Guardian 20th September 2011 'Chris Huhne halts 'dash for gas' to keep UK on course for carbon targets' http://www.guardian.co.uk/environment/2011/sep/20/chris-huhne-dash-for-gas?CMP=twf_fd
- ⁴⁰ These include Tory MPs Alun Cairns (Vale of Glamorgan) and Eric Ollershaw (Lancaster & Fleetwood) and Lib Dem MP Tessa Munt (Wells)