Northern Ireland Assembly

Research and Information Service Briefing Paper

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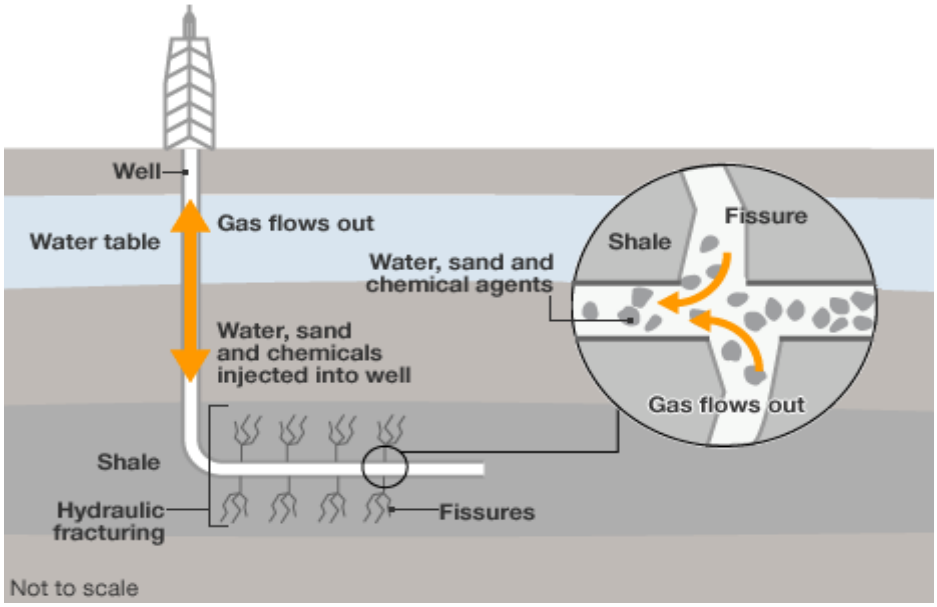
Fracking

1 What is fracking?

Fracking is the common term applied to the process of hydraulic fracturing used to recover natural gas from deep shale formations. It is called 'fracking' because it involves creating fissures or fractures in rocks to allow the gas to flow. The fractures are created by injecting a hydraulic fracturing fluid, usually consisting of water, sand and chemicals, down the well and into the shale gas formation. The sand keeps the fractures open and allows the gas to flow via the well to the surface where it is collected.

Fracking is invariably used in combination with horizontal drilling to access shale gas reserves. Fracking is therefore not a drilling process. It is applied *after* the drill hole has been completed. Figure 1 provides an illustration of how fracking works in practice.

Figure 2: Shale gas extraction – hydraulic fracture[i]



Source BBC

As with conventional drilling there are a number of issues relating to the preparation of a site for production of shale gas:

- Roads may need to be constructed to allow access to the site.
- Well pads are constructed to locate the drilling rig and associated equipment during the drilling process. Six to eight horizontal wells are drilled from a single well pad. Each pad requires an area to store fluid and equipment necessary for high volume fracturing operations as well as equipment associated with horizontal drilling. An average size multi-well pad is likely to be 1.5-2ha in size during the drilling and fracturing phase.

Excavation of pits: for example large volumes of water are required in the drilling and fracturing processes and this may require excavation of land to produce pits to store water. Alternatively it may be possible to extract water from lakes/rivers for this process though this would require laying pipes. In addition pits are required to store waste water used in these processes.

2 Fracking across the globe

2.1 USA

Fracking is common in the USA with at least 19 states involved in shale gas development.[ii] The production of natural gas from shale deposits has become economically viable for three reasons:

- Advances in horizontal drilling;

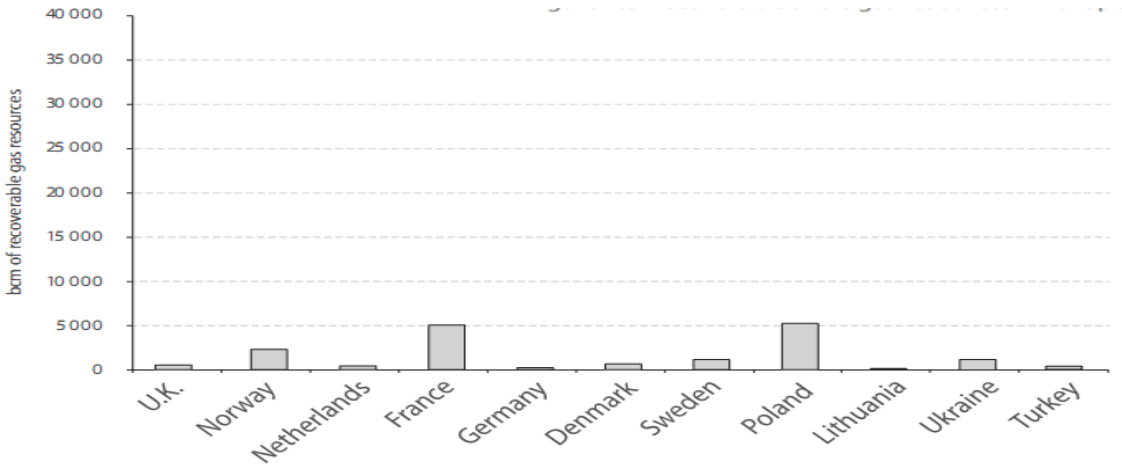
- Advances in hydraulic fracturing techniques; and, perhaps more importantly,
- Rapid increases in natural gas prices as a result of significant supply and demand pressures.[iii]

The only significant *production* of shale gas has also occurred in the USA where during the last decade shale gas production has increase fourteen-fold; it now accounts for 22% of US gas production and 32% of total remaining recoverable gas resources in the US.[iv]

2.2 Europe

A number of companies have bought up exploratory concessions within Europe. Exxon Mobil has bought up concessions in Germany and Poland. Shell is active in Sweden and Ukraine. Chevron is in Poland. Total is in Denmark and France, and Cuadrilla is exploring in the Netherlands, the Czech Republic as well as the UK.[v] The estimated shale gas resources in Europe are presented in Figure 2.[vi]

Figure 2 Recoverable shale gas formations in Europe in billions of cubic metres (bcm)



2.3 Island of Ireland

The Department of Communications, Energy and Natural Resources has issued onshore petroleum licences for exploration in the Clare Basin and the Lough Allen Basin. In relation to the Lough Allen Basin these were issued to Tamboran Resources Ltd covering 986km^2 over parts of Cavan, Leitrim and Sligo and to the Lough Allen Natural Gas Company Limited covering 467km^2 over parts of Cavan, Leitrim, Roscommon and Sligo.[vii]

These licences are solely for initial exploration allowing the companies to drill to a depth of 200m (650ft) and carry out technical studies to indicate whether the gas is commercially viable. If successful the companies will have a first option on a more

expensive exploration licence although this is a process that is at least 2½ years away.[viii]

2.4 UK

Cuadrilla Resources has been exploring in Lancashire since March 2011. According to the BBC, as of Septmber 2011:

> *It said it had found 200 trillion cubic feet of gas under the ground, which if recovered could provide 5,600 jobs in the UK, 1,700 of those in Lancashire.*[ix]

Dart Energy Limited has applied to use hydraulic fracturing in an exploratory well at Airth near Falkirk in Scotland before the end of the year.[x]

3 Northern Ireland

On the 29 June 2010 the Department of Enterprise, Trade and Investment (DETI) placed a notice in the Official Journal of the European Union announcing the availability of *all* of onshore Northern Ireland.[xi] The notice was in response to *Directive 94/22/EC of the European Parliament and of the Council on the conditions for granting and using authorisations for the prospection, exploration and production of hydrocarbons*.

The directive was designed with *'a view to reinforcing the integration of the internal supply market, encouraging greater competition within it and improving the security of supply'* and required Member States to establish common rules which *'establish non-discriminatory access to the activities of prospection, exploration and production of hydrocarbons'.*[xii]

DETI carried out a consultation on the implementation of the directive between August and September 2009 (the consultation closed 30 September 2009).[xiii]

The notice placed in June 2010 introduced two separate windows for applications. The first placed a limit on applications of the 27 August 2010, any applications received in this initial period were considered together. The second window began on the 30 August 2010 and is on-going. All applications received from this point are to be considered in the order they are received.

A number of key criteria were included in the original notice; these formed the basis on which applications would be judged. These are outlined below in their original wording:

- The financial viability of the applicant and its financial capability to carry out the activities that would be permitted under the licence during the initial term including the work programme submitted for evaluating the full potential of the area applied for;

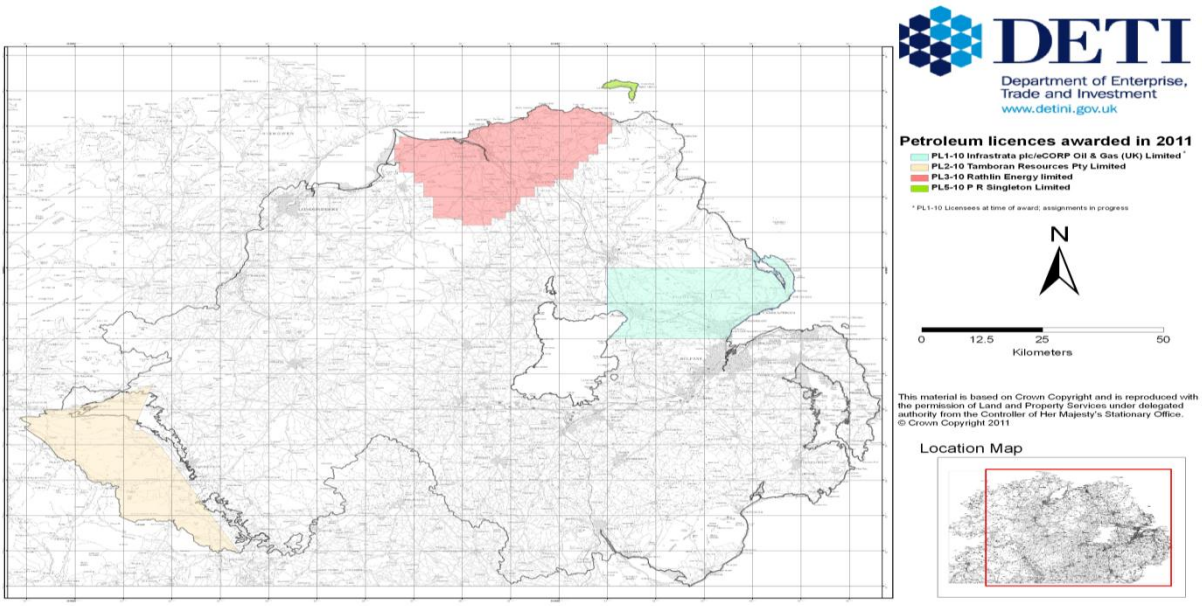
- The technical capability of the applicant to carry out activities that would be permitted under the licence during the initial term including the identification of hydrocarbon prospects within the area applied for;
- The way in which the applicant proposes to carry out the activities that would be permitted by the licence including the quality of the work programme submitted for evaluating the full potential of the area applied for. The work programme is to be structured with the aim of drilling of one well in the area before the expiry of the initial licence term which is a period of five years;
- Where the applicant holds, or has held, a licence under the Petroleum (Production) Act (Northern Ireland) 1964, any lack of efficiency and responsibility displayed by the applicant in operations under that licence.[xiv]

As a result of this process, there were four licences granted:

- Infrastrata plc and eCORP Oil & Gas UK Ltd – Lough Neagh Basin (Central Lane) – Licence number PL1/10;
- Tamboran Resources Pty Limited – Lough Allen Basin (North) – Licence number PL2/10;
- Rathlin Energy Limited – Rathlin Basin – Licence number PL3/10; and
- P.R. Singleton Ltd. – Rathlin Island – Licence number PL4/10

Figure 3 shows the geographical spread of these sites. All four licences grant the licence holder with permission to *'search and bore and get petroleum'.*[xv]

Figure2: Petroleum Licences in Northern Ireland June 2011



4 The Environmental Impact of Fracking

According to the Tyndall Centre for Climate Change Research there is very little information and data on which to base a quantified assessment of environmental and human health risk.[xvi] However, there are issues which are readily identifiable as potential sources of pollution and associated with standard oil or gas exploration:

4.1 Noise Pollution

Table 1 provides a summary of the activities associated with well pads prior to production. Individually and collectively this will produce noise for between 500-1500 days as indicated although it would be expected that continuous drilling of wells 24hrs per day for up to 18months would be significant for a single pad. If pads are allocated at 1.25-3.5pads/km^2 then this will obviously create greater noise pollution for a locality.[xvii]

4.2 Air Pollution

Air emissions occur during exploration and production activities including NOx, volatile organic compounds, particulate matter, SO_2 and methane.[xviii] However, the Environment Agency told the House of Commons Energy and Climate Change Committee[xix] that it was

> *…not expecting big air quality implications […] the Government have oversight of the implementation of the Air Quality Directive […] the Environment Agency has to have regard to the National Air Quality strategy". The Environment Agency "would prefer that if methane is being discharged that it was flared, because obviously that converts it to carbon dioxide, which is a much less potent greenhouse gas […] but we would respect the Health and Safety Executive's judgment about what is safe.*

4.3 Landscape Impacts

Impact on the landscape is inevitable with any drilling operation. Again table 1 highlights the mechanical processes involved in a site prior to production and the associated requirements e.g. storage sites, chemical tanks, drilling equipment, trucks etc. The visual, and associated, impacts will depend on the number of well pads located in an area i.e. it may be difficult to take steps to alleviate the visual impact if there are multiple well pads.

4.4 Traffic and Road Damage

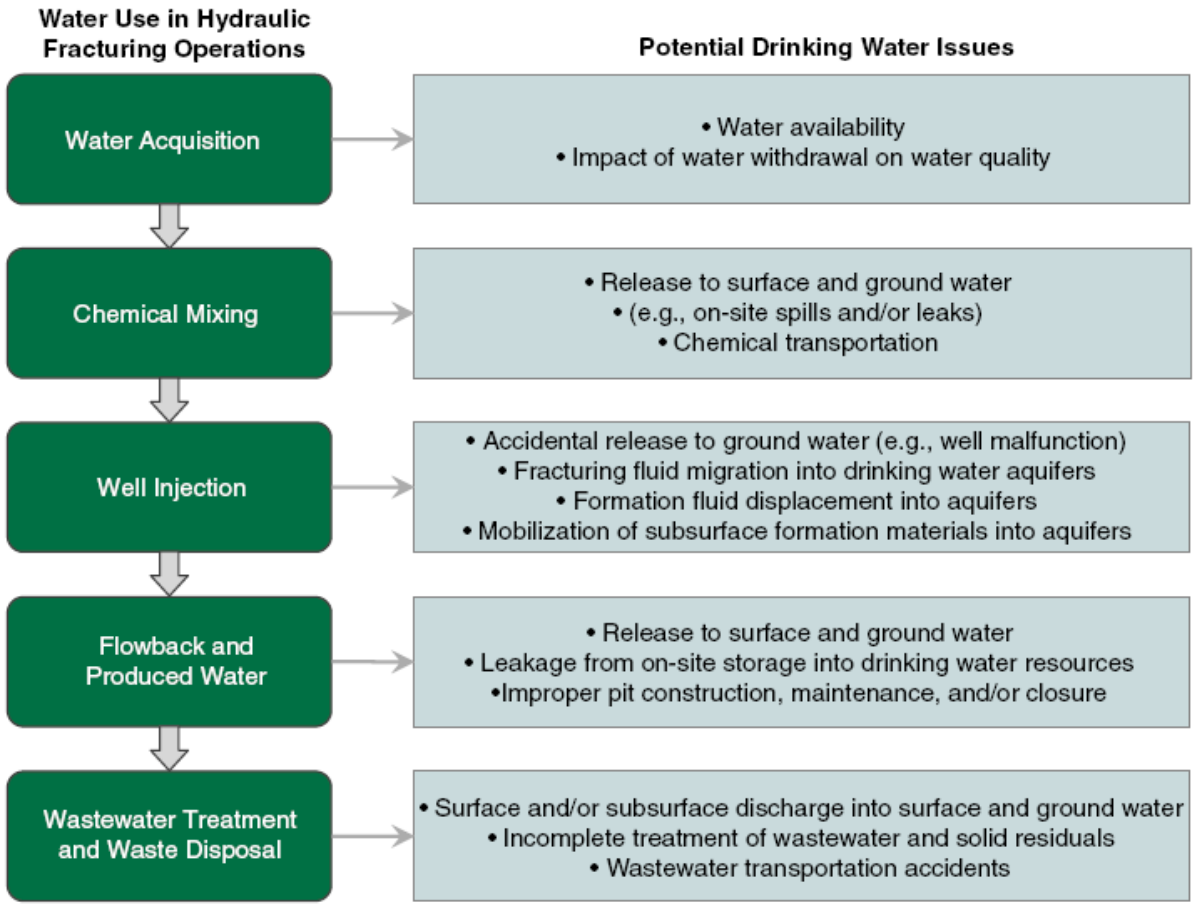
Increased traffic particularly truck visits to and from the site could be significant and will depend on the number of well pads. Coupled with this increase in heavy traffic is the potential for road damage.

4.5 Additional risks

4.5.1 Water Use in hydraulic fracturing operations

There are a number of associated risks from the use of water in the hydraulic fracturing process. The US Environmental Protection Agency identified the risks which are presented in a flowchart figure 4.

Figure 4 Water Use in Hydraulic Fracturing Operations



Source: US EPA, Draft to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water, February 2011, p 14

Perhaps of particular concern in relation to water is the potential for pollution of groundwater aquifers. The fracking process consumes huge amounts of water, between 2 and 4 million gallons, depending on the nature of the extraction site.[xx] As noted above this water comprises the large part of the fracturing fluid which also includes sand and other chemical additives. As many shale deposits are found under aquifers the process of drilling can potentially release this mixture of water and chemicals into the aquifer.

There has been concern in the USA that fracking has, in some cases, resulted in contamination of drinking water with chemicals and/or methane. A study[xxi] by Duke University in the USA outlines the concerns:

> *Concerns for impacts to groundwater resources are based on (i) fluid (water and gas) flow and discharge to shallow aquifers due to the high pressure of the injected **fracturing** fluids in the gas wells); (ii) the toxicity and radioactivity of produced water from a mixture of **fracturing** fluids and deep saline formation waters that may discharge to the environment; (iii) the potential explosion and asphyxiation hazard of natural gas; and (iv) the large number of private wells in rural areas that rely on shallow groundwater for household and agricultural use*

This is an important issue in the USA where nearly half the population relies on groundwater aquifers as their primary source of drinking water; rising in rural areas to around 95%.[xxii] Groundwater aquifers may also discharge water into rivers, lakes and wetlands and therefore if the groundwater is contaminated surface waters may also be contaminated by these discharges.

However, while the study did indicate that there was evidence for methane contamination of some shallow drinking-water systems due to poor well construction there was no evidence for contamination of drinking-water samples with deep saline brines or fracturing fluid.

The recent report by a House of Commons Select Committee, referred to above, concluded that:

> *…hydraulic fracturing itself does not pose a direct risk to water aquifers, provided that the well-casing is intact before this commences. Rather, any risks that do arise are related to the integrity of the well, and are no different to issues encountered when exploring for hydrocarbons in conventional geological formations. We recommend that the Health and Safety Executive test the integrity of wells before allowing the licensing of drilling activity.*[xxiii]

4.5.2 Increased Seismic Activity

There have been a number of reports in the media relating increased seismic activity with fracking. In the UK for example the energy company Cuadrilla Resources suspended its prospecting near Blackpool, Lancashire after concerns that the process had initiated two small earthquakes.[xxiv]

Other news reports in the USA suggest a correlation between fracking and increased seismic activity.[xxv]

However, there is no objective substantive evidence to suggest that fracking causes earthquakes.

5 Discussion

5.1 Shale gas

Shale gas has already had significant impact on the gas industry in the USA. In a 2009 report*, Modern Shale Gas Development in the United States: A Primer,* prepared for the US Department of Energy Office of Fossil Energy and National Energy Technology Laboratory by the Groundwater Protection and ALL Consulting, noted that:

> *At the U.S. production rates for 2007, about 19.3 tcf* (trillion cubic feet[xxvi])*, the current recoverable resource estimate provides enough natural gas to supply the U.S. for the next 90 years. Separate estimates of the shale gas resource extend this supply to 116 years.*[xxvii]

The report adds:

> *Shale gas resource estimates are likely to change as new information, additional experience, and advances in technology become available.*[xxviii]

Concluding:

> *Considering natural gas's clean-burning nature, the nation's domestic natural gas resources, and the presence of supporting infrastructure, the development of domestic shale gas reserves will be an important component of the U.S.'s energy portfolio for many years. Recent successes in a variety of geologic basins have created the opportunity for shale gas to be a strategic part of the nation's energy and economic growth.*[xxix]

The economic impact of increased shale gas exploration and production was illustrated in a recent Bloomberg article:

> *The shale gas rush is creating thousands of jobs and reviving the economy in states such as Wyoming, Texas, and Louisiana. In Pennsylvania, where 2,516 wells have been drilled in the last three years, $389 million in tax revenue and 44,000 jobs came from gas drilling in 2009, according to a Penn State report.*[xxx]

The same article goes on to state *'best of all, natural gas emits half the carbon emissions of oil'.* While it is true that natural gas is considerably 'cleaner' than oil – Department of Energy and Climate Change data estimates that in 2008 gas CO_2 emissions in the UK were approximately 0.19 kilograms of CO_2 per kilowatt hour of energy used (CO_2/kWh), compared to 0.25CO_2/kWh from oil, 0.34CO_2/kWh from solid fuel and 0.54CO_2/kWh from electricity – shale gas' emissions impact appears less favourable.

Commenting on shale gas in its report *Are we entering a golden age of gas?*[xxxi] (June 2011), the International Energy Agency (IEA) state:

> *Based on available data, we estimate that shale gas produced to proper standards of environmental has slightly higher 'well-to-burner' emissions than conventional gas, with combustion of gas being the dominant source of emissions. Best practice in production, effectively monitored and regulated, can mitigate other potential environmental risks such as excessive water use, contamination and disposal.*[xxxii]

Speaking at the launch of the report, IEA executive director, Nobuo Tanaka stated:

> *While natural gas is the cleanest fossil fuel, it is still a fossil fuel. Its increased use could muscle out low-carbon fuels such as renewables and nuclear, particularly in the wake of Fukushima. An expansion of gas use alone is no panacea for climate change.*[xxxiii]

A less optimistic conclusion was reached by researchers at Cornell, in a report published in the journal Climate Change[xxxiv]:

> *Compared to coal, the footprint of shale gas is at least 20% greater and perhaps more than twice as great on the 20-year horizon, and is comparable over 100 years.*[xxxv]

Speaking to the BBC the lead author commented:

> *We have produced the first comprehensive analysis of the greenhouse gas footprint of shale gas… We have used the best available data [and] the conclusion is that shale gas may indeed be quite damaging to global warming, quite likely as bad or worse than coal.*[xxxvi]

5.2 Fracking

The practice of Fracking has given rise to some controversy, recognised by the House of Commons Select Committee on Energy and Climate Change's 2011 report into shale gas:

> *The concern about the impact of more widespread use of hydraulic fracturing has produced political reactions.*[xxxvii]

The key environmental risk identified by the Committee was the possibility of contaminating drinking water. Quoting evidence gathered from the US Environmental Protection Agency (EPA), the Committee stated:

> *We heard during our visit to the US, that the US Environmental Protection Agency (EPA) believed that—from evidence it had gathered so far—that "if hydraulic fractures combine with pre-existing faults of fractures that lead to [drinking water] aquifers or directly extend into aquifers, injection could lead to the contamination of drinking water supplies by fracturing fluid, natural gas, and/or natural occurring substances".*
>
> *During the fracturing process, some of the hydraulic fracturing fluid may flow through the artificially created fractures to other areas within the shale gas formation, in a phenomenon known as "fluid leakoff". Fluid leakoff during hydraulic fracturing "can exceed 70 percent of the injected volume if not controlled properly", which could result in fluid migrating into drinking water aquifers. In comparison, coal-bed methane formations are mostly shallow, so where hydraulic fracturing is used there is a risk that it could be happening in—or very near to—shallow drinking water supplies*[xxxviii]

The report continues:

> *During our visit to the US, we heard little concern from environmental groups, state or federal regulators, or academics on the environmental impacts of the hydraulic fracturing process itself. Any instances of methane contamination of groundwater were either blamed on poor well construction (an issue that applies to conventional as well as unconventional hydrocarbons) or were thought to pre-date any hydrofracing activity.*[xxxix]

In other sections of the report, the Committee draw attention to the evidence presented by the World Wildlife Federation on which the report states:

> *…that it did not believe that shale gas production should be allowed to take place in the UK. At the very least it considered that "no permits should be granted for shale gas activity [...] until there is a robust scientific consensus demonstrating exactly what the risks are.*[xl]

Similarly, the Tyndall Centre's evidence to the Committee concluded that the risk of local pollution:

> *… leaves little doubt that in the absence of a much improved understanding of the extraction process shale gas should not be exploited within the UK.*[xli]

The report also makes clear that some regions had either placed a moratorium on fracking activity or were leaning towards doing so. New York State placed a temporary halt on the issuing of permits for hydraulic fracturing in August 2010, while the EPA carried out further research into the process (due 2012).[xlii] The New York ban was to be lifted in May 2011[xliii], but has been extended until June 2012[xliv]. (Note the section that follows contains a summary list of fracking moratoriums)

Three permits have been granted in France to date. However, in February 2011, the French Minister of the Environment stated the *'in light of the techniques that are used in North America, which are understandably criticized, we will heighten our vigilance'.*[xlv] A law bringing in an outright ban on fracking in the country passed the lower house of parliament on its first reading, in May 2011. The law must also pass the Senate for approval.[xlvi]

The Commons Select Committee report concluded however, that a moratorium was unwarranted:

> *Mitigation of the risk to water aquifers from hydraulic fracturing relies on companies undertaking the proper measures to protect the environment from pollution. However, there is no evidence that the hydraulic fracturing process itself poses a direct risk to underground water aquifers. That hypothetical and unproven risk must be balanced against the energy security benefits that shale gas could provide to the UK. We conclude that, on balance, a moratorium in the UK is not justified or necessary at present.*[xlvii]

Adding:

> *We conclude that hydraulic fracturing itself does not pose a direct risk to water aquifers, provided that the well-casing is intact before this commences. Rather, any risks that do arise are related to the integrity of the well, and are no different to issues encountered when exploring for hydrocarbons in conventional geological formations. We recommend that the Health and Safety Executive test the integrity of wells before allowing the licensing of drilling activity.*
>
> *We recommend that the Environment Agency should insist that all companies involved in hydraulic fracturing should declare the type, concentration and volume of all chemicals they are using.*

> *We recommend that before the Environment Agency permits any chemicals to be used in hydraulic fracturing fluid, they must ensure that they have the capabilities to monitor for, and potentially detect, these chemicals in local water supplies.*[xlviii]

A further environmental issue was highlighted by recent events in Blackpool, when the exploration of shale resulted in a 1.5 magnitude tremor. The test drilling in Blackpool was being carried out by Cuadrilla Resources, who have stated:

> *We take our responsibilities very seriously and that is why we have stopped fracking operations to share information and consult with the relevant authorities and other experts.*
>
> *We expect that this analysis and subsequent consultation will take a number of weeks to conclude and we will decide on appropriate actions after that.*[xlix]

As a result of the events in Blackpool, MPs for the area have called for a safety inquiry into shale gas extraction.[l]

In the Republic of Ireland, where Tamboran have also licensing option, the Department of Communications, Energy and Natural Resources have stated that fracking would not go ahead in the Lough Allen basin without a public consultation and environmental impact assessment.[li]

In the Irish Times interview, referred to above, Tamboran did not rule out the use of fracking in stating it would be *'impractical'* to do so. On the water contamination issue the Chief Executive Stated:

> *We use some chemicals. The bottom line some of the additives we use, we use a light detergent. It softens the water if you are going to 0.1 per cent by volume of a light deter much like you would use in a washing machine. We also use an additive that basically starves the bacteria. There is some really neat chemistry work that companies are using to try and find a greener process. There is a company in Alberta called Multichem which is doing a lot of work for the industry. In the very beginning a test would have very minor fractures. We need to determine if the rock will crack. A full size frack is years away because it takes time to understand what the rock will do. It is not a safety issue. We are just trying to get the best job. Most jobs are very expensive so we just don't want to go on a wing and a note.*[lii]

6 Identified Bans/Moratoriums

Pennsylvania – state legislature passed the Marcellus Shale Bill in May 2010 that enforced a three-year moratorium on further leasing of exploration acreage until a comprehensive environmental impact assessment has been carried out.[liii]

New York State – on August 2010 a temporary moratorium on new shale gas activity until the US Environmental Protection Agency (EPA) reported on its study of shale gas.[liv]

New Jersey – one year moratorium from 25th August 2011.[lv]

France – France became the first country to enact legislation to ban hydraulic fracturing to produce oil or gas as well as banning all research using the process. Anyone conducting hydraulic fracturing in France will be subject to fines and imprisonment.[lvi] Ban due to environmental considerations.

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[i] Ibid

[ii] http://fracfocus.org/sites/default/files/publications/shale_gas_primer_2009.pdf

[iii] Taken from Modern Shale Gas Development in the United States: A Primer, p.9

[iv] http://www.state.gov/s/ciea/gsgi/index.htm

[v] http://e360.yale.edu/feature/fracking_comes_to_europe_sparking_rising_controversy/2374/

[vi] European and Global Resources and the Potential of Unconventional Gas, pp.32, in Unconventional Gas – a Chance for Poland and Europe? Analysis and Recommendations

[vii] http://debates.oireachtas.ie/dail/2011/04/12/00021.asp

[viii] http://www.irishtimes.com/newspaper/ireland/2011/0221/1224290427180.html

[ix] BBC Shale gas firm finds 'vast' gas resources in Lancashire (Sept 2011) http://www.bbc.co.uk/news/uk-england-lancashire-14990573

[x] Natural Gas Europe Shale Stirs Debate in Scotland (May 2011) http://www.naturalgaseurope.com/shale-stirs-debate-scotland

[xi] Official Journal of the European Union United Kingdom Government notice concerning implementation in Northern Ireland of Directive 94/22/EC of the European Parliament and of the Council on the conditions for granting and using authorisations for the prospection, exploration and production of hydrocarbons — Notice of competent authority and arrangements for authorisations in Northern Ireland (June 2010) http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2010:169:0003:0003:EN:PDF

[xii] Europa, Summaries of European Legislation – Prospection, exploration and production of hydrocarbons http://europa.eu/legislation_summaries/energy/internal_energy_market/l27007_en.htm

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[xv] DETI Petroleum Licencing in Northern Ireland http://www.detini.gov.uk/deti-energy-index/minerals-and-petroleum/petroleum_licensing_2.htm

[xvi] Shale gas: a provisional assessment of climate change and environmental impact, pp. 15. Tyndall Centre for Climate Change Research (January 2011)

[xvii] Shale gas: a provisional assessment of climate change and environmental impact, pp. 70. Tyndall Centre for Climate Change Research (January 2011)

[xviii] Taken from Modern Shale Gas Development in the United States: A Primer, Executive Summary, p.5

[xix] Energy and Climate Change Committee – fifth report, Shale Gas http://www.publications.parliament.uk/pa/cm201012/cmselect/cmenergy/795/79502.htm

[xx] Taken from Modern Shale Gas Development in the United States: A Primer, Executive Summary p.4

[xxi] Osborn, S.G.,Vengosh,A., Warner, N.R., and R.B. Jackson (2011) Methane contamination of drinking water accompanying gas well drilling and hydraulic fracturing, Proceedings of the National Academy of Sciences of the United States of America

[xxii] http://fracfocus.org/water-protection/groundwater-aquifers

[xxiii] Energy and Climate Change Committee – fifth report, Shale Gas http://www.publications.parliament.uk/pa/cm201012/cmselect/cmenergy/795/79502.htm

[xxiv] http://www.independent.co.uk/environment/nature/mps-call-for-inquiry-into-shale-gas-drilling-after-earthquakes-2294389.html
[xxv] http://www.foxnews.com/scitech/2011/03/01/fracking-earthquakes-arkansas-man-experts-warn/
[xxvi] A trillion cubic feet is estimated by the US Department of Energy to be the equivalent of heating 15m homes for one year
[xxvii] US Department of Energy, Office of Fossil Energy and National Energy Technology Laboratory Modern Shale Gas Development in the United States: A Primer (April 2009) http://www.netl.doe.gov/technologies/oil-gas/publications/epreports/shale_gas_primer_2009.pdf (accessed 29/06/11)
[xxviii] Ibid
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[xxxiv] Howarth, Robert W, et al Methane and the greenhouse-gas footprint of natural gas from shale formations (April 2011) Climate Change (2011) 106:679–690 http://www.springerlink.com/content/e384226wr4160653/fulltext.pdf (accessed 29/06/11)
[xxxv] BBC News Shale gas 'worse than coal' for climate (12 April 2011) http://www.bbc.co.uk/news/science-environment-13053040 (accessed (29/06/11)
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