

Energy Minerals Topic Paper

June 2013

WWW.SOMERSET.GOV.UK



**Bath & North East
Somerset Council**



Contents

	Page
Executive Summary	3
1. Introduction	4
2. Fundamentals	6
What are energy minerals?	6
Conventional hydrocarbons	6
Unconventional hydrocarbons	7
Coal bed methane (CBM) extraction	8
Fracking	8
Oil and gas regulation	10
3. Geology and landscape	15
Local geology	15
Local landscape	18
4. The policy context	19
The regulatory framework: a European perspective	19
National planning policy	20
Evolving national position	21
Evolving local position	23
5. Industry experience	24
Learning from experiences elsewhere	24
The planning application near Keynsham	25
Industry outlook	27
6. Addressing key concerns	28
Introduction	28
The regulatory framework	28
Community engagement	29
The planning process	30
Protecting our water resources	30
What chemicals are used during fracking?	31
Disposal of waste water	31
Impact on investment in renewable energy	32
Seismic activity (earth tremors)	32
Monitoring	33
Economic impact	35
7. Concluding remarks	36
Appendix: Further Reading	39

Executive Summary

This Topic Paper brings together information collated by members of an informal working group on energy minerals. The working group comprises officers from the following organisations:

- Somerset County Council
- Bath & North East Somerset Council
- North Somerset Council
- Mendip District Council
- Environment Agency

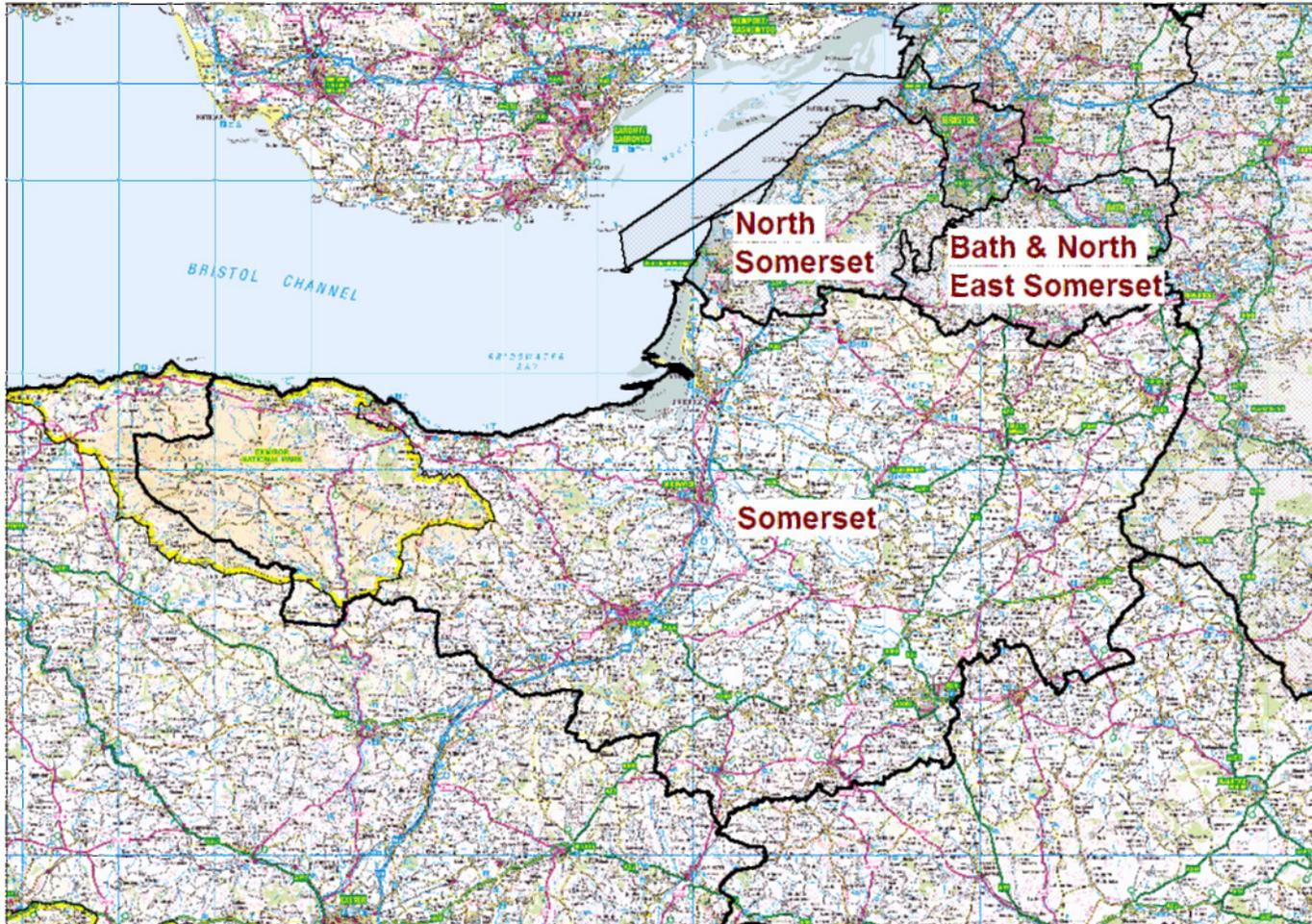
The main aim of this Topic Paper is to outline for a wide (general) audience basic information on energy minerals – in particular on hydraulic fracturing (fracking) for shale gas and coal bed methane (CBM) extraction – that will inform minerals planning policy development in the plan areas covered by the working group (principally Somerset, Bath & North East Somerset and North Somerset).

This Topic Paper does not include proposed policy. It is a technical paper only, bringing together information available in a rapidly changing field.

1. Introduction

- 1.1. This Topic Paper is prepared by a working group of officers from Somerset County Council (SCC), Bath and North East Somerset Council (B&NES), North Somerset Council, Mendip District Council and the Environment Agency.
- 1.2. The Health and Safety Executive have reviewed an advanced draft of the paper and provided comments.
- 1.3. The Topic Paper focuses on energy minerals – with a particular focus on hydraulic fracturing (fracking) for shale gas and coal bed methane (CBM) extraction – pooling relevant information and addressing key issues in a co-ordinated way. The Paper focuses on details that are particularly relevant to planning policy development.
- 1.4. SCC, B&NES and North Somerset Council are Minerals Planning Authorities and are each responsible for mineral planning policy in their respective areas and determining minerals planning applications.
- 1.5. Whilst B&NES and North Somerset Council are both a unitary authority, Somerset is a two tier authority area, in which Somerset County Council is the Minerals Planning Authority (MPA) for the whole of Somerset, excluding Exmoor National Park. Mendip District Council within Somerset is not an MPA, but is represented on the working group due to the geographical areas currently licensed for exploration and development (see section 2 for more information).
- 1.6. Not only does the collaboration via this working group help to fulfil legal obligations arising from the "Duty to Cooperate" embedded in the Localism Act, also it helps to fulfil the more practical aspects of co-operation, linked with delivery of a joined-up approach that provides reassurance and clarity to interested parties.
- 1.7. The Paper does not include proposed policy. It is a technical paper only, bringing together information available in a rapidly changing field.

Figure 1: The study area covered in this Topic Paper - Somerset, Bath & North East Somerset and North Somerset



2. Fundamentals

What are energy minerals?

- 2.1. Energy minerals include coal, oil and gas. These resources underpin key aspects of modern society, supplying energy to power industry and heat homes, fuel for transport to carry goods and people all over the world, and raw materials to produce everyday items.
- 2.2. Planning applications for the extraction of energy minerals are usually determined by the relevant Minerals Planning Authority (MPA) – see paragraphs 1.4 and 1.5 for more information.
- 2.3. The importance of energy security and the need to mitigate climate change by working toward carbon reduction targets combine to increase the significance of energy supply. Bigger household gas and electricity bills further heighten public interest in this issue.
- 2.4. Whilst this Topic Paper considers coal, oil and gas in conventional terms, the primary focus is on gas – in particular onshore gas such as shale gas and coal bed methane. This reflects recent national interests in exploiting new potential reserves, and the relative importance (linked with emerging minerals planning policy) of understanding the key planning issues underlying the exploitation of this resource.
- 2.5. Minerals planning policy, which can be used to consider proposals for minerals operations and their potential impacts, is explained further in section 4 of this Paper.
- 2.6. Uranium may technically be considered to be an energy mineral; however, it is outside the scope of this Paper.

Conventional hydrocarbons

- 2.7. Coal accounts for about 40% of the fuel used in the world annually to generate power¹ and over 7,500 million tonnes is mined per year.²
- 2.8. There are two main types of coal: brown coals (lignite and sub-bituminous coals) and black coals (also known as hard coals). Hard coal can be further divided into two main types: steam coal (sometimes referred to as thermal coal) which is used in industry to generate heat energy; and coking coal, used to make coke (an essential raw material in the steel making process). Substitutes for steam coal include oil,

¹ <http://www.iea.org/topics/coal/>

² <http://www.worldcoal.org/resources/frequently-asked-questions/>

gas, nuclear and renewables; but there is no effective substitute for coking coal.

- 2.9. The majority of the UK's coal output is steam coal of which a high proportion is supplied to industry to generate electricity.
- 2.10. Oil and gas are derived almost entirely from decayed plants and bacteria. Most oil and gas extracted in the UK is mined offshore, in particular beneath the North Sea and the Irish Sea.
- 2.11. UK gas production is declining, but the demand for gas is not. In 2011 gas-fired power stations provided roughly 40% of the country's electricity generating capacity.³ The UK became a net importer of gas in 2004. In 2011 its major international suppliers were Norway, Qatar and the Netherlands.
- 2.12. Developing domestic supplies of gas is seen as a valuable step in reducing our reliance on imports. Reflecting this, there is an increasing interest (from industry and central government) in developing onshore supplies that would contribute toward the country's energy security.
- 2.13. Onshore supplies can be accessed via the sinking of boreholes. This has taken place for many years as a way to access energy minerals from conventionally accessible sources.
- 2.14. Most conventional oil and gas that has been extracted is found in capped reservoir rock that is both porous and permeable. The capacity of rock to hold oil and gas will depend on its porosity; its permeability governs how easily oil and gas flow through the rock. Drilling in the right place of permeable rock allows oil and gas to shoot out. Oil and gas cannot be extracted so easily from rock that has low permeability.⁴
- 2.15. As more accessible sources of gas are exploited, so attention turns to sources that have (so far) been less accessible. Greater interest is being shown in the exploitation of "unconventional" hydrocarbons, which involve the use of technology not used to exploit conventional hydrocarbons.

Unconventional hydrocarbons

- 2.16. There are three main sources of "unconventional" hydrocarbons⁵.
- 2.17. The first is to recover methane from:
 - a) active coal mines, known as coal mine methane;
 - b) abandoned coal mines, known as abandoned mine methane; or
 - c) undisturbed coal seams, known as coal bed methane (CBM).
- 2.18. The second source is found in shales and mudrocks that have so far been too impermeable to mine for their natural gas.

³ Gas Generation Strategy (page 6), DECC, December 2012

⁴ Parliamentary commissioner for the environment, Evaluating the environmental impacts of fracking in New Zealand: an interim report, November 2012

⁵ British Geological Survey / Department for Communities and Local Government, Alternative fossil fuels, Minerals Planning Factsheet, October 2011

- 2.19. Finally, it is possible to combust gas in underground coal seams via a process termed 'underground coal gasification', which produces a syngas that can be used to power gas turbines.
- 2.20. This Topic Paper focuses in particular on accessing CBM and shale gas, because evidence indicates those are the two most likely sources of unconventional hydrocarbons within the study area (see section 3 for more on the local geology and section 5 for more on industry interests).

Coal bed methane (CBM) extraction

- 2.21. Exploration for coal bed methane (CBM) usually relies on the sinking of boreholes, enabling cores to be extracted from the coal seam for analysis of their methane content. This will then give an indication of the gas content of the coal seam.
- 2.22. Exploratory drilling is usually followed by a testing phase to determine the quality and quantity of gas available.⁶
- 2.23. Boreholes may be vertical; or, in some cases, these may be deviated to become horizontal.⁷
- 2.24. Having established that the coal seam is worthy of further appraisal and/or production, a pump is used (either underground or on the surface) to aid gas recovery. Gas extraction is promoted by creating a difference in pressure within the rock. This is done by pumping water out of the coal seam, thus allowing the gas to flow out.
- 2.25. The amount of pumping of water prior to entering any production phase can take weeks or months, and management of the pumped water usually requires a permit issued by the Environment Agency.
- 2.26. If an operator moves into a production phase, it is highly likely that this will entail the drilling of additional boreholes into the coal seam.
- 2.27. CBM extraction does not automatically entail hydraulic fracturing (fracking) but fracking is one way to enhance gas recovery.

Fracking

- 2.28. Hydraulic fracturing (fracking) is the process of opening and/or extending existing narrow fractures or creating new ones (fractures are typically hairline in width) in gas-bearing rock, which allows gas to flow into wellbore's to be captured.
- 2.29. Fracking is not a new technology. Its origins date back to US oil prospecting in the middle of the 19th century.⁸ This was further developed in the early part of the 20th century and in the mid-1970s the US government began funding research into higher volume hydraulic fracturing. Taranaki in New Zealand has been fracking for over 20 years. However, high pressure fracking of shales in the UK is in its infancy.

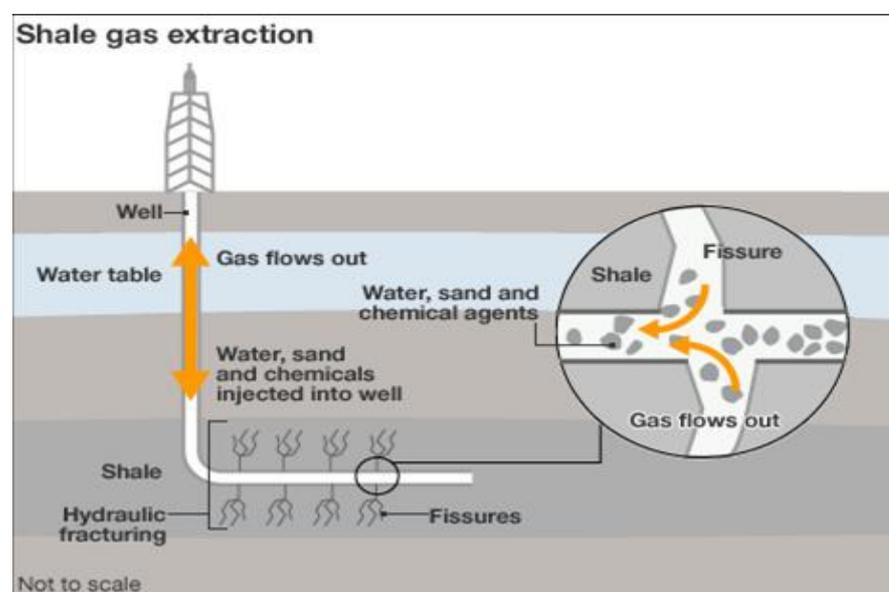
⁶ British Geological Survey, Alternative Fossil Fuels, Mineral Planning Factsheet, October 2011

⁷ British Geological Survey, Alternative Fossil Fuels, Mineral Planning Factsheet, October 2011

⁸ SPE, History of Hydraulic Fracturing – an Enduring Technology, December 2010

- 2.30. Fracking can be used to access unconventional hydrocarbons such as shale gas, and can be used to increase the flow of other gases such as CBM for gas-bearing coal seams.
- 2.31. During fracking, a mixture of water, chemicals and sand is pumped under pressure down a borehole into the rock unit – see Figure 2. The sand is used to prop the fractures open to increase gas extraction.
- 2.32. The borehole is lined with a steel and cement casing and a “perforating gun” is used to create perforations in that case and allow the fracking fluid to be injected into the rock.⁹ The distance of the fractures depends on the pressure used in the fracking process and the properties of the rock being fracked.
- 2.33. Plugs may be used to divide the well into smaller sections (termed stages). Stages are fractured sequentially, beginning with the stage furthest away.¹⁰ After the fracking is done, such plugs can be drilled through and the well is depressurised.
- 2.34. In this way, the system is designed to be closed loop, so that when the high pressure is removed, the fracking fluid returns to the surface for treatment and storage. The flowback water also may contain saline water with dissolved minerals from the shale rock formation. Estimates vary on what percentage of the fracking fluid returns to the surface: from 25-75%.¹¹ This wide range is explained by differences in the properties of the shale and the approach to the fracking.

Figure 2: Shale gas extraction (source: Environment Agency)



- 2.35. Only substances that have been assessed as being non-hazardous pollutants under the Groundwater Directive may be used in hydraulic

⁹ House of Commons note SN/SC/6073, Dr Patsy Richards, Shale Gas Fracking, December 2012

¹⁰ The Royal Society & The Royal Academy of Engineering, Shale Gas Extraction in the UK: a review of hydraulic fracturing, June 2012

¹¹ The Royal Society & The Royal Academy of Engineering, Shale Gas Extraction in the UK: a review of hydraulic fracturing, June 2012

fracturing fluids. (The Groundwater Directive is known as the “daughter” Directive to the Water Framework Directive).

- 2.36. The Environment Agency has powers to require full disclosure of chemicals used and has already made clear their intention to use those powers to ensure full disclosure of all chemicals proposed for use and to assess their hazard potential. However, the Environment Agency may not disclose the relative quantities in the mixture as this is commercially confidential.
- 2.37. So far in the UK, at Cuadrilla’s site in Lancashire, only four additives (Polyacrylamide friction reducer, Hydrochloric acid, Biocide and Sodium salt) have been used in the fracking fluid and these have been authorised by the Environment Agency and are published on the operator’s website.¹²
- 2.38. Information on the chemicals used by an operator in hydraulic fracturing fluid will normally be made available to the public.
- 2.39. Since high pressure fracking of shales is in its infancy in the UK, there remains significant uncertainty about how fracking would be deployed in years to come. *“The operations are likely to be modified in future years by technological changes and, in the UK, under pressure from environmental regulations”*.¹³

Oil and gas regulation

- 2.40. The Department of Energy and Climate Change (DECC) manages the release of Petroleum and Exploration Development Licences (PEDLs) which give exclusive rights for exploration and extraction of oil and gas resources within a defined area. This type of licence secures the rights to explore. It does not convey consent to drill or undertake any other form of operations.
- 2.41. In the planning areas covered by this Topic Paper (namely Somerset, B&NES and North Somerset) exploratory licences have been granted in four blocks (see Figure 2 below).
- 2.42. The companies with licences are Fairfax Shelfco 307 Ltd., UK Methane Ltd. and Eden Energy (UK) Ltd.
- 2.43. Eden Energy and UK Methane are partner companies.
- 2.44. In May 2013 it was announced that Eden Energy had signed heads of terms to sell its UK gas and petroleum assets to “Shale Energy”. Successful completion of the sale would change ownership of three of the PEDLs in the study area.

¹² <http://www.cuadrillaresources.com/about-us/communication-claims-support/fracturing-fluid/>

¹³ British Geological Survey, Potential problems in the Bath and North East Somerset Council and surrounding area with respect to hydrocarbon and other exploration and production, Commissioned Report CR/12/055, 2012 (page 4)

Figure 3: Areas licensed by DECC for petroleum exploration in Great Britain.
 (Source: DECC). For more information on PEDLs visit the DECC website:
http://og.decc.gov.uk/en/olqs/cms/data_maps/onshore_maps/onshore_maps.a_spx

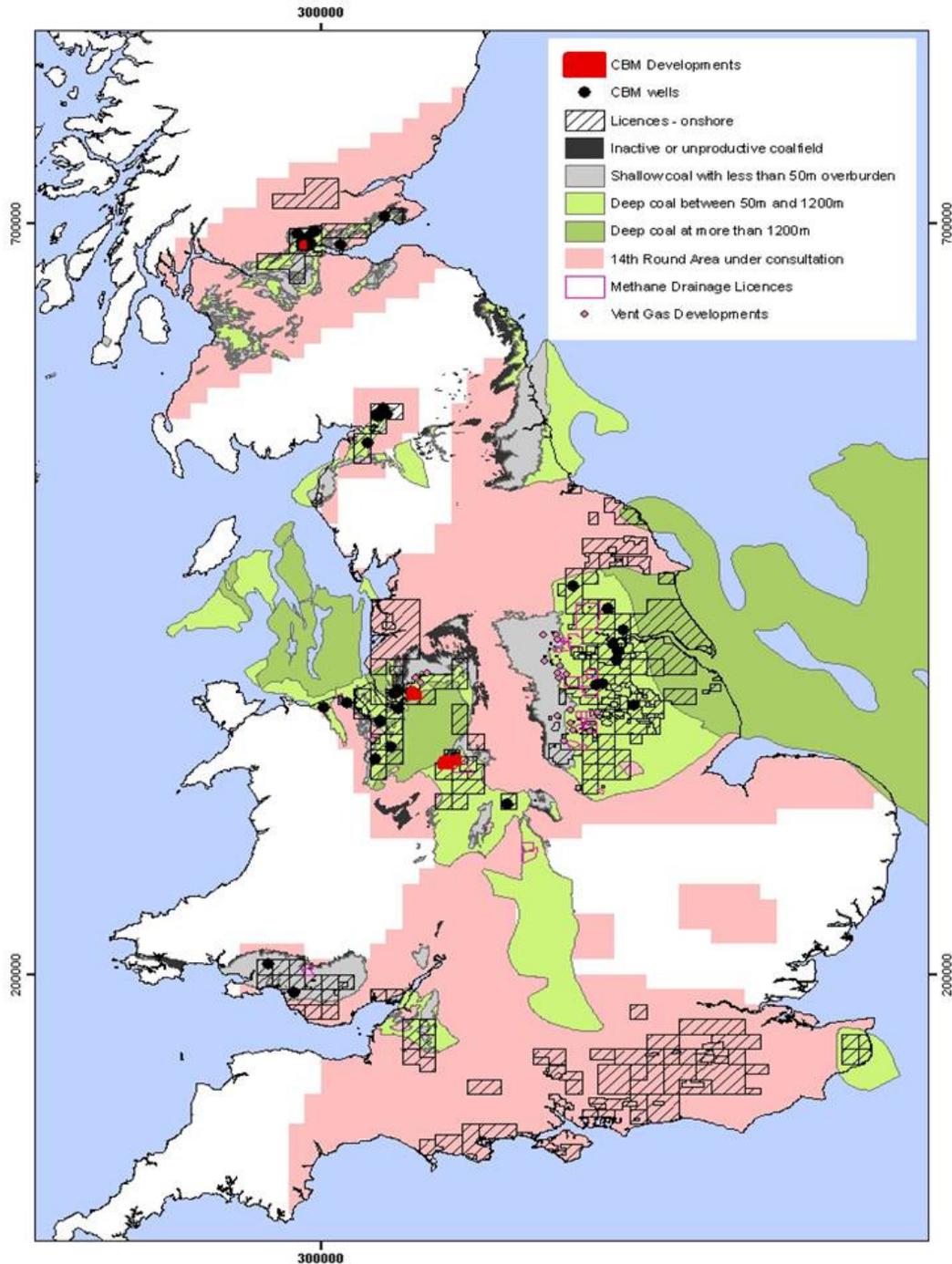
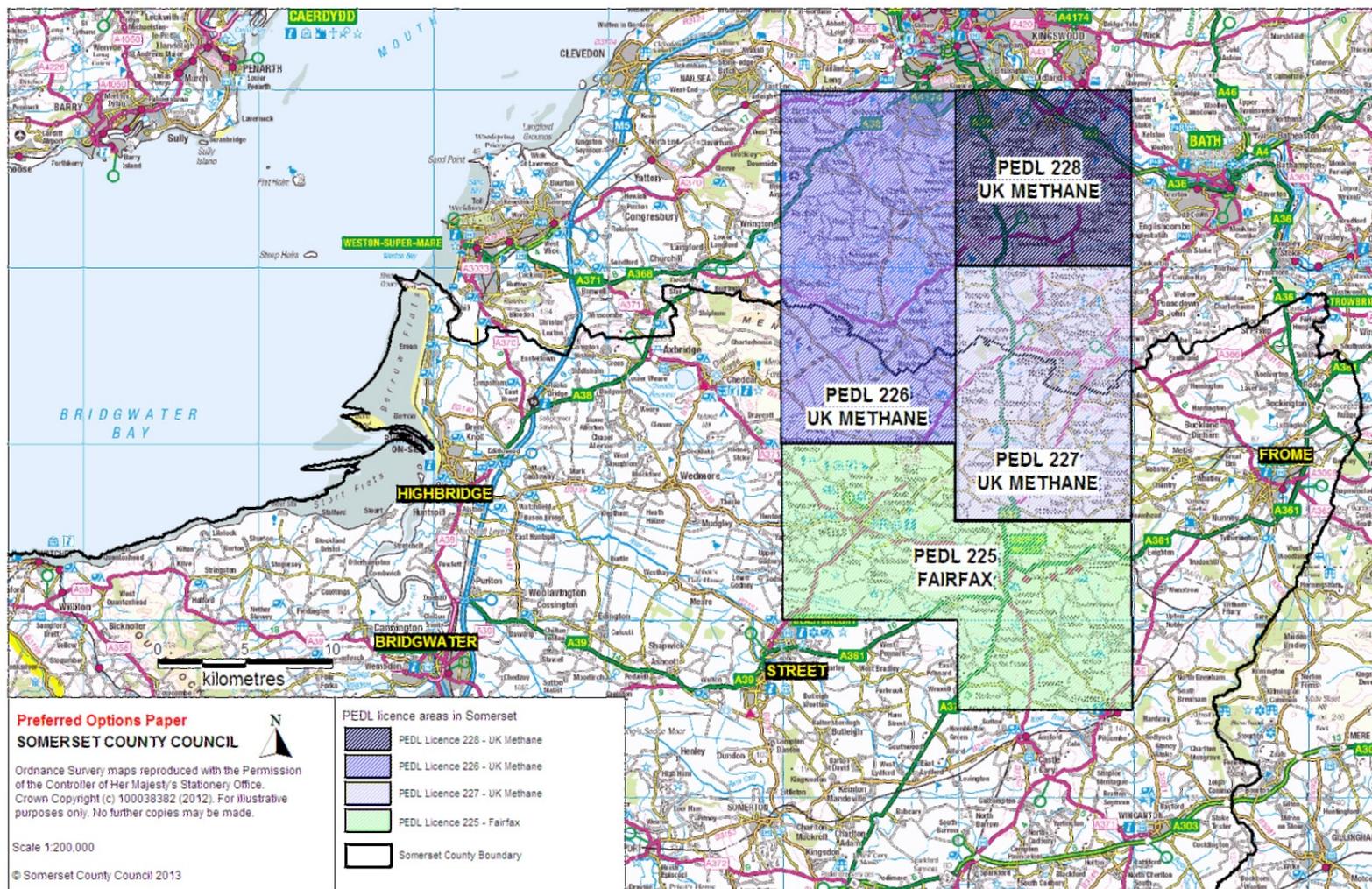
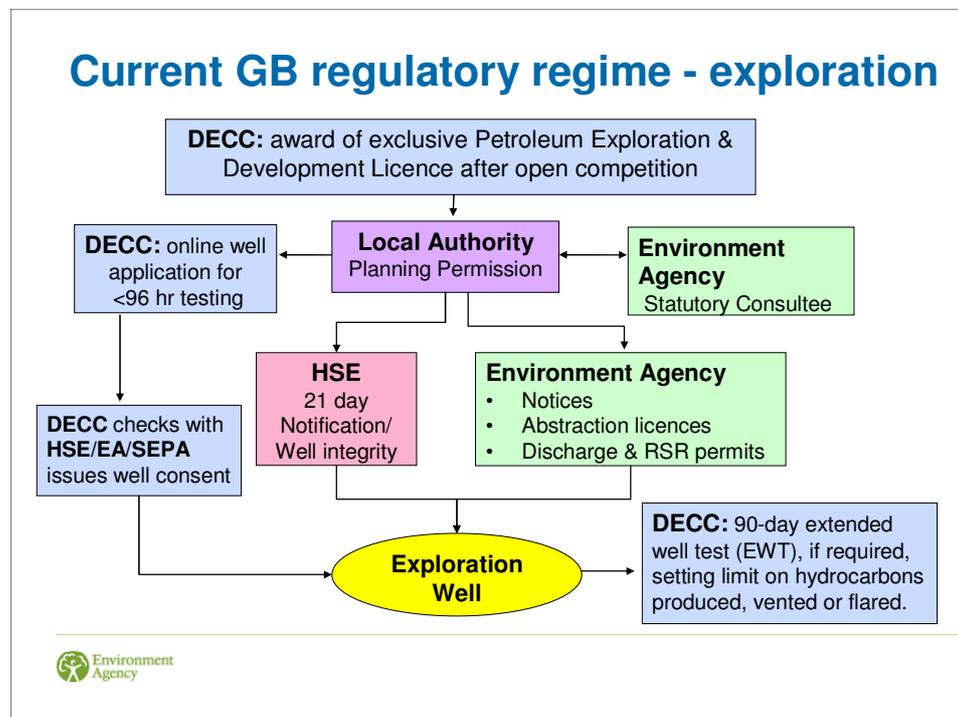


Figure 4: A map showing the PEDL areas in the study area covered by this Topic Paper



- 2.45. The current licence round (PEDLs) is time-limited. It is expected that the current licences will expire at the end of the initial term (June 2014) if the licensee has not at least begun drilling a well by then.
- 2.46. It is understood that DECC do grant extensions to operators if they can demonstrate that they are doing all that they can to achieve that date.
- 2.47. Further licence rounds may be expected, as central government continue to support exploration and greater energy independence.
- 2.48. Securing an exclusive licence is the first step in a multi-stage process. It gives exclusivity to the licensee for its respective license area.
- 2.49. There are three phases of what is termed "unconventional" development of oil and gas, as outlined by the National Planning Policy Framework (NPPF): exploration; appraisal; and production (see section 4 for further information).
- 2.50. Once a company has a PEDL, there are several further steps that need to be taken before the three phases of development can be taken forward. The first of which is to obtain planning permission for exploration from the relevant Minerals Planning Authority.
- 2.51. The flow chart below outlines links between the regulatory bodies at this exploration stage.

Figure 5: Current regulatory regime for onshore gas exploration (source: DECC)



- 2.52. As Figure 5 shows, ultimately, central government has the final decision on whether or not to give consent for the development. Before any such consent is granted (by the Department of Energy and Climate Change) the operator will also need to obtain appropriate permit(s) from the Environment Agency and inform the Health and Safety Executive of their plans (in particular with regard to well design). Furthermore, DECC will require a Frack Plan to be submitted by the operator if fracking is proposed.
- 2.53. In June 2013, the Environment Agency issued a commitment to streamline and simplify environmental regulation of onshore oil and gas exploratory activities. This commitment included extending the remit of the Environment Agency's shale gas unit to include all onshore oil and gas exploration (ensuring a single point of contact for the industry), issuing relevant technical guidance and significantly reducing the time it takes to obtain a permit for exploration.
- 2.54. Consent from the Coal Authority is required before any works take place that intersect coal seams and/or coal mine workings (whether abandoned or not) vested in the Authority.¹⁴ To date there are no coal bed methane agreements in place between operators and the Coal Authority within the study area.

¹⁴ <http://coal.decc.gov.uk/en/coal/cms/publications/mining/seams/seams.aspx>

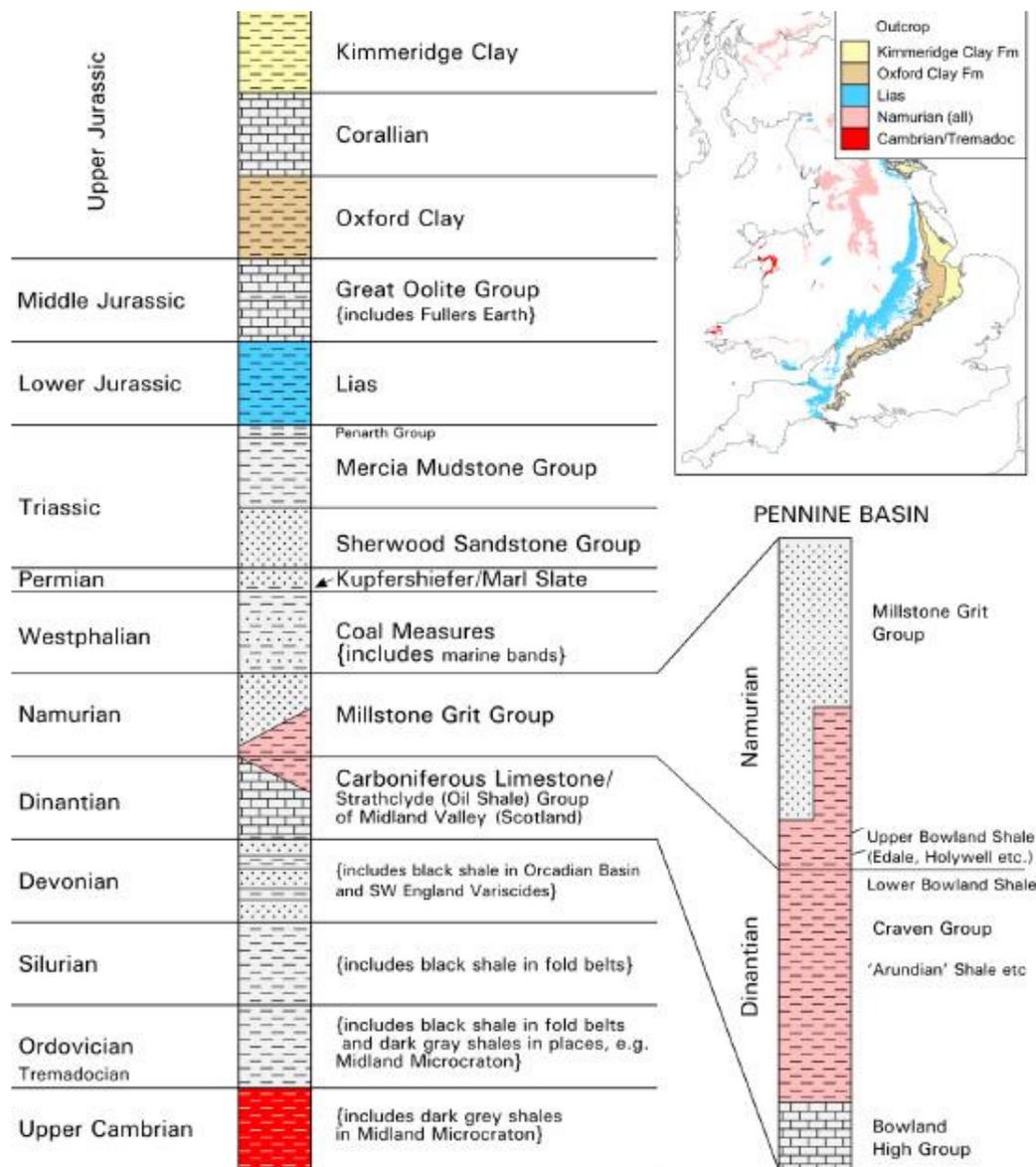
3. Geology and Landscape

Local geology

- 3.1. Minerals can only be worked where they occur. Therefore when discussing minerals extraction, it is important to have an understanding of the geology of the area.
- 3.2. This is an extremely technical area, which can best be interpreted by a qualified geologist. Furthermore, the geology of every area is different. The authors of this Topic Paper have endeavoured to keep the terms and language used here as simple and straight-forward as possible.
- 3.3. Exploration for energy minerals begins by considering areas that have good prospects, before exploring those areas in more detail.
- 3.4. When describing hydrocarbon "prospectivity", the onshore UK can be divided into productive basins, potentially productive basins and those where the prospectivity is less attractive.
- 3.5. The Wessex Basin, which runs from the south coast of Dorset and up into Hampshire and beyond, has been a productive basin in South West England.
- 3.6. The Wessex-Channel Basin incorporates the Wessex Basin plus its offshore extension in the central and eastern parts of the English Channel. The Wessex-Channel basin covers over 40,000 km² and contains sediments that are locally over 3 km thick.¹⁵
- 3.7. The study area for this topic paper is on the north-western margin of the Wessex-Channel Basin, and is therefore next to a productive basin. Geology in the study area is complex, and this Topic Paper will consider this in headline terms only.
- 3.8. Figure 6 shows a simplified diagram of UK onshore stratolithography – depicting the vertical location of rocks in an area; the oldest rocks are at the base of the column.

¹⁵ The Hydrocarbon Prospectivity of Britain's onshore basins, DECC, 2010

Figure 6: a simplified diagram of the UK on shore stratolithography (DECC)



- 3.9. In Figure 6 the primary section of interest (for the purposes of this Topic Paper) are just below the centre of this column. NB: due to variations in the rock, it is important to remember that sections in the column are referring to age rather than a standard cross-section going vertically down into the rock.
- 3.10. Carboniferous limestone plays a crucial role as an aquifer in the Mendip Hills, in the centre of the study area. An aquifer means a water-permeable rock from which groundwater can be extracted. Noting the importance of groundwater to our habitats and drinking water, it is crucial to ensure its protection. This key concern is addressed further in section 6.

- 3.11. Giving a clue to the depth of the carboniferous limestone, according to British Geological Survey (BGS), nowhere in the Bath Spa survey area (in the north east of the study area) is the top of the Carboniferous Limestone deeper than about 1200m.¹⁶
- 3.12. Above the carboniferous limestone in the upper Dinantian and lower Namurian sections are limestone shales interbedded with other rock.
- 3.13. Westphalian coal measures are younger still, as shown in Figure 6. The deepest coal mine in Somerset reached a depth of 560m.¹⁷ However, due to the geological structure of the Mendips, with its folds and thrust faults along which parts of the rock have slid across each other, this is not always the case.¹⁸
- 3.14. There is little evidence at this time to indicate there remain good prospects for extraction of conventional hydrocarbons such as coal in the study area (though the productive "Wessex Basin" does still contain prospects for conventional oil and gas extraction¹⁹).
- 3.15. The Bristol/Somerset coalfield – which runs from the Mendip Hills to South Gloucestershire, from Nailsea in the west to Bath in the east – has a long history of mining, dating back to Roman times. All such mining ceased in 1973.²⁰ Remaining coal seams are numerous but thin and have already often been extensively mined. "The gas content of the seams is not known but is believed to be low".²¹
- 3.16. It should be noted that this lack of evidence does not undermine the need to consider the potential safeguarding of reserves, in dialogue with the appropriate authority – in particular the Coal Authority, and by so doing protect the possibility of future extraction. Coal is identified as an important energy resource in the British Geological Survey (BGS) Safeguarding Guidance.²²
- 3.17. Looking further west, shales at Kilve in the northern part of Somerset contain significant organic matter that may yield oil on treatment. Indeed, oil was extracted via a borehole in the early part of the 20th century. However, the borehole was closed due to economic reasons in the 1920s.

¹⁶ BGS. Potential problems in the Bath and North East Somerset Council and surrounding area with respect to hydrocarbon and other exploration and production, 2012

¹⁷ <http://www.bgs.ac.uk/mendips/minerals/coal3.html>

¹⁸ http://www.bgs.ac.uk/mendips/geology/geological_structure.htm

¹⁹ "Norwest has already identified six structural leads with a 15% to 32% geological chance of success. After conducting further geological and geophysical studies, including the purchase and interpretation of new 2-D seismic data, a successful evaluation program will allow Norwest to advance these leads to drillable prospects" <http://www.norwestenergy.com.au/index.php/projects/uk/offshore-wessex-basin/>

²⁰ Mineral Resource Information in Support of National, Regional and Local Planning: Somerset (comprising Somerset, North Somerset Bath and North East Somerset, the city of Bristol, and part of Exmoor National Park).

²¹ Ibid.

²² BGS, Mineral Safeguarding in England: good practice advice (page 4), 2011

- 3.18. Research published by BGS indicates there is no potential for the development of coal mined methane in the Somerset-Bristol coalfield since there are no active pits in the area.²³
- 3.19. The same research indicates there is little prospect for abandoned mine methane, and states that potential for coal bed methane development from virgin coal seams in Somerset [using the historical county boundary] is "very low because of the low methane content".
- 3.20. For those interested in learning more about the coal resource, BGS has prepared a report entitled "UK Coal Resource for New Exploitation Technologies".²⁴
- 3.21. There are no known studies focused on the gas content of UK shales.²⁵ However, interest in this potential resource is growing.
- 3.22. In 2011 DECC issued a report on Unconventional Hydrocarbon Resources of Britain's Onshore Basins.²⁶ This report states that the onshore component of the Wessex Basin petroleum system covers approximately 700 km² and could perhaps yield up to 30 billion cubic feet (bcf) shale gas. Reports on the amount of shale gas resource are changing as more information comes to light.

Local landscape

- 3.23. When considering exploration within the study area – in particular minerals operations within the PEDL areas, it is vital to consider the characteristics of the local environment, and any related features that are formally protected via designation.
- 3.24. Key designations in the study area are listed in the bullet points below. This list is not intended to be comprehensive, but indicates that the area contains numerous designations and features of local, regional and national significance:
 - Mendip Hills AONB
 - Water Source Protection Zones
 - City of Bath World Heritage Site and in particular, Bath Hot Springs
 - Grade 1, 2 and 3a agricultural land
 - Chew Valley Special Protection Area (SPA)
 - Green Belt
 - Scheduled Ancient Monuments (SAM)
 - Historic Parks and Gardens
 - Sites of Special Scientific Interest (SSSIs)
 - Regionally important geological sites (RIGS)

²³ Mineral Resource Information in Support of National, Regional and Local Planning: Somerset (comprising Somerset, North Somerset Bath and North East Somerset, the city of Bristol, and part of Exmoor National Park).

²⁴ <http://www.bgs.ac.uk/downloads/start.cfm?id=1712>

²⁵ The Unconventional Hydrocarbon Resources of Britain's Onshore Basins – Shale Gas, DECC, 2011

²⁶ Ibid.

4. The policy context

The regulatory framework: a European perspective

- 4.1. Much of European law takes the form of Directives that set out general rules and objectives but give EU Member States some flexibility in terms of how these objectives are attained.
- 4.2. There are a number of different pieces of European legislation which set the context for national and local policy on energy minerals development; in particular the Water Framework Directive (2000/60/EC) and its daughter Groundwater Directive, the Mining Waste Directive (2006/21/EC), and the Environmental Impact Assessment Directive (2011/92/EU).
- 4.3. In England and Wales, the Water Framework Directive and Groundwater Daughter Directive are transposed through the Water Resources Act and Environmental Permitting Regulations, thus enabling the Environment Agency to regulate discharges to groundwater (including the requirement to disclose relevant chemicals).
- 4.4. The Environmental Permitting Regulations in England and Wales govern the regulation of the disposal of used fracking fluid through the Environment Agency (linked with transposing certain requirements of the Mining Waste Directive). Permits issued by the Environment Agency also control abstraction of water used in fracking (linked with the Water Resources Act).
- 4.5. Minerals planning authorities (MPAs) play a particularly important role in the implementation of the EIA Directive which is important in the consideration of proposals that may have a significant impact on our environment. Further clarity may be needed nationally to support the screening process for when EIAs are required for “unconventional” gas extraction proposals. As mentioned this is a new area for the UK, and planning guidance is expected to emerge in the summer of 2013. Meanwhile, Circular 02/99 Environment Impact Assessments is an important reference in this regard.
- 4.6. Information on research undertaken at a European level is shown in a text-box on the next page.

European research on shale gas

The European regulatory framework was one of a range of issues analysed in a study commissioned by the European Commission in 2012 which explored potential risks for the environment and public health arising from hydrocarbon operations involving hydraulic fracturing in Europe. The results of this study were published alongside two other studies, also commissioned by the European Commission. One focused on potential energy market impacts and the other focused on climate change impacts. The following bullet points are notes made that reflect some of the key points in the reports:

- shale gas may have an important bridging role en route to a lower carbon future;
- developing shale gas in the EU will help achieve the EU's goal of reducing greenhouse gas emissions by 2050 compared to 1990 levels, which is the basis of the Energy Roadmap for 2050.
- the shale gas boom in the USA has had a significant impact on the dynamics of the natural gas market and on prices;
- policy-makers would benefit from better data to enable them to make informed choices.

National planning policy

- 4.7. In March 2012 the Department for Communities and Local Government published the National Planning Policy Framework (NPPF), which sets out the Government's new planning policies for England and how these are expected to be applied. This is the cornerstone of national planning policy, replacing and consolidating a range of national planning policy statements and guidance.
- 4.8. The NPPF includes a restrictive approach to coal working (see paragraph 149) and focuses on energy minerals in paragraph 147, stating that Minerals Planning Authorities should:
- when planning for on-shore oil and gas development, including unconventional hydrocarbons, clearly distinguish between the three phases of development (exploration, appraisal and production) and address constraints on production and processing within areas that are licensed for oil and gas exploration or production;
 - encourage underground gas and carbon storage and associated infrastructure if local geological circumstances indicate its feasibility;
 - indicate any areas where coal extraction and the disposal of colliery spoil may be acceptable;
 - encourage capture and use of methane from coal mines in active and abandoned coalfield areas; and
 - provide for coal producers to extract separately, and if necessary stockpile, fireclay so that it remains available for use.

- 4.9. In a statement released on 13 December 2012, Ed Davey, Secretary of State for Energy and Climate Change, made this position more nuanced by noting that "*As regards the local or regional impacts, it should be noted that the planning system requires permission to be obtained separately for exploration and production activities (and for any appraisal phase **where distinguishable**).*" The text highlighted (by the authors of this Topic Paper) reflects the fact that it may not in fact be easy to distinguish between the different phases as indicated.
- 4.10. Further clarity may also be needed – potentially in terms of further national planning guidance – in what constitutes activities to “*address constraints on production and processing*” within licensed areas.²⁷

Evolving national position

- 4.11. Having noted the new planning context set by the NPPF, it is appropriate to reflect on the changes in central government's position on shale gas extraction that have taken place during 2011 and 2012 in response to recent events and a growing volume of research.
- 4.12. "*On 1 April and 27 May 2011 two earthquakes with magnitudes 2.3 and 1.5 were felt in the Blackpool area. These earthquakes were suspected to be linked to hydraulic fracture treatments at the Preese Hall well operated by Cuadrilla Resources Ltd. The hydraulic fracture treatments were carried out during exploration of a shale gas reservoir in the Bowland basin. As a result of the earthquakes, operations were suspended at Preese Hall and Cuadrilla Resources Ltd were requested to undertake a full technical study into the relationship between the earthquakes and their operations.*" This summary of the events in the Spring of 2011 was published by DECC on its website²⁸.
- 4.13. Since then an expert panel issued a report in April 2012²⁹ focusing on what happened at Preese Hall and lessons learned from those events. The report recommended the introduction of a traffic light system, whereby any seismic activity recorded above 0.5 ML would result in extraction operations being stopped (for further analysis and action as appropriate). Such a system is reliant on real-time monitoring of sites.
- 4.14. Central government published the Preese Hall report for consultation, inviting feedback on the recommendations within that document.
- 4.15. About the same time, the Royal Society and the Royal Academy of Engineering reviewed the available scientific and engineering evidence and considered whether the risks associated with hydraulic fracturing as a means to extract shale gas could be managed effectively in the UK. A report was issued in July 2012, concluding that the health, safety and environmental risks can be managed effectively.³⁰

²⁷ See the first bullet point of paragraph 147 in the NPPF

²⁸ <https://www.gov.uk/oil-and-gas-onshore-exploration-and-production>

²⁹ Preese Hall Shale Gas Fracturing, Review & Recommendations for Induced Seismic Mitigation, Green, Styles & Baptie, April 2012

³⁰ Shale gas extraction in the UK: a review of hydraulic fracturing, The Royal Society and the Royal Academy of Engineering, July 2012

- 4.16. Informed by the findings of both studies and feedback received, central government support for research and development in shale gas exploitation was affirmed in early December 2012, following publication of the government's Autumn Statement. Ed Davey, Secretary of State for Energy and Climate Change, on 13 December 2012, commented:

"...Having carefully reviewed the evidence with the aid of independent experts, and with the aid of an authoritative review of the scientific and engineering evidence on shale gas extraction conducted by the Royal Academy of Engineering and the Royal Society, I have concluded that appropriate controls are available to mitigate the risks of undesirable seismic activity. These new controls will be required by my Department for all future shale gas wells. On that basis, I am in principle prepared to consent to new fracking proposals for shale gas, where all other necessary permissions and consents are in place. This opens the way to a resumption of work on exploration for shale gas, though I stress the importance of the other regulatory consents, and planning permission, which are also necessary for these activities, and which must be in place before my Department will consider consent to individual operations..."

- 4.17. In effect this announcement lifted the suspension on fracking, allowing new proposals to be considered against a re-strengthened regulatory process.

- 4.18. At the same time, the government published a Gas Generation Strategy. This included a chapter on "Developing Shale Gas Resources". The summary of this chapter reads as follows:

"There are very large quantities of gas in the shales beneath the UK, but not enough is known to estimate what fraction of this could be produced.

If economic and safe, shale gas could, however, offer new economic opportunities for the UK. DECC will set up an Office for Unconventional Gas and Oil, which, working with Defra and other Government Departments, will join up responsibilities across Government, provide a single point of contact for investors and ensure a simplified and streamlined regulatory process.

HM Treasury has opened discussions with industry on the appropriate structure of a fair tax regime for future shale gas production, and DECC will consult on how its licensing regime could be modified to support the particular characteristics of shale gas developments. DECC will also consult on an updated Strategic Environmental Assessment with a view to further onshore oil and gas licensing.

If testing proves positive, shale gas production might commence in the second part of this decade, but production is likely to grow more slowly than has been seen in the United States."

- 4.19. Elsewhere within the Gas Generation Strategy, government acknowledges that the recent significant increase in shale production in the United States was supported by favourable geology, low population density, a competitive supply industry that has developed significant advantages of scale, variable levels of environmental regulation, and strong development incentives for landowners. Quoting from the Strategy: *"With the possible exception of the geology, these factors do not, at least for the time being, exist elsewhere"*.
- 4.20. The Budget 2013 introduced more specific next steps, including measures to support future investment in the UK shale gas industry, a commitment to produce technical planning guidance on shale gas by July 2013, develop proposals by summer 2013 to ensure that local communities will benefit from shale gas projects in their area, and provide detail of the objectives, remit and responsibilities of the Office of Unconventional Gas and Oil.

Evolving local position

Somerset policy

- 4.21. The Somerset Minerals Plan Preferred Options paper was published for consultation in early 2013. Work has begun on the Pre-submission Plan, informed by consultation feedback and the increasing amount of information available. Concerns raised during Somerset County Council's Preferred Options consultation have informed section 6 of this paper.
- 4.22. Until the new Minerals Plan is further advanced, the adopted Minerals Local Plan includes a range of saved policies that can be used to consider an application alongside other relevant policies in the Development Plan.

Bath and North East Somerset policy

- 4.23. The emerging Core Strategy includes a policy setting out the strategic approach to minerals in Bath & North East Somerset. The Core Strategy will be accompanied by the Placemaking Plan which will comprise site allocations and development management policies and is likely to include a number of minerals policies to replace those in the adopted Local Plan with the addition of one relating to energy minerals.

North Somerset policy

- 4.24. The Sites and Policies Plan Consultation Draft was advertised for public consultation between 28 February and 19 April 2013. It includes a development management policy on mineral working that includes reference to fracking.

5. Industry experience

Learning from experiences elsewhere

- 5.1. There are widespread examples of industry experience, in USA, New Zealand and elsewhere.
- 5.2. The first two commercial “fracks” in the USA took place in 1949. Frack treatments reached more than 3,000 wells a month for periods during the mid-1950s and the use of fracking became more widespread across both oil and gas sectors in subsequent decades. Some estimate that fracturing has increased US recoverable reserves of oil by at least 30% and of gas by 90%.³¹
- 5.3. Whilst fracking has undoubtedly had a significant impact on domestic energy supply in the USA, concerns have also been raised about the impacts of fracking from this activity in the USA; in particular this came to the fore in the UK with regard to the documentary film “*Gaslands*”.
- 5.4. This Topic Paper is not the place for reviewing the impacts of fracking in the USA. That is not the aim of the paper, and the USA and UK operate under different regulatory regimes³².
- 5.5. In New Zealand, the first known frack took place in 1989 at Petrocorp’s Kaimiro-2 gas well in Taranaki. Taranaki is the focal point for New Zealand’s fracking activities to date. There have been two unsuccessful attempts to frack for coal seam gas (in Ohai in Southland, as well as Solid Energy’s coal seam gas pilot in the Waikato). Currently Baker Hughes is the only contractor with the equipment and ability to carry out hydraulic fracturing in New Zealand.³³
- 5.6. When considering experiences from elsewhere, it is also important to note there are key differences from country to country in the impact that unconventional gas extraction may have on the local energy market. A report from DECC contrasts the UK outlook with the US picture as follows: *“Even if one assumes that the American shale gas producing analogies are valid, many of the operating conditions are different in the UK. In the UK, land owners do not own mineral rights, so there is less incentive to support development, and local authorities*

³¹ Carl T. Montgomery and Michael B. Smith, NSI Technologies, Hydraulic Fracturing: history of an enduring technology, December 2010

³² For example, the Environment Protection Agency (the US equivalent of the Environment Agency) issued guidance in 2011 that no company could frack with diesel in the mixture without a permit. In contrast, in Europe only substances that have been assessed as being non-hazardous pollutants under the Groundwater Directive may be used in hydraulic fracturing fluids.

³³ Parliamentary Commissioner for the Environment, Evaluating the impacts of fracking in New Zealand, November 2012.

*must grant planning consent. The US has relatively permissive environmental regulations, low population densities, tax incentives, existing infrastructure, well developed supply chains and access to technology. Cumulatively, these factors mean that it is far from certain that the conditions that underpin shale gas production in North America will be replicable in the UK."*³⁴

The planning application near Keynsham

- 5.7. In late 2012 an application was submitted to Bath & North East Somerset Council to sink a borehole aimed at the Westphalian Coals. The applicant was UK Methane Ltd (50% stake) in partnership with Adamo Energy (UK) Ltd a wholly owned subsidiary of Eden Energy Ltd (50%).
- 5.8. The site is located on land adjacent to the Junction (Hicks Gate Roundabout) of the A4 and A4175 North West of Keynsham, in Bath & North East Somerset. The total area of the site is 0.122 hectares.
- 5.9. The application stated that this borehole would not enter the Carboniferous limestones that may be a conduit for the water flow to Bath Hot Springs. The water/fluids used for drilling would be contained in a closed loop system. The drilling fluid would be held in tanks on the surface so that they can be checked for levels and leaks. At the end of the drilling operation all excess drilling fluid would be tankered off site to a licensed disposal facility. In the event of a loss of fluid to the system the source of that loss will be investigated.
- 5.10. Whilst this application was withdrawn in early 2013, its submission prompted further research in particular on how any such application might impact on Bath Hot Springs.
- 5.11. As part of its response to this industry interest, the British Geological Survey (BGS) was commissioned by B&NES to undertake a study on hydrocarbon and other potential extraction in the Bath and North East Somerset and surrounding area.³⁵ In particular the remit of the study was to provide:

"1. A short review of methods of shale gas and coal-bed methane working, and the potential problems that have been attributed to hydraulic fracturing that could give rise to detrimental effects in the B&NES area. These should include changes to the groundwater regime that might affect local water supplies and/or the hot springs; methane leakage at surface into water supplies (potable and the hot springs); and induced seismic events. Comment should be made on the potential risks associated with horizontal drilling if any.

³⁴ DECC, The Unconventional Hydrocarbon Resources of Britain's Onshore Basins – Shale Gas, 2012

³⁵ British Geological Survey, Potential problems in the Bath and North East Somerset Council and surrounding area with respect to hydrocarbon and other exploration and production, Commissioned Report CR/12/055, 2012

2. *A summary of the geological succession and structure with particular respect to possible shale gas and coal-bed methane targets in the area and the hydrogeology of the hot springs. Reference could be made here to geothermal projects which may also use hydraulic fracturing.*

3. *An assessment of the possible risks from hydraulic fracturing that B&NES, adjacent councils and other regulatory bodies would need to consider.*

4. *Conclusions and recommendations - Having identified the possible risks, what reassurances would B&NES and/or neighbouring councils require from developers to ensure that any proposed works would not have a detrimental effect on persons, facilities or infrastructure in their areas of governance, with particular reference to the hot springs."*

- 5.12. The BGS report concluded that the greatest threat to the Springs would be from geothermal schemes close to Bath as they would be targeting the hot water aquifers. [This is entirely different to schemes focused on "unconventional" oil and gas extraction.]
- 5.13. Furthermore, it noted that exploration for coal bed methane (CBM) and shale gas with only vertical cored wells, undertaken properly under the current licensing regime should not have measurable effects on the Springs. *"Properly conducted CBM exploration should not pose any problems to the hot springs".*³⁶ However, there would need to be very close control on any vertical wells that penetrate the Carboniferous Limestone.
- 5.14. The report notes that there would be a potential risk if the hydraulic fracturing, high gas flow, high density wells (HVHF) model is applied. Both the Courceyan Lower Limestone Shale Group and early Namurian targets are close enough to the probable formations in which the waters are migrating to pose an undefinable risk to the springs. If a slower, low gas flow, cottage-industry type development was allowed and the gas flowed freely from fractures this is considered no risk to the springs.
- 5.15. The report states that there is a low probability of economic shale gas production being achieved in the area. Commercial flows of CBM are also likely to be difficult as has been proved in other areas of the country. *"Until wells are drilled there is no way of knowing whether there is a potential for field development but both the coalbed methane and shale gas targets are not in areas with conventional gas production or significant shows. This would make them exploration venues with a high risk of failure by comparison both with the US and other UK areas with conventional hydrocarbon production".*³⁷

³⁶ Ibid

³⁷ British Geological Survey, Potential problems in the Bath and North East Somerset Council and surrounding area with respect to hydrocarbon and other exploration and production, Commissioned Report CR/12/055, 2012

Industry outlook

- 5.16. The intentions regarding other areas within the current PEDL areas in the area shown in Figure 4 are not yet known. However, anecdotal evidence suggests the focus would more likely be on coal bed methane before considering shale gas extraction, and an application is likely to be submitted soon to Somerset County Council for coal bed methane extraction by UK Methane.
- 5.17. It is expected that the PEDL licences in the 13th round of DECC's licensing will end at the end of the initial term (June 2014) if the licensee has not at least begun drilling a well by then. It is understood that DECC may grant extensions to operators if they can demonstrate that they are doing all they can to achieve that date. Further licence rounds may be expected, as central government continue to support further exploration and greater energy independence.

6. Addressing key concerns

Introduction

- 6.1. This section of the Topic Paper explores a range of issues linked in particular with unconventional gas extraction. It does not offer comprehensive analysis of all concerns, but gathers information from a range of sources to inform planning policy development and broader stakeholder interests.
- 6.2. There is inevitably a degree of repetition of content when comparing this section to other content in the Paper. This is unavoidable, since the authors wish to ensure this section remains as complete as possible without undermining the overall structure of the paper; however, such repetition is kept to a minimum.
- 6.3. There are other sources of useful information, in particular on the DECC website: <https://www.gov.uk/oil-and-gas-onshore-exploration-and-production>. The Appendix includes a non-exhaustive list of relevant publications and websites.

The regulatory framework

- 6.4. The Department of Energy and Climate Change (DECC) manages the release of Petroleum and Exploration Development Licences (PEDLs) which give exclusive rights for exploration and extraction of oil and gas resources within a defined area.
- 6.5. Once a PEDL has been granted by DECC the licensee must then engage in the planning process and gain planning permission from the relevant Minerals Planning Authority and appropriate permit(s) from the Environment Agency. The Health and Safety Executive must also be informed. Once these steps have been undertaken, DECC will then take a final view on any proposal before drilling can proceed.
- 6.6. Sufficient progress must have been made by the licensee (in basic terms the licensee must start to drill) before the PEDL expires. The current round of PEDL licences are expected to run until June 2014; however, this date may be extended by DECC.
- 6.7. When considering a “new” type of development such as unconventional gas extraction, it is important to establish how the different regulatory regimes are co-ordinated. New national planning guidance (due to emerge summer 2013) is expected to inform this, as will the work of the Office of Unconventional Gas and Oil at DECC.

Community engagement

- 6.8. There are different ways in which local communities contribute to local decision-making on energy minerals development. Broadly these can be split into the plan-making stages and then “plan use” (in other words, commenting on actual applications).
- 6.9. Focusing on the plan-making stage, a period of continuous engagement informs the preparation of the Minerals Local Plan, which includes consultation with a wider range of stakeholders.
- 6.10. Consultation and engagement during plan-making is carried out within the context of relevant regulations (in particular The Town and Country Planning (Local Planning) (England) Regulations 2012) and other guidance documents such as a Statement of Community Involvement as produced by the relevant local planning authority.
- 6.11. In the study areas, the current position of the new/emerging Minerals Plan documents for the respective Minerals Planning Authorities is summarised at the end of section 4 of this Topic Paper.
- 6.12. Focusing on plan use, it is important to recognise that local engagement on matters of national relevance (such as energy security) can occur via various routes. Proposals that are considered to be a "Nationally Significant Infrastructure Project" (NSIP) will not be determined by the local Minerals Planning Authority.
- 6.13. In late 2012 / early 2013, the Department for Communities and Local Government (DCLG) consulted on changes to the planning regime, entitled ‘Nationally significant infrastructure planning: extending the regime to business and commercial projects’. The consultation ran from 26 November 2012 and 7 January 2013.
- 6.14. The key thrust of the DCLG consultation document was to help speed up planning decisions for the most complex projects and to increase choice for developers. The Government proposed to extend the scope of the Planning Act 2008 so that a wider range of development can be brought within the nationally significant infrastructure planning regime. This will allow developers of nationally significant business or commercial projects to apply to the Secretary of State for the option of using the streamlined planning regime set out in the Planning Act.
- 6.15. Annex A of the DCLG consultation document included a list of the types of business and commercial projects the Secretary of State considers could be brought forward under the new proposals. This included onshore oil and gas extraction above identified thresholds.
- 6.16. Indications are that, for the foreseeable future, national arrangements will remain unchanged, meaning that planning decisions for onshore gas extraction by default will remain with the local Minerals Planning Authority (rather than be fast-tracked through the NSIP route). It is likely that this will be kept under review by central government.

- 6.17. There will be clear opportunities for the local community to be involved in the decision-making process, either through the NSIP “development consent” route or via a more conventional planning application to the local minerals planning authority.

The planning process

- 6.18. There are three phases of what is termed "unconventional" development of oil and gas, as outlined by the National Planning Policy Framework (NPPF): exploration; appraisal; and production.
- 6.19. In a statement released on 13 December 2012, Ed Davey, Secretary of state for DECC, clarified the planning requirement for unconventional oil and gas extraction, stating '*As regards the local or regional impacts, it should be noted that the planning system requires permission to be obtained separately for exploration and production activities (and for any appraisal phase **where distinguishable**)*' [bold formatting added by the authors].
- 6.20. Consequently, the licensee will need to obtain planning permission from the relevant Minerals Planning Authority at each "distinguishable" phase in the process.
- 6.21. On receipt of a planning application, the Planning Authority must treat this in the same way as any other proposal. This entails checking proximity to designated areas such as Areas of Outstanding Natural Beauty, Sites of Special Scientific Interest, or Groundwater Protection Zones. All such designations, and impacts upon them, are relevant considerations when determining a planning application. It must also be considered whether or not the proposal should be subject to Environmental Impact Assessment (EIA) via a suitable screening process. A period of consultation is set by the Planning Authority for any comments on the application to be submitted. In this way, the potential impacts on residents and the environment are carefully considered by the Planning Authority before a final decision is reached.
- 6.22. One issue that requires further review and clarity – potentially via national planning guidance – is how to define the boundary of development. A default approach (used in particular for vertical drilling) is to set this “red line” as the well pad area. However, greater clarity is needed on whether the boundary identified at the planning stage should be broadened if/when horizontal drilling is proposed.

Protecting our water resources

- 6.23. The Environment Agency has a key role to play in the regulation of impacts from shale gas or CBM extraction on the water environment and has stated its position that risks from fracking can be controlled through proper design and management of the drilling and extraction site. This view is further supported by a report issued by the Royal

Society and the Royal Academy of Engineering (June 2012) which states that "*The health, safety and environmental risks can be managed effectively in the UK*". This report also emphasises the importance of well integrity.

- 6.24. The Environment Agency has issued a guidance note on the regulation of exploratory shale gas operations, and has signed a joint working statement with the Health and Safety Executive (HSE).
- 6.25. More information on the EA position and guidance is available via its website: <http://www.environment-agency.gov.uk/>

What chemicals are used during fracking?

- 6.26. The use of chemicals in the UK is more tightly regulated than in America. As mentioned in section 2 above, so far in the UK only four additives (Polyacrylamide friction reducer, Hydrochloric acid, Biocide and Sodium salt) have been used in the fracking fluid; these have been authorised by the Environment Agency and are published on the operator's website. Sand is also used to help keep open the hairline fractures created by fracking and allow gas to be extracted.
- 6.27. "*Any toxicity of the components, such as acid, is greatly reduced by dilution in the pumped fluid and by the reaction of the acid with the rock in the subsurface that converts the acid into salts*".³⁸

Disposal of waste water

- 6.28. Focusing on fracking, the system is designed to be "closed loop" so that when the high pressure is removed (when undertaking a frack), the fluid returns to the surface for treatment and storage. Estimates vary on what percentage of the fracking fluid returns to the surface: from 25-75%³⁹. This wide range is explained by differences in the properties of the shale and the approach to the fracking.
- 6.29. CBM extraction also generates large quantities of wastewater, because the coal seam is dewatered to allow the gas to follow. The wastewater for CBM extraction will also need to be managed appropriately – most likely by being tankered off-site.
- 6.30. A report from BGS on the potential impact of unconventional gas extraction in the Bath & North East Somerset area comments: "*Unlike in the US where this is disposed of down wells, in the UK it is likely to be tankered away, for treatment prior to disposal. However, the Royal Society report (2012) does not rule out the option of subsurface disposal in the UK*".⁴⁰

³⁸ BGS, Potential Problems in the Bath and North East Somerset Council and surrounding area with respect to hydrocarbon and other exploration and production, 2012

³⁹ The Royal Society & The Royal Academy of Engineering, Shale Gas Extraction in the UK: a review of hydraulic fracturing, June 2012

⁴⁰ BGS, Potential Problems in the Bath and North East Somerset Council and surrounding area with respect to hydrocarbon and other exploration and production, 2012

Impact on investment in renewable energy

- 6.31. The Department of Energy and Climate Change (DECC) states that gas forms an integral part of the UK's generation mix playing a critical role in maintaining energy security, affordability and decreasing carbon emissions in the UK. Gas generation is, in general, an efficient form of thermal generation, meaning that more electricity can be produced from less fuel than is the case with other fossil fuel technologies.
- 6.32. Currently gas-fired power stations provide approximately 40% of the UK's energy. Supplying this amount of energy securely and affordably is a huge undertaking. Off-shore gas reserves are diminishing – reportedly our own gas supplies are predicted to fall by another 25% by 2020.⁴¹ Reviewing the potential for on-shore resources to be exploited is a logical alternative to consider.
- 6.33. There would appear to be conflicting reports on whether or not onshore gas extraction is a step toward a more sustainable approach to our carbon balance.
- 6.34. The position statement issued by the Chartered Institution of Water and Environmental Management states that *"Shale Gas is a carbon based fuel and is not a sustainable energy source... ..Pursuing shale gas will make it more difficult to reach our climate change commitments and renewable energy targets."*
- 6.35. However, it may be argued that this concern reflects a longer-term perspective that depends on the point of comparison. DECC's Gas Generation Strategy notes: *"A recent study undertaken by consultants for the European Commission, however, supports the view that life-cycle carbon emissions, even on a worst case scenario, are significantly lower than coal"*.
- 6.36. This divergence of views reflects that more research is needed on this topic, echoed in the report issued by the Royal Society and Royal Academy of Engineering (which notes that *"Priorities should include research into the public acceptability of the extraction and use of shale gas in the context of UK policies on climate change, energy and the wider economy"*) and in Ed Davey's statement in December 2012 (which included a commitment to commission a study into the possible impacts of shale gas extraction on greenhouse gas emissions).

Seismic activity (earth tremors)

- 6.37. Fracking activity was suspended nationally after earthquakes at Preese Hall in Lancashire, the largest of which measured 2.3 M_L. Since then, research has been undertaken to identify what happened and establish what controls are needed to avoid a reoccurrence. Research highlighted the need for a "traffic light" approach to monitoring of seismic activity, so that fracking is stopped if seismic events are noted above a certain level (0.5 M_L).

⁴¹ <http://www.bbc.co.uk/news/business-21501878>

Monitoring

6.38. In a report published by the Royal Society and Royal Academy of Engineering in June 2012, the executive summary notes that *"Monitoring should be carried out before, during and after shale gas operations to inform risk assessments. Methane and other contaminants should be monitored, as well as potential leakages of methane and other gases into the atmosphere. The geology of sites should be characterised and faults identified. Monitoring data should be submitted to the UK's regulators to manage potential hazards, inform local planning processes and address wider concerns. Monitoring of any potential leaks of methane would provide data to assess the carbon footprint of shale gas extraction"*.

6.39. Monitoring featured also in the recommendations emerging from the Preese Hall study, which proposed a "traffic light" system linked with monitoring seismic activity. The following specific measures were recommended in this report:

"1. Hydraulic fracturing procedure should invariably include a smaller pre-injection and monitoring stage before the main injection.

2. Hydraulic fracture growth and direction should be monitored during future treatments.

3. Future HF operations in this area should be subject to an effective monitoring system that can provide automatic locations and magnitudes of any seismic events in near real-time.

4. Operations should be halted and remedial action instituted, if events of magnitude 0.5 M_L or above are detected.

6.40. During the second half of 2012, DECC reviewed these two reports and other evidence available. In a statement in December 2012, Ed Davey commented as follows:

Operators will first be required to review the available information on faults in the area of the proposed well to minimise the risk of activating any fault by fracking, and required to monitor background seismicity before operations commence. Real time seismic monitoring will also continue during operations, with these subject to a "traffic-light" regime, so that operations can be quickly paused and data reviewed if unusual levels of seismic activity is observed.

We will also be requiring operators to take a more cautious approach to the duration and volumes of fluid used in the fracking itself. A fracking plan will be required to be submitted to my Department before consent is given to any fracking. The fracking plan should be progressive, starting with the injection of small volumes of fluid and analysing the resulting data carefully before the full stage. Each stage of the frac will

be carefully designed to use just enough fluid to create a fracture sufficient to enable gas to flow. A flow-back period will be required immediately after each stage to re-balance the pressures. Real-time recording of earthquakes during and for 24 hours after each stage of the frac will be analysed to look for abnormal induced events amidst the normal background seismicity.

Operators will also be required to monitor the growth in height of the frac away from the borehole. This will allow the operator to evaluate the effectiveness of the frac, but also ensure that the actual fracture is conforming to its design, and that it remains contained and far away from any aquifers.

So far as Cuadrilla's current exploration programme in Lancashire is concerned, the remedial action level for the traffic light system (that is, the "red light") will be set at magnitude 0.5 (far below a perceptible surface event, but larger than the expected level generated by the fracturing of the rock). I consider that this is an appropriately precautionary approach. We received representations in our consultation that this is too cautious, by comparison with the control protocols established for geothermal energy, construction and quarrying projects. I emphasise that this level is adopted only for fracking operations for shale gas, and the reasons for setting it at this level are entirely specific to the context. And it may well prove to be the case that, as our experience of applying this type of control to fracking operations develops, it can be confirmed that trigger levels can be adjusted upwards without compromising the effectiveness of the controls.

For the first few operations, DECC will have an independent expert on site to observe the operator's conformance to the protocols we have established and to monitor the operator's interpretation of data. We will therefore be able to learn as much as possible from these first operations and to put the lessons promptly into effect. But it would clearly not be right, in our present state of knowledge, to attempt to establish definitive standards, and I have preferred to start on an explicitly cautious basis.

At the present time, no applications for consent to fracking operations for shale gas are outstanding, and it is too soon to say exactly how the new protocols will be applied to any such proposals which may come forward in other basins. I can say that we will apply the same principles, of careful prior analysis of the risk of seismic activity, progressive design of the fracking process and feedback from the emerging data, and systematic monitoring by the operators before, during and after the operations. We will also expect operators to make monitoring data promptly available to the public.

Economic impact

6.41. In September 2012 a report was issued by the Institute of Directors entitled "Britain's Shale Gas Potential". The report states that a "conservative" estimate of UK production (assuming we would be half as successful as the Americans) would generate 35,000 extra jobs.⁴² Overall IoD members are in favour of careful, well-regulated shale gas development in the UK. 58% of members said that extensive development of the UK's shale gas resources would have a positive or very positive impact on British business.

⁴² Institute of Directors, Britain's Shales Gas Potential, September 2012

7. Concluding remarks

7.1. This final section of the Topic Paper highlights issues for further consideration by the members of the working group who have prepared this paper. They are intended to inform emerging policy considerations and provide a steer for future areas of research and discussion.

1: Continue collaborating!

The collaboration that has resulted in this paper has been productive. Continued collaboration between the partners will be important to continue learning about this rapidly evolving field.

According to the BGS report commissioned by Bath & North East Somerset Council: *"Close cooperation is needed with adjacent planning authorities so that conditions can be imposed on drilling. It is not reasonable to ban seismic reflection acquisition and all drilling, and we believe these types of exploration will contribute to knowledge about the subsurface which will improve knowledge of the springs. However, it should be possible to preclude certain developments, particularly hydraulic fracturing and extensive horizontal drilling in formations adjacent to the Carboniferous limestone"*.⁴³

One mechanism for further collaboration between planning officers is via the Planning Officers Society (more explicitly, an oil and gas sub-group of the Minerals "PAG" of the Planning Officers Society Minerals and Waste Forum).

2: Await further guidance from central government on national policy

According to the NPPF, policies should distinguish between three phases of development. However, the statement from Ed Davey highlights that it may not always be possible to distinguish between exploration and appraisal. Until further guidance emerges that suggests a different approach is required, it is appropriate for planning policy officers to seek as much differentiation as possible between these stages.

Furthermore, greater clarity is needed on the role of Minerals Planning Authorities in addressing the constraints in processing and production within PEDL areas (as stated in paragraph 147 of the NPPF); and in agreeing a common approach to defining the boundary of the development proposal at the planning stage.

⁴³ BGS, Potential problems in the Bath and North East Somerset Council and surrounding area with respect to hydrocarbon and other exploration and production, 2012

3: Engage with wider partners and stakeholders to bring further clarity to areas that lie within the remit of the minerals planning authority

There are aspects of proposed development for energy minerals that are within the domain of the Minerals Planning Authority and aspects that lie outside that domain. Further work in particular is needed to clarify responsibility around the following the topics.

- **Seismicity:** *"MPAs should consult the British Geological Survey (BGS) to advise on induced seismicity and help to identify suitable locations for wells... BGS could provide similar technical assistance to help operators carry out consistent seismic risk assessments and to help MPAs oversee the implementation of traffic light monitoring systems and other mitigation measures".*⁴⁴
- **Well integrity:** there is little evidence to suggest that Minerals Planning Authorities have a clear role regarding well integrity. The Health and Safety Executive (HSE) are responsible for inspecting by means of a notification the well design and confirm the construction by means of weekly reports from the well operator. In his ministerial statement in December 2012, Ed Davey commented: *"This issue is central to the regulation of the safety of well operations by the HSE"*⁴⁵. It is noted that, to date, only one shale gas well in the UK has been partially fractured and tested.

4: The need for data

Unconventional gas and oil extraction is a new field of interest in the UK and the data available (not least on estimated gas resources) are continuously being improved. Plan-making must be supported by robust evidence and proposals for new development should consider relevant issues (informed by requirements of the Minerals Planning Authority) in an appropriate level of detail. Reviewing recent industry interest near Keynsham as an example: *"There has been a recent tendency in the UK to explore for CBM without seismic reflection, making concealed highs and faults impossible to locate prior to drilling. No such data, west of Bath, has been acquired either for hydrocarbon or NCB purposes. At the planning stage it could be suggested that these data are required."*⁴⁶

⁴⁴ The Royal Society & Royal Academy of Engineering, Shale gas extraction in the UK: a review of hydraulic fracturing, June 2012

⁴⁵ <https://www.gov.uk/government/speeches/written-ministerial-statement-by-edward-davey-exploration-for-shale-gas> (accessed 24 April 2013)

⁴⁶ BGS, Potential problems in the Bath and North East Somerset Council and surrounding area with respect to hydrocarbon and other exploration and production, 2012

5: Assessing the risks: a precautionary approach

The key findings of the Royal Society report on shale gas extraction report stated that:

- The health, safety and environmental risks can be managed effectively in the UK. Operational best practice must be implemented and enforced through strong regulation.⁴⁷
- Well integrity is the highest priority.
- Options for disposing of waste should be planned from the outset.
- Monitoring data should be submitted to the UK's regulators to manage potential hazards, inform local planning processes and address wider concerns. Operators should carry out site-specific monitoring of methane and other contaminants in groundwater before, during and after shale gas operations.
- Wastewater should be recycled and reused where possible.
- Techniques and operational practices should be implemented to minimise water use and avoid abstracting water from supplies that may be under stress.

The report states that an Environmental Risk Assessment (ERA) should be mandatory. Every shale gas operation should assess risks across the entire lifecycle of operations, from water use through to the disposal of wastes and the abandonment of wells.⁴⁸ Furthermore, the report states that "*seismic risks should feature as part of the ERA*".

The ERA forms part of the licensing process and so it may be possible for Minerals Planning Authorities to draw from material prepared by the Licensee when acquiring a PEDL. Regardless of the PEDL process, it is important that any environmental assessment required by the Minerals Planning Authority is made available by the applicant at an appropriate stage in the planning process and is complete and up-to-date.

6: The importance of communication

The importance of clear, focused communication to maintain momentum in dialogue that will lead to greater clarity in policy. Communication with the Minerals Planning Authority will be encouraged at all stages, including activities that do not require planning permission.

⁴⁷ The Royal Society & Royal Academy of Engineering, Shale Gas Extraction in the UK: a review of hydraulic fracturing, June 2012

⁴⁸ The Royal Society & Royal Academy of Engineering, Shale gas extraction in the UK: a review of hydraulic fracturing, June 2012

APPENDIX: Further reading

British Geological Survey, Coal, March 2010

<http://www.bgs.ac.uk/downloads/start.cfm?id=1404>

British Geological Survey / DCLG, Coal – Mineral Planning Fact Sheet, 2010, <http://www.bgs.ac.uk/downloads/start.cfm?id=1354>

Draft reports prepared for the **European Parliament**

<http://www.europarl.europa.eu/news/en/headlines/content/20120913STO51335/html/MEPs-asked-to-back-strict-rules-on-shale-gas-drilling>

International Energy Agency, Are we entering a golden age of gas?

http://www.iea.org/media/weowebiste/2011/WEO2011_GoldenAgeofGasReport.pdf

Parliamentary Energy and Climate Change Select Committee – Shale Gas inquiry, May 2011 (parts 1 & 2):

Volume I <http://www.publications.parliament.uk/pa/cm201012/cmselect/cmenergy/795/79502.htm>

Volume II <http://www.publications.parliament.uk/pa/cm201012/cmselect/cmenergy/795/795vw01.htm>

Chatham House – The ‘Shale Gas Revolution’: Hype and Reality, Sept 2010: <http://www.chathamhouse.org/publications/papers/view/178865>

Environment Agency, Monitoring and control of fugitive methane from unconventional gas operations (PDF, 2.35MB)

<http://cdn.environment-agency.gov.uk/scho0812buwk-e-e.pdf>

Environment Agency, Review of assessment procedures for shale gas well casing

<http://www.environment-agency.gov.uk/cy/busnes/pyncliau/134508.aspx>

Friends of the Earth position paper:

www.foe.co.uk/resource/briefings/shale_gas.pdf

Royal Society, Shale gas extraction in the UK: a review of hydraulic fracturing,

http://royalsociety.org/uploadedFiles/Royal_Society_Content/policy/projects/shale-gas/2012-06-28-Shale-gas.pdf

Tyndall Centre, The University of Manchester - Shale Gas: an updated assessment of environmental and climate change impact

<http://www.mace.manchester.ac.uk/media/eps/schoolofmechanicalaerospaceandcivilengineering/newsandevents/news/research/pdfs2011/shale-gas-threat-report.pdf>

UK Onshore Shale Gas Well Guidelines, **United Kingdom Onshore Operators Group**, Feb 2013

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/185935/UKOOGShaleGasWellGuidelines.pdf

Additional relevant websites (the content of which is outside the control of the organisations and officers involved in preparing this topic paper):

Department of Energy and Climate Change

Increasing the use of low-carbon technologies

http://www.decc.gov.uk/en/content/cms/meeting_energy/renewable_ener/renewable_ener.aspx

Health and Safety Executive

Unconventional oil and gas web page

<http://www.hse.gov.uk/offshore/unconventional-gas.htm>

Frack Free Somerset

Frack Free Somerset is a coalition of concerned groups in Somerset who are taking action on unconventional gas developments.

<http://www.frackfreesomerset.org/>

Frome Anti-Fracking

Frome based interest group, part of the Frack Free Somerset group

<http://fromeantifracking.blogspot.co.uk>

Frack Off

Extreme Energy Action Network website

<http://www.frack-off.org.uk>