

Energy Minerals Topic Paper

Version 2

June 2014

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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	11
3. Geology and landscape	17
Local geology	17
Local landscape	20
4. The policy context	22
The regulatory framework: a European perspective	22
National planning policy	23
Evolving national position	26
Evolving local position	29
5. Industry experience	31
Learning from experiences elsewhere	31
The planning application near Keynsham	32
Industry outlook	34
6. Addressing key concerns	35
Introduction	35
The regulatory framework	35
Community engagement	36
The planning process	37
Protecting our water resources	38
What chemicals are used during fracking?	38
Disposal of waste water	39
Impact on investment in renewable energy	39
Seismic activity (earth tremors)	40
Monitoring	40
Economic impact	42
7. Concluding remarks	44
Appendix: Further Reading	47

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).

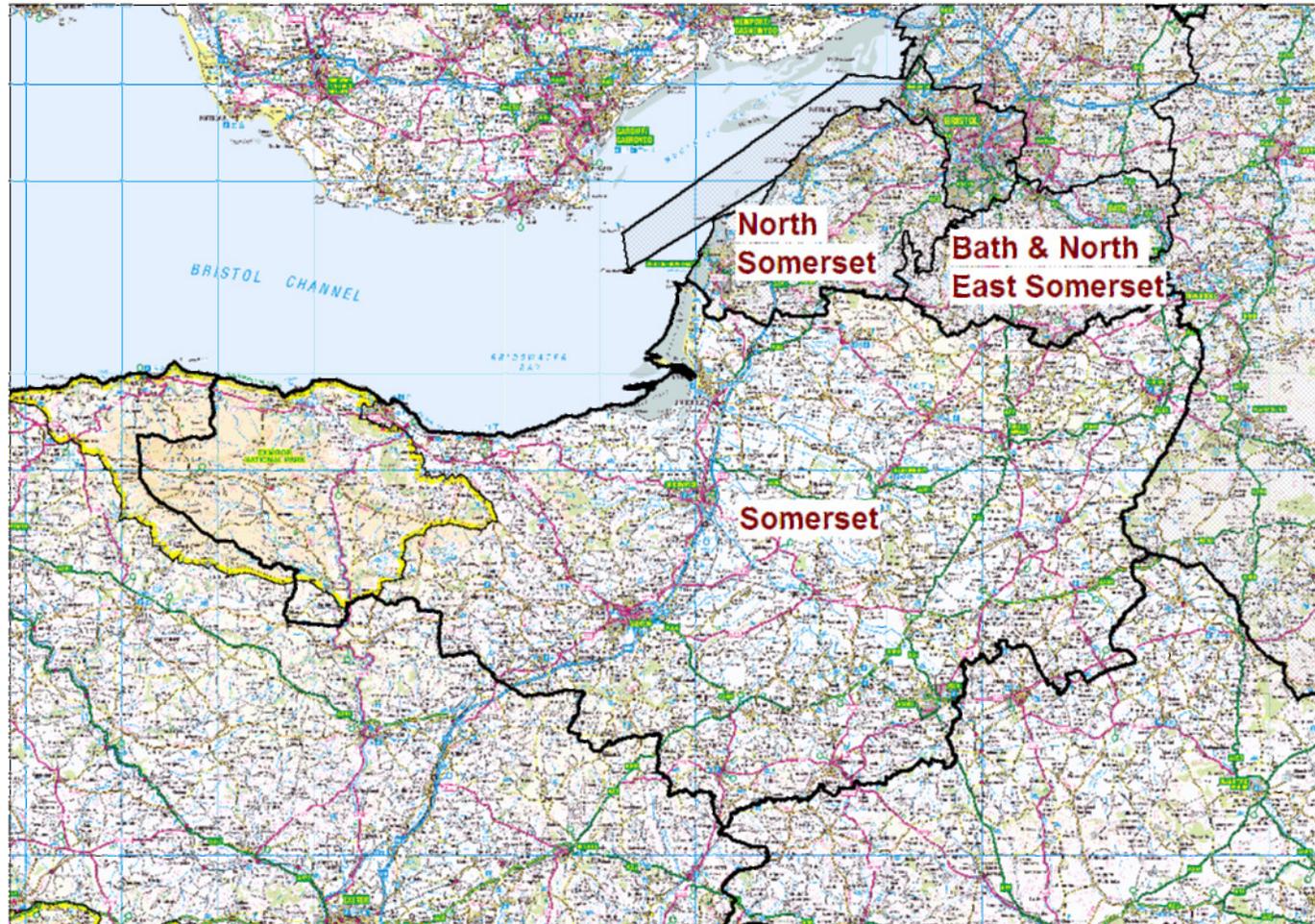
This Topic Paper does not include proposed policy. It is a technical paper only, bringing together information available in a rapidly changing field.

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, Avon and Somerset Constabulary and the Environment Agency¹. All parties have signed a Memorandum of Understanding, which sets out to formalise partnership working in plan preparation, monitoring and implementation.
- 1.2. The Health and Safety Executive have reviewed an earlier draft of the paper and provided comments, which have been incorporated in this Topic Paper.
- 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.

¹ Other corresponding members include: the Highways Agency, the Public Health Authority Bristol City Council; the Coal Authority; Dorset County Council; the Health and Safety Executive; Mendip AONB; South Gloucestershire Council; South Somerset District Council; and Wiltshire County Council.

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 increases 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 power² and over 7,500 million tonnes is mined per year.³
- 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, gas, nuclear and renewables; but there is no effective substitute for coking coal.

² <http://www.iea.org/topics/coal/>

³ <http://www.worldcoal.org/resources/frequently-asked-questions/>

- 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.⁴ 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.⁵
- 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" hydrocarbons⁶.
- 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.
- 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.

⁴ Gas Generation Strategy (page 6), DECC, December 2012

⁵ Parliamentary commissioner for the environment, Evaluating the environmental impacts of fracking in New Zealand: an interim report, November 2012

⁶ British Geological Survey / Department for Communities and Local Government, Alternative fossil fuels, Minerals Planning Factsheet, October 2011

- 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.⁷
- 2.23. Boreholes may be vertical; or, in some cases, these may be deviated to become horizontal.⁸
- 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 ground 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 wellbores 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.⁹ 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.

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

⁸ British Geological Survey, Alternative Fossil Fuels, Mineral Planning Factsheet, October 2011

⁹ 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, fracturing fluid (a mixture of water, chemicals and sand) is injected under high 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.¹⁰ 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.¹¹ After the fracking is done, such plugs can be drilled through and the well is depressurised.

Hydraulic fracturing fluids

- 2.34. In considering a permit to inject fluids, the Environment Agency requires full disclosure of all the chemicals (and carrier fluids) proposed for use and will assess whether they have hazardous potential using a methodology that follows the requirements of the Groundwater Daughter Directive (“daughter” to the Water Framework Directive)¹². Although information about chemicals used by an operator will normally be made publicly available, the Environment Agency may not disclose relative quantities in the mixture as this is commercially confidential¹³.
- 2.35. So far in the UK, at Cuadrilla’s Preese Hall site in Lancashire, 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.¹⁴
- 2.36. 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 fluid that returns to the surface is called “flowback water” and “is a mixture of the original fracturing fluid and saline water containing dissolved minerals from the shale formation”¹⁵. Estimates vary on what percentage of the fracking fluid returns to the

¹⁰ House of Commons note SN/SC/6073, Dr Patsy Richards, Shale Gas Fracking, December 2012

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

¹² http://a0768b4a8a31e106d8b0-50dc802554eb38a24458b98ff72d550b.r19.cf3.rackcdn.com/LIT_7983_3b53c2.pdf

¹³ Onshore oil and gas exploration in the UK: regulation and best practice: <https://www.gov.uk/government/publications/regulatory-roadmap-onshore-oil-and-gas-exploration-in-the-uk-regulation-and-best-practice>

¹⁴ <http://www.cuadrillaresources.com/about-us/communication-claims-support/fracturing-fluid/>

¹⁵ The Royal Society & The Royal Academy of Engineering, Shale Gas Extraction in the UK: a review of hydraulic fracturing, June 2012

surface: from 25-75%¹⁶. This wide range is explained by differences in the properties of the shale and the approach to the fracking.

- 2.37. The flowback water and produced water constitute “wastewaters” (EPA, 2011). Produced water is: “the fluid that returns to the surface during the production phase of a well that contains both fracturing fluid and saline water from the rock formation”¹⁷.
- 2.38. The Environment Agency is likely to require that these wastewaters are “fully contained [in] flowback fluid transfer systems and banded tank storage”¹⁸ before being treated and then reused wherever possible. This should be for as short a time as possible and no longer than three months. Wastewater may be treated on site or moved with tankers to specialist water treatment facilities. After treatment, the remaining liquids and solids must be disposed of safely and are regulated under the Mining Waste Directive and Water Framework Directive, where environmental permits are required.

Venting and flaring

- 2.39. The hydraulic fracturing process may also involve venting and flaring during the exploration, appraisal and production phases of the development. The venting of natural gas may only be permitted for safety reasons, while flaring may occur where an operator finds it is not economical to recover the gas during the exploration phase¹⁹. A temporary flare is used during production testing as an important way of determining pressure, flow and composition of the gas²⁰. Flaring is the controlled burning of natural gas, through a system consisting of pipes that lead to a flare stack²¹. Flaring reportedly “reduces greenhouse gas emission by about 80% compared to venting”²². Under the PEDL licences the flaring of gas requires specific written consent from the Minister.
- 2.40. Operators are required to keep the release of gases to a minimum, as a condition of their PEDL licence from the Department for Energy and Climate Change (DECC). Most gas emissions occur during well completion, after fracking, with the return of the “frack fluids” to the surface (flowback)²³.
- 2.41. “Green completion” technologies offer an alternative to venting or flaring and separate out gas, water and sand in flowback fluid before directing the recovered gas into pipelines. Although green completion technology is not yet established in the UK, the Royal Society makes it

¹⁶ The Royal Society & The Royal Academy of Engineering, Shale Gas Extraction in the UK: a review of hydraulic fracturing, June 2012

¹⁷ The Royal Society & The Royal Academy of Engineering, Shale Gas Extraction in the UK: a review of hydraulic fracturing, June 2012

¹⁸ http://a0768b4a8a31e106d8b0-50dc802554eb38a24458b98ff72d550b.r19.cf3.rackcdn.com/LIT_7983_3b53c2.pdf

¹⁹ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/277219/Air.pdf

²⁰ <http://www.epa.state.oh.us/portals/0/General%20pdfs/gas%20flaring.pdf>

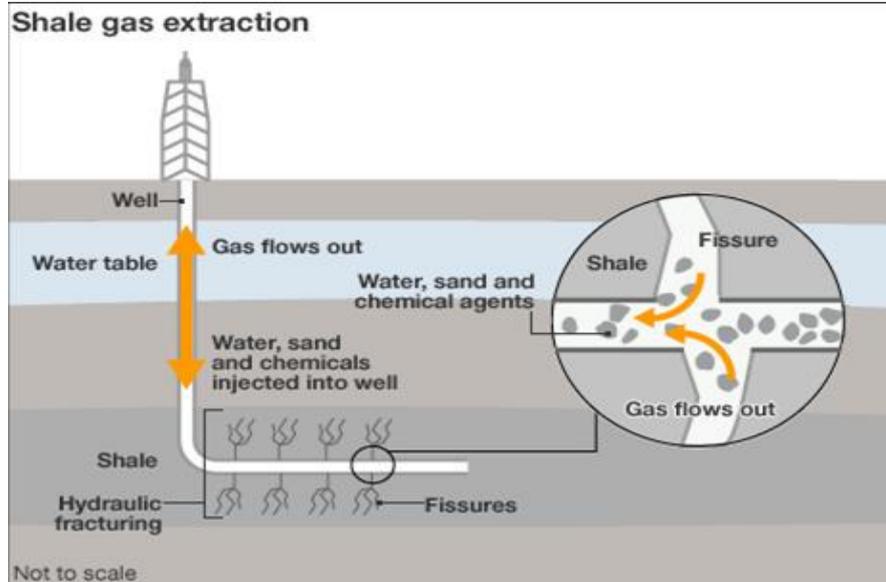
²¹ <http://www.epa.state.oh.us/portals/0/General%20pdfs/gas%20flaring.pdf>

²² https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/277219/Air.pdf

²³ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/277219/Air.pdf

clear in their review of hydraulic fracturing (June 2012), that “consideration should be given [to] the possible use of green completion technologies”²⁴.

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



2.42. 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"*.²⁵

Oil and gas regulation

2.43. 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.

2.44. 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).

2.45. The companies with licences are Fairfax Shelfco 307 Ltd., UK Methane Ltd. and Eden Energy (UK) Ltd.

2.46. Eden Energy and UK Methane are partner companies.

²⁴ http://royalsociety.org/uploadedFiles/Royal_Society_Content/policy/projects/shale-gas/2012-06-28-Shale-gas.pdf

²⁵ 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)

2.47. In September 2013 Eden Energy signed an agreement with “Shale Energy” which gave “Shale Energy” a 50% stake in three of the PEDLs in the study area.

Figure 3: Areas licensed by DECC for petroleum exploration in Great Britain as at 1 June 2014. (Source: DECC). For more information on PEDLs visit the DECC website: http://og.decc.gov.uk/en/olgs/cms/data_maps/onshore_maps/onshore_maps.aspx

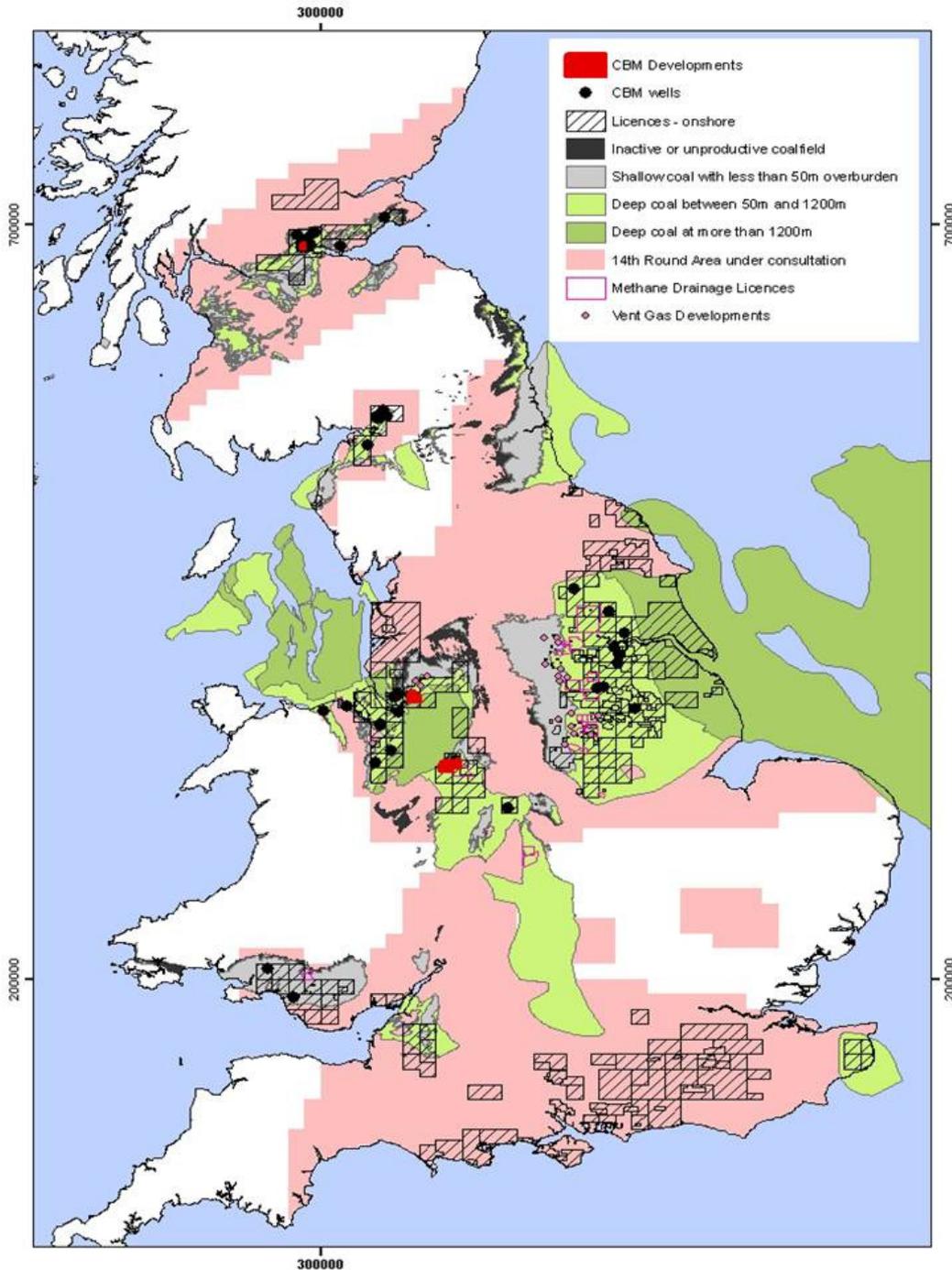
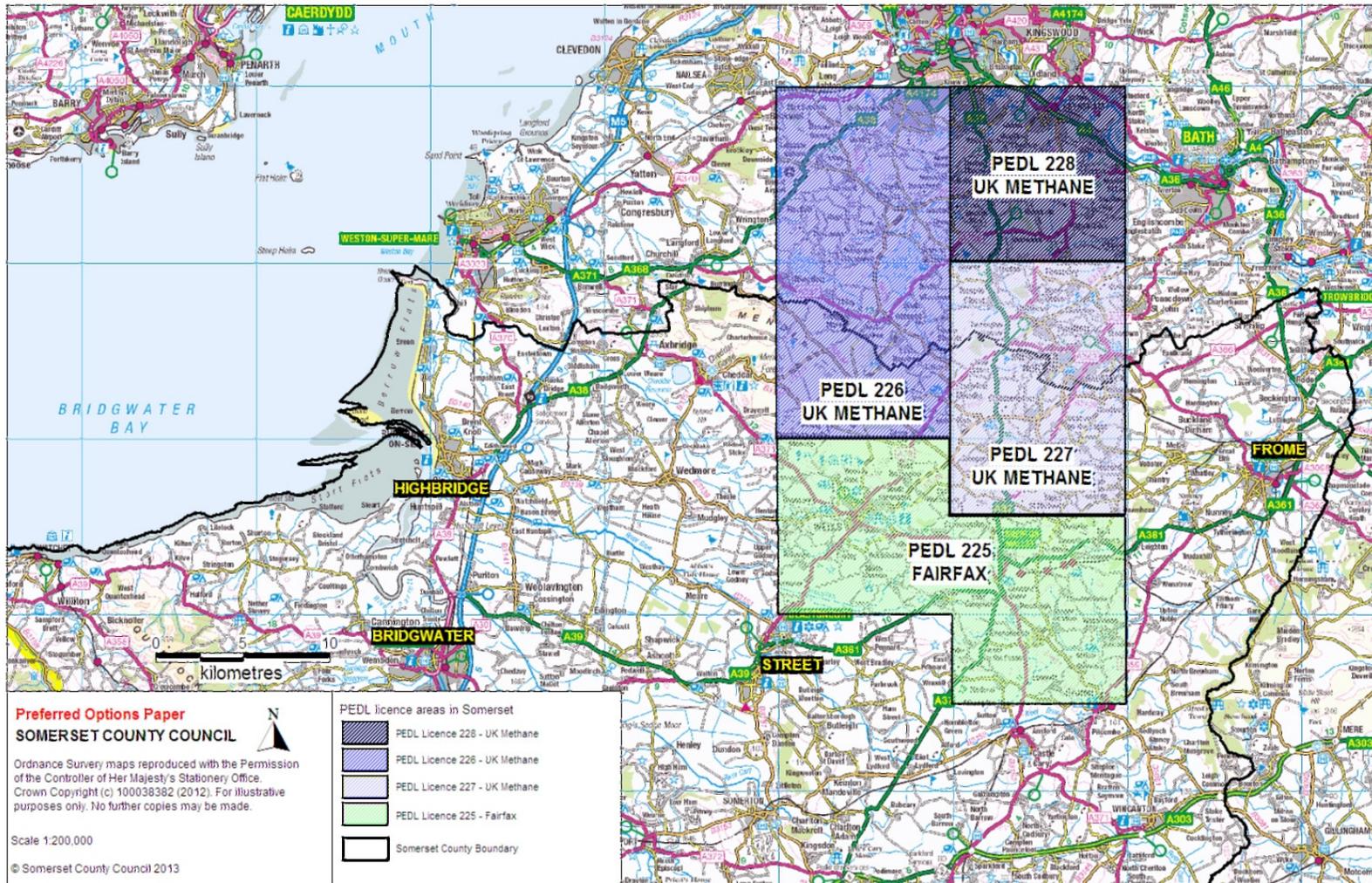
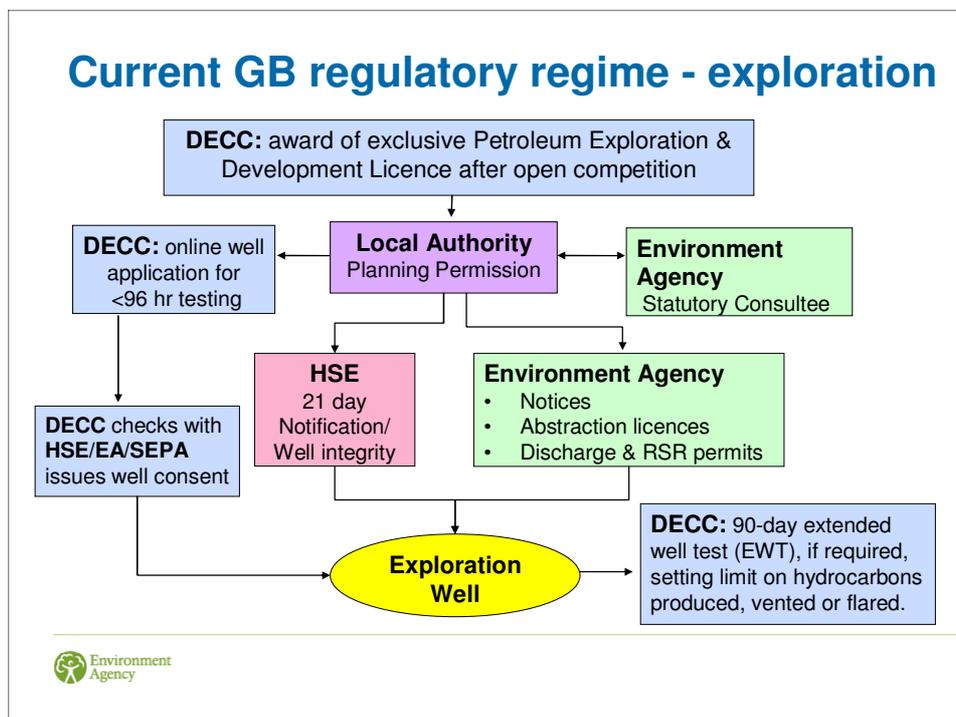


Figure 4: A map showing the PEDLs (from the 13th onshore licensing round in 2008) in the area covered by this Topic Paper



- 2.48. The PEDLs are issued for a limited time, with the current round due to expire in June this year (2014) if the licensee has not at least begun drilling a well by then.
- 2.49. 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.
- 2.50. Following the consultation on the Strategic Environmental Assessment (SEA) of further onshore oil and gas licensing, a further round of licensing is anticipated in the latter part of 2014.
- 2.51. Securing an exclusive licence is the first step in a multi-stage process. It gives exclusivity to the licensee for its respective license area.
- 2.52. 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).
- 2.53. 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.
- 2.54. 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)



- 2.55. 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.
- 2.56. 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.
- 2.57. 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.²⁶ To date there are no coal bed methane agreements in place between operators and the Coal Authority within the study area.
- 2.58. The Department of Energy and Climate has published a regulatory roadmap which outlines the responsibilities of the different regulators in oil and gas development.²⁷

²⁶ <http://coal.decc.gov.uk/en/coal/cms/publications/mining/seams/seams.aspx>

²⁷ Onshore oil and gas exploration in the UK: regulation and best practice: <https://www.gov.uk/government/publications/regulatory-roadmap-onshore-oil-and-gas-exploration-in-the-uk-regulation-and-best-practice>

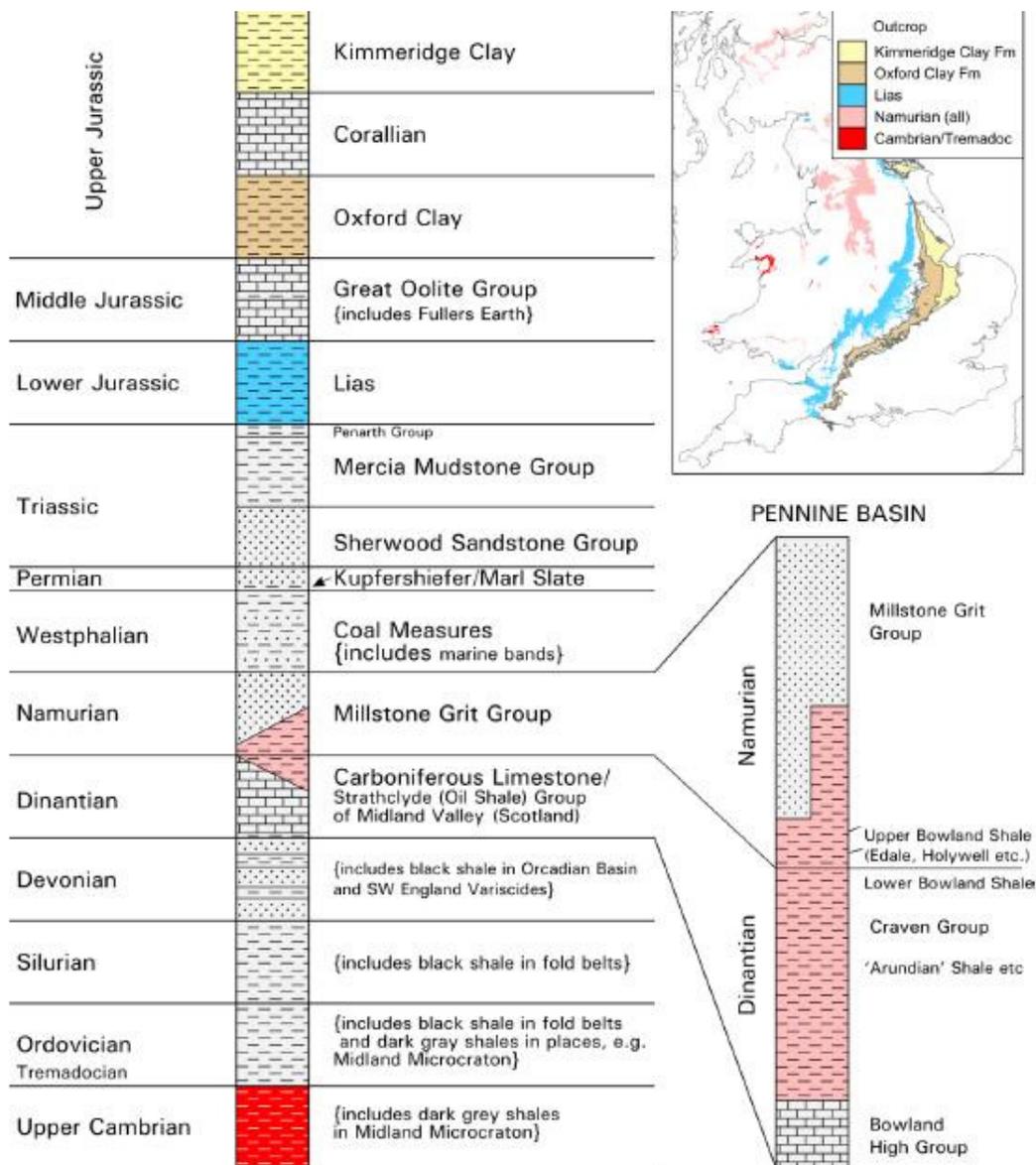
3. Geology and Landscape

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.²⁸
- 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.

²⁸ 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.²⁹
- 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.³⁰ 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.³¹
- 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 extraction³²).
- 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 1973.³³ 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".³⁴
- 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.³⁵
- 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.

²⁹ BGS. Potential problems in the Bath and North East Somerset Council and surrounding area with respect to hydrocarbon and other exploration and production, 2012

³⁰ <http://www.bgs.ac.uk/mendips/minerals/coal3.html>

³¹ http://www.bgs.ac.uk/mendips/geology/geological_structure.htm

³² "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/>

³³ 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).

³⁴ Ibid.

³⁵ 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.³⁶
- 3.19. The same research indicates there is little prospect for abandoned mine methane³⁷, 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".³⁸
- 3.21. There are no known studies focused on the gas content of UK shales.³⁹ 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.⁴⁰ 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), including Mendip Caves SSSIs

³⁶ 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) – paragraph 8.2.2.

³⁷ 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) – paragraph 8.2.1.

³⁸ <http://www.bgs.ac.uk/downloads/start.cfm?id=1712>

³⁹ The Unconventional Hydrocarbon Resources of Britain's Onshore Basins – Shale Gas, DECC, 2011

⁴⁰ Ibid.

- Regionally important geological sites (RIGS)

3.25. The geology of the Mendip Hills means that it is home to a complex system of caves, which have been recorded and indexed by the Mendip Cave Registry and Archive, available via the following link: www.mcra.org.uk. Any proposals for oil and gas development should identify and take into account cave systems and passages

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. National Planning Practice Guidance published in March 2014 states that (bold formatting added by the Topic Paper authors):
“The mineral planning authority should consider whether any proposal for onshore oil and gas extraction requires an Environmental Impact Assessment. Applications for the exploratory and appraisal phases are likely to fall under paragraph 2 of Schedule 2 to the Town and Country Planning (Environmental Impact Assessment) Regulations 2011. An Environmental Impact Assessment is therefore required if the project is likely to have significant environmental effects. A flow chart summarising the screening process is set out under the National Planning Practice Guidance for Environmental Impact Assessment. Whilst all applications must be assessed on a case-by-case basis, it is unlikely that an Environmental Impact Assessment will be required for exploratory drilling operations which do not involve hydraulic fracturing. However, when considering the need for an assessment, it is important to consider factors such as the nature, size and location of the proposed development (selection criteria for screening Schedule 2 development are set out in Schedule 3 to the Regulations).

Applications for the production phase are also likely to fall under paragraph 2 of Schedule 2 to the 2011 Regulations, in which cases they should be screened for likely significant effects, but applications where more than 500 tonnes of oil or 500,000 cubic metres of gas will be extracted per day may fall under Schedule 1, in which case an Environmental Impact Assessment is mandatory.

- 4.6. Information on research undertaken at a European level is shown in a text-box below.

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.

- 4.7. On 22 January 2014, the European Commission issued a Recommendation on minimum principles for the exploration and production of hydrocarbons (such as shale gas) using high volume hydraulic fracturing (2014/70/EU). This recommendation sought to address gaps in current EU environmental legislation, which was developed before high volume hydraulic fracturing was used in Europe. Member States are encouraged to apply the principles, which seeks to draw together existing EU legislation and new guidance on strategic planning, underground risk assessment, well integrity, baseline and operational monitoring, capturing methane emissions and disclosure of information on chemicals used.

National planning policy

- 4.8. 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.

- 4.9. 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.
- 4.10. Further clarity was provided in the *Planning Practice Guidance for Onshore Oil and Gas*, published in July 2013, which was subsequently incorporated into National Planning Practice Guidance (NPPG - an online resource) published in March 2014. This provides a detailed explanation of what each phase of hydrocarbon extraction may involve. It explains that each of the three phases of development require planning permission – although some initial seismic work may have deemed planning consent under part 2 of Schedule 2 of the Town and Country Planning (general Permitted Development) order 1995⁴¹.
- 4.11. The NPPG outlines requirements for information and policy on hydrocarbons within Mineral Plans, including:
- Petroleum Licence Areas on their proposals maps; and
 - Criteria-based policies for each of the exploration, appraisal and production phases of hydrocarbon extraction. These policies should set clear guidance and criteria for the location and assessment of hydrocarbon extraction within the Petroleum Licence Areas.⁴²
- 4.12. The NPPG provides advice on the planning application process, including:
- Who the key regulators for hydrocarbon extraction are (see also Figure 7 below);
 - Other bodies that may be involved in the process of consenting hydrocarbon extraction, for example, the Coal Authority, Natural England, the British Geological Survey and Hazardous Substances Authorities.

⁴¹ <http://www.legislation.gov.uk/uksi/1995/418/schedule/2/made>

⁴² <http://planningguidance.planningportal.gov.uk/blog/guidance/minerals/planning-for-hydrocarbon-extraction/how-mineral-planning-authorities-plan-for-hydrocarbon-extraction/>

- 4.13. The NPPG includes a section on what hydrocarbon issues can mineral planning authorities leave to other regulatory regimes, stating: “*There exist a number of issues which are covered by other regulatory regimes and mineral planning authorities should assume that these regimes will operate effectively. Whilst these issues may be put before mineral planning authorities, they should not need to carry out their own assessment as they can rely on the assessment of other regulatory bodies. However, before granting planning permission they will need to be satisfied that these issues can or will be adequately addressed by taking the advice from the relevant regulatory body*”. The issues covered include mitigation of seismic risks, well design and construction, well integrity during operation, operation of surface equipment on the well pad, mining waste, flaring or venting of any gas produced, final off-site disposal of water, well decommissioning and abandonment.
- 4.14. Further to this, the Guidance from 2013 explained that “the principal issues that mineral planning authorities should address, bearing in mind that not all issues will be relevant at every site, to the same degree”, including:
- noise associated with the operation
 - dust
 - air quality
 - lighting
 - visual intrusion into the local setting and the wider landscape caused by any the placement of any building or structure within the application site area
 - landscape character
 - archaeological and heritage features
 - traffic
 - risk of contamination to land
 - soil resources
 - the impact on best and most versatile agricultural land
 - flood risk
 - land stability/subsidence
 - internationally, nationally or locally designated wildlife sites, protected habitats and species, and ecological networks
 - nationally protected geological and geomorphological sites and features
 - site restoration and aftercare ⁴³

⁴³https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/224238/Planning_practice_guidance_for_onshore_oil_and_gas.pdf

Mineral Planning Authority (MPA)	Department for Energy and Climate Change (DECC)	Environment Agency (EA)	Health and Safety Executive (HSE)
Permission for location of exploratory well	Petroleum and Exploratory Drilling Licences (PEDLs)	Protecting water resources	Regulates safety of the work
Imposing conditions	Grant consent to drill	Treatment and disposal of mining waste	Design/ construction of well casing
	Assess risk and monitor seismic activity	Treatment and management of naturally occurring radioactive materials (NORM)	
	Consent for flaring or venting		

Figure 7: Key regulatory responsibilities

Evolving national position

- 4.15. Central government's position on shale gas extraction has evolved since events in Blackpool in Spring 2011, and the subsequent growing volume of research.
- 4.16. *"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 website⁴⁴.
- 4.17. Since then an expert panel issued a report in April 2012⁴⁵ 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.
- 4.18. Central government published the Preese Hall report for consultation, inviting feedback on the recommendations within that document.

⁴⁴ <https://www.gov.uk/oil-and-gas-onshore-exploration-and-production>

⁴⁵ Preese Hall Shale Gas Fracturing, Review & Recommendations for Induced Seismic Mitigation, Green, Styles & Baptie, April 2012

- 4.19. 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.⁴⁶
- 4.20. 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..."

- 4.21. In effect this announcement lifted the suspension on fracking, allowing new proposals to be considered against a re-strengthened regulatory process.
- 4.22. Following the publication of the government's Gas Generation Strategy in December 2012, the government has begun to deliver on some of its objectives to assist in developing shale gas resources. 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.

⁴⁶ Shale gas extraction in the UK: a review of hydraulic fracturing, The Royal Society and the Royal Academy of Engineering, July 2012

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."

- 4.23. 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"*.
- 4.24. The Budget 2013 introduced specific steps to promote the development of shale gas and oil in the UK, including: measures to support future investment in the UK shale gas industry; a commitment to produce technical planning guidance on shale gas; develop proposals 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 (OUGO).
- 4.25. As such, the UK government has further refined the role of OUGO, with its stated aim of promoting "the safe, responsible, and environmentally sound recovery of the UK's unconventional reserves of gas and oil", with a view to: making the most of our natural resources; enabling development; ensuring local communities benefit; supporting public engagement; and building our knowledge base.⁴⁷
- 4.26. Further to this, HM Treasury also consulted on a fiscal regime for shale gas, to assist in giving the industry a kick-start, between July and September 2013, resulting in legislation for a new onshore allowance being introduced in the Finance Bill 2014, in which⁴⁸:
- "The allowance will remove an amount equal to 75 per cent of capital expenditure incurred by a company in relation to an onshore site from its adjusted ring fence profits which are subject to the supplementary charge, subject to certain capacity limits (for production yield). Onshore oil and gas projects will also be removed from the scope of existing field allowances."*⁴⁹
- 4.27. Secondary legislation has also been introduced to support future investment in the industry by changing the notification requirements;

⁴⁷ <https://www.gov.uk/government/policy-teams/office-of-unconventional-gas-and-oil-ougo>

⁴⁸ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/264650/PU1580_final_.pdf

⁴⁹ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/263643/Shale_gas.pdf

introducing a standardised form for onshore oil and gas developments; and calculating the application fee⁵⁰.

- 4.28. The changes mean that there is no requirement to serve notice on individual land owners and tenants, where development relates to land below a certain depth.
- 4.29. The government will seek to clarify the arrangements for the fee payable for onshore oil and gas planning applications, specifying that it should be calculated on the basis of the area of above ground works only. There is also an intention to increase fees for planning applications for onshore oil and gas developments by 10% on the basis of surface area works, in acknowledgement of the increased public interest and scrutiny applications for oil and gas are likely to receive.
- 4.30. Finally, following on from the Budget 2013 statement, the United Kingdom Onshore Operators Group (UKOOG) announced the formation of a community benefit scheme on 13 January 2014, to support government proposals. The industry launched a pilot scheme of selected shale gas exploration sites in the UK which involve exploratory drilling, hydraulic fracturing and flow testing. Once consent has been given, each well site will have £100,000 available for the benefit of the local community.
- 4.31. At the time of writing, DECC has been exploring changes to trespass laws to address geothermal access rights. Amendments would seek to make it easier for producers to access potential shale gas reserves. Under current UK law, although land owners do not own the oil and gas reserves under their land (the Crown has these rights), it is possible that drilling under someone else's land may incur a trespass action.

Evolving local position

Somerset policy

- 4.32. The Somerset Minerals Plan Pre-Submission paper was published for consultation in March 2014. Concerns raised during Somerset County Council's Preferred Options consultation have informed section 6 of this paper.
- 4.33. 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

- 4.34. The 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

⁵⁰ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/274955/Revised_requirements_relating_to_planning_applications_for_onshore_oil_and_gas_-_proposals_paper_-_Summary_of_responses_and_government_response.pdf

allocations and development management policies and will include a number of minerals policies to replace those in the adopted Local Plan with the addition of one relating to energy minerals. The Placemaking Plan was launched in July 2013 and consultation on policy and site Options is anticipated to commence at the end of 2014.

North Somerset policy

- 4.35. 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. The plan is progressing in light of the consultation and an updated version will be produced in due course.

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%.⁵¹
- 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 regimes⁵².
- 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.⁵³
- 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 must grant planning consent. The US has relatively permissive*

⁵¹ Carl T. Montgomery and Michael B. Smith, NSI Technologies, Hydraulic Fracturing: history of an enduring technology, December 2010

⁵² 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.

⁵³ Parliamentary Commissioner for the Environment, Evaluating the impacts of fracking in New Zealand, November 2012.

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."⁵⁴

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 are likely to 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.⁵⁵ 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.

⁵⁴ DECC, The Unconventional Hydrocarbon Resources of Britain's Onshore Basins – Shale Gas, 2012

⁵⁵ 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".*⁵⁶ 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".*⁵⁷

⁵⁶ Ibid

⁵⁷ 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.
- 5.18. The next (14th) round of licences is anticipated in the latter part of 2014, as central government continues to support further exploration and greater energy independence. In preparation, and to fulfil the requirement under EU law, DECC consulted on the Strategic Environmental Assessment (SEA) for further onshore oil and gas licensing between 17 December 2013 and 28 March 2014. This document assesses the likely environmental effects from DECC's proposals to invite applications for and issue new licences. The Environmental Report therefore identifies, describes and evaluates: reasonable alternatives to that plan; and how these effects can be reduced or offset.
- 5.19. The Plan identifies a large proportion of Great Britain for consideration for new licences. This does not mean that there will necessarily be any oil or gas activity in a particular part of a licensed area. The licences do not permit actual drilling or production operations, which always require planning permission; the licences merely allocate the oil and gas resource in a specific area to a particular company.

6. Addressing key concerns

Introduction

- 6.1. This section of the Topic Paper explores a range of issues linked 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.
- 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 gain planning permission from the relevant Minerals Planning Authority and appropriate permit(s) from the Environment Agency. The Health and Safety Executive must be informed and be satisfied with the well design, the operator must arrange an examination of the well design by an independent, competent well examiner, and the British Geological Survey has been notified of the intent to drill. 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 Practice Guidance and the Regulatory Roadmap prepared by DECC inform this issue, as does 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. National Planning Practice Guidance states what information should be included on a location plan for oil and gas extraction i.e. helping to define the boundary of development. A default approach (used in particular for vertical drilling) has been to set the “red line” as the well pad area. However, greater clarity emerged on this issue via the publication of the NPPG which states that:

“The location plan should include all land necessary to carry out the proposed development (e.g. land required for access to the site from a public highway, visibility splays, landscaping, car parking and open areas around buildings) and should identify sufficient roads and/or buildings on adjoining land to ensure that the exact location of the application site is clear.

A distinction should be made in the location plan between those areas where surface works are proposed and those where only underground operations are proposed to take place. The location plan should

identify the surface area of the application site by edging it clearly with a red line. A dotted red line should edge the likely extent (including length and direction) of any lateral boreholes. The underground area should be indicated even where it is within the area of the surface workings.

A blue line should be drawn around any other land owned or controlled by the prospective minerals operator, close to or adjoining the surface area of the application site. At the exploratory stage, the location plan should identify indicative underground zones where lateral drilling and hydraulic fracturing (if applicable) may take place.

At the appraisal or production stage the location plan should also show the area where extraction of oil and gas is likely to take place, using a shaded red area.

A location plan should be based on an up-to-date map and wherever possible scaled to fit onto A4 or A3 size paper."

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".⁵⁸*

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%⁵⁹. 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".⁶⁰*

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 2020.⁶¹ 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.

⁵⁸ BGS, Potential Problems in the Bath and North East Somerset Council and surrounding area with respect to hydrocarbon and other exploration and production, 2012

⁵⁹ The Royal Society & The Royal Academy of Engineering, Shale Gas Extraction in the UK: a review of hydraulic fracturing, June 2012

⁶⁰ BGS, Potential Problems in the Bath and North East Somerset Council and surrounding area with respect to hydrocarbon and other exploration and production, 2012

⁶¹ <http://www.bbc.co.uk/news/business-21501878>

- 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).

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.⁶² 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.
- 6.42. This was followed by further report by the Institute of Directors (IoD), in May 2013, entitled "Getting shale gas working", reporting that investment could reach £3.7 billion, supporting 74,000 jobs. Such jobs might include: geologists, engineers, construction workers, business analysts, cement and steel manufacturers, equipment manufacturers, drilling service companies and water treatment specialists.⁶³ It also

⁶² Institute of Directors, Britain's Shales Gas Potential, September 2012

⁶³ <http://www.iod.com/influencing/policy-papers/infrastructure/infrastructure-for-business-getting-shale-gas-working>

presents a scenario in which gas import dependency could be reduced from 76% to 37% in 2030.

- 6.43. Subsequently, in April 2014, the UK Onshore Operators Group and the Department for Business, Innovation and Skills published the report “Getting ready for Shale Gas: supply chain and skills requirements and opportunities”, giving further support for the figures published in the IoD’s report of May 2013. It identifies that in the period 2016 to 2032, a spend of c.£33 billion could be required to bring up to 4,000 wells into production⁶⁴.
- 6.44. This report also outlines key opportunities and requirements for the UK, at the start of onshore oil and gas exploration, where government and industry should work together to: develop skills; define common pad and hydraulic fracturing standards; and encourage investment in specialised areas such as steel, rigs and hydraulic fracturing equipment.

⁶⁴ http://www.ukoog.org.uk/images/ukoog/pdfs/Getting_ready_for_UK_shale2_gas_FINAL2022.04.14.pdf

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"*.⁶⁵

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 legislation relating to onshore oil and gas

There is ongoing uncertainty about arrangements for the planning applications fees for onshore oil and gas development – it is anticipated that legislation will specify that the fee should be calculated on the basis of the above area works only. Further legislation is also anticipated, for an increase in planning fees of 10% for planning applications for onshore oil and gas – to acknowledge the increased public interest and scrutiny these applications are likely to receive.

DECC is currently exploring changes to trespass laws to address geothermal access rights, and the outcome of this review is awaited with interest.

⁶⁵ 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".*⁶⁶
- **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"*⁶⁷. 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."*⁶⁸

⁶⁶ The Royal Society & Royal Academy of Engineering, Shale gas extraction in the UK: a review of hydraulic fracturing, June 2012

⁶⁷ <https://www.gov.uk/government/speeches/written-ministerial-statement-by-edward-davey-exploration-for-shale-gas> (accessed 24 April 2013)

⁶⁸ 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.⁶⁹
- 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.⁷⁰ Furthermore, the report states that "*seismic risks should feature as part of the ERA*".

In April 2014, DECC published a working draft of *Guidance on the preparation of an environmental risk assessment of shale gas operation in Great Britain*, In response to this Report. Although this document needs to be refined and developed further, DECC asks operators to apply these principles in all new projects. 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.

⁶⁹ The Royal Society & Royal Academy of Engineering, Shale Gas Extraction in the UK: a review of hydraulic fracturing, June 2012

⁷⁰ 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>

US Environmental Protection Agency (EPA) (2011), Plan to study the potential impacts of hydraulic fracturing on drinking water resources.

http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/upload/final-study-plan-hf_web_2.pdf

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>