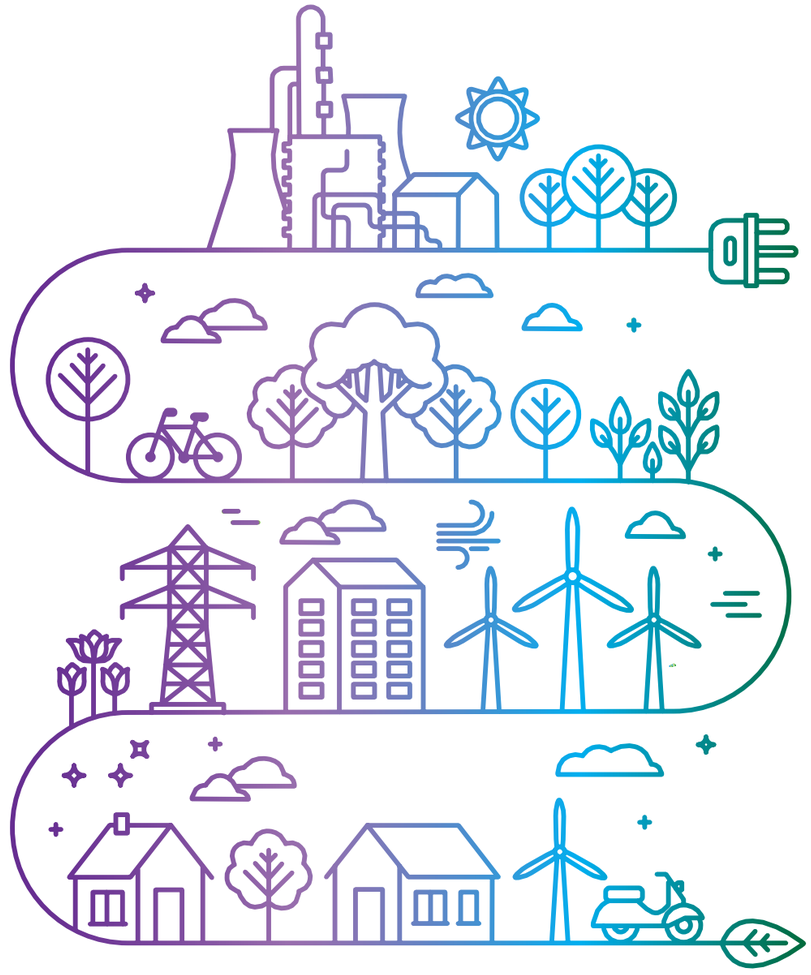
Talking "Fracking"

A Consultation on Unconventional Oil and Gas



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Content

Ministerial foreword

PAUL WHEELHOUSE MSP
Minister for Business, Innovation and Energy

The future of unconventional oil and gas in Scotland has proven both complex and controversial. It is also an issue that has stimulated intense debate, motivated by deeply held and sincere views on all sides. Now we want to understand your views.

The Scottish Government's position is to take a cautious, evidence-led approach while we gather and consider evidence. In January 2015, the Scottish Government put in place a moratorium on unconventional oil and gas development in Scotland, which prevents hydraulic fracturing for shale oil and gas, and coal bed methane extraction taking place while the Scottish Government has investigated evidence on potential impacts. We also ensured that no further unconventional oil and gas licences were issued by the UK Government for sites in Scotland.

Most of Scotland's unconventional oil and gas deposits occur in and around former coalfields and oil shale fields in Scotland's central belt, which contains some of the most densely populated areas of the country, as well as in the area around Canonbie, Dumfriesshire.

As an advanced economy, Scotland needs to ensure it has access to safe, clean, reliable and affordable energy to underpin our economic competiveness and to contribute to the wider wellbeing of our society. As a responsible, progressive nation, Scotland must also continue to demonstrate its strong leadership on climate change; an issue in which everyone across Scotland has an interest and on which there is a strong consensus across civic Scotland and the political spectrum. This is why it is vitally important that we not only consult local communities in the central belt and Dumfriesshire, but that we give communities, business and interest groups from across Scotland an opportunity to put their views across, given the potential for the generation of any new source of emissions to impact upon Scotland's transition to a low carbon economic model.

To establish a comprehensive evidence base on which to consider the future of unconventional oil and gas in Scotland, in 2013 the Scottish Government asked an Independent Expert Scientific Panel to examine unconventional oil and gas. When the Panel reported in July 2014, they identified a number of key gaps in the evidence base and so, to address these gaps, we commissioned a suite of expert reports to examine specific issues in more detail, and these key studies were published in November 2016.

Throughout this process we have sought to present impartial, independent information on unconventional oil and gas in order to encourage informed dialogue and debate.

Your view is important and so this consultation invites your participation in determining the future of unconventional oil and gas in Scotland. The consultation does not set out or advocate a preferred Scottish Government position or policy. Instead, we want to create space for dialogue and allow different perspectives to come forward.

The Scottish Government has a very important decision to make in determining the future of unconventional oil and gas in Scotland. Once the consultation closes and the responses have been independently analysed, we will then consider the full range of evidence, and make our recommendation. In doing so, we will give careful consideration to the extraction methods for both shale oil and gas, and coal bed methane.

We will then ask the Scottish Parliament to vote on our recommendation, and we will come to a final decision by the end of 2017 on whether or not unconventional oil and gas has a role in Scotland's energy mix.

Definitions

BARREL	A unit of volume measurement used for oil and its products.
BOREHOLE	A hole drilled in to the earth. Boreholes can be used to remove core samples of rock for geologic analysis. A borehole that is used to extract oil or gas or water is sometimes called a well.
CARBON CAPTURE AND STORAGE (CCS)	Carbon capture and storage is a technology that can capture the carbon dioxide emissions produced from the use of fossil fuels, preventing the carbon dioxide from entering the atmosphere.
COAL BED METHANE	Coal bed methane is considered to be an unconventional source of gas because the gas is absorbed in the coal rather than being held in pore spaces.
CONVENTIONAL OIL AND GAS	Oil and gas that is recovered by drilling a well in porous rock, with the oil or gas flowing out under its own pressure.
DECOMMISSIONING	The process to remove all the equipment used for production of unconventional oil and gas and return the site to its original condition and use.
DRILLING PAD	A hard standing area for development of drilling wells and production of gas and oil.
DRILLING RIG	The equipment used to drill holes into the earth called boreholes and wells.
ETHYLENE CRACKER	A piece of equipment used in the petrochemical industry to convert hydrocarbons into ethylene which will then be used in manufacturing.
FUGITIVE EMISSION	Emissions of gasses or vapours from industrial equipment due to leaks or other unintended or irregular releases, during industrial activities.
GREENHOUSE GAS	A greenhouse gas is any gaseous compound in the atmosphere that is capable of absorbing infrared radiation, thereby trapping and holding heat in the atmosphere.
HAZARD/RISK	A hazard is a potential source of harm, e.g. electricity, chemicals, stress. A risk is the likelihood, or chance, that something will cause harm.

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HYDRAULIC FRACTURING	A drilling technique, commonly referred to as 'fracking', that fractures rock to release the oil and gas contained in the rocks.
HYDROCARBON	A compound containing the elements hydrogen and carbon. May exist as a solid, a liquid or a gas. The term is mainly used in a catch-all sense for oil, gas and condensate.
LIQUIFIED NATURAL GAS	Gas, chiefly methane, liquefied for transportation.
MORATORIUM	A temporary prohibition in an activity.
NATURAL GAS	Natural gas is a source of energy. It is typically composed of a mixture of hydrocarbons such as methane, hydrogen, carbon monoxide, carbon dioxide and nitrogen.
NATURAL GAS LIQUIDS	The portions of gas from a reservoir that can be liquefied. Ethane, propane, butane, isobutane, and pentane are all natural gas liquids.
OIL	A mixture of liquid hydrocarbons.
OPERATOR	The company that has legal authority to drill wells and to access hydrocarbons.
PETROCHEMICALS	Chemical products obtained from petroleum/natural oil and gas. Companies supply petrochemicals for use in manufacturing and production.
PETROLEUM	A generic name for hydrocarbons, including crude oil, natural gas liquids, natural gas and their products.
RESERVE	The amount of technically and economically recoverable oil and gas in a particular location.
RESOURCE	The amount of estimated oil and gas in a particular location.
SEISMIC ACTIVITY	Vibration of the ground or earthquakes due to natural or artificial causes.
SHALE GAS	Shale gas is a form of natural gas trapped within shale rock.
SHALE ROCK	Shale is an impermeable rock from which natural oil and gas can be extracted.
WELL	The hole drilled by a drilling rig to explore for or develop oil and/or natural gas.

SUMMARY OF EVIDENCE ON UNCONVENTIONAL OIL AND GAS

THE MOST COMMON HEATING FUEL IN SCOTLAND IS GAS WITH AROUND 1.9 MILLION SCOTTISH HOUSEHOLDS (78%) USING MAINS GAS AS THEIR PRIMARY HEATING FUEL.

TOTAL ANNUAL GAS CONSUMPTION IN SCOTLAND IS CURRENTLY AROUND 150 BILLION CUBIC FEET PER YEAR.

SCOTLAND HAS SIGNIFICANT SHALE RESOURCES

The Midland Valley (central Scotland) is estimated to hold at least 49.4 trillion cubic feet of shale gas.

BUT IT IS LIKELY THAT ONLY SOME OF IT COULD BE EXTRACTED

Under a central production scenario, around 2% of this resource (947 billion cubic feet*) is likely to be commercially viable for production.

DEVELOPING THESE RESOURCES COULD LEAD TO…

	CHALLENGES OR RISKS	OPPORTUNITIES AND SAFEGUARDS
SOCIAL	As with other developments, communities would experience disturbances (short and/or longer term), including increased traffic, noise, and visual impacts. Available studies are inadequate for determining risks to public health.	The planning system and environmental regulation is designed to consider and mitigate impacts. Community benefit schemes could fund local investment.
ECONOMIC	Unlikely to have an impact on household energy costs.	Could generate £1.2 billion (in total) for Scotland's economy, and create 1,400 jobs. Could increase security of gas supply, particularly for high energy use industries. Potentially important raw material for Scotland's petrochemical sector, which is a significant employer.
ENVIRONMENT	Strong, coordinated regulation would be required to reduce or eliminate adverse impacts. An unconventional oil and gas industry is likely to lead to increased greenhouse gas emissions, which would make it more challenging to achieve Scottish climate change targets.	Scotland has a rigorous regulatory framework, and research had shown how this framework could be strengthened further.

*Figures based on the central production scenario in the economic research project (page 40).

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PART ONE

Introducing the consultation and the issues

About this consultation

This section sets out the steps the Scottish Government is taking to conduct an open and inclusive consultation that gives everyone with an interest in unconventional oil and gas an opportunity to get involved in the discussion and put their views across.

WHY WE ARE CONSULTING

Studies have shown that Scotland's geology, and in particular a stretch of land through Scotland's central belt (referred to as the Midland Valley), contains significant quantities of shale gas and oil, and coal bed methane. The central belt is also one of Scotland's most populated regions, supporting important industries and business.

Accessing these resources would require the use of technologies such as hydraulic fracturing (commonly referred to as 'fracking'). This has led to a widespread debate on potential environmental, health and economic impacts, and on compatibility with Scotland's ambitious climate change targets.

The Scottish Government's approach to unconventional oil and gas is therefore one of caution while we gather and consider evidence, encourage dialogue, and give you an opportunity to set out your views.

This consultation does not set out or advocate a preferred Scottish Government position or policy. Instead, this consultation is an opportunity for the people of Scotland and our stakeholders to consider the evidence, and to present views on that evidence and the future of this industry in Scotland.

WHAT WE ARE CONSULTING ON

This is a consultation about onshore unconventional oil and gas. It covers the potential processes and technologies that would be involved in extracting shale oil and gas, including hydraulic fracturing, or coal bed methane. Evidence on potential impacts is discussed under the following themes: community, economic, environmental.

To support this consultation, the Scottish Government has compiled a comprehensive evidence-base. This has included commissioning a report by an Independent Expert Scientific Panel, and commissioning a series of research projects to explore certain issues in more detail. We also recognise that there may be other information and evidence that you may wish to draw on when responding to this consultation.

Conventional onshore and offshore oil and gas are outside the scope of this consultation. The difference between conventional and unconventional oil and gas is discussed on page 16.

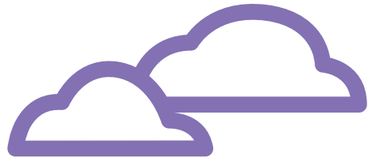
The future of unconventional oil and gas is relevant to wider energy issues, and our climate change ambitions. The launch of this consultation has therefore been coordinated with the publication of our third Climate Change Plan and our consultation on Scotland's draft Energy Strategy.

More information on Scotland's draft Climate Change Plan can be found at: http://www.gov.scot/Publications/2017/01/2768

More information on Scotland's draft Energy Strategy can be found at: https://consult.scotland.gov.uk/energy-and-climate-change-directorate/draft-energy-strategy/

The consultation on Scotland's draft Energy Strategy explores the supply of safe, clean, reliable and affordable energy that will both underpin the Scottish economy and contribute to the wellbeing of our society.

Views on unconventional oil and gas should be directed through this consultation, whereas views on wider energy matters should be submitted through the draft Energy Strategy consultation.



HOW WE ARE CONSULTING

The Scottish Government has listened carefully to the views of stakeholders on conducting a fair and impartial consultation. In undertaking this consultation, the Scottish Government is committed to:

- **evidence-led policy making**, and using the evidence of public views gathered in this consultation as part of the pool of evidence;
- providing the public with **impartial** information on the issues, and supporting open and informed **dialogue**;
- **supporting a fair and balanced debate** on the issues that creates space for different perspectives and arguments to be presented and considered;
- transparency throughout the consultation process **and giving all contributions fair and due consideration**;
- **actively seeking participation from a broad cross-section of the Scottish population, including individuals**, businesses and interest groups.

To encourage wide participation, the Scottish Government has created a number of ways for you to engage in the consultation.

In addition to publishing this consultation document, we have launched a temporary unconventional oil and gas website: www.talkingfracking.scot

The site has been designed to provide a user-friendly route to accessing all the materials and evidence that support this consultation. We encourage those wishing to explore the issues further to visit this site.

A discussion pack has been designed and prepared to help communities and stakeholders to explore and discuss the issues in groups. This can be accessed through our unconventional oil and gas website.

The results of those discussions can be submitted to the Scottish Government and will be treated as a formal response to this consultation.

The consultation is also available in alternate formats on request, including Easy Read, large print, Braille, BSL and other languages. You can request these by emailing us at requestalternativeconsultation@gov.scot or calling us on 0131 244 9380. We are also happy to receive responses in alternative formats, e.g. spoken responses, other languages.

RESPONDING TO THIS CONSULTATION

We are inviting responses to this consultation by 31 May 2017. Please respond using the Scottish Government's consultation platform, Citizen Space. You can view and respond to the consultation online at: https://consult.scotland.gov.uk/energy-and-climate-change-directorate/fracking-unconventional-oil-and-gas/

You can save and return to your responses while the consultation is still open. Please ensure that consultation responses are submitted before the closing date of 31 May 2017. If you are unable to respond online, please complete the Respondent Information Form (see 'Handling your Response' below) and send it to:

Consultation on Unconventional Oil and Gas
Onshore Oil and Gas Team
The Scottish Government
3J South
Victoria Quay
Edinburgh
EH6 6QQ
uogconsultation@gov.scot

You can also download our discussion pack and submit a group response to the consultation.

HANDLING YOUR RESPONSE

If you respond using Citizen Space you will be directed to the Respondent Information Form. Please indicate how you wish your response to be handled and, in particular, whether you are happy for your response to published.

If you are unable to respond via Citizen Space, please complete and return the Respondent Information Form included in this document. If you ask for your response not to be published, we will regard it as confidential, and we will treat it accordingly.

All respondents should be aware that the Scottish Government is subject to the provisions of the Freedom of Information (Scotland) Act 2002 and would therefore have to consider any request made under the Act for information relating to responses made to this consultation exercise.

NEXT STEPS

Where respondents have given permission for their response to be made public, and after we have checked that they contain no potentially defamatory material, responses will be made available to the public at http://consult.scotland.gov.uk. If you use Citizen Space to respond, you will receive a copy of your response via email.

Following the closing date, all responses will be independently analysed and the consultation analysis report will be considered alongside the full suite of evidence gathered. The analysis of your responses will be published in full.

On 8 November 2016, the Minister for Business, Innovation and Energy confirmed that:

- a recommendation on the future of unconventional oil and gas will be made after the consultation closes and the responses have been independently analysed;
- the Scottish Parliament will then be asked to vote on this issue; and
- the Scottish Government will then come to a considered judgment on the future of unconventional oil and gas in Scotland.

If you have any comments about how this consultation exercise has been conducted, please send them to:

Onshore Oil and Gas Team
The Scottish Government
3J South
Victoria Quay
Edinburgh
EH6 6QQ
uogconsultation@gov.scot

Introduction and context

The future of unconventional oil and gas is an important issue for the country, which has proven to be both complex and controversial.

This section describes Scottish Government policy and our evidence-led approach to unconventional oil and gas. We have also provided background information on unconventional oil and gas resources in Scotland and the technologies involved in extraction.

A CAUTIOUS AND EVIDENCE-LED APPROACH

Unconventional oil and gas has sparked intense debate. Some have highlighted the impact that shale developments in North America have had on their energy and chemicals industries, and advocated that Scotland pursue similar opportunities.

Others have highlighted concerns over potential environmental impacts, the location of the reserves, which are mainly across Scotland's populated central belt (between Glasgow and Edinburgh) and issues on compatibility with Scotland's ambitious climate change targets, and called for an outright ban.

The Scottish Government has therefore adopted a cautious and evidence-led approach to unconventional oil and gas. On 28 January 2015, the Scottish Government put in place a moratorium on developments involving hydraulic fracturing or coal bed methane. This means that that no such developments can take place.

The Scottish Government has undertaken an extensive and comprehensive period of evidence-gathering that examines the issues, challenges and opportunities presented by unconventional oil and gas.

This included commissioning an Independent Expert Scientific Panel to examine unconventional oil and gas in 2013, and then commissioning a series of research projects in 2016 to examine specific issues in more detail.

This evidence is summarised and considered in Part Two of this consultation.

UNCONVENTIONAL OIL AND GAS LICENCES AND ROLES

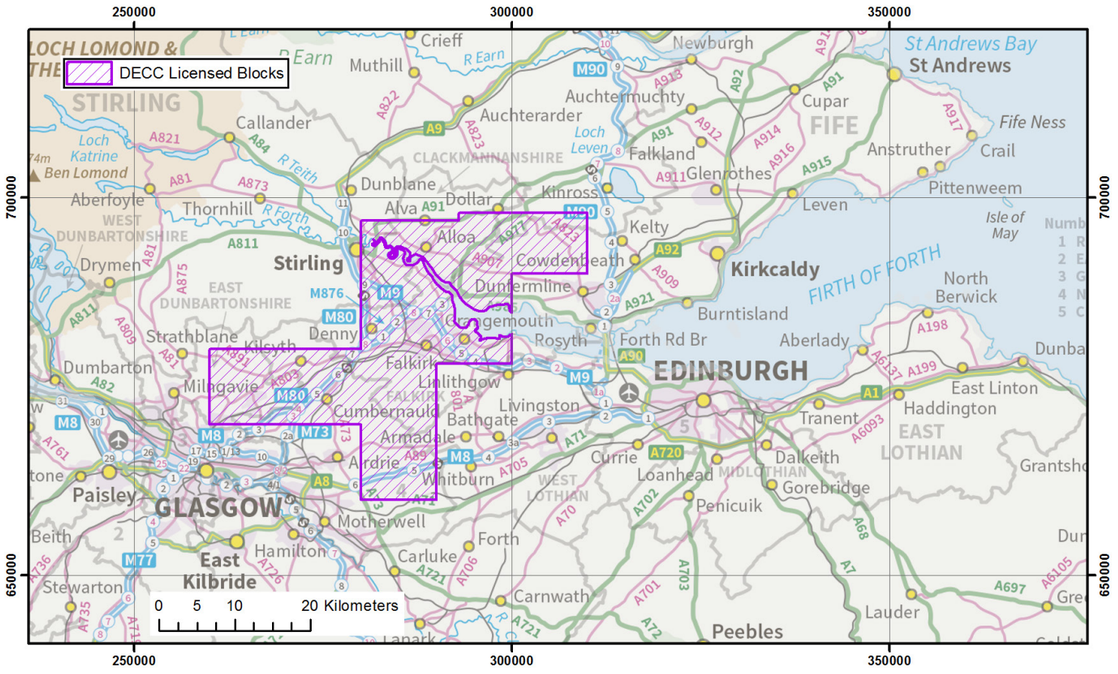
Exclusive rights to oil and gas in a given area are governed by a licensing system. There are currently three licences for unconventional oil and gas in Scotland, all of which were issued by the UK Government (Figure 1).

The licences, known as Petroleum Exploration and Development Licences, grant the right to search for and extract oil and gas in a given area.

The licences do not give the licence-holder automatic permission to commence operations. A range of additional planning and environmental permits are required before a development can commence.

Figure 1

Map of PEDL areas in Scotland licensed by the Department of Energy and Climate Change (DECC).



A number of organisations would be involved in assessing and regulating proposals for unconventional oil and gas developments. These organisation and their roles are summarised in Figure 2.

More information on the regulatory framework is provided on page 50. Information on opportunities for community involvement in prospective developments is provided on page 32.

In line with the Scottish Government's cautious and evidence-based approach to unconventional oil and gas, in 2014 the Scottish Government asked the UK Government not to issue any further licences in Scotland.

The Scotland Act 2016 passes responsibility for onshore oil and gas licensing to Scottish Ministers. These powers are due to be transferred in Spring 2017. The use of these powers will be informed by a suite of evidence, including this consultation.

Figure 2

Responsibilities of organisations involved in assessing and regulating unconventional oil and gas developments.

Oil and Gas Authority (devolution to Scottish Government underway)	• Regulates the terms and conditions of licences that confer exclusive rights to explore for, and produce, petroleum; issues licences. • These powers and responsibilties are due to transfer to Scottish Ministers.
Local Authority/ Planning Authority	• Planning authorities consider planning applications for all surface works associated with an unconventional oil and gas development (design, construction, operation, maintenance, decommissioning.) • Local Authorities are responsible for Environmental Health matters, which includes protecting the public from the harmful exposures they may encounter in the environment and with improving its health.
Scottish Environment Protection Agency	• Regulates specific activities that may cause pollution or that pose other risks to the environment throughout the life cycle of an unconventional oil and gas development (design, construction, operation, maintenance, decommissioning).
Health and Safety Executive (reserved*)	• Regulates to ensure the operator is managing the health and safety risks appropriately throughout the life cycle of an unconventional oil and gas development (design, construction, operation, maintenance, decommissioning).

* Reserved means that these powers are the responsibility of the UK Parliament.

The technologies involved

This section describes unconventional oil and gas technologies, what they involve in practice, what is located at a typical site and the scale of the resource in Scotland.

CONVENTIONAL VERSUS UNCONVENTIONAL OIL AND GAS

The oil and gas industry use a range of techniques to extract oil and gas from underground reserves.

Conventional oil and gas reserves can be exploited by drilling a well, with oil or gas then flowing out under its own pressure.

Conventional deposits are contained in porous rocks with interconnected spaces, such as limestone and sandstone. These interconnected spaces give rise to permeability that allows oil or gas to effectively flow through the reservoir to the well.

Unconventional oil and gas deposits are contained in impermeable rocks, such as shale or coal deposits. In these cases, the oil or gas cannot easily flow through the reservoir. To extract the oil and gases, techniques such as hydraulic fracturing (commonly referred to as fracking) or coal bed methane are used (Figure 3).

WHAT IS HYDRAULIC FRACTURING?

Hydraulic fracturing (or 'fracking') is a drilling technique that is used to fracture rock to release the oil and gas contained in those rocks. It is most commonly used to extract oil and gas from shale.

The rock is fractured by injecting pressurised fluids into the rock to prise open small spaces in the rocks, which release the oil or gas.

Hydraulic fracturing is used extensively in North America for extracting oil and gas from shale reserves. By 2015, the number of hydraulically fractured wells in the United States reached 300,000[1]. Hydraulic fracturing is also used by other industries, as outlined in Box 1.

BOX 1: OTHER USES OF HYDRAULIC FRACTURING

Hydraulic fracturing is not a new technology. It is used to increase the permeability of subsurface rocks and may be undertaken for a variety of purposes outside of unconventional oil and gas developments, including:

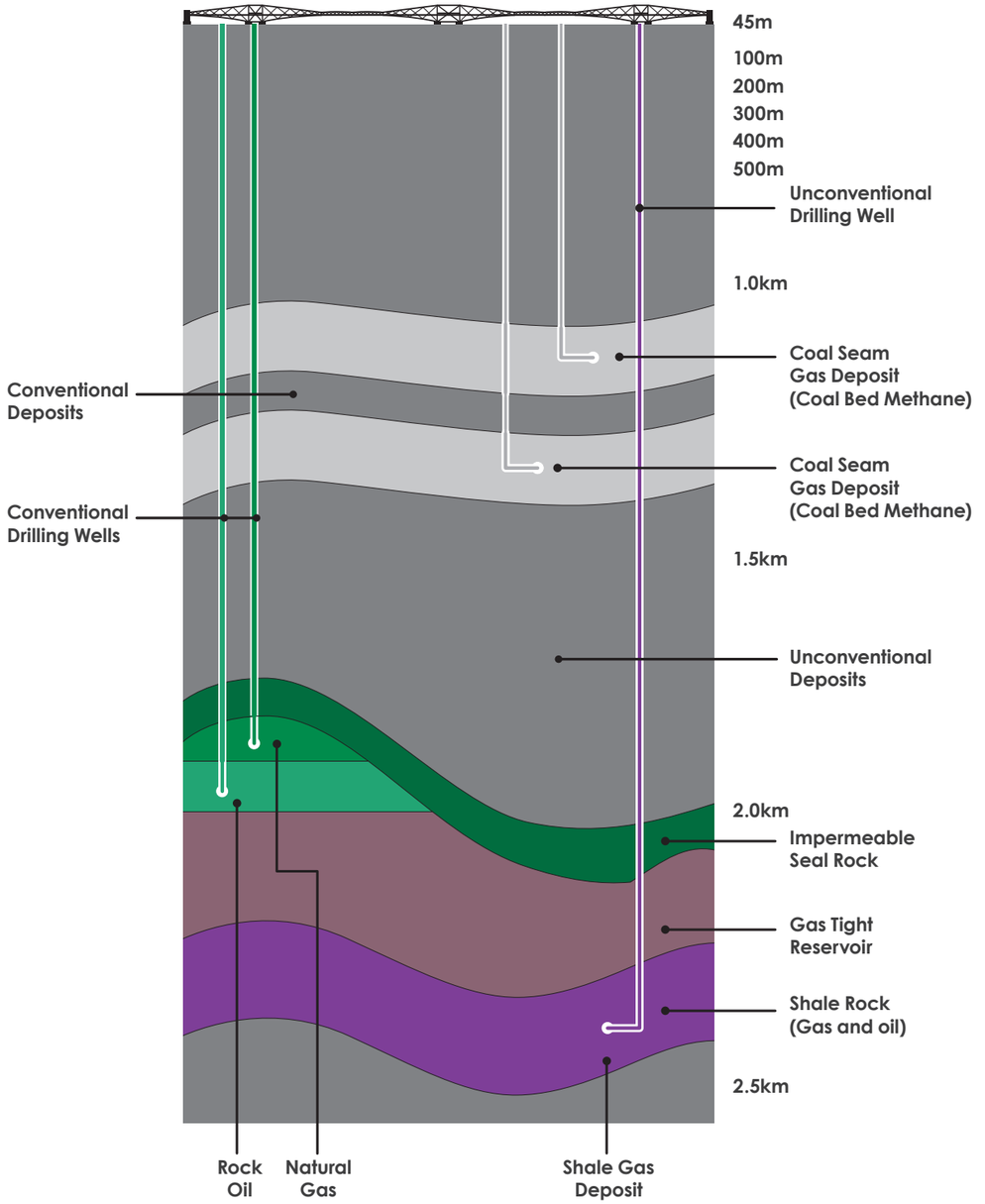
- to stimulate groundwater wells;
- to stimulate conventional oil and gas deposits, for instance in the North Sea;
- to measure stress in the Earth; and
- as part of a deep geothermal project.

The specific processes and technologies involved (for instance the duration and depth of the activity, whether wastewater is produced or whether chemicals are used) will vary depending on the purpose and form of the hydraulic fracturing.

1 U.S. Energy Information Administration. Oil Production in the United States 2000-2015.

Figure 3 Conventional versus unconventional deposits[2].

The use of the Forth Bridge is for scale only, and does not indicate a potential geographical drilling location.



2 KPMG 2016. Unconventional Oil and Gas: Economic Impact Assessment and Scenario.

HOW IS HYDRAULIC FRACTURING CARRIED OUT?

A well drilled for hydraulic fracturing for unconventional oil and gas is usually between 1 and 3 kilometres deep. The well, which has concrete and steel casings, is drilled vertically until it has reached the shale rock, at which point it will curve horizontally into the shale.

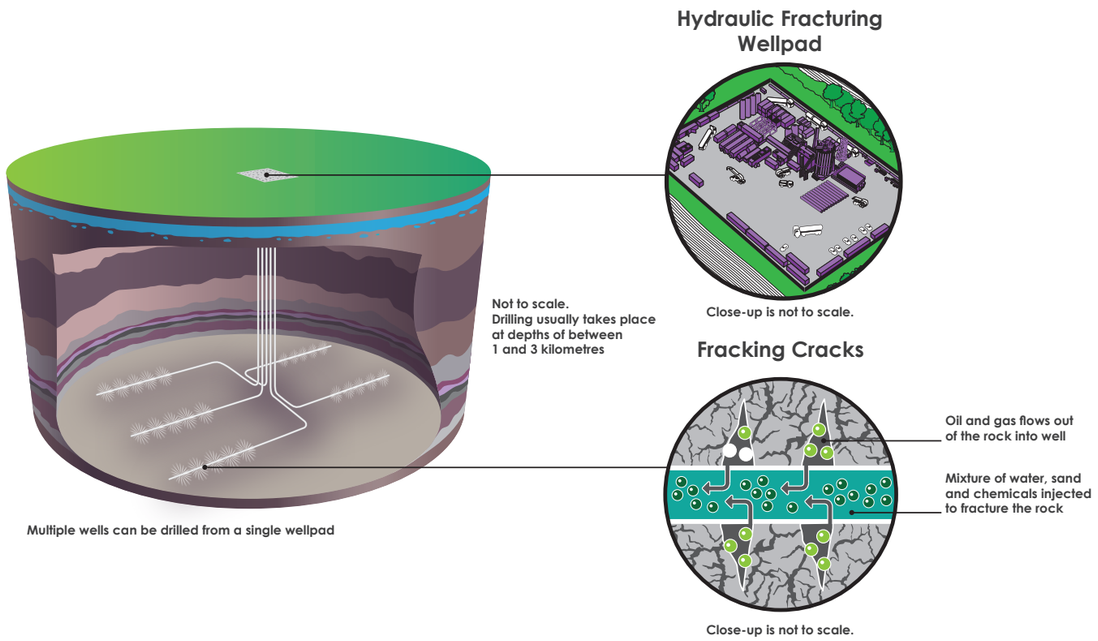
Water is injected into the shale at high pressure to create, or enlarge, existing tiny fractures in the rock that may only be a few fractions of a millimetre in width.

The injected water contains proportions of sand (around 5%) to help hold open the fractures. Chemicals are also used (less than 1%) to reduce friction and protect the drilling equipment from corrosion, and to remove the accumulations of microorganisms and mud from drilling equipment.

The number and type of chemical additives used will depend on the characteristics of the water and geology. The chemicals used in hydraulic fracturing is one of the issues examined by the Health Impact Assessment, which is described on page 34.

Some fluid will return to the surface once the shale has been fractured. This fluid is known as flowback water, and it is stored, treated and disposed of at a suitable waste treatment facility.

Figure 4 Illustration of hydraulic fracturing.



WHAT IS COAL BED METHANE?

Coal bed methane is also considered to be an unconventional source of gas. This is because the gas is present in the coal rather than being held in pore spaces.

To extract the gas, water is drained from the coal seam to release pressure (known as dewatering). This may be undertaken with or without hydraulic fracturing, depending on local geological conditions.

HOW IS COAL BED METHANE EXTRACTED?

The majority of the gas in a coal seam is absorbed within the microscopic pores in the coal. Water contained in the seam is removed to encourage gas to flow from the microscopic pores in the coal.

To do this, boreholes are drilled and water from the coal seam is pumped from those boreholes. Gas then travels to the borehole along the main fractures in the coal. Horizontal boreholes may be used to encourage maximum flow of gas into the borehole.

The gas can then be collected at the surface and dispatched to surface facilities for processing and use. The pumped water is stored, treated and disposed of at a suitable waste treatment facility.

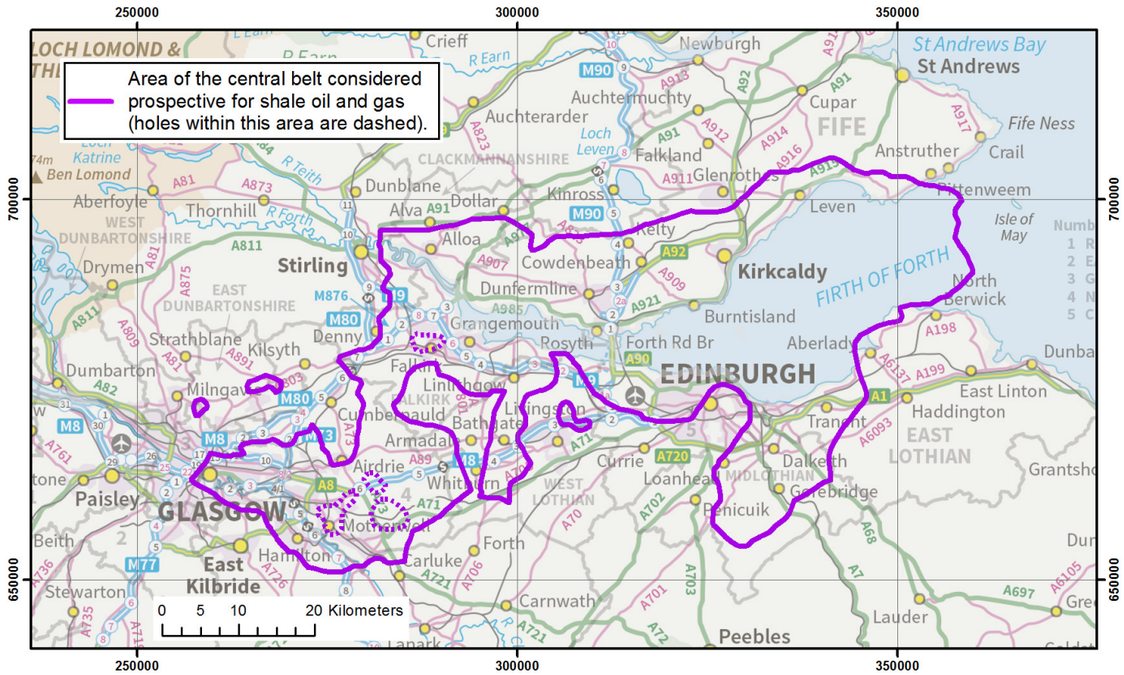
WHERE ARE UNCONVENTIONAL OIL AND GAS RESOURCES?

Shale deposits are mainly found at depths greater than 1 kilometre, and in Scotland they are usually located at depths of between 1 and 3 kilometres.

There are a number of shale deposits in Scotland, most notably across an area of Scotland's central belt known as the Midland Valley (Figure 5). An analysis of the potential shale resources was published by the British Geological Survey in 2014[3].

There are also coal deposits from which coal bed methane could be extracted in the Midland Valley and in south-west Scotland.

Figure 5 **Shale oil and gas resources in the Midland Valley according to the British Geological Survey (BGS) Report.**



3 Monaghan, A.A. 2014. The Carboniferous shales of the Midland Valley of Scotland: geology and resource estimation. British Geological Survey.

HOW MUCH UNCONVENTIONAL OIL AND GAS IS THERE?

The BGS estimate that the Midland Valley holds between 49.4 – 134.6 tcf (trillion cubic feet) of shale gas. By comparison, the Bowland Basin in Lancashire, England is estimated to hold between 822 tcf and 2,281 tcf of shale gas. For comparison, total annual gas consumption in Scotland in 2014 was estimated to be 150 billion cubic feet/year (0.15 tcf)[4].

Only a proportion of these resources is likely to be commercially viable for development or production. Exploratory work would be required to better understand how much oil and gas could be economically and technically recovered.

The research to examine economic impacts commissioned by the Scottish Government has identified three potential unconventional oil and gas production scenarios in Scotland. These are discussed further on page 29.

WHAT TAKES PLACE AT A TYPICAL SITE?

A prospective development would usually undergo four stages (Figure 6). The moratorium on unconventional oil and gas means that only boreholes to take core samples are currently permitted in Scotland (Box 2).

BOX 2: BOREHOLES FOR CORE SAMPLING

Drilling a borehole for core sampling is a standard method of investigating what is underground. It produces a core of rock that allows the features of what is underground to be examined. Boreholes are drilled regularly across Scotland for a variety of purposes, including civil engineering projects, water supply, and geothermal energy. It is estimated that over 5,000 boreholes are drilled each year in Scotland.

In line with our evidence-led approach to unconventional oil and gas, the Scottish Government supports scientific work to improve our understanding of oil and gas resources in Scotland. In October 2015, the Scottish Government confirmed that boreholes for core sampling are not included under the terms of the moratorium.

A drilling pad is a base built to provide space for the drilling rig, piping and storage equipment, and other site facilities such as mobile cabins for workers. Pads are usually around the size of a football pitch (5,000-8,000 square metres).

The average height of a typical drilling rig is about 38 metres, which is equivalent to a 10 or 11 storey building. Drilling rigs are temporary features of a site, and are on-site while drilling takes place.

Further details of what takes place at a typical site for hydraulic fracturing are provided in Figure 7.

4 Department for Business Energy and Industrial Strategy, 2016. Digest of UK Energy Statistics.

Figure 6

Stages of a typical unconventional oil and gas development. Timeframes are indicative and do not include the time taken to secure relevant planning or environmental consents.

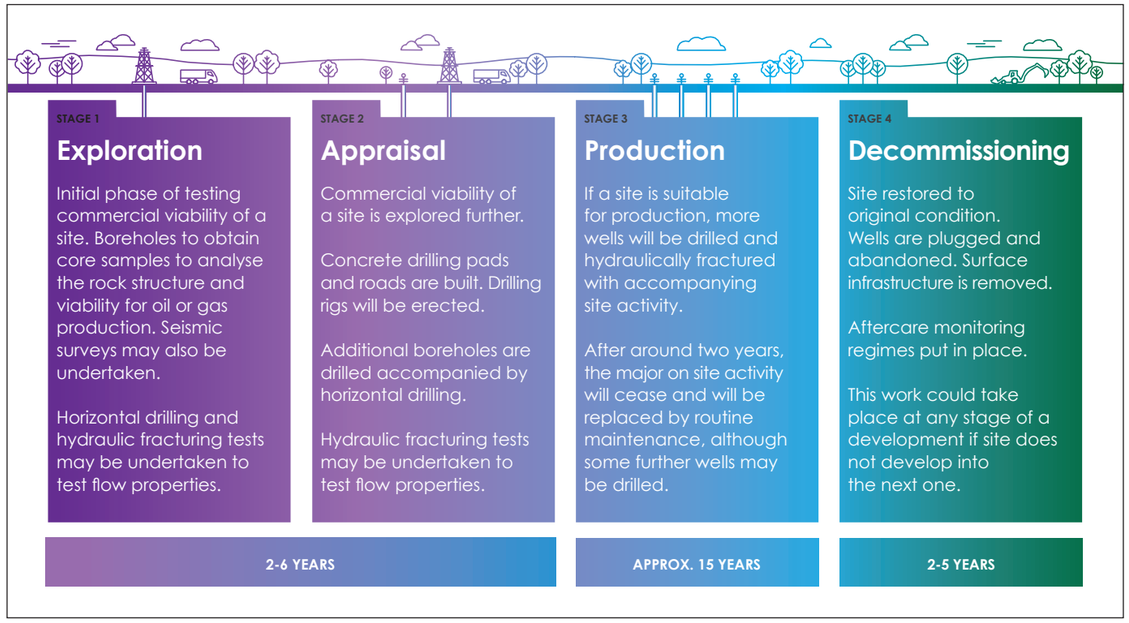
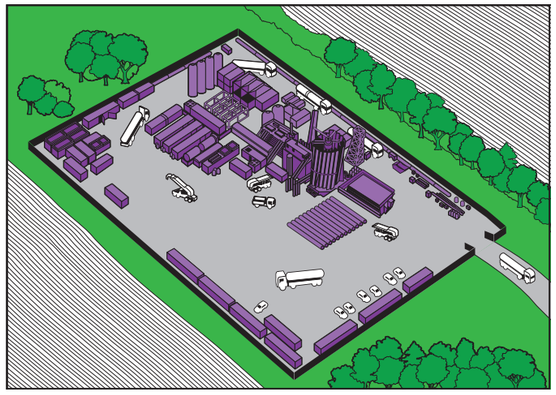


Figure 7

Examples of what takes place at a typical site.

STAGES OF AN UNCONVENTIONAL OIL AND GAS DEVELOPMENT

A prospective unconventional oil and gas site typically undergoes four stages of development. The total estimated lifespan of a site can be up to 20-30 years depending on whether the site is suitable for production. The main activities that take place during the different phases of an unconventional oil and gas development are summarised here:



EXPLORATION AND APPRAISAL PHASE

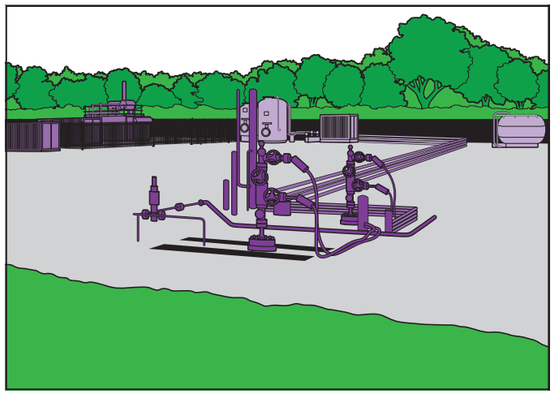
'Exploration and appraisal' refers to the initial phases of testing the commercial viability of a site. Boreholes are drilled to obtain core samples to analyse the rock structure and viability for oil or gas production. Seismic surveys may be undertaken. Horizontal drilling and hydraulic fracturing tests may be undertaken.

The exploration and appraisal phase typically lasts between two and six years. Drilling pads and roads must first be built (and maintained). A drilling pad is roughly the size of a football pitch. Drilling rigs would be erected at a height of around 38 metres.

The total time required to drill and complete a well is four to five weeks depending on target depth and underlying geological conditions.

Flood lights may be mounted on the drilling rig and other lighting to support safe working at night may be put in place. The site would also house generators, sealed container units for chemicals and waste materials and fluids. Portable offices and work amenities would be located on-site.

A number of goods and materials would be transported on and off site, including equipment, drill cuttings, fluids and chemicals. The transport impacts research estimated that a well pad could require traffic movements to be sustained at around 190 per week for a period of approximately two years during the exploration and appraisal phase. For comparison, a warehouse/distribution centre may be expected to generate approximately 5,000 two-way HGV movements per week (further details on transport impacts are outlined on page 35).



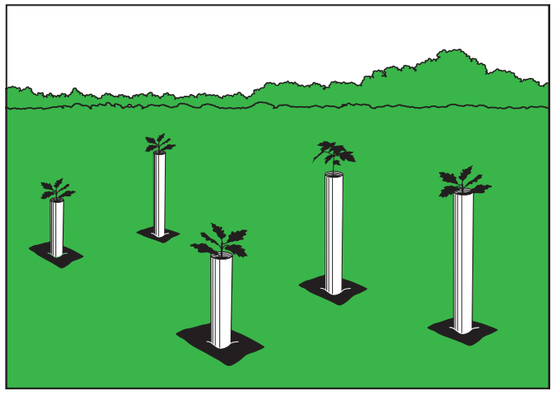
PRODUCTION PHASE

If a site is suitable for production, more wells would be drilled and hydraulically fractured with accompanying site activity. After around two years, the major on-site activity would cease and would be replaced by routine maintenance, although some further wells may be drilled.

The initial phase of production would entail similar activities to an exploration and appraisal phase.

Once these activities cease, the primary activities at a site would be maintenance and movement of goods from the site, although further wells may be drilled. The production phase typically lasts around 15 years. The pad would remain in place, alongside some small pieces of surface infrastructure and equipment.

During the production phase, the transport impacts research predicts that traffic movements would be significantly lower than during the exploration and appraisal phase.



DECOMMISSIONING PHASE

The site is restored and wells are plugged and decommissioned. Surface infrastructure is removed. This work could take place at any stage of a development if a decision is taken not to move to the production phase.

All sites should be restored to their prior condition as soon as possible after drilling is complete. Wells are filled with cement and pipes are cut and plugged at around 2 metres from the ground. The pad is removed.

HOW COULD THE OIL AND GAS BE USED?

The main product from unconventional oil and gas reserves is natural gas, which is a source of energy for heating, cooking, and electricity generation. More information on the role of gas in Scotland's energy mix is provided on page 41.

The natural gases from shale deposits may also have a high content of natural gas liquids, which are gases that can be converted or processed as liquids at the surface, and include substances like ethane, propane or butane.

Natural gas liquids such as ethane are important raw materials for the petrochemical and manufacturing industry. They have applications in a wide range of high-value products including plastics, detergents, clothing and solvents (Table 2).

Not all shale deposits hold large quantities of natural gas liquids, such as ethane. Further exploratory work would be required to understand whether Scottish shale deposits contain high levels of ethane or methane that are economically and technically viable for industry.

Some shale deposits may also release shale oils, also known as tight oils, which are a form of light crude oil. Shale oils have similar properties to crude oils extracted by conventional methods, for instance in the North Sea. They can be refined to produce heating oils, naphtha, diesel, kerosene, gasoline, liquid petroleum gas and other commodities used in industry and manufacturing.

Table 2 **Uses of natural gas liquids[5].**

NATURAL GAS LIQUID	APPLICATIONS	END-USE PRODUCTS	PRIMARY SECTORS
Ethane	Ethylene for plastics production; petrochemical feedstock	Plastic bags; plastics; anti-freeze; detergent	Industrial
Propane	Residential and commercial heating; cooking fuel; petrochemical feedstock	Home heating; small stoves and barbeques; LPG	Industrial, residential, commercial
Butane	Petrochemical feedstock; blending with propane or gasoline	Synthetic rubber for tyres; LPG; lighter fuel	Industrial, transportation
Isobutane	Refinery feedstock; petrochemical feedstock	Alkylate for gasoline; aerosols; refrigerant	Industrial
Pentane	Natural gasoline; blowing agent for polystyrene foam	Gasoline; polystyrene; solvent	Transportation
Pentane Plus	Blending with vehicle fuel; exported for bitumen production in oil sands	Gasoline; ethanol blends; oils and production	Transportation

5 KPMG, 2016. Unconventional Oil and Gas: Economic Impact Assessment and Scenario.

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PART TWO

Exploring the evidence

OUR EVIDENCE-LED APPROACH

The Scottish Government has undertaken an extensive and comprehensive period of evidence-gathering that examines the issues, challenges and opportunities presented by unconventional oil and gas.

This work began in 2013 with the establishment of the Independent Expert Scientific Panel ('the Expert Panel') to investigate unconventional oil and gas. More information on the work of the Expert Panel can be found at: http://www.gov.scot/Publications/2014/07/1758/0

A summary of the Expert Panel's remit and main findings is provided in Box 3.

After considering the Expert Panel's findings, the Scottish Government commissioned a series of research projects in 2016 to examine specific issues in more depth. Box 4 describes the steps that were taken to deliver impartial and robust evidence.

A number of the projects focused on issues identified by the Expert Panel, which included gaps in the framework for decommissioning, the role of Health Impact Assessments, and potential climate change implications.

The following research studies were commissioned in 2016:

- Economic impacts and scenario development (undertaken by KPMG)
- Climate Change impacts (undertaken by the Committee on Climate Change)
- Understanding and monitoring induced seismic activity (undertaken by the British Geological Survey)
- Transport – Understanding and mitigating community level impacts (undertaken by Ricardo)
- Decommissioning, site restoration and aftercare – obligations and treatment of financial liabilities (undertaken by AECOM)
- Health impact of unconventional oil and gas in Scotland (undertaken by Health Protection Scotland)

The research reports were published in full on 8 November 2016. The research reports can be read in full at: http://www.gov.scot/Topics/Business-Industry/Energy/onshoreoilandgas/EvidenceGathering

The findings from these studies are summarised and considered in the proceeding sections under the following themes:

- Community considerations
- Economic considerations
- Environmental considerations.

Table 3

Summary of economic scenarios prepared by the economic study.

PRODUCTION SCENARIO	SHALE	COAL BED METHANE
Central	**20 pads** **15 wells per pad** **15-year life span**	**2 pads** **15 wells per pad** **12-year life span**
High	31 pads 30 wells per pad 15-year life span	2 pads 15 wells per pad 12-year life span
Low	10 pads 10 wells per pad 15-year life span	10 pads 10 wells per pad 12-year life span

The research to examine economic impacts commissioned by the Scottish Government identified three potential unconventional oil and gas production scenarios in Scotland: high, central, and low. These scenarios informed the economic study and have been used or referred to in the other research studies.

The scenarios were based on estimates of potentially accessible oil and gas resources, and were informed by discussions with stakeholders, including those representing industry and environmental interests. Table 3 outlines the scenarios.

This consultation mainly discusses the central production scenario. Please refer to the economic study's final report for more information on the other scenarios.

BOX 3: INDEPENDENT EXPERT SCIENTIFIC PANEL

The remit of the Expert Panel was to deliver:

- a robust, well-researched evidence base relating to unconventional oil and gas upon which the Scottish Government can reliably base future policy in this area;
- a well-developed narrative on the environmental and regulatory issues associated with the potential development of unconventional oil and gas in Scotland;
- an assessment of the potential resources available to Scotland.

The Expert Panel made a number of observations, including:

- Suitable petrochemical feedstocks from the North Sea are declining, in particular ethane and other light hydrocarbons. The potential availability of these feedstocks from unconventional oil and gas resources in Scotland could have a beneficial impact on Scotland's petrochemical industry in the long term.
- Although further exploratory drilling will be required, Scotland's geology suggests that there could be significant reserves of unconventional oil and gas – the greatest potential reserves are likely to be in the Midland Valley of Scotland.
- There are a number of technical challenges associated with unconventional oil and gas extraction, though it is the Expert Panel's view that none of these are insurmountable. The technology exists to allow the safe extraction of such reserves, subject to robust regulation being in place.
- The regulatory framework is largely in place to control the potential environmental impacts of the production of unconventional oil and gas in Scotland, although there may be gaps to address.
- The high population density of those parts of Scotland most likely to host significant unconventional oil and gas resources would be a challenge for any form of re-industrialisation, and will thus be so for any future unconventional oil and gas industry.
- Public concerns around unconventional oil and gas development include concerns about technical risk such as water contamination, public health and seismicity, but also wider issues such as social impacts on communities, effect on climate targets and trust in operators, regulators and policymakers.
- Many of these social and environmental impacts can be mitigated if they are carefully considered at the planning application stage. Added to which, there are already considerable legislative safeguards to ensure such impacts are not realised.
- Early consultation with communities on unconventional oil and gas developments is vital to identify potential impacts on the community, to scope potential benefits and develop plans to mitigate the impacts and enhance the benefits.

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BOX 4: DELIVERING IMPARTIAL AND ROBUST EVIDENCE

To support the Scottish Government's commitment to gathering robust and impartial evidence on the potential impacts of unconventional oil and gas, the research projects were awarded following Scottish Government procurement guidelines, and subject to confirmation that there were no conflicts of interest in carrying out the work.

The studies that examine climate change and health impacts were undertaken by public bodies with particular expertise (described below). All the other projects were awarded through competitive tender.

The Committee on Climate Change is the independent body tasked with advising UK and devolved governments on meeting their emissions targets and reporting on progress made in reducing greenhouse gas emissions and preparing for climate change.

Health Protection Scotland is part of NHSScotland and they provide advice, support and information to health professionals, national and local government, the general public and a number of other bodies that play a part in protecting health.

Community considerations

The location of unconventional oil and gas resources in Scotland means that some communities in populated areas of Scotland would be in close proximity to developments.

With emphasis on the research we commissioned to examine potential health and transport impacts, this section explores the potential social and health implications of unconventional oil and gas developments.

COMMUNITY IMPACTS

Most of Scotland's unconventional oil and gas deposits occur in and around former coalfields and oil shale fields in Scotland's central belt, which are amongst the most densely populated parts of the country.

The Expert Panel noted that there are a range of public concerns around unconventional oil and gas developments, including concerns about technical risk such as water contamination, public health and seismicity, but also wider issues. The Expert Panel also noted the importance of sustained and meaningful community engagement.

The Scottish Government is committed to listening to the views of communities, and to encouraging community involvement in local decision making. This consultation is part of that process.

The presence, scale and nature of potential impacts, and steps that can be taken to mitigate or minimise impacts, vary across the different stages of an unconventional oil and gas development.

Regulatory controls provide a framework for assessing and mitigating potential impacts, and for consulting communities on specific development proposals. The section on regulation (page 50) discusses these issues further.

COMMUNITY INVOLVEMENT IN PROSPECTIVE DEVELOPMENTS

The Scottish Government is committed to involving people in the decisions that affect them and to making information and data accessible.

The EU's Public Participation Directive provides a legal framework for doing this, including in relation to any plans to extract oil and gas for commercial purposes. The Directive requires public participation in decision-making and regulation, including through access to information and consultation.

Before Petroleum Exploration and Development Licences can be offered for award, the licensing authority (currently the Oil and Gas Authority, but the responsibilities are transferring to the Scottish Government) must conduct a Strategic Environmental Assessment of their plan.

Effective public engagement lies at the heart of Strategic Environmental Assessment, and is a legal requirement within it, ensuring that those with an interest or likely to be affected by a plan have an opportunity to help shape it. An environmental assessment is first conducted, and the findings are captured within an Environmental Report which is published alongside the plan, for public consultation.

Once an operator has a Petroleum Exploration and Development Licence they can make a planning application.

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Everyone has the right to comment on any planning application that is being considered by a planning authority. Community councils have a formal role in the planning system as they are consulted during the pre-application consultation by the developer, and later when the planning application has been submitted.

The planning system provides an early and direct role in considering and mitigating potential community impacts. In considering a planning application, the Planning Authority (and developer) would need to consider and address a range of factors, including:

- disturbance, disruption and noise, and potential pollution of land, air and water;
- impacts on local communities, houses, hospitals, schools, dwellings and businesses;
- benefits to the local and national economy;
- how the impacts would add to those already in place from other mineral or landfill sites in the area;
- effects on natural heritage, habitats and the historic environment;
- transport, landscape and visual impacts; and
- restoration and aftercare (including any benefits which may arise from areas being improved from their original state following decommissioning).

The Scottish Environment Protection Agency (SEPA) consult with the public at certain parts of the regulatory process, for example, they may consult when making changes to permits for protecting the environment from pollution.

All the regulatory bodies that would be involved in any unconventional oil and gas development in Scotland make a range of information publically available. This includes:

- information about Petroleum Exploration and Development Licences, drilling consents and drilling activity. This information is currently published by the Oil and Gas Authority, and will be published by the Scottish Government when powers are transferred;
- applications for access to coal are publicised for 30 days by the Coal Authority, who also maintain a list of all applications which is available to the public;
- registers containing details of permits and authorisations issued by SEPA are maintained by SEPA and are open to public inspection; and
- the Health and Safety Executive make details available in the event of taking enforcement action against a company, including issuing a notice or prosecuting.

The regulatory regimes that apply to unconventional oil and gas developments are discussed further in the section on regulation, which begins on page 50.

RESEARCH FINDINGS: POTENTIAL HEALTH IMPLICATIONS

One of the most prominent concerns for communities is potential impacts on human health.

The Scottish Government asked Health Protection Scotland to undertake a rigorous and robust assessment of the available evidence on the health impacts arising from unconventional oil and gas extraction. We also asked Health Protection Scotland to review evidence on potential wider health-related issues, including on issues such as physical and mental wellbeing.

To carry out the assessment, Health Protection Scotland drew on the expertise of others including NHS Health Scotland and SEPA. The Health Impact Assessment was peer-reviewed by a panel of four reviewers, three of which were nominated by stakeholders representing community, environmental and industry interest.

The findings of this Health Impact Assessment are summarised below.

What are the potential risks to health associated with exploration for, and exploitation of, shale oil and gas and coal bed methane?

- The overall conclusion of the Health Impact Assessment is that the evidence considered was 'inadequate' as a basis to determine whether development of shale oil and gas or coal bed methane would pose a risk to public health.
- **Inadequate means:** 'The available studies are of insufficient quality, consistency or statistical power to allow a conclusion to be drawn regarding the presence or absence of an association between unconventional oil and gas-related activities and health outcomes, or activities and exposure above health based limits. Or there were no studies available.'
- In this context, a risk to public health is the probability that unconventional oil, and gas-related activities would result in exposure of the public to environmental hazards above recognised health-based limits that could lead to adverse health effects.
- Individual conclusions were drawn on particular types of unconventional oil and gas-related hazards; and specific types of health outcome.

What are the wider health implications of deploying the technology necessary for the exploration and exploitation of shale oil and gas and coal bed methane?

- The evidence reviewed on the wider implications of unconventional oil and gas on health was primarily qualitative. This identified varied views in the studied communities on the perceived positive and negative impacts of unconventional oil and gas development. The review focused on self-reported concerns, anxieties and stress and possible economic benefits.

What options could there be to mitigate any potential adverse impacts that are identified?

- The study concluded that the evidence reviewed, while lacking in quantity, quality and consistency, would justify adopting a precautionary approach if unconventional oil and gas development were to be allowed in Scotland in the future.
- The study also noted that a precautionary approach should be proportionate to the scale of the hazards and potential health impacts, both adverse and beneficial.

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- The study noted that within environmental public health, adopting a precautionary approach can take a number of forms. It is not unusual for a precautionary approach to be adopted in order to allow the development of a technology, where it is considered that realistic, practical opportunities can be identified to control potentially hazardous exposures, or to mitigate any potential adverse impacts on health.
- The study summarises the approaches taken to unconventional oil and gas by other countries/governments, ranging from bans to supporting industry. The study concludes that a precautionary approach in Scotland could be based on adopting a range of mitigation measures involving operational best practice, regulatory frameworks and community engagement.
- The health impact assessment identifies areas where there was a consensus among experts that the current regulatory framework for development in Scotland could be strengthened, including in respect of planning and environmental regulation and in relation to local health impact assessment.

RESEARCH FINDINGS: POTENTIAL TRANSPORT IMPLICATIONS

One of the potentially most significant and visible impacts for communities could be increased traffic volumes on certain nearby roads, in particular from Heavy Goods Vehicles (HGV). Possible further impacts could include increased noise and local air pollution and the potential for an increased number of traffic incidents.

To examine these issues further, we commissioned research to better understand the potential for local increases in traffic volume during an unconventional oil and gas development.

The research also explored how traffic volumes and impacts might vary by location (such as remote rural or urban centres) as well as the duration of impacts, that is, whether the impacts are short term or longer lasting.

A summary of the main research findings is provided below.

How would traffic volumes in and around sites change during the different stages of unconventional oil and gas development?

- The additional traffic movements associated with unconventional oil and gas developments are unlikely to be significant or detectable at a regional (i.e. local authority) or national scale, in view of the much greater numbers of traffic movements resulting from other activities.
- Each well pad could require traffic movements to be sustained at around 190 per week for a period of approximately two years during the development (exploration and appraisal) phase. For context, a warehouse/distribution centre may be expected to generate approximately 5,000 two-way HGV movements per week. A wind farm construction can require 800-1,000 two-way movements at its peak.
- The main factor affecting traffic flows is the requirement for transportation of water. If that can be avoided (e.g. by use of pipelines or re-using wastewater) the impacts can be significantly reduced.

What are the potential impacts of increased traffic and what steps could be taken to mitigate impacts on communities?

- Any increase in vehicle movements could result in an increase in noise, vehicle emissions, road damage or traffic accident risks, which may be identified as negligible, or may require mitigation.
- Provided the planning and Environment Impact Assessment system is properly implemented, any significant impacts would be avoided through the use of appropriate mitigation measures.
- However, even with mitigation and guidance in place, local communities would experience an increase in traffic numbers, potentially for a number of years.

POTENTIAL COMMUNITY BENEFITS

There are a number of examples of schemes that help communities who host industrial activity to share in the economic benefits of those developments. An example is community benefit schemes for onshore wind development, where operators provide a voluntary contribution to local communities affected by wind energy developments.

Another example is Scotland's Landfill Communities Fund, which recognises that those living close to landfill sites may experience loss of amenity and other impacts as result of the storage, treatment and handling of waste close to their communities. The Scottish Landfill Communities Fund allows landfill operators to fund local environmental and community projects.

A number of proposals have been made by the industry and the UK Government on reinvesting the proceeds of unconventional oil and gas developments in local communities.

The onshore industry trade body (UK Onshore Oil and Gas) has published a charter for community benefits, which voluntarily commits operators to providing communities with a £100,000 payment per exploratory (hydraulically fractured) well site and a community revenue stream of (no less than) 1% of revenues during the production stage.

The economic impact analysis examines potential contributions to communities from voluntary industry commitments. Table 4 sets out the total community benefits that would arise from a community benefit payment of 4% of revenues. The analysis is based on production scenarios described on page 29. The research noted that a licence-holder in Scotland announced in 2014 that it would give 6% of the shale gas revenues to homeowners, landowners and communities close to its wells.

In the Autumn Statement 2015, the UK Government announced that it will commit up to 10% of shale gas tax revenues to a Shale Wealth Fund – this is projected to invest up to £1 billion in the North of England and other shale producing areas over the next 25 years.

Table 4

Community benefit payments under different industry scenarios[6].

		CENTRAL	HIGH	LOW
Shale gas	£m	187	578	63
Associated liquids	£m	30	85	1
Total	**£m**	**217**	**663**	**64**

In August 2016 the UK Government launched a Shale Wealth Fund consultation in which it set out proposals for how the Fund is to be managed and who will benefit. The consultation includes a proposal that local communities as well as regions affected should gain directly from the benefits of shale development.

Whilst the licensing of onshore production has been devolved, the fiscal regime remains reserved.

SCOTTISH GOVERNMENT OBSERVATIONS ON THE EVIDENCE

Correspondence received by the Scottish Government highlights the depth of concern many communities and individuals feel toward unconventional oil and gas.

Our evidence-led approach has provided new and important sources of information on potential benefits and risks, and the safeguards in place to manage those risks.

Proposed development sites would be located across Scotland's heavily populated central belt, and the Scottish Government is committed to involving people in the decisions that affect them and to making information and data accessible.

There are gaps in the evidence-base on health impacts, and in view of that we acknowledge the precautionary approach outlined by Health Protection Scotland and that this this should be proportionate to the scale of the hazards and potential health impacts, both adverse and beneficial.

While this period of consultation and deliberation takes place, Health Protection Scotland will monitor new health studies and keep the evidence-base (domestic and international) under continuous review to ensure their assessment of health impacts reflects the current state of knowledge.

CONSULTATION QUESTIONS

This section discussed potential social, community and health implications of an unconventional oil and gas industry in Scotland, and the findings from the evidence we have commissioned to examine these issues.

In answering the following questions, please consider whether, in your view, there are any specific gaps in the evidence presented.

Q1: What are your views on the potential social, community and health impacts of an unconventional oil and gas industry in Scotland?

Q2: What are your views on the community benefit schemes that could apply, were an unconventional oil and gas industry to be developed in Scotland?

6 KPMG 2016. Unconventional Oil and Gas: Economic Impact Assessment and Scenario.

Economic considerations

Unconventional oil and gas has had a major impact on manufacturing and energy in North America. This section discusses the potential economic implications of unconventional oil and gas in Scotland, including in the context of Scotland's energy and manufacturing industries.

ECONOMY AND DRAFT ENERGY STRATEGY

Scotland's Economic Strategy sets out an overarching framework for achieving a more productive, cohesive and fairer Scotland. It is underpinned by four priorities for sustainable growth:

- investing in our people and our infrastructure in a sustainable way;
- fostering a culture of innovation and research and development;
- promoting inclusive growth and creating opportunity through a fair and inclusive jobs market and regional cohesion; and
- promoting Scotland on the international stage to boost our trade and investment, influence and networks.

Sustainable growth also means securing the transition to a more resource-efficient, lower carbon economy, which will reduce the cost to the economy of climate change.

Our actions to tackle climate change by reducing greenhouse gas emissions represent a fundamental transition in all sectors of the economy, including energy.

Scotland needs safe, clean, reliable and affordable energy to underpin the Scottish economy and contribute to the wellbeing of our society. This is why the Scottish Government has consistently made better energy provision a guiding objective.

On 24 January 2017, we published the draft Scottish Energy Strategy for consultation. The draft Strategy sets out our long-term vision for the future of the energy system in Scotland:

- a modern, integrated, clean energy system, delivering reliable energy supplies at an affordable price, in a market that treats all consumers fairly; and
- a strong, low carbon economy – sharing the benefits across our communities, reducing social inequalities and creating a vibrant climate for innovation, investment and high-value jobs.

The Strategy's central approach is 'systems-based' – that is, an integrated view of the challenges of meeting Scotland's heat, power and transport needs.

The Strategy recognises the importance of maintaining a flexible outlook on the combination of energy sources available to us as we transition towards a decarbonised energy system. This will allow Scotland's energy system to react and respond to changes in supply and demand, and to market conditions.

The draft Energy Strategy also considers the overall role of hydrocarbons in Scotland's energy mix (Box 5).

More information on Scotland's draft Energy Strategy can be found at: https://consult.scotland.gov.uk/energy-and-climate-change-directorate/draft-energy-strategy/

BOX 5: DRAFT ENERGY STRATEGY: EXPLORING THE ROLE OF ENERGY SOURCES

Advances in technology mean that new and innovative ways of using hydrocarbons are emerging, and will continue to do so in the decades ahead. Some of these advances could have a transformative impact on the energy system and lead to lower net carbon emissions, such as:

- Production of hydrogen as a low carbon energy carrier; in stationary power and Combined Heat and Power (CHP), in the gas mains supply for heating, or to power fuel cells in cars, vans, buses or even marine vessels; and
- Liquid Natural Gas, Compressed Natural Gas and Liquid Petroleum Gas – in particular, biomass-derived versions of these – to join liquid biofuels as options for replacing fossil diesel and petrol as cleaner fuels in internal combustion engines.

To support the emergence of new technologies and energy sources in a way that maximises their benefits to the their benefits to the economy, for consumers, and in an environmentally sound way, the Scottish Government will draw on the range of powers available to it to support this transformation, including the planning system, energy consenting and licensing.

In some cases, the Scottish Government may choose not to support particular technologies, on environmental or social grounds, or because of their potential negative impact on greenhouse gas emissions. Underground Coal Gasification is an example of a technique the Scottish Government has chosen not to support, following a thorough assessment of the scientific evidence[7], and it is proposed that UCG will have no place in Scotland's energy mix[8].

The Scottish Government is committed to examining the evidence and engaging with the citizens of Scotland to gather their views and understand their needs and perspectives. Our approach to evaluating the potential impact of unconventional oil and gas is an example of this evidence-led and measured approach.

The Scottish Government also recognises the importance of understanding how new energy sources and industries can be developed or introduced in a way that promotes economic opportunity, while minimising any significant additional long-term pressure on meeting Scotland's climate change targets, or other sectors.

7 October 2016 Professor Campbell Gemmell, Independent Review of Undergrounded Coal Gasificaiton – Report
8 Paul Wheelhouse statement on Underground Coal Gasification, October 2016

RESEARCH FINDINGS: POTENTIAL ECONOMIC IMPLICATIONS

Shale gas has also had a considerable impact on the North American energy market; gas production had plateaued in the early 1970s at around 24 trillion cubic feet per year, and has risen dramatically since the mid-2000s to an all-time high of 33 trillion cubic feet in 2015[9].

The Expert Panel also noted that in North America the development of shale gas has led to investment in the chemical and manufacturing industry of over $100 billion. As a result, US chemical products are now nearly half the price of similar European products.

There has been no unconventional oil and gas production in Scotland, and therefore very few studies examining the potential impact of unconventional oil and gas on Scotland's economy have been conducted.

To gain a better understanding of the potential economic implications in Scotland, we commissioned research to examine the impact that unconventional oil and gas could have on jobs and the wider Scottish economy under a range of potential production scenarios. The scenarios developed through this project are described on page 29.

A summary of the main research findings are as follows:

Under different production scenarios, what is the potential cumulative impact of unconventional oil and gas development on the Scottish economy?

Gas and oil production through to 2062

- Under their central scenario[10], the study estimated that total, cumulative gas production through to 2062 would be 947 bcf (billion cubic feet), equivalent to around 5.5 years of Scottish consumption at current levels.
- The study estimated that total associated liquid (oils) production through to 2062 would be 17.8 mmboe (million barrels of oil equivalent) in their central scenario.

Potential economic impacts

- In their central scenario, the study estimates that the total, cumulative industry expenditure in Scotland would be £2.2 billion through to 2062.
- The study estimates that this would add £1.2 billion to Scotland's economy over this period, which is approximately equivalent to 0.1% of Scottish GDP – a measure of Scotland's economic output – per year over the lifetime of the industry.
- In their central scenario, it is estimated the industry would support 1,400 jobs in Scotland at its peak. This includes indirect jobs in the supply chain and jobs created in other sectors of the economy, for instance hotel and taxi businesses.
- In their central scenario, the study estimates that the cumulative, additional tax receipts (for the UK and not including coal bed methane) would be £1.4 billion.

9 U.S. Energy Information Administration. Oil Production in the United States 2000-2015

10 The high and low scenario estimates are set out in the research report, KPMG 2016. Unconventional Oil and Gas: Economic Impact Assessment and Scenario.

Market conditions

- The study observes that if oil and gas prices were to remain at today's historically low levels, it would be unlikely that unconventional oil and gas resources in Scotland would be economically viable to develop at scale.
- The study also notes that exploration work would be required to determine the commercial feasibility and production potential of the resources contained in the Midland Valley of Scotland.

With reference to the potential economic impact of unconventional oil and gas in Scotland, what sectors and groups are likely to be affected?

- The study observes that Grangemouth petrochemical facility has been unable to operate at full capacity due to lack of feedstock.
- The study notes that a number of petrochemical companies could see a positive impact on their supply chain if unconventional oil and gas is developed as they would avoid the costs of importing/ transporting their primary input.
- The study also considers a number of other economic factors, including potential impacts on local house prices, road use, agriculture, visual amenity, environmental costs and health costs. The study sets out a number of potential issues and costs reported in the literature, alongside concerns raised by stakeholders, and highlights some of the uncertainties associated with assessing these costs.

What is the potential nature and extent of any community benefit payments?

- As discussed on page 37, in their central scenario, the study estimates that the cumulative value of community benefit payments through to 2062 would be £217 million. This is based on an assumed contribution of 4% of revenues to local communities.

THE ROLE OF NATURAL GAS IN SCOTLAND'S ENERGY MIX

Total annual gas consumption in Scotland in 2014 is estimated to be 150 billion cubic feet/ year[11].

As outlined in our draft Energy Strategy, the consumption of heat accounts for 53% of the energy consumed by Scotland's homes and businesses. Around 1.9 million Scottish households (79%) use mains gas as their primary heating fuel.

These figures show that Scotland currently relies on natural gas to supply the bulk of energy demand for heat, and natural gas will be an important part of Scotland's energy mix for the foreseeable future. Gas is also central to the global energy mix, with demand forecast to increase until 2040. Addressing this demand represents a key challenge for the future in balancing the needs of consumers with a lower carbon secure energy system.

The majority of the UK's domestic sources of natural gas historically came from the North Sea. The production of natural gas from the North Sea is declining. By 2025, the UK is expected to be importing 67% of its gas from outside the UK[13].

11 Department for Business Energy and Industrial Strategy, 2016. Digest of UK Energy Statistics.

13 Department for Energy and Climate Change, 2016. UKCS Oil and Gas Production Projections 2016

Our current supplies of gas are a mixture of gas from North Sea gas fields and imported supplies from pipelines within continental Europe, or from liquefied natural gas from international markets.

Our future demand for gas is likely to change as we move towards a largely decarbonised energy system. For instance, in the short to medium term (<20 years), increased emphasis on energy efficiency and heat networks is likely to lower demand for gas. A key challenge in this longer-term transition is finding cost-effective substitutes for energy and manufacturing, without increasing our dependence on imports.

Longer term, trends in supply and demand are more difficult to forecast. The pace of innovation in hydrogen and biogas as new gas grid sources, alongside energy storage, are likely to play a significant role in the future of gas. Furthermore, the commercial viability of Carbon Capture and Storage will have a considerable bearing on the long-term role of gas.

In terms of a role for unconventional oil and gas, the economic study estimates that total production up to 2062 under their central scenario would be 947 bcf (billion cubic feet), which is equivalent to around 5.5 years of Scottish gas consumption at current levels. Under the low and high production scenarios, the economic study estimates that production would be 316 bcf (about two years of Scottish gas consumption) and 2,934 bcf (about 20 years of Scottish gas consumption).

The economic study concludes that the volumes of natural gas that are likely to be recoverable from unconventional oil and gas reserves in Scotland would not have an impact on global gas prices. This suggests that there would be no noticeable effect on energy costs for households.

However, the research also notes that there may be opportunities for natural gas from unconventional oil and gas developments to provide a cost-effective gas supply to local energy networks, particularly for high energy-use industries.

POTENTIAL MANUFACTURING IMPLICATIONS

The economic impact study highlights that natural gas liquids produced from shale reserves can be an important feedstock (a raw material to supply or fuel an industrial process) in manufacturing industries.

Manufacturing can play a crucial role in boosting Scotland's productivity. The sector can support inclusive growth, a central part of our economic strategy, by helping to address regional imbalances through local spillovers and supply chain linkages, whilst providing jobs that are typically high-skilled and well-paid.

However, energy-intensive manufacturing and petrochemicals sectors require certainty that energy and feedstocks will be secure and competitive. This is an important factor for investment decisions. The long-term decline of local supplies of natural gas liquids presents a challenge.

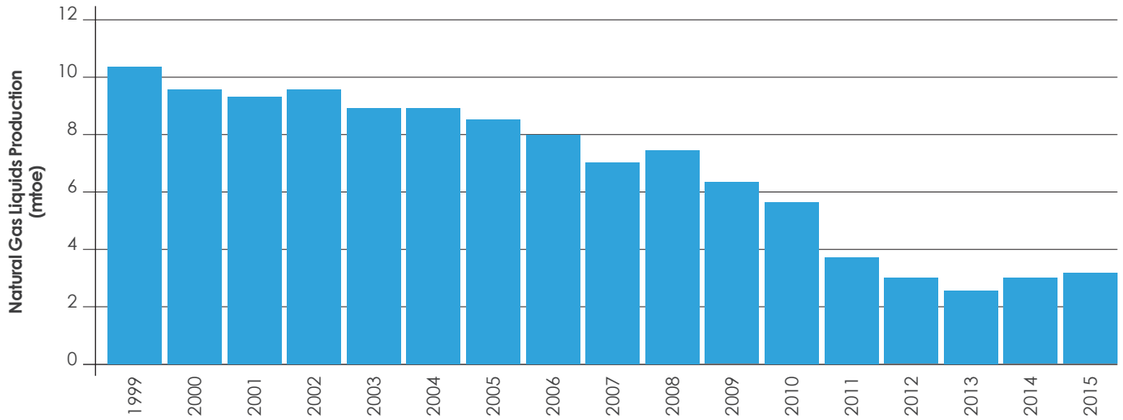
As shown in Figure 8, North Sea natural gas liquids production has fallen from 10.3 million tonnes of oil equivalent (mtoe) in 1999 to 2.9 mtoe in 2015, with the quality/blend of North Sea Natural Gas Liquids also diminishing over this period.

As outlined on page 25, shale reserves can hold quantities of natural gas liquids, such as ethane. Exploratory work would be required to understand whether Scottish shale contains high levels of ethane or methane that are economically and technically viable for industry.

The economic impact study discusses the Scottish chemicals manufacturing sector. It highlights that in Scotland there are 150 manufacturing companies involved in the manufacture of chemicals and chemical products supporting around 3,500 direct jobs.

These companies are involved in the manufacture of primary chemicals, chemical products for industrial applications, pharmaceuticals, and plastic manufacturing. The chemical sciences industry is estimated to support a direct employment of 9,000 in Scotland and around 70,000 people are employed in dependent services[14].

Figure 8 **Trend in natural gas liquid production from the North Sea[15].**



Most of these companies are large and well-established organisations, and include Scotland's largest petrochemical refinery in Grangemouth (Box 6). The 10 million tonnes of chemical products produced annually at Grangemouth are used in the manufacture of a range of everyday consumer goods such as emulsion paint, car fuel tanks, plastic bottles, wrappers, food film, carpets, cabling, water pipes and camping gas[16].

There is also a large ethylene plant in Fife which was the first plant specifically designed to use natural gas liquids from the North Sea as feedstock. This has an annual capacity of 83,000 tonnes of ethylene and around 50% of this is distributed via the UK ethylene pipeline network[17].

The economic study observes that the development of unconventional oil and gas could provide a positive effect on the petrochemical industry in Scotland.

14 Scottish Enterprise. Skills Investment Plan for Scotland's Chemical Sector.
15 Scottish Government, 2016. Oil and Gas Production Statistics 2015-16.
16 Chemical Industries Association, 2012. Advantage Scotland.
17 Chemical Industries Association, 2012. Advantage Scotland.

BOX 6: GRANGEMOUTH ETHANE SUPPLY PROJECT

INEOS, the owner of the Grangemouth petrochemical facility, has recently begun importing ethane from North American hydraulically-fractured shale reserves, and has stated publicly that a cost-effective and long-term supply of ethane is vital to their long-term plans for Grangemouth.

The Grangemouth site received £450 million of investment by INEOS to build a storage facility and gas import terminal. Even after factoring in the transportation costs of shipping the ethane across the Atlantic, INEOS has stated publicly that it is a competitive source of raw material.

This new source of ethane has enabled the ethylene cracker at Grangemouth to move from operating at half of its capacity to full capacity. The Grangemouth facility has one of only four gas crackers in Europe capable of using ethane gas to manufacture ethylene.

SCOTTISH GOVERNMENT OBSERVATIONS ON THE EVIDENCE

The amount of unconventional oil and gas that could be economically or technically recovered in Scotland is not known. Further exploratory work (including core sampling) would be required to better understand the resources that could be commercially exploited.

The total economic impact of unconventional oil and gas is estimated to be relatively low, and is not comparable to the current offshore industry in Scotland.

An unconventional oil and gas sector in Scotland could provide a cost-effective gas supply for local energy networks, and increase security of supply, particularly for high energy use industries.

However, as the scale of production in Scotland would be relatively low in comparison to European or international gas production, it would be unlikely to have an impact on global gas supply prices, and therefore on consumer energy costs.

Scotland's petrochemical sector is a major employer and contributor to Scotland's economy. In response to declining domestic sources of natural gas liquids, imported ethane is enabling the petrochemicals sector to significantly expand production. An unconventional oil and gas sector in Scotland could provide important benefits to Scotland's petrochemical sector.

Talking "Fracking"
A Consultation on Unconventional Oil and Gas

CONSULTATION QUESTIONS

This section has discussed the potential economic implications of an unconventional oil and gas industry in Scotland, including in the context of Scotland's energy and manufacturing industries. The findings from the evidence we have commissioned to examine these issues has also been discussed.

In answering the following questions, please consider whether, in your view, there are any specific gaps in the evidence presented.

Q3: What are your views on the potential impact of unconventional oil and gas industry on Scotland's economy and manufacturing sector?

Q4 What are your views on the potential role of unconventional oil and gas in Scotland's energy mix?

Environmental considerations

The extraction of unconventional oil and gas is an industrial process and, as with most industrial processes, if not appropriately undertaken and controlled, it could result in adverse impacts to the environment and to local communities.

This section summarises and discusses the studies we commissioned in 2016 to examine climate change, decommissioning and risks of induced seismicity. The section also discusses regulation and how it could be strengthened.

UNCONVENTIONAL OIL AND GAS, AND CLIMATE CHANGE

The Scottish Parliament has set ambitious climate change targets to reduce emissions of greenhouse gases by 80% by 2050, from 1990 levels.

As of 2014, we have delivered a 45.8% reduction from baseline levels[18] meeting our annual target for that year and exceeding our 2020 target for a 42% reduction, six years early.

The Scottish Government's third Climate Change Plan, which was published in draft on 19 January 2017, shapes and sets out our approach to tackling climate change and paving the way for Scotland's transition to a low carbon economy.

More information on Scotland's draft Climate Change Plan can be found at: http://www.gov.scot/Publications/2017/01/2768

The current policy on unconventional oil and gas is a moratorium, pending a decision after this public consultation. As such, the draft Climate Change Plan does not consider the potential role of, or emissions from, unconventional oil and gas.

Greenhouse gas emissions can occur at different stages of an unconventional oil and gas development. Some of these emissions will be carbon dioxide (CO_2), and others will be methane. The UK Committee on Climate Change note that the Fourth Assessment of the Intergovernmental Panel on Climate Change indicates that a tonne of methane emitted is equivalent to 25 tonnes of CO_2 in terms of its warming potential.

The Committee on Climate Change have identified the following main sources of emissions from an unconventional oil and gas development:

- **Fugitive emissions**, which include both vented emissions and unintentional leaks. Vented emissions are a result of planned releases, where permitted, as a result of maintenance operations and safety concerns. Unintentional methane leaks include those from valves and pipe joints, compressors, well heads, and accidental releases above and below ground from the well, through to injection into the grid or before being put to use.
- **Combustion emissions** that occur from on-site burning of fossil fuels. The emissions come from engines, such as those used for drilling and hydraulic fracturing, as well as from any flaring of gas.
- **Indirect emissions** that result from transporting materials and waste to and from a site.
- **Land-use change emissions**, which include the CO_2 released when land is converted from one use to another, as well as any emissions relating to land remediation during decommissioning.

18 Based on emissions adjusted for trading in the EU-Emissions Trading Scheme.

RESEARCH FINDINGS: POTENTIAL CLIMATE CHANGE IMPLICATIONS

In response to the potential significance of emissions from unconventional oil and gas to Scotland's ambitious climate change agenda, we asked the Committee on Climate Change to provide us with advice on the potential impact of unconventional oil and gas on Scottish and global greenhouse gas emissions.

To examine these issues, the Committee on Climate Change used the production scenarios developed by the study exploring economic impacts, which are discussed on page 29.

A summary of the main research findings is provided below.

What would be the impact of unconventional oil and gas production in Scotland on our greenhouse gas emissions?

- The Committee on Climate Change's assessment is that exploiting unconventional oil and gas reserves on a significant scale is not compatible with Scotland's climate change targets unless:
  - Emissions are limited through tight regulation. Within this, much greater clarity is necessary over the respective roles of different actors in the regulatory system, particularly around fugitive emissions.
  - Fossil fuel consumption remains in line with the requirements of Scottish emissions targets. Scottish unabated fossil energy consumption must be reduced over time within levels previously advised by the Committee. This means that Scottish unconventional oil and gas production must displace imported gas rather than increasing domestic consumption.
  - Emissions from production of unconventional oil and gas are offset through reductions in emissions elsewhere in the Scottish economy.
- Central estimates are for emissions from unconventional oil and gas to reach 2.6 Mega tonnes per year (Mt) CO_2 equivalents in 2035 for unregulated production under the economic impact and scenario development High Production scenario. Emissions fall to 1.6 Mt under a 'minimum necessary regulation' scenario, and to 1.1 Mt with fuller technical mitigation.
- Under the central production scenario, emissions are estimated to be 0.6 Mt per year in 2035 if the minimum necessary regulation were adopted.
- To put these figures into context, the annual emissions target in 2032 is 26.4 Mt of CO_2 equivalents.
- The high level of ambition embodied in Scottish annual emissions targets means that finding offsetting effort elsewhere in order to accommodate even moderate additional emissions from unconventional oil and gas production or other sources (e.g. aviation) would be challenging.
- The implications for greenhouse gas emissions of unconventional oil and gas exploitation are subject to considerable uncertainties, both regarding the size of any future industry and the emissions footprint of production. The research sets out a number of potential emission trajectories under a number of different scenarios.

What would be the impact of unconventional oil and gas production in Scotland on global greenhouse gas emissions?

- The overall emissions footprint of Scottish shale gas, if tightly regulated, is likely to be broadly similar to that of imported gas. Tightly-regulated domestic production may provide an emissions saving when displacing imports of liquefied natural gas, and would provide greater control over the level of emissions associated with supply.
- Initial evidence suggests that tightly-regulated shale gas production is likely to have a broadly neutral impact on global emissions, with emissions savings due to switching from higher-carbon fossil fuels approximately offsetting emissions increases due to increased use of unabated gas.
- Within the context of a world committed to decarbonisation, it is likely that domestic production of hydrocarbon liquids would displace high-cost production elsewhere in the world, rather than increasing overall oil product consumption or driving fuel switching.

How might these impacts vary over time?

- The emissions relating to production grow over time, broadly in line with the growth in hydrocarbons produced, peaking slightly after 2035 under each scenario.

RESEARCH FINDINGS: DECOMMISSIONING AND AFTERCARE

Recent experience with the remediation of open-cast coal sites in Scotland has highlighted the importance of robust decommissioning and restoration regimes. Robust regimes mean ensuring operators comply with their obligations, and communities and the public sector aren't left to deal with restoration and aftercare issues and costs.

The Expert Panel report summarised the key issues relating to decommissioning and remediation, including potential risks arising from well integrity. The Expert Panel report also highlighted potential gaps in aftercare requirements and long-term monitoring.

To understand these issues in more detail we commissioned research to tell us more about potential environmental risks, industry best practice, and the adequacy of regulatory controls over decommissioning, including for long-term monitoring.

A summary of the main research findings is provided below.

What steps can be taken to ensure decommissioning, site restoration and aftercare can be undertaken in a way that minimises impacts on communities and the environment?

- Scotland has a mature framework for the regulation and control of unconventional oil and gas development which is at least the equal of those examined in other countries or other industries. With appropriate regulatory oversight and monitoring, the framework is sufficient to manage risks of well leakage consistent with the aim of providing suitable protection for communities and the environment.
- The risk of leakage from abandoned wells is likely to be low, and international experience suggests that long-term well integrity can be achieved by implementing best practice during well construction and abandonment operations under a strong regulatory regime.
- There is a risk that a small proportion of wells may fail. Leaks may occur from these wells if there is a source of oil or gas under pressure (which is generally not the case). Therefore it may be appropriate to monitor for leakage from decommissioned wells for as long as Scottish Environment Protection Agency consider necessary.

What forms of financial guarantee provide robust security against liabilities?

- It is essential that unconventional oil and gas operators have sufficient funds available to cover liabilities associated with the abandonment and decommissioning of wells.
- Taking lessons from open cast coal mining there are financial mechanisms available which can minimise the risk of operators failing to honour their commitment to decommissioning.

RESEARCH FINDINGS: RISK OF INCREASED SEISMICITY

Many activities involve small amounts of induced seismicity (ground vibrations or earthquakes) including construction, quarrying and many commonly occurring drilling operations.

The Expert Panel also noted that data compiled from American sources suggests that induced seismicity from hydraulic fracturing is typically minor and unlikely to be felt by individuals. Nevertheless, a more significant seismic event was attributed to hydraulic fracturing operations in Lancashire in north-west England in April and May 2011.

Experience from North America suggests that disposing of wastewater from hydraulic fracturing by re-injecting it into the ground can result in an increased risk of seismic activity.

We therefore commissioned research to develop a better understanding of the risks of seismic activity that could be presented by unconventional oil and gas developments in Scotland.

A summary of the main research findings is provided below.

What levels of induced seismic activity could be associated with unconventional oil and gas developments in Scotland?

- Hydraulic fracturing is accompanied by seismic events of low magnitude. The magnitudes of these events are usually less than 2.0 making them too small to be felt by people.
- The process of hydraulic fracturing as presently implemented poses a low risk of inducing felt, damaging or destructive earthquakes.

What regulatory and non-regulatory actions can be taken to mitigate any noticeable effects on communities?

- Recent increases in earthquake rates and significant earthquakes in many areas of the United States where hydraulic fracturing is undertaken have been linked to the disposal of wastewater by injection into deep wells rather than hydraulic fracturing itself.
- In the UK, following induced seismicity near Blackpool in 2011, the UK Government put steps in place to mitigate risks. This included identifying a limit of 0.5ML where operations should be halted. An event of this magnitude is unlikely to be felt, does not pose any seismic hazard, and would only be detected by sensitive monitoring equipment in the vicinity of the epicentre.
- The study concludes that a dense network of monitoring stations is essential for reliable detection and discrimination of induced seismic events, and to allay public concern.

REGULATION OF UNCONVENTIONAL OIL AND GAS

As outlined by the Expert Panel, the existence of a potential impact does not mean that it will occur, and effective regulation, best practice and other assessments can reduce, or eliminate, adverse occurrences.

A regulatory framework already exists in Scotland, which covers the vast majority of activities requiring control and monitoring as part of unconventional oil and gas developments. Figure 9 summarises some of the main controls.

The Expert Panel observed that this framework is generally well coordinated between the main regulatory bodies.

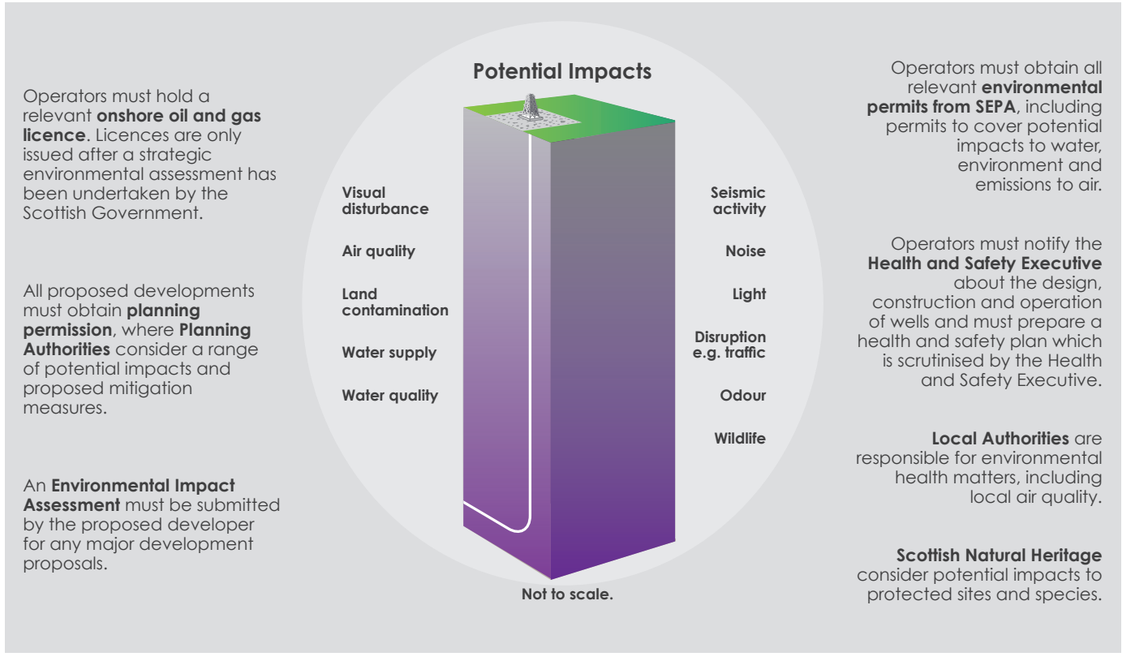
The following section provides information on the current regulatory framework for unconventional oil and gas developments. This is followed by a discussion of areas where the framework could be strengthened.

The current regulatory framework

As discussed on page 13, rights to oil and gas in a given area are governed by a licensing system. There are currently three licences for unconventional oil and gas in Scotland, all of which were issued by the UK Government. The Scottish Government moratorium means that there is no unconventional and gas activity in these areas.

The licences do not give the licence-holder automatic permission to begin exploration, appraisal or extraction as a range of other planning and environmental permits are required before a development can commence.

Figure 9 **Examples of regulatory controls to minimise or mitigate impacts.**



The focus of the planning system is on determining whether a proposal is an appropriate use of land, but other regulatory regimes covering health and safety and environmental protection would be relevant to the consideration of an application or planning permission.

Underground operations as well as above ground development can only be undertaken once planning permission has been granted. Planning Authorities are responsible for considering planning applications for works associated with an unconventional oil and gas development. Further information on factors considered during a planning application is provided on page 33.

The Scottish Environment Protection Agency (SEPA) regulate specific activities that may cause pollution or pose other risks to the environment. For example, SEPA consider applications for licences under the Pollution Prevention and Control (Scotland) Regulations 2012, to control emissions to air, land and water and the Water Environment (Controlled Activities) (Scotland) Regulations 2011, to control borehole construction, abstraction of water from surface water or groundwater, and activities that are liable to cause pollution of the water environment.

The Health and Safety Executive regulate to ensure the operator is managing the health and safety risks appropriately throughout the life cycle of an unconventional oil and gas development. Operators must notify the Health and Safety Executive about the design, construction and operation of wells and must prepare a health and safety plan which sets out how health and safety risks are managed on-site. Health and Safety Executive specialist inspectors scrutinise the information provided by the operator and further information provided each week during the abandonment process to ensure that the well is being abandoned to the correct standards.

Local Authorities are responsible for Environmental Health matters, which includes protecting the public from the harmful exposures they may encounter in the environment. Local Authorities also require waste to be managed in a way that minimises risk to human health and the impact on the environment, and are regularly required to review and assess air quality against the objectives contained in the Air Quality Strategy for England, Scotland, Wales and Northern Ireland.

Scottish Natural Heritage consider potential impacts to wildlife, protected species, and scenic and special conservation areas.

The Scottish Government has prepared a more extensive overview of the current regulatory framework, which can be found at: http://www.gov.scot/Resource/0050/00509369.pdf.

Areas where the regulatory framework could be strengthened

The Expert Panel concluded that 'The regulatory framework is largely in place to control the potential environmental impacts of the production of unconventional oil and gas in Scotland, although there may be gaps to address'.

The Expert Panel highlighted the strength and quality of regulation in Scotland, and that there are considerable legislative safeguards to ensure that potential impacts are not realised. The Expert Panel also identified specific regulatory issues that could create gaps in the regulatory framework and where regulation could be strengthened or transparency enhanced.

In response to the Expert Panel's conclusion, and to inform this consultation, the research projects commissioned by the Scottish Government were asked to examine relevant regulatory issues and lessons from international best practice. The Scottish Government also hosted a workshop in October 2016 with the main regulators to discuss regulation and the issues identified by the research projects and the Expert Panel.

A summary of the workshop, which includes a summary of areas were regulation could be strengthened (BOX 7), can be found at:

http://www.gov.scot/Resource/0051/00510364.pdf

BOX 7: EXAMPLES OF AREAS WHERE REGULATION COULD BE STRENGTHENED

Air Quality: The Independent Expert Scientific Panel noted that some air emissions, including fugitive emissions, may not be fully regulated under current arrangements. The Committee on Climate Change also observe that greater clarity is necessary over the respective roles of different bodies to ensure full coverage of greenhouse gas emissions.

The Scottish Government considers that amendments to legislation to bring overarching coherence to the regulatory framework for air emissions would be necessary, which could include a single or lead competent authority to regulate all sources of emissions across the lifetime of a project.

Decommissioning: The decommissioning study noted that there is currently no power to require specific arrangements for well decommissioning and aftercare if a company fails financial tests after consent to drill a well has been given. The study observed that financial strength tests could be run regularly, with greater emphasis on testing the sufficiency of funds to cover decommissioning and restoration costs. Where a company fails a financial test, provisions such as Parent Company Guarantees, insurance, bonds or letters of credit or payment into escrow accounts could be required.

The study also observed that there is a low probability of well failure. If such a failure did occur, long-term insurance products, or a mutual-fund, could be required to cover the costs of repairing wells that fail following decommissioning, and any accompanying remediation.

Induced Seismic Events: The UK Government has issued guidance that operations should cease if seismic events of 0.5ML or greater are induced. The study examining seismicity notes that existing monitoring networks are not capable of reliable detection and location of these magnitude levels, and that improved monitoring and measurement are required to implement the system successfully.

Further observations from the research on how regulation could be strengthened:

A Health Impact Assessment, Environmental Impact Assessment and Traffic Management Plan could be required for all planning applications relating to unconventional oil and gas developments.

Improved engagement with the local community could be required, including release of data to enable communities to scrutinise operational standards, and increased transparency of chemicals used.

Improved baseline monitoring of environmental and health data to allow any environmental and health impacts to be effectively identified.

Establishment of appropriate setback distances, in order to minimise risks to residents and to address risk perception issues.

The delegates at the workshop held in October 2016 agreed that the following points should guide any future analysis of the regulatory framework:

- the observations on regulation made by the researchers and during the workshop would form a basis for organising work to examine how regulation could be strengthened if that was to be required;
- that an effective approach, in the event that it is required, to advancing such work would be the formation of an Expert Regulatory Group, chaired by the Scottish Government with representation from the regulators present at the workshop; and
- the group would require access to technical and legal resource, would make use of existing professional networks and would consider community impacts and involvement.

SCOTTISH GOVERNMENT OBSERVATIONS ON THE EVIDENCE

An unconventional oil and gas sector in Scotland is likely to have a broadly neutral impact on global greenhouse gas emissions if it is tightly regulated.

However, within the context of Scotland's climate change legislation, an unconventional oil and gas industry would create challenges in meeting Scotland's ambitious and world-leading climate change targets.

In respect to environmental regulation, the research project findings are broadly consistent with the findings of the Independent Expert Scientific Panel, which concluded that 'The regulatory framework is largely in place to control the potential environmental impacts of the production of unconventional oil and gas in Scotland, although there may be gaps to address'.

The study examining seismicity concludes that the risk of felt earthquakes from unconventional oil and gas developments is low. However, where disposal of wastewater by reinjection into a hydraulically-fractured well has been permitted in North America, there is evidence it has increased the risk of earthquakes. We note that this form of wastewater disposal is not a practice that has been proposed by industry in the UK.

We are committed to undertaking all relevant statutory assessments in coming to a final position on unconventional oil and gas, including undertaking a Strategic Environmental Assessment, which would be required regardless of the form of our final decision.

The regulators are confident that the research we have commissioned has provided a clear analysis of where regulation could be strengthened in key areas.

CONSULTATION QUESTIONS

This section discussed potential environmental and climate change implications of an unconventional oil and gas industry in Scotland, and the findings from the evidence we have commissioned to examine these issues.

In answering the following questions, please consider whether, in your view, there are any specific gaps in the evidence presented.

Q5: What are your views on the potential environmental impacts of an unconventional oil and gas industry in Scotland?

Q6: What are your views on the potential climate change impacts of unconventional oil and gas industry in Scotland?

Q7: What are your views on the regulatory framework that would apply to an unconventional oil and gas industry in Scotland?

Talking “Fracking”
A Consultation on Unconventional Oil and Gas

PART THREE

A choice for Scotland

Concluding remarks

The section summarises Scottish Government observations on the evidence-base and outlines actions taken on unconventional oil and gas by other countries or jurisdictions.

SCOTTISH GOVERNMENT OBSERVATIONS ON THE EVIDENCE

The Scottish Government is committed to presenting impartial information, without passing judgement on that evidence or the industry, so that you can openly explore the issues, and present your views to the Scottish Government.

As such, this consultation does not set out or advocate a preferred Scottish Government position on unconventional oil and gas.

To aid consideration of the future of this industry, the Scottish Government has highlighted throughout this document key aspects of the evidence on unconventional oil and gas that we believe are important. A summary of these observations is presented below.

Community considerations (pages 32 to 37)

- Correspondence received by the Scottish Government highlights the depth of concern many communities and individuals feel toward unconventional oil and gas.
- Our evidence-led approach has provided new and important sources of information on potential benefits and risks, and the safeguards in place to manage those risks.
- Proposed development sites would be located across Scotland's heavily-populated central belt, and the Scottish Government is committed to involving people in the decisions that affect them and to making information and data accessible.
- There are gaps in the evidence-base on health impacts, and in view of that we acknowledge the precautionary approach outlined by Health Protection Scotland. This should be proportionate to the scale of the hazards and potential health impacts, both adverse and beneficial.
- While this period of consultation and deliberation takes place, Health Protection Scotland will monitor new health studies (domestic and international) and keep the evidence-base under continuous review to ensure their assessment of health impacts reflects the current state of knowledge.

Economic considerations (pages 38 to 45)

- The amount of unconventional oil and gas that could be economically or technically recovered in Scotland is not known. Further exploratory work (including core sampling) would be required to better understand the resources that could be commercially exploited.
- The total economic impact of unconventional oil and gas is estimated to be relatively low, and isn't comparable to the current offshore industry in Scotland.
- An unconventional oil and gas sector in Scotland could provide a cost effective gas supply for local energy networks, and increase security of supply, particularly for high energy use industries.
- However, as the scale of production in Scotland would be relatively low in comparison to European or international gas production, it would be unlikely to have an impact on global gas supply prices, and therefore on consumer energy costs.
- Scotland's petrochemical sector is a major employer and contributor to Scotland's economy. In response to declining domestic sources of natural gas liquids, imported ethane is enabling the petrochemicals sector to significantly expand production. An unconventional oil and gas sector in Scotland could provide important benefits to Scotland's petrochemical sector.

Potential environmental implications (pages 46 to 53)

- An unconventional oil and gas sector in Scotland is likely to have a broadly neutral impact on global greenhouse gas emissions if it is tightly regulated.
- However, within the context of Scotland's climate change legislation, an unconventional oil and gas industry would create challenges in meeting Scotland's ambitious and world leading climate change targets.
- In respect to environmental regulation, the research project findings are broadly consistent with the findings of the Independent Expert Scientific Panel, which concluded that 'The regulatory framework is largely in place to control the potential environmental impacts of the production of unconventional oil and gas in Scotland, although there may be gaps to address'.
- The study examining seismicity concludes that the risk of felt earthquakes from unconventional oil and gas developments is low. However, where disposal of wastewater by reinjection into a hydraulically fractured well has been permitted in North America, there is evidence it has increased the risk of earthquakes. We note that this form of wastewater disposal is not a practice that has been proposed by industry in the UK.
- We are committed to undertaking all relevant statutory assessments in coming to a final position on unconventional oil and gas, including undertaking a Strategic Environmental Assessment, which would be required regardless of the form of our final decision.
- The regulators are confident that the research we have commissioned has provided a clear analysis of where regulation could be strengthened in key areas.

EXAMPLES OF ACTION TAKEN BY OTHERS

In response to their own evidence and circumstances, other countries or jurisdictions have taken a range of positions on unconventional oil and gas.

Some countries or jurisdictions, notably France, Bulgaria, and Victoria (Australia), have instituted indefinite bans on unconventional oil and gas developments on the basis of environmental concerns. In North America, a number of counties and some states move moved toward banning hydraulic fracturing for shale.

Other countries or jurisdictions, including New York State, Nova Scotia and Holland have invoked moratoriums or advised not proceeding until further evidence becomes available. Northern Ireland, the Republic of Ireland and Wales have all introduced some form of moratorium or position to allow further evidence to be collated and considered.

In 2013, the German Advisory Council on the Environment published a review into hydraulic fracturing, and recommended that, in view of 'serious knowledge gaps' hydraulic fracturing should not be used for commercial production of shale gas.

The Council acknowledged, however, that the evidence base relating to the local German context could be improved by permitting pilot projects with subsequent systematic interpretation of (openly available) data on the environmental impact of permitted activities. This option was also advocated as a possible means of enabling engagement with local communities in the evidence evaluation process. In 2016, the German Government moved to ban hydraulic fracturing for shale gas for an indefinite period, but with some exceptions for pilot or scientific studies.

England, a number of states (or provinces) in North America, Australia and Canada, and some other European countries (notably Poland) have actively promoted unconventional oil and gas developments through policy or fiscal incentives. The main commercial unconventional oil and gas developments are in Australia and North America.

Around 10% of Australia's gas production is exploited through coal bed methane or similar technologies. By 2015 the number of hydraulically-fractured wells in the United States reached 300,000, producing around two-thirds of US natural gas[19].

A number of US states have used buffer zones to control where development can take place in the vicinity of water supplies and surface water. The size of buffer zones varies considerably between states. For example, Ohio requires a 50-foot setback for streams, while Pennsylvania requires a 300-foot setback.

A CHOICE FOR SCOTLAND

The Scottish Government has maintained a cautious and evidence-led approach to unconventional oil and gas.

It is the job of government to base decisions on evidence – including scientific, expert opinion and views of the public – and to seek a collective way forward.

We believe that the research we have commissioned and presented provides a strong basis upon which to consider and debate the future of unconventional oil and gas in our country.

Some will conclude that the research shows the economic impact is low and the risks and costs associated with mitigating climate change impacts are too great, where others may argue that the risks can be managed and that gas is an important part of the low-carbon transition or that the potential economic gain cannot be ignored. We want to hear all views, whether in favour or in opposition.

As outlined on the previous page, a variety of options are available to the Scottish Government to guide or determine the future of unconventional oil and gas in Scotland.

Once the consultation closes and the results have been independently analysed and published we will make our recommendation on the future of unconventional oil and gas to the Scottish Parliament. We will then ask the members of the Scottish Parliament to vote on our recommendation, and then the Scottish Government will make their decision.

19 U.S. Energy Information Administration. Oil Production in the United States 2000-2015.

CONSULTATION QUESTIONS

This document has set out a range of evidence available to Scottish Ministers to guide or determine the future of unconventional oil and gas in Scotland.

Q8: Overall, and in light of the available evidence, what do you think would be the main benefits, if any, of an unconventional oil and gas industry in Scotland?

Q9: Overall, and in light of the available evidence, what do you think would be the main risks or challenges, if any, of an unconventional oil and gas industry in Scotland?

Q10: If you have any other comments on the issues discussed in this consultation, please provide them here.

Scottish Government
Riaghaltas na h-Alba
gov.scot

Respondent Information Form

Please Note this form **must** be completed and returned with your response.

Are you responding as an individual or an organisation?

☐ Individual

☐ Organisation

Full name or organisation's name

Phone number

Address

Postcode

Email

If you are responding on behalf of an organisation, please select a type/sector that best describes your organisation.

☐ Business / industry

☐ Academic / research

☐ Professional / trade body

☐ Public body

☐ Third sector / NGO

☐ Community group

☐ Other (please provide further details below)

The Scottish Government would like your permission to publish your consultation response. Please indicate your publishing preference:

☐ Publish response with name

☐ Publish response only (without name)

☐ Do not publish response

Information for organisations:

The option 'Publish response only (without name) is available for individual respondents only If this option is selected, the organisation name will still be published.

If you choose the option 'Do not publish response', your organisation name may still be listed as having responded to the consultation in, for example, the analysis report.

We will share your response internally with other Scottish Government policy teams who may be addressing the issues you discuss. They may wish to contact you again in the future, but we require your permission to do so. Are you content for Scottish Government to contact you again in relation to this consultation exercise?

☐ Yes

☐ No