The UK voice for onshore oil and gas exploration

UK shale gas – do we need it?

Professor Averil Macdonald OBE
UKOOG Chair of Board

United Kingdom Onshore Oil and Gas
4 November 2016
UK Energy Production 2015

- **Petroleum**: 35%
- **Natural Gas**: 35%
- **Coal**: 13%
- **Bioenergy & Waste**: 7%
- **Nuclear**: 8%
- **Wind/Solar/Hydro**: 2%
Importance of natural gas to the UK

- **Heat:** 84% of homes (23 million) heated by gas\(^1\)
- **Cooking:** 61% homes use gas for cooking\(^2\)
- **Electricity:** Around 1/3 electricity generated from gas\(^3\)
- **Manufacturing:** 500,000 jobs in chemical and pharmaceutical industries depend on gas (ethane, propane etc) as a raw material\(^4\). *(Uses about 10% of all natural gas produced\(^{4a}\)*)
- **Products:** Gas used to make almost anything – clothing, plastics, toothpaste, medicines, cosmetics, adhesives, tyres
- **Food production:** Key component of nitrogen-based fertiliser\(^5\) – spread on 75% of UK farmland\(^6\)
- **Transport:** Natural gas cleaner than diesel – potential in buses and trucks

**Sustainability**
- Gas provides back-up electricity when wind doesn’t blow
- Used as a raw material to manufacture renewable energy hardware
- Glass recycling furnaces need 1 million cubic metres gas per day\(^7\)
Thanks to oil and gas...

So many of the products we use and the things we do at home would not be possible without oil and gas and the compounds and materials produced from them. Oil and gas is used in all of the following:

- aeroplane fuel
- manufacturing solar panels
- loft insulation
- clothes & shoes
- hot water
- lighting
- windows
- nitrogen based fertiliser
- paints
- car parts
- food & food packaging
- cooking
- cleaning products
- medicines & cosmetics
- plastics
- toiltries
- laptops & computers
- glasses
- electricity
- sofas
- televisions
- sofas
- carpets
- phones

What would you do without them?
Brief history: offshore production

- Early 1970s – oil price spike and 3-day week
- North Sea gas and oil gave UK self-sufficiency
- North Sea gas and oil changed energy mix for the better reducing CO2

UK primary energy consumption, 1965-2013
We need gas

UKCS production and UK gas demand

Historic

Projections

Import requirement

Source: DECC
Where do we get our gas from?

- 30% Norway
- 48% UK North Sea
- 14% LNG - Qatar
- 8% Europe incl. Russia
Predictions for future UK gas use to 2050

UK Energy Research Centre (UKERC)
2013 : in their lowest-carbon scenario, gas is not used for power generation after 2030, but continues to be widely used for heating.

The Energy Technologies Institute (ETI),
2015 : in their clockwork scenario, gas will still play a significant role in the UK energy mix in 2050, requiring a total of 1.2 trillion cubic feet.

All scenarios expect gas to play a significant role, globally and in the UK between now and 2050

National Grid’s ‘Gone Green’ scenario,
2015 : envisages that in 2050 UK “gas demand reduces to around half today’s level in 2050

Friends of the Earth (FoE) examined only the UK electricity sector – which accounts for less than a fifth of total energy use in the UK at present (though FoE would like to see heating and transport electrified). The FoE scenario envisages that in 2030 24% of UK electricity will be from gas (13% unabated, 11% abated).
UK Onshore – building on history

- Long history
- >2000 wells drilled in UK
- Largest onshore oilfield in Western Europe
- c30 fields at c120 sites
- Hydraulic fracturing has been used to produce hydrocarbons since 1947
- Approximately 2.5 million hydraulic fracture jobs have been completed worldwide
- Routinely used in the North Sea and Onshore UK conventional hydrocarbon basins (e.g. East Midlands) for 30+ years.
- 200 onshore wells in the UK have been hydraulically fractured
UK Onshore – building on history

50-year-old fracking site that makes a mockery of the Balcombe zealots: It's next to a nature reserve - and has fracked enough gas and oil to power 21,000 homes every day... with no complaints from locals

- There has been fracking near Beckingham Marshes since 1963
- The site employs 35 people and pumps 300 barrels of oil a day
- Locals say there have been no environmental problems from the site

By ADAM LUSHER and WAYNE FRANCIS
Published: 02:00, 15 August 2013 | Updated: 02:00, 15 August 2013

The beautiful expanse of grassland on the RSPB’s Beckingham Marshes reserve is exactly the kind of environment antifracking protesters are so determined to protect.

During their ‘Solidarity Sunday’ today in the West Sussex village of Balcombe, thousands of eco-warriors will tell the world that fracking— the process of pumping water into underground wells to fracture the rock and force out oil and gas— should be banned to avoid ‘industrialising’ the countryside.

In fact there has been fracking here in Nottinghamshire since 1963, the last time in 1989. One well has been fracked four times.
Shale gas potential: UK energy security

- British Geological Survey – 1,400 tcf shale gas in place
- 10% of this equal to nearly 50 years consumption

**UK natural gas production and consumption, 2000-2030**

- Blue line: UK natural gas production without shale
- Orange line: UK natural gas consumption
- Red dashed line: Including IoD mid-case shale scenario
“Strong economy supports offshore development. Green policies support biomethane more than other onshore sources.”

“Weaker economy limits offshore development. Policy supports biomethane but lack of funds limits development. Higher gas price drives some shale development”

“Weaker economy limits offshore development. No money available for shale gas or biomethane development. Lack of indigenous supply leads to high imports.”

“Strong economy and a focus on innovation support development of challenging reserves, offshore and onshore. Strong indigenous supply reduces import requirement below current level.”
Public opinion is important

National Research & Segmentation

Populus

RESEARCH | STRATEGY

July 2014
Adults in Great Britain split into six distinct segments

Segment proportions

- **Hostiles**: 11%, 5,366,790 adults
- **Uncommitted Concern**: 19%, 9,269,910 adults
- **Disengaged**: 14%, 6,830,460 adults
- **Guarded Acceptance**: 12%, 5,854,680 adults
- **Open-minded Content**: 30%, 14,636,700 adults
- **Advocates**: 13%, 6,342,570 adults

Survey data shows that 11% of adults are opposed to natural gas from shale, 45% are undecided, and 43% are supportive of natural gas from shale.

Hostiles – profiling

**Gender**
- Male: 49% (All adults), 43% (Hostiles)
- Female: 51% (All adults), 57% (Hostiles)

**Average age**
- **47 vs 49**
  - All adults: 47
  - Hostiles: 49

**Social grade**
- AB: 27% (All adults), 25% (Hostiles)
- C1: 28% (All adults), 30% (Hostiles)
- C2: 22% (All adults), 19% (Hostiles)
- DE: 24% (All adults), 26% (Hostiles)

**Read The Guardian**
- Less often: 12% (All adults), 21% (Hostiles)
- At least weekly: 88% (All adults), 79% (Hostiles)

**Children under 18**
- No: 29% (All adults), 19% (Hostiles)
- Yes: 71% (All adults), 81% (Hostiles)

**University educated**
- No: 40% (All adults), 50% (Hostiles)
- Yes: 60% (All adults), 50% (Hostiles)

*Base: All Hostiles (496)*
Hostiles – views towards shale gas production

### Most persuasive reason to support shale gas
- **Energy security / UK production of energy**
- **Direct cash payments to those affected**
- **Impact on the local landscape**
- **Details about the safety of fracking**

### General attitudes
- **Cleaner energy**
  - 71%
  - ...believe the country should move on from fossil fuels to focus on clean energy (vs. 49% overall)
- **High risk energy**
  - 5%
  - ...think the risks of shale are no different to other forms of energy production (vs. 45% overall)
- **An unnecessary risk**
  - 95%
  - ...believe that shale gas is a risk the country doesn’t need to take (vs. 22% overall)
- **Divided expert opinion**
  - 75%
  - ...say disagreement among experts on the safety of shale worries them (vs. 40% overall)
- **Regulatory doubts**
  - 1%
  - ...are confident that shale gas in the UK is properly regulated (vs. 37% overall)
- **Impact of proper regulation**
  - 0%
  - ...say they would support shale gas in the UK if it was properly regulated (vs. 60% overall)

*Base: All Hostiles (496)*
Uncommitted Concern – profiling

**Gender**
- Male: 49% (All adults), 51% (Uncommitted Concern)
- Female: 44% (All adults), 56% (Uncommitted Concern)

**Average age**
- All adults: 47
- Uncommitted Concern: 45

**Social grade**
- AB: 27% (All adults), 28% (Uncommitted Concern)
- C1: 28% (All adults), 26% (Uncommitted Concern)
- C2: 22% (All adults), 24% (Uncommitted Concern)
- DE: 24% (All adults), 22% (Uncommitted Concern)

**Urban/rural**
- Rural: 22% (All adults), 20% (Uncommitted Concern)
- Urban: 78% (All adults), 80% (Uncommitted Concern)

**Children under 18**
- No: 71% (All adults), 69% (Uncommitted Concern)
- Yes: 29% (All adults), 31% (Uncommitted Concern)

**University educated**
- No: 60% (All adults), 60% (Uncommitted Concern)
- Yes: 40% (All adults), 40% (Uncommitted Concern)

*Base: All Uncommitted Concern (764)*
### Uncommitted Concern – views towards shale gas production

| Most persuasive reason to support shale gas | Energy security |
| Most persuasive reason to support shale locally | Direct cash payments to those affected |
| Most important issue about local development | Impact on the local landscape |
| Most important issue to know more about | Details about the safety of shale gas |

#### General attitudes

<table>
<thead>
<tr>
<th>Energy mix</th>
</tr>
</thead>
<tbody>
<tr>
<td>38%</td>
</tr>
<tr>
<td>...support shale as long as it is part of an energy mix including renewables (vs. 59% overall)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Job creation</th>
</tr>
</thead>
<tbody>
<tr>
<td>39%</td>
</tr>
<tr>
<td>...would be more likely to support knowing that 64,000 jobs will be created (vs. 59% overall)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>An unnecessary risk</th>
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<table>
<thead>
<tr>
<th>Divided expert opinion</th>
</tr>
</thead>
<tbody>
<tr>
<td>59%</td>
</tr>
<tr>
<td>...say disagreement among experts on the safety of shale gas worries them (vs. 40% overall)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Regulatory doubts</th>
</tr>
</thead>
<tbody>
<tr>
<td>9%</td>
</tr>
<tr>
<td>...are confident that shale gas in the UK is properly regulated (vs. 37% overall)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Impact of proper regulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>27%</td>
</tr>
<tr>
<td>...say they would support shale gas in the UK if it was properly regulated (vs. 60% overall)</td>
</tr>
</tbody>
</table>

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**Base: All Uncommitted Concern (764)**
### Disengaged – profiling

<table>
<thead>
<tr>
<th>Category</th>
<th>Base: All Disengaged (558)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>All adults Disengaged</td>
</tr>
<tr>
<td>Female</td>
<td></td>
</tr>
<tr>
<td><strong>Average age</strong></td>
<td></td>
</tr>
<tr>
<td>All adults Disengaged</td>
<td></td>
</tr>
<tr>
<td><strong>Social grade</strong></td>
<td></td>
</tr>
<tr>
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<td></td>
</tr>
<tr>
<td>AB</td>
<td></td>
</tr>
<tr>
<td>C1</td>
<td></td>
</tr>
<tr>
<td>C2</td>
<td></td>
</tr>
<tr>
<td>DE</td>
<td></td>
</tr>
<tr>
<td><strong>Urban/rural</strong></td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>All adults Disengaged</td>
</tr>
<tr>
<td>Urban</td>
<td></td>
</tr>
<tr>
<td><strong>Children under 18</strong></td>
<td></td>
</tr>
<tr>
<td>All adults Disengaged</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td><strong>University educated</strong></td>
<td></td>
</tr>
<tr>
<td>All adults Disengaged</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>
**Disengaged – views towards shale gas production**

<table>
<thead>
<tr>
<th>Apathy</th>
<th>Uncertainty of risks</th>
<th>House prices</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>75%</strong></td>
<td><strong>94%</strong></td>
<td><strong>25%</strong></td>
</tr>
<tr>
<td>...do not have a strong opinion about shale gas production in their local area (vs. 58% overall)</td>
<td>...are unsure whether the risks of shale are any different to other forms of energy (vs. 38% overall)</td>
<td>...want to know about the impact of shale gas on house prices (vs. 21% overall)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Low awareness of claims</th>
<th>Regulatory uncertainty</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>26%</strong></td>
<td><strong>88%</strong></td>
</tr>
<tr>
<td>...have heard of one or more of the claims about shale gas, compared to 84% overall</td>
<td>...don’t know whether shale gas in the UK is properly regulated (vs. 43% overall)</td>
</tr>
</tbody>
</table>

- **Most persuasive reason to support shale gas**: Creation of 64,000 jobs
- **Most persuasive reason to support shale locally**: Money off energy bills / council tax for residents
- **Most important issue about local development**: Noise from the site / impact on the landscape
- **Most important issue to know more about**: Details about the safety of shale gas

Base: All Disengaged (558)
Guarded Acceptance – profiling

### Gender
- Male: 49% (All adults), 51% (Guarded Acceptance)
- Female: 40% (All adults), 60% (Guarded Acceptance)

### Average age
- All adults: 51%
- Guarded Acceptance: 60%

### Social grade
- AB: 27% (All adults), 21% (Guarded Acceptance)
- C1: 28% (All adults), 32% (Guarded Acceptance)
- C2: 22% (All adults), 20% (Guarded Acceptance)
- DE: 24% (All adults), 27% (Guarded Acceptance)

### Urban/rural
- Rural: 22% (All adults), 19% (Guarded Acceptance)
- Urban: 78% (All adults), 81% (Guarded Acceptance)

### Children under 18
- No: 71% (All adults), 29% (Guarded Acceptance)
- Yes: 62% (All adults), 37% (Guarded Acceptance)

### University educated
- No: 60% (All adults), 40% (Guarded Acceptance)
- Yes: 65% (All adults), 35% (Guarded Acceptance)

Base: All Guarded Acceptance (462)
Guarded Acceptance – views towards shale gas production

- **Most persuasive reason to support shale gas**: Creation of 64,000 jobs
- **Most persuasive reason to support shale locally**: Money off energy bills for local residents
- **Most important issue about local development**: Noise from the site
- **Most important issue to know more about**: Details about the safety of shale gas

**Energy infrastructure**: 89%
- Think the UK needs an improved energy infrastructure, which includes shale (vs. 57% overall)

**Energy security**: 43%
- Have heard that shale gas would make the UK less dependent on foreign energy (vs. 78% overall)

**Low risk energy**: 57%
- Think the risks of shale gas are no different to other forms of energy production (vs. 45% overall)

**Unconvinced on regulation**: 40%
- Are confident that shale gas in the UK is properly regulated (vs. 37% overall)

**Impact of proper regulation**: 98%
- Say they would support shale gas in the UK if it was properly regulated (vs. 60% overall)

*Methodology and demographics | Summary | Understanding the segments | General attitudes | Natural gas production | Concerns and desires | Media consumption*

*Base: All Guarded Acceptance (462)*
Open-minded Content – profiling

**Gender**

- Male: 49%
- Female: 57%
- Open-minded Content: 43% vs 51%

**Average age**

- 27% vs 28%
- Open-minded: 22% vs 23%

**Social grade**

- AB: 27% vs 32%
- C1: 28% vs 27%
- C2: 22% vs 21%
- DE: 24% vs 20%

**Urban/rural**

- Rural: 22% vs 23%
- Urban: 78% vs 77%

**Children under 18**

- Yes: 29% vs 28%

**University educated**

- No: 60% vs 55%
- Yes: 40% vs 45%

Base: All Open-minded Content (1,213)
# Open-minded Content – views towards shale gas production

<table>
<thead>
<tr>
<th>Most persuasive reason to support fracking</th>
<th>Energy security</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most persuasive reason to support fracking locally</td>
<td>Money off energy bills for local residents</td>
</tr>
<tr>
<td>Most important issue about local development</td>
<td>Impact on the local landscape</td>
</tr>
<tr>
<td>Most important issue to know more about</td>
<td>Details about the safety of shale gas</td>
</tr>
</tbody>
</table>

## Energy mix
- **90%**
  - support shale gas as long as it is part of an energy mix including renewables (vs. 59% overall)

## Energy infrastructure
- **93%**
  - think the UK needs an improved energy infrastructure, which includes shale gas (vs. 57% overall)

## Low risk energy
- **73%**
  - think the risks of shale gas are no different to other forms of energy (vs. 45% overall)

## Divided expert opinion
- **40%**
  - say disagreement among experts on the safety of shale worries them (vs. 40% overall)

## Confidence in regulation
- **59%**
  - are confident that shale gas in the UK is properly regulated (vs. 37% overall)

## Impact of proper regulation
- **96%**
  - say they would support shale in the UK if it was properly regulated (vs. 60% overall)

*Base: All Open-minded Content (1,213)*
Advocates – profiling

Gender

All adults: 49% Male, 26% Female
Advocates: 74% Male, 26% Female

Average age

47 vs 56
All adults: 47
Advocates: 56

Social grade

AB: 27% All adults, 29% Advocates
C1: 28% All adults, 25% Advocates
C2: 22% All adults, 25% Advocates
DE: 24% All adults, 21% Advocates

Urban/rural

All adults: 78% Rural, 22% Urban
Advocates: 73% Rural, 27% Urban

Children under 18

All adults: 71% No, 29% Yes
Advocates: 79% No, 21% Yes

University educated

All adults: 60% No, 40% Yes
Advocates: 63% No, 37% Yes

Base: All Advocates (563)
Advocates – views towards shale gas production

### Energy infrastructure
- **100%**
  - Think the UK needs an improved energy infrastructure, which includes shale (vs. 57% overall)

### Limitations of renewables
- **77%**
  - Think renewables alone can’t provide enough energy so shale & nuclear have a role (vs. 41% overall)

### Low risk energy
- **96%**
  - Think the risks of shale gas are no different to other forms of energy (vs. 45% overall)

### Economic benefits
- **31%**
  - Would most want to know about the economic benefits of shale if proposed locally (vs. 15% overall)

### Confidence in regulation
- **90%**
  - Are confident that shale gas in the UK is properly regulated (vs. 37% overall)

### Impact of proper regulation
- **100%**
  - Say they would be more likely to support shale if it was properly regulated (vs. 60% overall)

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*Base: All Advocates (563)*
A minority of adults feel as if they know a lot or a fair amount about terms like fracking and natural gas from shale

Please say which of these descriptions best describes your understanding of the following terms. [% saying ‘Heard of it and know a lot/fair amount about’]

- Fracking
- Natural gas from shale
- ‘Green’ energy tariffs
- Energy security

**Base: All (4,086).**
Optimism about family and the country overall

On a scale of 0-100, where 100 means very well, 0 means very badly, and 50 is average, how well would you say life is going...

Base: All (4,086).
UKOOG’s Continuing Priorities

- Public acceptance
- Planning and regulation
- Land access – minimising traffic movements
- Baseline monitoring – transparent data to show impact
- Supply chain – job creation
- Skills (NCOOG)
- Insurance and Liabilities/Decommissioning
- Climate Change
Can shale gas be extracted safely?
Potential risks

- Impact on water resources from water used in hydraulic fracturing
- Fugitive emissions of methane
- Inadequate transport or processing of produced gas
- Inadequate treatment/disposal of drill cuttings
- Gas emissions to atmosphere
- To river or STW
- Production Platform
- Storage tanks
- Water table
- Water + sand + chemicals
- Possible Aquifer
- Confining Layers
- Production Zone
- Inadequate transport or treatment of waste waters
- Contamination of soil, surface or groundwater due to spills of chemicals or return fluids
- Contamination of groundwater due to poor well design or failure
- Contamination of groundwater due to mobilization of solutes or methane
Regulatory roadmap

- DECC issues PEDL to operator
  - Operator conducts ERA (shale gas only)
    - MPA – Operator pre-application consultation (best practice)
      - MPA screens for EIA
        - EIA scope defined by MPA
          - EIA conducted by operator
            - Operator makes initial minerals planning application
              - MPA advertises and consults on finalised planning application
                - Agree plan for site restoration
                  - Planning decision reached
                    - Planning appeals process
                      - Operator discharges relevant planning conditions to MPA
                        - Satisfaction and prepares site for drilling

- Operator engages with local community and statutory consultees
  - Formal engagement arranged by developer
    - Environmental regulator – Operator pre-application consultation (best practice)
      - Operator applies for and obtains relevant permits from environmental regulator
        - Environmental appeals process
          - Operator agrees and establishes data reporting methods
            - DECC CONSENT TO DRILL
              - Agree traffic light system, outline HFP and fracture monitoring
                - DECC consent to fracture
                  - DECC consent for EWT
                    - Operator notifies HSE of intention to drill 21 days in advance
                      - Operator arranges independent examination of well under established scheme
                        - Operator informs BGS of intention to drill
                          - Operator consults with Coal Authority and obtains permit if required
What’s typically in fracturing fluid

<table>
<thead>
<tr>
<th>Compound</th>
<th>Purpose</th>
<th>Common application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acids</td>
<td>Helps dissolve minerals and initiate fissure in rock (pre-fracture)</td>
<td>Swimming pool cleaner</td>
</tr>
<tr>
<td>Sodium Chloride</td>
<td>Allows a delayed breakdown of the gel polymer chains</td>
<td>Table salt</td>
</tr>
<tr>
<td>Polyacrylamide</td>
<td>Minimizes the friction between fluid and pipe</td>
<td>Water treatment, soil conditioner</td>
</tr>
<tr>
<td>Ethylene Glycol</td>
<td>Prevents scale deposits in the pipe</td>
<td>Automotive anti-freeze, deicing agent, household cleaners</td>
</tr>
<tr>
<td>Borate Salts</td>
<td>Maintains fluid viscosity as temperature increases</td>
<td>Laundry detergent, hand soap, cosmetics</td>
</tr>
<tr>
<td>Sodium/Potassium Carbonate</td>
<td>Maintains effectiveness of other components, such as crosslinkers</td>
<td>Washing soda, detergent, soap, water softener, glass, ceramics</td>
</tr>
<tr>
<td>Glutaraldehyde</td>
<td>Eliminates bacteria in the water</td>
<td>Disinfectant, sterilization of medical and dental equipment</td>
</tr>
<tr>
<td>Guar Gum</td>
<td>Thickens the water to suspend the sand</td>
<td>Thickener in cosmetics, baked goods, ice cream, toothpaste, sauces</td>
</tr>
<tr>
<td>Citric Acid</td>
<td>Prevents precipitation of metal oxides</td>
<td>Food additive; food and beverages; lemon juice</td>
</tr>
<tr>
<td>Isopropanol</td>
<td>Used to increase the viscosity of the fracture fluid</td>
<td>Glass cleaner, antiperspirant, hair coloring</td>
</tr>
</tbody>
</table>

Well integrity

The process of well design, construction and fracturing operations are regulated by:

- The Offshore Installation of Wells (Design & Construction) Regulations 1996 (DCR) – covering all wells (onshore or offshore) on the UKCS

- In addition to DCR for onshore well sites is BSOR (Borehole Sites and Operations Regulations 1995)

Additional guidance also exists from HSE, DECC, Environment Agency, UK Oil & Gas, UKOOG and relevant industry codes (ISO, API)

As wells are drilled, each section is cased off with steel tubulars cemented in place

Integrity of each section is tested to confirm hydraulic isolations

By the time the well reaches deep shale formations, several sections of cemented casings can exist, isolating and protecting shallower formations that may contain aquifers/groundwater

For the full life cycle of the well, a continuous programme of well integrity monitoring is in place
Fracturing fluid and drinking water

- Hydraulic fracturing has been used in over 2 million wells world-wide since the 1940s. Comprehensive studies have found no historical cases in which hydraulic fracturing has contaminated drinking water.

**Concerns include:**
- The extent that fractures may extend upwards from the host strata
- The potential for the injected fluids to migrate via these induced fractures into overlying aquifers

**Evidence includes:**
- Micro fractures extend typically less than 180 metres upward from the well bore
- Layered sedimentary rocks provide natural barriers to the progression of the micro fractures

(Source: International Association of Oil and Gas Producers – Shale Gas and Hydraulic Fracturing)
Induced seismicity

• The Government, The Royal Academy of Engineering and the Royal Society and others have made recommendations in order to mitigate induced seismicity associated with hydraulic fracturing. These include:

  • Risk Assessment
  • Best practise operating procedures via warning systems and local geological research
  • A traffic light system, with all drilling activity stopped if very small tremors are detected (0.5 magnitude)

“most fracking-related events release a negligible amount of energy roughly equivalent to or even less than someone jumping off a ladder onto the floor....”

Professor Richard Davies from Durham University’s Energy Institute
Third Party Review : regulation

The health, safety and environmental risks associated with hydraulic fracturing (often termed ‘fracking’) as a means to extract shale gas can be managed effectively in the UK as long as operational best practices are implemented and enforced through regulation.  
**The Royal Society & Royal Academy of Engineering, June 2012**

If adequately regulated, local GHG emissions from shale gas operations should represent only a small proportion of the total carbon footprint of shale gas. **MacKay & Stone, DECC, September 2013**

The currently available evidence indicates that the potential risks to public health from exposure to emissions associated with the shale gas extraction process are low if operations are properly run and regulated. **Public Health England, October 2013**

Water UK has reviewed recent reports into shale gas extraction, and believes that while there are potential risks to water and wastewater services, these can be mitigated given proper enforcement of the regulatory framework. **WaterUK, November 2013**

Compared to other fossil fuels the overall water use intensity of shale gas is low, ... claims by some opponents that the industry represents a threat to the security of public water supplies are alarmist. **CIWEM, January 2014**
But do we really need shale gas?
Future scenarios: Three options

DECC: UK natural gas consumption projection, 2014-2035

Option 1:
Gas remains important, but no UK shale production

Option 2:
We try to replace gas and only develop low-carbon sources

Option 3:
Gas remains important, and we develop UK shale gas
Future scenarios: Can UK replace gas?

Option 2: We try to replace gas and only develop low carbon sources

- **2014:** Renewables and nuclear 40% electricity and 15% total energy
- **Electricity challenges:** Intermittency and overall capacity needed
- **Heating challenges:** Can’t realistically electrify heat
  - Peak electricity demand 50GW; peak heat demand 300GW
  - Capital cost of electricity infrastructure 6 times that of equivalent gas infrastructure
  - Electricity 3x cost of gas – 15p/KWh compared with 5p/KWh. Fuel poverty issue
- **Biomethane:** Will remain small – only up to 10% of UK gas demand

Financial Times, 3 November 2015:

*UK turns to diesel to meet power supply crunch... even solar-power developers, which have recently had their own subsidies cut, are building diesel generation on their sites as a way of maximising their returns*
We can’t realistically electrify UK heat
But what about climate change?

Greenpeace advocates keeping 80% of fossil fuels in the ground globally.
2030: Fifth Carbon Budget 1 – CCC scenario

- CCC central scenario in 2030:
  - Non-biomethane gas demand 700 TWh
  - UK non-shale production 170 TWh
  - Net imports 530 TWh
  - Highest shale production scenario of 334 TWh in 2030 – reduces net imports by 63%

![2030 gas demand, production and imports](chart.png)
Widespread shale gas production is compatible with the carbon budgets provided three tests are met.

Key points:

- With tight regulations, fugitive methane emissions are less than 1%.
- With a high level of shale gas production, fugitive methane emissions would be around 3% of the average annual allowance in the Fifth Carbon Budget period.
- Emissions from UK production of shale gas are included within the UK's carbon budgets, whereas emissions from the production and transportation of gas produced overseas are not included – in reality, therefore, shale gas does not add to the UK's carbon footprint.
- The report confirms that lifecycle emissions from shale gas are slightly lower than from imported liquefied natural gas (LNG), and far lower than from coal.
- The report confirms that: "If these conditions (3 tests) are met, then shale gas could make a useful contribution to UK energy supplies, including providing some energy security benefits." It is clear that the three tests are met by existing UK regulations and policy.
Test 1: "Well development, production and decommissioning emissions must be strictly limited. Emissions must be tightly regulated and closely monitored in order to ensure rapid action to address leaks."

"A range of technologies and techniques to limit methane emissions should be required, including 'reduced emissions completions' (also known as 'green completions') and liquid unloading mitigation technologies (e.g. plunger lift system) should these be needed"

The Environment Agency (EA) has already stated that it considers green completions to be a 'best available technique'.

"A monitoring regime that catches potentially significant methane leaks early is essential in order to limit the impact of 'super-emitters'"

Environmental permits will include the need to monitor emissions to air to demonstrate compliance with the permit. In addition, Section 50 of the Infrastructure Act 2015 states that hydraulic fracturing cannot take place unless appropriate arrangements have been made for monitoring emissions of methane into the air.

"Production should not be allowed in areas where it would entail significant CO2 emissions resulting from the change in land use (e.g. areas with deep peat soils)"

CO2 emissions resulting from a change in land use will be taken into account in the planning process.

"The regulatory regime must require proper decommissioning of wells at the end of their lives. It must also ensure that the liability for emissions at this stage rests with the producer."

It is the responsibility of the licence holder to decommission the well in accordance with regulations, and the HSE will ensure that the well is properly decommissioned. Environmental permits can only be relinquished once the EA is satisfied that environmental risks are no longer present or are sufficiently low. Finally, provision for decommissioning and restoration may be required as a condition of the planning permission and licencing conditions
Test 2: "Consumption – gas consumption must remain in line with carbon budgets requirements. UK unabated fossil energy consumption must be reduced over time within levels we have previously advised to be consistent with the carbon budgets. This means that UK shale gas production must displace imported gas rather than increasing domestic consumption."

- We agree with this and note that under the higher shale gas production scenario and the lowest gas consumption scenario in the CCC report, the UK is still a small net importer of gas. With North Sea production declining, there is considerable room for shale gas to replace imported gas. The report also states that the cheapest way to create low-carbon hydrogen is from gas with Carbon Capture and Storage (CCS), and we fully support efforts to develop this technology.

Test 3: "Accommodating shale gas production emissions within carbon budgets. Additional production emissions from shale gas wells will need to be offset through reductions elsewhere in the UK economy, such that the overall effort to reduce emissions is sufficient to meet carbon budgets."

- The report states that with a high level of shale gas production, fugitive methane emissions would be around 11 million tonnes of CO2-equivalent per annum in 2030. This is around 3% of the average annual allowance in the Fifth Carbon Budget period (the Fifth Carbon Budget recommends a level of 1,765 million tonnes of CO2-equivalent for 2028-32, an average of 353 million tonnes a year). The Government has confirmed its commitment to meeting the Fifth Carbon Budget, and at up to 3% of the total, shale gas emissions can be accommodated.
Renewables need gas

- **Renewables need gas:**
  - Variable renewable generation needs gas back-up – limited pumped hydro and other storage not yet at grid scale
  - Diesel peaking plant not a sustainable option

- **Shale gas production and renewables can thrive together:**
  - Texas biggest shale gas producer\(^{12}\) and biggest wind producer in US\(^{13}\)
  - Wind generation increased from 13 TWh to 99 TWh in the 18 shale gas producing states between 2005 and 2013 – accounting for 59% of US total\(^{14}\)
  - Between 2005 and 2014, US renewable generation (including hydro) increased by 52% and gas generation by 48%\(^{15}\)
  - Average residential electricity prices rose 32% in US over same period\(^{16}\) – in the UK they doubled\(^{17}\)
Globally 2040: 450 parts per million

- COP21 commitment to keep temperature rises to less than 2 degrees means limiting greenhouse gas concentrations to 450 ppm:
  - IEA 450 ppm scenario, detailed in 2015 World Energy Outlook
  - Coal demand falls 37%; Gas demand rises 15%; Big growth in renewables and nuclear

<table>
<thead>
<tr>
<th>Million tonnes of oil equivalent</th>
<th>2013</th>
<th>2040</th>
<th>Change</th>
<th>Percentage change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>3,929</td>
<td>2,495</td>
<td>-1,434</td>
<td>-36.5%</td>
</tr>
<tr>
<td>Oil</td>
<td>4,219</td>
<td>3,351</td>
<td>-868</td>
<td>-20.6%</td>
</tr>
<tr>
<td>Gas</td>
<td>2,901</td>
<td>3,335</td>
<td>+434</td>
<td>+15.0%</td>
</tr>
<tr>
<td>Nuclear</td>
<td>646</td>
<td>1,627</td>
<td>+981</td>
<td>+151.9%</td>
</tr>
<tr>
<td>Hydro</td>
<td>326</td>
<td>588</td>
<td>+262</td>
<td>+80.4%</td>
</tr>
<tr>
<td>Bioenergy</td>
<td>1,376</td>
<td>2,331</td>
<td>+955</td>
<td>+69.4%</td>
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<tr>
<td>Other renewables</td>
<td>161</td>
<td>1,470</td>
<td>+1,309</td>
<td>+813.0%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>13,559</td>
<td>15,197</td>
<td>+1,638</td>
<td>+12.1%</td>
</tr>
<tr>
<td>CO₂ emissions (million tonnes)</td>
<td>31,646</td>
<td>18,777</td>
<td>-12,869</td>
<td>-40.7%</td>
</tr>
</tbody>
</table>
2040: 450 parts per million 2

• Key challenge
  ➢ Global Coal Plant Tracker – 2,400 coal plants planned; would emit 6.5 GtCO₂ annually\(^1\)
  ➢ This is one third of allowable global total in 2040 in IEA 450 ppm scenario

• Opportunities
  ➢ Need abundant global gas supplies to help ensure planned coal plants do not get built
  ➢ LNG that doesn’t go to UK can go elsewhere e.g. Asia
  ➢ Additional gas supplies from shale provide the resource that can replace coal

• Fugitive methane
  ➢ Berkeley Earth paper for CPS: Methane leakage would have to be 5.3% (20 year average) or 12% (100 year average) for gas to lose advantage over coal
  ➢ UK will have green completions which will minimise fugitive emissions

<table>
<thead>
<tr>
<th>Methane leakage to lose global warming advantage vs coal(^2)</th>
<th>0 yr</th>
<th>0-20 yr average</th>
<th>20 yr</th>
<th>0-100 yr average</th>
<th>100 yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>% leakage for coal equivalence</td>
<td>3.8%</td>
<td>5.3%</td>
<td>12%</td>
<td>12%</td>
<td>65%</td>
</tr>
</tbody>
</table>
How do we decarbonise UK heat?
2050: Decarbonised heat in the UK

- Can’t realistically electrify heat in UK:
  - Peak electricity demand c.50 GW;
  - Peak heat demand nearly 300 GW\(^{21}\)
  - Capital cost of electricity infrastructure 6 times that of equivalent gas infrastructure\(^{22}\)
  - Electricity 3x cost of gas – c.15p/KWh compared with c.5p/KWh\(^{23}\).
  - Households with gas heating far less likely to be in fuel poverty\(^{24}\).
2050: Decarbonised heat in the UK

- But could use gas grid for hydrogen – Northern Gas Networks project:
  - Upgrade to plastic pipes in cities underway already – will allow transport of hydrogen
  - Use NTS to transport methane; convert to hydrogen at city gate with CCS
  - Adapting appliances to run on hydrogen could be undertaken in similar way to 1970s conversion of appliances from town gas to natural gas
2050: Decarbonised heat in the UK

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  ➢ Adapting appliances to run on hydrogen could be undertaken in similar way to 1970s conversion of appliances from town gas to natural gas
2050: Decarbonised heat in the UK

• Convert all gas heating systems to decarbonised gas!
  – No need to replace radiators
  – No need to dig up roads for thicker cables
  – No need to build more power stations
  – Uses current gas pipes
  – Requires conversion like in 1970s

The UK has done it before!!!!!!
2050: Transport

• HGVs make up 1.5% of road vehicles but 21% of surface transport CO\textsubscript{2} emissions:\textsuperscript{25}
  ➢ Significant technical challenges remain for the development of electric HGVs
  ➢ Long-haul and regional delivery accounts for around 70% of HGV emissions\textsuperscript{26} – can’t benefit from cleaner final-mile delivery vehicles
  ➢ 136 billion tonne kilometres by road; only 22 billion tonne kilometres by rail\textsuperscript{27} – growth in rail freight alone will not solve problem

• Natural gas vehicles can help to reduce HGV emissions, including of air pollutants and noise:
  ➢ Low Carbon Truck trial ongoing, including using methane – important evidence being gathered\textsuperscript{28}
When assessing the role of shale gas production in meeting carbon reduction goals, we need to consider the UK in the medium term, the global 450 ppm objective, and the UK’s longer term 80% carbon reduction target.

Shale gas production can contribute to all three:

- **2030**: Fifth Carbon Budget – UK shale replaces gas imports, emits less carbon than imported LNG, and supports sustainability efforts
- **2040**: 450 parts per million – IEA 450 ppm scenario sees global gas demand rise by 15% between 2013 and 2040, with world coal demand falling by 37%
- **2050**: UK’s 80% target – Decarbonising heat can be achieved with methane converted to hydrogen and piped through city gas networks, or through fuel cell technology
Further work

Shale gas can support UK and global decarbonisation efforts, but further research is required in a number of areas:

- **Fugitive methane**: Minimising fugitive methane emissions through green completions, improving best practice and supporting robust independent monitoring
- **CCS**: Decarbonising electricity from gas generation will require CCS in the medium term, or some other industrial use of carbon that removes the need for storage
- **Hydrogen heating**: We believe that using hydrogen in the city gas network is the most promising route to decarbonising heat. The use of fuel cell technology in boilers should also be explored
- **Transport**: Natural gas vehicles have the potential to reduce emissions of $\text{CO}_2$, air pollutants and noise from HGVs and buses
Endnotes 1


   • uploads/2014/10/Drilling-Deeper_FULL.pdf


8. US Energy Information Administration, Shale Gas Production https://www.eia.gov/dnav/ng/ng_prod_shalegas_s1_a.htm


10. US Energy Information Administration, Electricity generation by state, by energy source and type of producer/sector https://www.eia.gov/electricity/data.cfm

11. NB: ‘Renewables’ includes hydro, solar, renewable sources excluding hydroelectric and solar, pumped storage. US Energy Information Administration, Electricity generation by energy source https://www.eia.gov/electricity/data.cfm
Endnotes 2

16. US Energy Information Administration, Average retail price of electricity to ultimate customers by end-use sector [https://www.eia.gov/electricity/data.cfm#sales](https://www.eia.gov/electricity/data.cfm#sales)
22. Figure supplied by Northern Gas Networks
EIA is projecting 2016 U.S. CO2 emissions to drop to 5.2 billion metric tons, down 1.5 percent from 2015 levels.

The trend of increased natural gas use and decreasing CO2 emissions has all happened at the same time the U.S. economy has grown 15 percent.
Some perspectives: chemical disclosure

- Current regulations require chemical disclosure and reporting to the authorities
- Chemical substances are already registered and approved under the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) Regulation
- Shale gas operations will require additional disclosures

The UKOOG guidelines require operators to measure and publically disclose additional operational data on, for example:
- EA/SEPA approvals for fluids used.
- Material Safety Data Sheets information.
- Volumes of material, including proppant, base carrier fluid and chemical additives.
- The trade name of each additive and its general purpose in the fracturing process.
- Concentrations of each reportable chemical ingredient
Some perspectives: household insurance

- Damage as a result of earthquake, subsidence, heave and landslip are all covered, in general, under buildings insurance;
- There is, at present, little evidence to show a link between fracking and seismic activity that could cause damage to a well-maintained property, however, insurers will continue to monitor the potential for fracking, or similar explorations, to cause damage.
- We are not aware of any claims, to date, where seismic activity as a result of fracking has been mooted as a cause for damage;
- As in all locations, a reported history of subsidence (or indeed any other type of loss) in a location will be taken into account when offering and pricing insurance.
Asthma – setting the story straight

According to Pennsylvania health department asthma hospitalization rates in the top five shale counties are significantly lower than nine counties in the study area with no shale production.

Between 2009 to 2013 the Pennsylvania Department of Health data actually show a significant 26 percent reduction in inpatient asthma hospitalizations throughout the entire state during significant growth in shale production.

PM2.5 currently killing over 3 million globally, 400,000 in Europe and 75,000 in US. Compared to coal shale gas results in a 400 fold reduction in PM2.5, 4000 fold reduction in Sulphur dioxide, 70 fold reduction in nitrous oxides, and a 30 fold reduction in mercury.

In the UK potential environmental hazards are well known; understood; are not bespoke to the oil and gas industry and are already addressed through the regulatory planning and permitting process set to protect the environment and health.
Some perspectives: property values - RICS

- Fracking for shale gas is in its embryonic stage and therefore market evidence on its effect (if any) on property values has not yet emerged. RICS Valuation Professional Standards are based on current market evidence and therefore this issue will not be reflected in our members’ valuations until it is reflected in the market.

- Currently there are few sales of property in areas directly affected by fracking therefore there is a limited data set on which valuers can draw. Should any market evidence emerge then our members will take note of this and reflect it in their valuation. Any commentary on any possible effects on property value therefore would be very premature, including the attempt to draw any parallels with other nations.

- RICS are keeping a watching brief on this and will provide an update with any further information that emerges.