Exploiting Scotland’s shale gas opportunities

This document comprises material presented during an Engineering Policy Group Scotland ‘Holyrood Briefing’ on Wednesday 26th February 2014.
Introduction

This document comprises material presented during an Engineering Policy Group Scotland ‘Holyrood Briefing’ on Wednesday 26th February 2014, at the Scottish Parliament, in Committee Room 2.

The event was graciously hosted and chaired by Murdo Fraser MSP, Convener of the Economy, Energy and Tourism Committee.

Professor Rebecca Lunn - Head of Department, of the Department of Civil and Environmental Engineering at the University of Strathclyde, was the guest Speaker who gave the keynote address. Professor Lunn kindly agreed to allow the reproduction of her PowerPoint presentation herein.

The first section of the document gives a summary of the issues raised, and the dominant Panel views expressed, during the Question and Answer session.

On this occasion, in addition to the Speaker and Chairman, the Panel included:

<table>
<thead>
<tr>
<th>Chic Brodie MSP</th>
<th>SNP Member of the Energy Committee</th>
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</thead>
<tbody>
<tr>
<td>Iain Gray MSP</td>
<td>Labour Party Energy spokesperson</td>
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<tr>
<td>Patrick Harvie MSP</td>
<td>Leader of the Green Party</td>
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<td>Prof Robin MacLaren</td>
<td>Scottish Electrical Energy Consultant</td>
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</table>

A number of images in the document have been based upon the Royal Society and Royal Academy of Engineering report: “Shale gas extraction in the UK: a review of hydraulic fracturing” June 2012, http://www.royalsociety.org/policy/projects/shale-gas-extraction and http://www.raeng.org.uk/shale. The authoritative report is duly acknowledged and appreciation expressed for the kind permission to use the images.

Key Issues

Technology

- Mature and in use in a large number of overseas commercial/industrial operations, notably USA
- The extraction process (fracking) occurs at a depth of 1500m (5000ft)

Safety

- Correct processes are known for safe gas extraction, and environment protection
- Implementation could be controlled by regulation and inspection
- Triple lining of the bore hole is required to prevent seepage
- Extraction occurs below the water table

Scottish Need

- To ensure medium and long term energy base load (electricity, heating and transportation)
- Currently there is a very high dependency on gas for space heating
- Given 2020 42% carbon dioxide emissions reduction commitment shale gas extraction might be useful short term solution to the projected energy gap, with the consequential need for reduction of coal fired electricity generation, and pending alternative (renewable) energy source(s) development
- Shale gas extraction technology may be an ability Scotland wants both for its own energy purposes and global exports

Scottish Government and Parliament

- Main barrier to shale gas extraction implementation is public acceptance
- Lead time to commercial production 8-10 years, but:
  - 2020 political carbon dioxide reduction goal probably rules out private investment (negligible time for return on investment);
  - Is it tenable to subsidise a fossil fuel unless it gives, say, a 5:1 carbon dioxide emission reduction?
  - Carbon capture technology is unproven industrially
- Rejection of shale gas will require a re-evaluation of the stance “no to new nuclear” or be highly reliant upon importation of energy, with all its security implications
- Public policies to reduce energy consumption remain essential
**Briefing on Shale Gas Extraction**

**Scottish Parliament**

Prof Becky Lunn  
Head of Department: Civil and Environmental Engineering  
Strathclyde

Thanks to:  
Prof Zoe Shipton (University of Strathclyde)  
Prof Paul Younger (University of Glasgow)

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**UK Energy Sources**

![Electricity supplied by fuel type, 1980 to 2011](chart)

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**UK Energy Consumption**

Non-Transport Energy Use for the UK in 2012

- Heat accounts for 46% of total energy use
- 80% of heat is gas

Source: DECC, [www.gov.uk](http://www.gov.uk) July 2013

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**Energy Production in Scotland**

Scottish Energy Production - 2010

<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>Output GWh</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>147115</td>
<td>25%</td>
</tr>
<tr>
<td>Oil</td>
<td>12112</td>
<td>2.4%</td>
</tr>
<tr>
<td>Gas</td>
<td>8318</td>
<td>1.6%</td>
</tr>
<tr>
<td>Nuclear</td>
<td>13293</td>
<td>5.6%</td>
</tr>
<tr>
<td>Renewables</td>
<td>9515</td>
<td>19.1%</td>
</tr>
<tr>
<td>Other</td>
<td>792</td>
<td>1.3%</td>
</tr>
</tbody>
</table>

Nuclear power stations to be decommissioned in 2023 (Torness) and 2016 (Hunterston B)

EU Large Combustion Plant Directive is forcing closer of most coal-fired power plants

Total production ~ 50 GWh  
**Future loss of capacity ~ 30 GWh**  
Total consumption ~ 40 GWh  
⇒ 20 GWh energy deficit

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**Scottish Renewables Targets**

- 30% of total Scottish energy consumption from renewables by 2020
- Energy production target of ~16 GWh (rising from ~9.5 GWh in 2010)
  - 100% of equivalent electricity consumption
  - 10% share of biofuels in transport
  - 11% heat demand

Even if targets are met we are still facing an overall Scottish energy deficit of ~13GWh

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**Energy constraints**

- Need to produce more energy that can contribute to baseload
- 40% of Scotland’s energy consumption is currently gas-fired heating
- Require low carbon technologies
- Timescales are short (~ 10 years)

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**Tough Decisions ...**

Low carbon solutions

- **Renewables**: Scottish targets already ambitious would need long-term investment in renewables for baseload e.g. geothermal or in energy storage
- **Nuclear**: new reactor designs produce very little waste
  - requires policy change, and solution for spent fuel (e.g. reprocessing, deep borehole disposal at >6 km, GDF

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**Tough Decisions ...**

Carbon-based solutions

All rely on carbon capture and storage technology; **unproven** at an industrial scale

- Conventional gas in North Sea is declining
- Gas imports bring energy security issues and a lack of environmental controls
- Unconventional gas resources ...
Shale-Gas

What are the risks and can they be managed?

Shale-Gas

Shale gas extraction in the UK: a review of hydraulic fracturing
June 2012

Yes the risks can be managed, as long as operational best practices are implemented and enforced through strong regulation.

Addressing concerns

- Seismicity and fracture propagation
- Water abstraction and use
- Wastewater and well integrity
- GHG emissions
- Public health implications

How does shale-gas extraction work?

- Each fracture creates a small seismic event
- Magnitude of event proportional to fracture length

UK Natural seismicity (red) and Coal mining-induced seismicity (green) from 1382 to 2012

Magnitude: 1.0 - 5.0

- Magnitude: 1.0 - 2.0
  - 2.0: 1 each year

- Magnitude: 2.0 - 3.0
  - 3.0: 1 each year

- Magnitude: 3.0 - 4.0
  - 4.0: 1 every 3-4 years

- Magnitude: 4.0 - 5.0
  - 5.0: 1 every 20 years

UK Natural seismicity (red) and Coal mining-induced seismicity (green) from 1382 to 2012

Fracking < Magnitude 3 (Green et al. 2012)

87 natural earthquakes recorded in Greece yesterday of magnitudes between 1 and 3!!
• Only risk is fluid pressure increase causing earthquake on pre-existing geological fault

> 1,000,000 fracking wells worldwide since the 1940s - damaging earthquake has never occurred

Mitigating induced seismicity
• National surveys (BGS) and site-specific surveys to identify fault locations
• Check for historic seismicity
• Monitor microseismic events to check they are not approaching known faults

Water Consumption
Water needed to operate a frack well for 10 years = 19,000 m³.
Equivalent to:
1. amount needed to water a golf course for a month
2. The amount needed to run a 1000 MW coal-fired power plant for 12 hours
3. The amount lost to leaks in United Utilities’ region in northwest England per hour


Groundwater pollution

1. Methane migration through rock
   • Shale permeability so low it could only occur if fractures extended into the aquifer

   Channel tunnel
   75 m (250 ft)
   Bux Shiraffa, Dubai
   828 m (2717 ft)
   Ben Nevis
   134 m (440 ft)
   Fracture growth vs depth of overlying water sources
   (Fisher and Happersett 2013)
   Data from Marcellus Shale, USA

2. Methane migration through poor well integrity
   • UK requires triple well casing
   • Cement bond integrity monitored using ultrasonic logging
   • Public and regulatory confidence needs baseline aquifer methane concentration data
   • Well design and construction inspected via independent well examination scheme

Water pollution: Surface site management
• Risk is from failure to follow best practices
   – bunded sites
   – waste water stored in tanks not open ponds
• Scotland has plenty of experience from minewater

Addressing concerns

• Seismicity and fracture propagation
• Water abstraction and use
• Wastewater and well integrity
• GHG emissions
• Public health implications

Groundwater pollution

Addressing concerns

• Seismicity and fracture propagation
• Water abstraction and use
• Wastewater and well integrity
• GHG emissions
• Public health implications
Fugitive emissions need to be minimised:
- Recent estimates puts methane as 34 x more potent that CO₂

Public health risk

“The currently available evidence indicates that the potential risks to public health from exposure to the emissions associated with shale gas extraction are low if the operations are properly run and regulated”

Issues of importing

Ethical: Imported base load energy will be a mixture of nuclear and hydrocarbon
- Devolves responsibility to others for environmental regulation of greenhouse gas emissions, nuclear operation and waste disposal
- Devolves responsibility to human rights in terms of worker conditions

Energy security
- Scottish economy reliant on other nations
- Could be exposed to political blackmail

BGS – Potential Shale-Gas Resources

- Big difference between the size of the resource and recoverability
- No realistic estimates for Scotland’s two potential shale-gas reserves
- BGS due to publish desk-based study for Scotland in April 2014

Public acceptability – what can be done?

- Transparency is crucial
- Respectfully address legitimate public concerns
- Respond to scare stories calmly, with the facts
- Engage in constructive debate
- Involve the public in discussion of monitoring regimes

So what are the big issues if they are not the major public concerns?
But … …

- Emissions similar to those of other hydrocarbons – cleaner than traditional coal
- Requires strict regulation to minimise fugitive emissions
- Reduced carbon emissions rely on carbon storage technologies - unproven at an industrial scale

Andressen, January, 2018

Climate change

Datchet, Berkshire, Feb, 2013
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