DECC - BGS Assessment of Resource Potential of the Bowland Shale, UK

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1. British Geological Survey, Edinburgh, UK
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3. British Geological Survey, Keyworth, UK
Previous work in study area
• 2010 DECC-commissioned BGS study estimated potential production:
  - The UK Carboniferous (Upper Bowland Shale) shale gas play, if equivalent to the Barnett Shale of Texas, could potentially yield up to 4.7 tcf shale gas.”

• 2011 Cuadrilla 200 tcf (5,664 BCM) estimate for Gas in Place

So Cuadrilla claim 200 tcf gas in place on their licence where DECC estimate 4.7 tcf could potentially be produced.

Both may be right.
How to estimate shale gas resources

• In-place resource estimates based on a geological model, volumetrics and gas contents (‘bottom-up approach’), and

• Technically recoverable resource estimates based on well technology, well performance, well density (‘top-down approach’).
Data sources

15,000 miles of 2D and 400 sq miles 3D from www.ukogl.org.uk
Data sources

Outcrop studies, BGS fault and surface geology, BGS Subsurface Memoirs, gravity and magnetic data
Data sources

Over 1000 wells in study area and 64 key wells (>50 ft net shale)
Organic carbon content (TOC)

Barnett shale - up to 10%, average 3.7%
Comparison of Barnett Shale (Jarvie, 2008) vs Bowland shale geochemical data.
1 Northern Bowland Basin

2 Eastern Bowland Basin
3 Edale Basin

4 Gainsborough Trough
Inversion – Permo-Triassic on 8000 ft of Bowland-Hodder unit

5 Widmerpool Trough

SSW

Long Eaton

Widmerpool Trough

S

Strelley

NNE

Two-way time (seconds)

0

0.5

1.0

1.5

2.0

Base Permo-Trias

Top Millstone Grit

Top Bowland-Hodder

Base Bowland-Hodder

Base Carboniferous

2 km
## North American Shale Gas Analogies

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</thead>
<tbody>
<tr>
<td>Age</td>
<td>Mississippian 340 MYA</td>
<td>Cretaceous 100 MYA</td>
<td>U Jurassic 170 MYA</td>
<td>U. Devonian 370 MYA</td>
<td>M Devonian 385 MYA</td>
<td>U Dev/L Mississ. 360 MYA</td>
<td>L. Carboniferous (Mississ) 327 MYA</td>
</tr>
<tr>
<td>Lithology</td>
<td>Siliceous mudst</td>
<td>Bituminous shales</td>
<td>Argill/Calcereous</td>
<td>Brittle Shale</td>
<td>Argill mudst</td>
<td>Sst/Siltst/Carbonate</td>
<td>Brittle Shale</td>
</tr>
<tr>
<td>Depth (ft)</td>
<td>7,500</td>
<td>11,500</td>
<td>12,000</td>
<td>8,800</td>
<td>7,000</td>
<td>10,000</td>
<td>10,000</td>
</tr>
<tr>
<td>Thickness (ft)</td>
<td>300</td>
<td>250</td>
<td>225</td>
<td>450</td>
<td>350</td>
<td>150</td>
<td>Over 6000 in basin centre</td>
</tr>
</tbody>
</table>

source: www.transformsw.com/papers-and-presentations/studies.html
Early Carboniferous half graben model

- Top Bowland-Hodder unit
- Millstone Grit
- Bownland-Hodder Unit
- Upper
- Lower
- Base Bowland-Hodder unit
- Turnasian
- Pre-Carboniferous

- Millstone Grit" lithofacies with hemipelagics
- Platform/ramp carbonate lithofacies
- Continental and peritidal lithofacies
- Hemipelagic lithofacies (with mass-flow limestones and sandstones)
- Base of upper unit
Shale percentage (lower unit)
Onset of gas generation

- **Diagenesis**
  - Immature zone
  - Biomarkers
- **Catagenesis**
  - Oil window
  - Oil
- **Metagenesis**
  - Gas window
  - Wet gas
  - Dry gas
  - Graphite

- Biogenic methane

**Quantity**

- $R_o = 0.6\%$
- $R_o = 1.1\%$
- $R_o = 3.5\%$

**Increasing temperature**

**Thermal maturity**
Maturity data
Maturity interpretation: depth to gas window
Workflow

Seismic data
Outcrop - stratigraphy, lithology & structure
Wells - stratigraphy & lithology
Structural and palaeogeographical model

Well & model-driven
Organic carbon

Maturity data
from wells & outcrop
inc new BGS analyses
Burial history

gross rock volume

shale percentage
net shale volume

maturity cut-off
net mature shale volume
apply depth cut-off
from US data
final mature shale volume

from US data

final mature shale volume
Gas-filled porosity
Depth/pressure

final mature shale volume
Bulk density
Adsorbed gas content
Reservoir pressure

Free gas
+ Adsorbed gas
= total in-place
gas volume
Factors determining the viability of natural gas developments (IEA 2011)

- Geological understanding → Resource size → Too small/uncertain
- Physical, social or environmental constraints → Resource access → Inaccessible
- Resource productivity and capacity of service industry → Extraction technology → Not technically or economically recoverable
- Governments’ experience, knowledge and expectations → Regulatory framework → Unable to secure regulatory approvals
- Infrastructure, contractual & political limitations → Market access → Unable to achieve commercial price or volume
- Development and production → Not developed
In-place gas figure

…. will be announced by DECC later this summer

See press release or visit