Unconventional Gas Production

Opportunities and Challenges
- Shale Gas

Report, May 2013

Presented by:
Dr Vaughan Beck, FTSE
Deputy Chair, Expert Working Group

21 August 2013
Engineering Energy: Unconventional Gas Production
Securing Australia’s Future – Project Six

Professor Peter Cook CBE, FTSE (Chair)
Dr Vaughan Beck FTSE, FIEAust (Deputy Chair)
Professor David Brereton
Professor Robert Clark AO, FAA, FRSN
Dr Brian Fisher AO, PSM, FASSA
Professor Sandra Kentish
Mr John Toomey FTSE
Dr John Williams FTSE
Scope

What have we got? Where is it?

Economic extraction

- Global Gas Supply & Demand
- Gas Resources & Reserves
- Technology & Engineering
- Infrastructure
- Financial Analysis

Impact on environment

- Landscape & Biodiversity
- Water Resources & Ecosystem
- Induced Seismicity
- Greenhouse Gas Emissions
- Community Issues

Governance

- Monitoring & Regulation
- Knowledge Needs
- {Not: Reduce fossil fuels?}

Report available at: www.acola.org.au
Conventional and Unconventional Gas Defined by its geology not by its gas type. Natural gas is mostly methane.
## Difference between Shale Gas and CSG
Both composed of methane but...

### Coal Seam Gas
- Mainly in eastern Australia
- Depth ~ 300-1000m (wells cheap)
- Generally only methane
- Occurs only in coals
- Fracking sometimes necessary
- Massive amounts of produced water
- Consequential lowering of the water table
- Monitoring easier—shallow
- Well defined (2P) reserves
- Available infrastructure & markets

### Shale Gas
- Especially N, W & Central Australia
- Depth approx. 2000-3000m
- Can contain valuable petroleum liquids
- Occurs in fine siltstones and shales
- Fracking always necessary
- Very little produced water
- Significant quantities of fracking fluids
- Monitoring more difficult - deep
- No defined reserves, only major resources
- Limited infrastructure & few markets
Conventional and Unconventional Gas

Estimates of technically recoverable shale gas resources (trillion cubic feet, tcf) based on 48 major shale formations in 32 countries (EIA 2011) Russia, Central Asia, Middle East, South East Asia and central Africa were not addressed in the Energy Information Administration report from which this data was taken.

Source: EIA 2012
Shale gas (and shale oil)
Resources and Reserves

- **Conv. Gas**: 167 tcf
- **CSG 2P reserves**: 93 tcf
- **CSG 203 tcf**
- **T.G. 20 tcf**

**Shale Gas**: 396-1000 tcf ??
Central technology components for shale gas include

- Reduced drill time
- Well completions
- Horizontal drilling
- Multiple wells from a single well pad
- Multiple hydraulic fracturing (fracking)
- Real time sensing technology

All of these are applicable to Australia – but with tailoring to suit particular Australian geological, environmental and economic conditions.
Well Drilling and Hydraulic Fracturing in Australia
Infrastructure

- Suitable drilling rigs in short supply - may delay development
- Pipeline & roads far less developed than the USA - access to domestic markets more restricted.
- Cost competitive manufacturing opportunities may be limited
- Access to specialist skills an issue
- Could provide infrastructure stimulus to areas that currently lack it
- Possible thousands of jobs
Economics: Drivers and Financial Analysis

**Drivers**

- 2P reserves of CSG almost fully committed to export LNG from 2015-2016
- Cost of US shale gas possibly at or below some gas price projections for E Australia
- Shale oil and NGLs can be a driver for overall shale gas economics

**Analysis**

- Current low price of US shale gas not sustainable ($3/ GJ)
- Capital intensity of shale gas extraction is significantly higher in Australia than US
- Estimate of well head prices for shale gas $6-9/GJ – cf east coast domestic prices of $4/GJ, netback price of $10 GJ for gas to Japan

**Shale Gas Well Decline Curve**

- 3 Million cf/day
- 5 Years
Landscape and Biodiversity

Shale Gas – aggregated and cumulative impacts

CSG, Queensland

- Infrastructure-related surface disturbance might include:
  - Fragmentation of habitats, landscape function
  - Loss of ecological communities, threatened species habitats
  - Increase in invasive species

- Prior strategic environmental assessment desirable
  - Use of cumulative risk assessment tool

Cooper Basin
Composition of Fracking Fluid

One Well
15 ML Water
25 kL Additives
1 000 tonne Sand

Source: British Geological Survey
Water

The volume of water used for shale gas fracking is large; the total amount of water produced over the life of the project is small; the reverse of CSG.

<table>
<thead>
<tr>
<th>Parameter (unit)</th>
<th>Quantity for One Well</th>
<th>Annual Well Development</th>
<th>Coal Seam Gas</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Number of Wells</td>
<td>1</td>
<td>20</td>
<td>500</td>
</tr>
<tr>
<td>Water Consumption (ML)</td>
<td>15</td>
<td>300</td>
<td>7,600</td>
</tr>
<tr>
<td>Flowback (ML)</td>
<td>7.5</td>
<td>152</td>
<td>3,800</td>
</tr>
<tr>
<td>Produced Water (ML)</td>
<td>0.28</td>
<td>5.7</td>
<td>142.5</td>
</tr>
</tbody>
</table>

Induced Seismicity

• Many cases of induced seismicity in Australia associated with large dams, mining and geothermal

• Overseas evidence suggests re-injection of produced water can result in induced seismicity of 3-4 magnitude

• Very few cases of low magnitude induced seismicity from fracking

• Leading practice involves geological characterisation of faults, real time monitoring, and prescribed ‘cease work’ triggers
Greenhouse Gas Emissions

- GHG Emissions at: extraction, production & use
- In addition to ‘usual gas’ GHG emissions, shale gas produces extra emissions – at initial well completion (flowback)
- “Green completions” can minimise methane emissions at Flowback
- Using shale gas in gas turbines results in ~20% more emissions than conventional gas, but 50-75% emissions of black coal – significant GHG emissions reductions
- Some shale gas may be high in CO2 and carbon capture and storage may needed.
Community Issues

- CRITICAL: Gaining and retaining a Social Licence to Operate. Need:
  - Building trust and respect
    E.g. a transparent approach to collection and dissemination of data
  - Dialogue - how shale gas development might address other societal priorities such as improved infrastructure?

- Native Title or Aboriginal Lands; important scale and impact of developments is fully understood
  - Existing compensation schemes appropriate?
  - Some overseas health concerns regarding emissions; limited data for CSG in Australia does not indicate a problem.
  - Need for health risk assessment in potentially impacted local populations
Best Practice

• Reliable resource-reserve assessment
• Excellent baseline data
• Informed risk assessment – holistic approach
• High integrity well completions
• Effective monitoring
• Effective mitigation and remediation strategies
• A transparent Regulatory Regime & companion Codes of Practice
• Meaningful consultation
Office of the Chief Scientist:
Recommendations – June 2013 PMSEIC

• **Recommendation 1**
  Support the scientific, economic and social research required to facilitate the safe and sustainable development of a new source of natural gas and oil - including social acceptance & effective management regimes & regulatory frameworks.

• **Recommendation 2**
  Develop a comprehensive environmental risk assessment plan to monitor, and mitigate impacts of exploration and production on landscape and biodiversity.

• **Recommendation 3**
  Research to understand the structure and dynamics of Australia’s sedimentary basins that contain natural gas and oil associated with shale.

• **Recommendation 4**
  Through relevant frameworks (e.g. Commonwealth and COAG) build an efficient, transparent and effective regulatory system to achieve a resilient “compact” between the industry and communities.

THANK YOU

Dr Vaughan Beck

sa.vaughanbeck@atse.org.au
Acknowledgements.

The Review would not have been possible without the contribution of many people from Australia and overseas. Special thanks are extended to the following...

The members of the Expert Working Group (and their families!)
The ATSE staff especially Dr Lauren Palmer
The ACOLA staff
The Office of the Chief Scientist
The Peer Reviewers
The many people from NGOs, Government, Industry, Consultants (especially Dr John Burgess), Academia and Research Organizations who so generously contributed their knowledge to the Review.
DISCLAIMER

• This presentation summarises outcomes of the ACOLA Review of Unconventional Gas in Australia

• The Review, which focuses on shale gas, was undertaken to inform government policy

• The Review was not undertaken as a guide to investing in shale gas, or other resources, or to any activities or industries that might relate in any way to shale gas

• Investors in shale gas-related projects or resources should obtain their own independent advice

www.acola.org.au