Research Paper

Unconventional Gas:
Coal Seam Gas, Shale Gas and Tight Gas

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An introduction and overview of issues relevant to the development of unconventional gas in Victoria

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Introduction

This Research Paper provides an introduction and overview of issues relevant to the development of unconventional gas – coal seam, shale and tight gas – in the Australian and specifically Victorian context.

At present, the Victorian unconventional gas industry is at a very early stage. It is not yet known whether there is any coal seam gas or shale gas in Victoria and, if there is, whether it would be economically viable to extract it. A moratorium on fracking has been in place in Victoria since August 2012 while more information is gathered on potential environmental risks posed by the industry. The parts of Victoria with the highest potential for unconventional gas are the Gippsland and Otway basins. Notably, tight gas has been located near Seaspray in Gippsland but is not yet being produced.

There is a high level of community concern in regard to the potential impact an unconventional gas industry could have on agriculture in the Gippsland and Otway regions. Industry proponents, however, assert that conventional gas resources are declining and Victoria’s unconventional gas resources need to be ascertained and developed.

This Research Paper is structured as follows:

Chapter 1 provides an introductory explanation of unconventional gas and the characteristics of coal seam, shale and tight gas. It explains the process of gas production and provides information on conventional and unconventional gas resources in Victoria and Australia generally.

Chapter 2 provides an overview of some key reports on the coal seam gas industry in Australia and a summary of the issues identified in these reports regarding the potential environmental and social impacts of the industry. It includes information on the industry’s potential impact on water, the process of hydraulic fracturing or ‘fracking’, fugitive emissions, and issues relating to agriculture and land access.


Chapter 4 provides information on developments in the regulation of unconventional gas in Victoria, and a summary of developments at the Commonwealth and Council of Australian Governments (COAG) level regarding regulatory reform that is relevant to Victoria.

Chapter 5 presents the views of stakeholder groups on the development and regulation of unconventional gas in Victoria, including the Australian Petroleum Production & Exploration Association, the Lock the Gate Alliance, and the Victorian Farmers Federation.

Chapter 6 provides an overview of the development and regulation of unconventional gas in other jurisdictions, including Queensland, New South Wales, the United States and the United Kingdom.
Chapter 1: What is Unconventional Gas?

Overview of Unconventional Gas

Coal seam gas, shale gas and tight gas are forms of unconventional natural gas. Natural gas is a fossil fuel that mostly consists of methane (CH₄). It is used in Victoria for things such as home heating and cooking, generating electricity, vehicle fuel and manufacturing.¹ Natural gas is extracted by drilling wells into underground reservoirs and is called ‘conventional’ or ‘unconventional’ depending on the geology of the reservoir it comes from.² There is no functional difference in the gas that is extracted from conventional and unconventional wells. They both produce naturally occurring methane which has formed from the decay of organic matter over geological time by the same processes that produce coal and oil.³

In basic terms, conventional natural gas is the gas that is easier to access and extract and unconventional natural gas is harder to access and extract. The Commonwealth Scientific and Industrial Research Organisation (CSIRO) explains that: ‘Conventional gas is obtained from reservoirs that largely consist of porous sandstone formations capped by impermeable rock, with the gas trapped by buoyancy. The gas can often move to the surface through the gas wells without the need to pump’. Unconventional gas, however, is ‘generally produced from complex geological systems that prevent or significantly limit the migration of gas and require innovative technological solutions for extraction’.⁴

Unconventional gas has historically been uneconomical due to difficulties in extraction and low production rates, however, recent advances in mining technology have aided its viability. Horizontal drilling techniques developed since the mid-1980s in the United States have increased the accessibility of unconventional deposits.⁵ Further, the practice of hydraulic fracturing (otherwise known as ‘fracking’ or ‘fraccing’) – which involves pumping fluid into a well to cause fractures in the surrounding rock to enable the gas to flow more freely – has increased the productivity of unconventional wells.⁶

It is expected that reserves of conventional natural gas will run out in coming decades and this is driving the exploration for new – unconventional – sources of natural gas.⁷ Notably,

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⁷ DSDBI (2012) op. cit.
unconventional gas wells have a shorter productive lifespan than conventional gas wells. For example, a coal seam gas well is typically productive for 10 to 15 years, whereas a conventional gas well can be productive for up to 50 years.\(^8\)

A brief overview of the key characteristics of coal seam, shale and tight gas is provided below. A table which provides further details on key differences between conventional, coal seam, shale and tight gas is provided in Appendix 1.

**Coal Seam Gas**

Coal seam gas (CSG) is extracted from coal deposits – or ‘seams’ – at depths of 300-1000 metres underground.\(^9\) It is sometimes called ‘coal seam methane’ or ‘coal bed methane’. The gas occurs in the pores and cracks in the coal seam and is held there by underground water pressure. To extract the gas, a well is drilled into the coal seam and the water is pumped out – a process called ‘dewatering’ – which allows the gas to be released from the coal and brought to the surface.\(^10\) The quantity of water produced can be large.\(^11\)

Significantly, some coal seam gas wells are fracked but not all coal seam gas wells require fracking.\(^12\) Another characteristic is that as coal seams tend to have a lower flow rate (or permeability) than conventional gas systems, gas is only sourced from close to the well and as such a higher density of wells is required to develop a CSG resource than a conventional gas resource.\(^13\) However, CSG wells are cheaper than other unconventional gas wells as they are shallower, can use standard vertical wells and may not require fracking.\(^14\)

**Shale Gas**

Shale gas is found in low permeability sedimentary rock at depths of 1000 to over 2000 metres.\(^15\) Shale gas has a number of features that sets it apart from coal seam gas, as Rutovitz et al. explain: ‘shale is much harder than coal, is much more impermeable, and is usually found deeper underground. Shale always requires fracturing in order to allow the gas to flow, simply because it is so impermeable’.\(^16\) Shale gas producers also usually employ directional or horizontal drilling to gain maximum exposure to the deposit.\(^17\)

The low permeability nature of shales also means that the amount of water produced is lower than coal seams, and since the gas is induced to flow by hydraulic fracturing, produced

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\(^10\) McCormick et al. (2013) op. cit., p. 7; CSIRO (2012) ‘What is Coal Seam Gas?’op. cit; Rutovitz et al. (2011) op. cit., p. 3.  
\(^11\) Produced water and the volume of produced water are discussed in detail in Chapter 2 of this paper.  
\(^12\) CSIRO (2012) ‘What is Hydraulic Fracturing?’ op. cit.  
\(^13\) Personal Communication with G. Mudd, 5 December 2013.  
\(^14\) ibid.; Rutovitz, et al. (2011) op. cit., p. 4.  
\(^16\) Rutovitz et al. (2011) op. cit., p. 3.  
\(^17\) NSW Chief Scientist & Engineer (2013) op. cit., p. 40.
water is controlled by the permeability and is not linked to the need to reduce the water pressure as in coal seams. Hence, shale gas extraction requires larger quantities of water for fracking than coal seam gas extraction does, but it does not produce the large quantities of water that CSG extraction does through the ‘dewatering’ process.

Notably, the discovery and exploitation of shale gas in the United States in recent years has transformed the US energy market. The fracking of shale in the US has also been the subject of the controversial documentaries *Gasland* and *Split Estate*, which argue that the industry is not sufficiently regulated and is having negative health and environmental impacts.

**Tight Gas**

Tight gas is found in rock with very low permeability at depths greater than 1000 metres. The CSIRO explains that the pores in the rock that contain the tight gas are ‘miniscule’ and that ‘the interconnections between them are so limited that the gas can only migrate through it with great difficulty’. All methods to increase the productivity of tight gas deposits are employed, including fracking and horizontal drilling. Tight gas, like shale gas, requires large quantities of water for fracking.

Figure 1 below demonstrates the different features of conventional and unconventional gas deposits and wells:

**Figure 1: Examples of Conventional and Unconventional Gas Deposits**

Source: NSW Chief Scientist & Engineer (2013)

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18 Personal Communication with G. Mudd, 5 December 2013.
20 ibid., p. 20; *Gasland* (2010) Directed by J. Fox, United States, Gasland Productions; *Split Estate* (2009) Directed by D. Anderson, United States, Red Rock Pictures. The United States is discussed in further detail in Chapter 5 of this paper.
21 NSW Chief Scientist & Engineer (2013) op. cit., p. 40.
23 NSW Chief Scientist & Engineer (2013) op. cit., p. 40.
24 ibid., p. 39.
Wells and Groundwater

As shown in Figure 1, a well has to pass through layers of different geological formations, including groundwater formations, to reach the gas. Groundwater is water that is located below the earth’s surface.\(^{25}\) It consists of water that has migrated from the surface through the ground and become stored in porous soils and rocks.\(^{26}\) The National Water Commission explains that these saturated soils and rocks are called aquifers and that the top of the saturated portion of ground is known as the water table.\(^{27}\) Australia is a dry continent and groundwater is a vital water source for agriculture, people and the environment.

Unconventional gas wells are constructed out of telescoping steel and cemented well casings to minimise the possibility of gas or fluids leaking out of a well and into nearby groundwater.\(^{28}\) It is important that unconventional gas production does not contaminate or interfere with groundwater resources. Groundwater and well integrity are discussed in further detail in Chapter 2 of this paper. Figure 2 below shows a schematic diagram of a coal seam gas well passing through an aquifer.

**Figure 2: Schematic Diagram of a Coal Seam Gas Well**

Source: NSW Department of Primary Industries, Office of Water (2013)\(^{29}\)

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\(^{27}\) ibid.


Conventional Gas Resources in Australia

Australia’s conventional gas resources are mostly located offshore from Western Australia in the Carnarvon, Browse and Bonaparte basins; offshore from Victoria in the Gippsland, Otway and Bass basins; and onshore in the Cooper-Eromanga Basin in South Australia. Geoscience Australia states that if current levels of production are continued, these conventional gas resources will last for around 60 years.

Victoria is Australia’s second largest producer of conventional gas after Western Australia. Most of Victoria’s gas comes from the Gippsland basin, with some coming from the Otway basin, and only a minor amount coming from the Bass basin. A large proportion of the Gippsland and Otway basins are located offshore, with a lesser portion located onshore. The Bass basin is entirely offshore in Bass Strait.

The Gas Market Taskforce, chaired by the former Commonwealth Government Minister the Hon. Peter Reith, explains that Victoria’s current conventional gas supplies are sourced offshore in Commonwealth waters beyond three nautical miles (about 5.5 kilometres) from the Victorian coastline. The gas extracted in the offshore fields in the Gippsland and Otway basins is processed onshore at the Longford, Minerva, Port Campbell and Iona processing plants. Gas from the Bass basin is transferred to Victoria for processing at the Lang Lang plant.

These large offshore resources of conventional gas mean that Victoria is the largest consumer of gas in the eastern states and has well developed gas infrastructure. Victoria is also a net gas exporter to other states in eastern Australia. The Gas Market Taskforce states that Victoria’s supplies of conventional gas will last about another 30 years.

Figure 3 on the following page provides a map of Australian gas fields, markets and key pipelines. Figure 4 shows the gas consumption in the eastern states in 2011-12.

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30 Geoscience Australia (2012) ‘Energy Basics: Gas’, Geoscience Australia website, viewed 21 November 2013, <http://www.ga.gov.au/energy/basics.html>. The gas industry makes a distinction between gas resources that are proven to exist and resources that potentially exist, as well as whether the gas can actually be extracted and sold. The conventional gas resources referred to above are an ‘economic demonstrated resource’ (EDR).

31 ibid.


33 The Gas Market Taskforce was established in December 2012 to provide policy options to the Victorian Government regarding the east coast gas market. The Taskforce report and recommendations are discussed in more detail in Chapter 4 of this paper.


36 ibid.


Figure 3: Australia’s Gas Basins and Key Pipelines

Source: Gas Market Taskforce and Geoscience Australia (2013) 40

Figure 4: Gas Consumption in Eastern States 2011-12

Source: Gas Market Taskforce and Bureau of Resources and Energy Economics (2013) 41

Gas represents a significant proportion of the overall energy consumption in Australia. According to the most recent data available from the Bureau of Resources & Energy Economics (BREE), gas made up 24.8 per cent of Australian energy consumption in 2010–11, with oil representing 36 per cent, coal 34.9 per cent, and renewables 4.3 per cent. In Victoria in 2010-11, as shown in Figure 5 below, gas represents approximately 19.4 per cent of energy consumption, with energy generated from coal representing 49 per cent of consumption.

Figure 5: Type of Energy as a Proportion of Total Energy Consumption, by Jurisdiction, 2010–11

Unconventional Gas Resources in Australia

Coal seam gas has been commercially produced in Australia since 1996 but the development of shale and tight gas resources is in its infancy. The vast majority of coal seam gas is being produced in Queensland in the Bowen and Surat basins. A small amount of coal seam gas is being produced in NSW in the Sydney basin. The first shale gas well in Australia began

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41 ibid., p. 12.
43 ibid., p. 24.
44 ibid.
operation in the Cooper Basin in South Australia in October 2012.\textsuperscript{46} Tight gas is yet to be commercially produced. The following sections provide statistics on potential resources of unconventional gas in Australia before providing an overview of the production of known unconventional resources in Australia.

**Potential Resources**

There are a number of estimates of the levels of unconventional gas in Australia, which vary due to the nature of unconventional gas deposits and developments in exploration. Resources are measured in a variety of ways: by energy (joules) and volume (cubic feet or metres). The common units of measurement are:

<table>
<thead>
<tr>
<th>Table 1: Units of Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abbreviation</td>
</tr>
<tr>
<td>tcf</td>
</tr>
<tr>
<td>tcm</td>
</tr>
<tr>
<td>PJ</td>
</tr>
</tbody>
</table>

**Source:** Bureau of Resources and Energy Economics (2013) *Gas Market Report*\textsuperscript{47}

According to BREE, Australia’s conventional and unconventional energy resources, measured in energy and volume, are as follows:

<table>
<thead>
<tr>
<th>Table 2: Australia’s Identified and Potential Gas Resources (2012)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resource category</td>
</tr>
<tr>
<td>----------------------------------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Conventional gas</td>
</tr>
<tr>
<td>Coal Seam Gas</td>
</tr>
<tr>
<td>Shale Gas</td>
</tr>
<tr>
<td>Tight Gas</td>
</tr>
<tr>
<td><strong>Total Gas</strong></td>
</tr>
</tbody>
</table>

**Source:** Bureau of Resources & Energy Economics (2012) *Gas Market Report*\textsuperscript{48}

Table 2 shows that while there are large potential resources of shale gas and CSG, conventional gas remains the largest source of gas that has been clearly identified as an economic demonstrated resource or ‘EDR’. BREE explains that EDR means the quantity of resources that is judged to be economically extractable under current market conditions with current technology.\textsuperscript{49}


According to the United States Energy Information Administration’s (EIA) 2013 survey of world shale deposits, Australia has great potential for the production of shale gas: ‘With geologic and industry conditions resembling those of the USA and Canada, Australia has the potential to be one of the next countries with commercially viable shale gas and shale oil production’. The EIA further states, however, that ‘with the remoteness of many of Australia’s shale gas and shale oil basins, development will likely proceed at a moderate pace’.

The EIA estimates 2,046 tcf of shale gas in-place, with 437 tcf of this technically recoverable. According to the EIA, this places Australia’s technically recoverable shale gas resources as the seventh largest in the world, behind China, Argentina, Algeria, USA, Canada and Mexico.

A study of shale gas in Australia which was published in May 2013 by the Australian Council of Learned Academies also found that shale gas is likely to be plentiful in Australia but that the lack of infrastructure in this country (relative to the United States) is likely to add to production costs.

**Unconventional Gas Production in Australia**

As previously stated, coal seam gas production is the most established mode of unconventional gas production in Australia. The first stand-alone production of CSG in Australia commenced in 1996 in Queensland, and annual production has grown from 1 petajoule in 1996 to 247 petajoules in 2011-12, which is more than 10 per cent of total gas production in Australia. The Australian Energy Regulator states that CSG represented 23 per cent of gas produced for the Australian domestic gas market in 2011–12.

BREE’s *Energy in Australia* 2013 emphasises that CSG has become an important part of the gas market, particularly the eastern Australia market:

> Production of coal seam gas (CSG) has increased significantly in the past five years, with its share of total Australian gas production, on an energy content basis, increasing from 2 per cent in 2002–03 to 12 per cent (and 39 per cent of Eastern market production) in 2011–12. Most CSG production is sourced from Queensland, which accounted for around 98 per cent of total CSG production in 2011–12 (New South Wales produces the remainder). Production of CSG is expected to continue to grow, with a number of projects under construction and planned in both states.

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51 ibid., p. III-2.


53 See Cook et al. (2013) op. cit.


Table 3 below presents BREE’s figures of gas production by state from 2007-2012. It shows that Western Australia and Victoria are still the largest producers of gas due to their conventional offshore resources. It also shows the increasing growth of CSG in Queensland since 2007-08.

Table 3: Australia’s Gas Production by State in Petajoules (2007–2012)

<table>
<thead>
<tr>
<th>State</th>
<th>2007-08</th>
<th>2008-09</th>
<th>2009-10</th>
<th>2010-11</th>
<th>2011-12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qld</td>
<td>28</td>
<td>27</td>
<td>21</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>Coal seam gas</td>
<td>129</td>
<td>150</td>
<td>195</td>
<td>233</td>
<td>241</td>
</tr>
<tr>
<td>Total</td>
<td>157</td>
<td>177</td>
<td>216</td>
<td>243</td>
<td>245</td>
</tr>
<tr>
<td>NSW</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coal seam gas</td>
<td>5</td>
<td>5</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Vic</td>
<td>313</td>
<td>274</td>
<td>270</td>
<td>342</td>
<td>334</td>
</tr>
<tr>
<td>SA</td>
<td>78</td>
<td>134</td>
<td>107</td>
<td>41</td>
<td>45</td>
</tr>
<tr>
<td>WA</td>
<td>1143</td>
<td>1235</td>
<td>1371</td>
<td>1439</td>
<td>1458</td>
</tr>
<tr>
<td>NT</td>
<td>22</td>
<td>22</td>
<td>27</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Australia</td>
<td>1717</td>
<td>1846</td>
<td>1997</td>
<td>2091</td>
<td>2353</td>
</tr>
</tbody>
</table>

Source: Bureau of Resources and Energy Economics (2013) Energy in Australia

In regard to coal seam gas already being produced in Queensland and New South Wales, proponents argue that the gas is highly valuable, both as a domestic energy source and as a future export commodity. It is seen as a driver of economic development, employment, export income and revenue.

Queensland, LNG Export and the Eastern Gas Market

The growth of Queensland’s coal seam gas production has led to plans for the state to export CSG overseas in the form of liquefied natural gas or ‘LNG’. This is an important development because it will affect the operation of the gas market in eastern Australia.

Australia has three gas markets: the eastern gas market, the western gas market and the northern gas market. Importantly, as was shown in Figure 3, these markets are not connected. They are geographically and economically distinct. Victoria, New South Wales, Queensland, South Australia and Tasmania are all connected by gas pipelines and form the eastern gas market. While the western market exports its gas overseas (as well as using it domestically), the eastern gas market only provides gas for use in eastern Australia. It does not export gas.

This, however, is about to change as almost $60 billion in capital is currently being invested by gas companies in developing the Queensland port of Gladstone for the export of LNG to overseas markets from 2014. It is expected that when eastern Australia is connected to

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the international gas market, the price of gas in eastern Australia will increase from its relatively low domestic price to reach international parity.\textsuperscript{61}

The Gas Taskforce Report and a recent report by the Grattan Institute titled \textit{Getting Gas Right} (2013) address this issue in detail. These reports state that increasing the supply of gas, by allowing unconventional gas production in Victoria and increasing production in the other states, will help to combat the price rise.\textsuperscript{62} Conversely, the New South Wales Parliamentary Inquiry into coal seam gas in 2012 found that evidence on the matter was ‘highly conflicting’ and the price rise will not be influenced by the development of coal seam gas in NSW:

The Inquiry received highly conflicting evidence in regard to the potential impact of the coal seam gas industry on energy security and the price of gas in New South Wales. It appears likely that when coal seam gas produced in Queensland begins to be exported to Asia, gas prices will increase, as Australia’s East Coast gas market will be influenced by the higher gas prices paid internationally. Price rises are likely regardless of whether we develop coal seam gas reserves in New South Wales.\textsuperscript{63}

\textbf{Unconventional Gas Resources in Victoria}

At present, Victoria has no coal seam gas or shale gas production or confirmed resources. The parts of Victoria with the highest potential for unconventional gas are the Gippsland and Otway basins. Since 2000, a number of exploration licences have been issued and exploratory drilling undertaken. If located, the feasibility of successful extraction of CSG or shale gas is uncertain. Notably, the exploration company Lakes Oil found tight gas in Gippsland in 2004, which is yet to be produced. There is the potential for more tight gas to be found in the Gippsland and Otway basins for which the feasibility of extraction would need to be determined.\textsuperscript{64}

In regard to Victoria’s potential coal seam gas resources, it is important to note that the production of CSG in Queensland and New South Wales is from black coal deposits (bituminous and sub-bituminous coals). The kind, or rank, of coal is an integral factor in determining the gas properties of coal seams. It may be that Victoria’s brown coal (lignite) deposits yield less coal seam gas than black coal deposits. It may also be the case that if there is coal seam gas in Victoria’s brown coal deposits it may be harder to extract and hence more costly to produce than CSG from black coal deposits.\textsuperscript{65}

\textsuperscript{61} ibid., pp. 8, 11.
It is challenging at this early stage to estimate the costs of production of potential unconventional gas resources in Victoria. A 2012 Core Energy Group paper prepared for the Australian Energy Market Operator provides modelling of the costs of production in current and prospective gas fields in eastern Australia. According to its modelling, the prospective costs of supply of unconventional gas from Victoria’s onshore basins would be high relative to other conventional and unconventional fields or basins in eastern Australia (see Appendix 2).

The Core Energy Group paper states that the sources with high projected costs of supply 'are typified by fields/basins of lower geographical quality, resulting in lower well productivity and increased cost of extraction.' The paper argues that the primary factors influencing the higher cost of CSG extraction from the onshore Otway basin are that the CSG is relatively deep underground (deep wells are significantly more costly) and has a higher CO₂ content that would require additional facilities to process. The paper argues that low permeability in the onshore Gippsland basin would require deep horizontal drilling and fracking in order to develop the target sections, resulting in expensive well costs.

The exploration for unconventional gas resources in Victoria and how the exploration is regulated is discussed in Chapters 3 and 4 of this paper.

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67 ibid., p. 22.
68 ibid., p. 23.
69 ibid.
Chapter 2: Identified Potential Issues with Coal Seam Gas

The longer history of the coal seam gas industry in Australia has meant that there is more community emphasis on coal seam gas, and an increasing body of work on CSG production, while shale and tight gas are less understood. Accordingly, this section of the paper focuses primarily on issues that are being identified with the production of coal seam gas in the Australian context.

Key reports on the potential impacts of coal seam gas production in Australia, informing political debate, include:

- The NSW Legislative Council General Purpose Standing Committee No. 5, 2012 *Inquiry into Coal Seam Gas* (‘NSW Parliamentary Inquiry’);
- COAG’s Standing Council on Energy and Resources (SCER) 2013 *National Harmonised Regulatory Framework for Natural Gas from Coal Seams*; and
- The NSW Chief Scientist and Engineer Professor Mary O’Kane’s 2013 *Initial Report on the Independent Review of Coal Seam Gas Activities in NSW* (‘O’Kane Report’).

The body of available literature, including these key reports, identifies a number of potential issues with the production of coal seam gas that may have negative environmental and social impacts. These issues include: the large amount of water pumped out of coal seams to release the gas and the potential associated impacts this may cause; the potential environmental implications of fracking which may involve the risk of creating new fractures in the rock that intersect adjacent aquifers and contaminate water resources; and the leakage of methane, also known as ‘fugitive emissions’.

Additionally, coal seam gas, and shale and tight gas, can be located under privately owned agricultural land. In Victoria, as in the rest of Australia, the Crown owns the mineral and petroleum resources under privately owned land. The state government, on behalf of the Crown, licenses companies to explore for and extract unconventional gas. There is concern that farms may be impacted by the access and use of land and water resources by gas companies. These issues are examined in more detail below.

Firstly, however, it is important to note that these issues are complex and contested. Additionally, government reviews are recommending that identified issues can be successfully mitigated with adherence to best practice guidelines (which are discussed in Chapter 4 of this paper).
Produced Water

The potential impact of coal seam gas extraction on groundwater resources is a significant source of community concern.71 As stated earlier, coal seam gas extraction requires the removal of large volumes of water from coal seams to release the gas. The CSIRO explains that once the water and gas reach the surface they are separated. The gas is then sent to a central compressor station and delivered to markets by pipeline. The water is piped elsewhere for use or further treatment.72

This water is usually called ‘produced water’ or ‘CSG water’. The O’Kane Report explains that ‘produced water is commonly saline and can contain other chemicals either naturally from the seam or as a result of hydraulic fracturing’.73 The management of the produced water is of key importance to the gas industry.74

Volume of Produced Water

The CSIRO states that the amount of water produced by a coal seam gas well can vary, but in Queensland, water production averages about 20,000 litres per well per day.75 As the Commonwealth Parliamentary Library elaborates by drawing on reports from the Queensland Water Commission and Melbourne Water:

An average CSG well in Queensland withdraws about 20,000 litres of water per day from the coal seam. A typical CSG field contains between several dozen and several hundred wells, which means that a single CSG field can withdraw millions of litres of water every day. In 2011, CSG production in the Surat basin in Queensland [one of several CSG producing areas in Queensland] withdrew 18 gigalitres per annum [one gigalitre is 1,000,000,000 litres]; this could increase to 125 gigalitres per annum when full CSG production in the basin is achieved. As a comparison, homes and businesses in Melbourne consumed 365 gigalitres in 2011-12.76

Depletion of Groundwater and Inter-Aquifer Connectivity

The concern is that the removal of large quantities of water may deplete groundwater and drawdown the water table, which could impact on other water users such as farmers (for example by affecting the levels of nearby bore water) and the environment in general.77 The SCER explain that ‘If there are inter-aquifer connections with coal seams, surrounding groundwater is likely to be affected through pressure reductions or falling underground water levels’.78 The O’Kane Report similarly states that:

Worry about how groundwater extraction during CSG activities will affect the water table is one of the most often raised concerns due to the possible impacts on the availability of

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71 COAG, Standing Council on Energy and Resources (2013) op. cit., p. 35.
73 NSW Chief Scientist & Engineer (2013) op. cit., p. 52.
76 McCormick et al. (2013) op. cit., p. 8.
77 COAG Standing Council on Energy and Resources (2013) op. cit., p. 46.
groundwater for regional communities, farmers and the environment. Groundwater is accessed for stock, irrigation and other bore water use for regional areas, and is also critical for providing base flow to some rivers, streams and lakes as well as ecosystems dependent on groundwater-fed springs.\textsuperscript{79}

Water production from a coal seam gas well can last for approximately 15 years depending on the actual geological formation.\textsuperscript{80}

\textbf{Subsidence}

The dewatering of coal seams could potentially lead to subsidence of the ground surface. The Williams Report states that: ‘Subsidence within a landscape is generally expected when groundwater aquifers are dewatered. It is a well-understood process in over-exploited groundwater systems around the world. Land subsidence over large areas can effect surface-water systems, ecosystems, irrigation and grazing lands’.\textsuperscript{81} It is also possible that hydraulic fracturing can lead to subsidence.\textsuperscript{82} The potential for subsidence depends on the geology and hydrogeological conditions of the region. Estimates of predicted subsidence of CSG fields vary.\textsuperscript{83} A subsidence monitoring program is currently being undertaken in Queensland.\textsuperscript{84}

\textbf{Quality of Produced Water}

An additional concern with the removal of groundwater for coal seam gas production is, as stated previously, that the produced water tends to be saline, and can contain geogenic materials or chemicals from fracturing. The SCER defines 'geogenic material' as 'contamination of naturally occurring elevated concentrations of certain elements, such as arsenic, fluoride, uranium or selenium, in groundwater which have a negative effect on human health'.\textsuperscript{85} The CSIRO states that the quality of produced water varies from site to site but is generally not fit for human consumption.\textsuperscript{86} Associate Professor L.D. Nghiem et al., from the University of Wollongong, state that ‘In general, without any treatment or amendment, CSG water is often not suitable for direct surface discharge or irrigation’.\textsuperscript{87} Nghiem et al. further state that CSG water may be fit for livestock to drink but that can only account for a small portion of the total CSG water produced.\textsuperscript{88}

\textbf{Disposal of Produced Water}

Beneficial uses of produced water – such as using it for irrigation or drinking water – are limited without treatment such as reverse osmosis (desalination). Additionally, as the SCER states, the ‘treatment of produced water using desalination technologies results in brine and, ultimately, salt residues that must be appropriately managed’.\textsuperscript{89} This saline brine or solid salt can require further treatment or disposal.\textsuperscript{90} The Williams Report states that: ‘A well

\textsuperscript{79} NSW Chief Scientist & Engineer (2013) op. cit., p. 67.
\textsuperscript{80} Nghiem et al. (2011) op. cit., p. 317.
\textsuperscript{81} Williams et al. (2012) op. cit., p. 53.
\textsuperscript{82} NSW Chief Scientist & Engineer (2013) op. cit., p. 78.
\textsuperscript{83} See ibid., pp. 79; Williams et al. (2012) op. cit., pp. 53-54.
\textsuperscript{84} See NSW Chief Scientist & Engineer (2013) op. cit., p. 83.
\textsuperscript{87} Nghiem et al. (2011) op. cit., p. 318.
\textsuperscript{88} ibid., pp. 319-320.
\textsuperscript{89} COAG Standing Council on Energy and Resources (2013) op. cit., p. 47.
discharging 20,000 L/day of saline water with 5,000 mg salt/L will yield about 100 kg of salt a day’. 91

In regard to the disposal of untreated CSG water, the CSIRO states that: ‘In Queensland most untreated produced water was, historically, disposed of in evaporation ponds ranging from 1 to 100 hectares in area. In 2010 evaporation ponds were discontinued as a primary means for the disposal of CSG water because of concerns over leakage of saline waters into soils, aquifers and rivers’. 92 The Williams Report states that the disposal of salt and associated chemicals is a major challenge that awaits resolution. 93

**Induced Seismicity**

One way of dealing with produced water is to reinject it into underground water systems. This reinjection can, however, potentially induce seismicity (cause earthquakes). 94 It is important to note that the seismic activity/earthquakes can be small and barely noticeable at surface level. The O’Kane Report explains that earthquakes can be triggered or ‘induced’ by human activities such as ‘filling of large water reservoirs, mining and activities involving pumping fluids into and out of the crust, such as required in hydrocarbon extraction, geothermal activity and some water resource activities’. 95

The O’Kane Report further states that it is the reinjection of produced water underground rather than fracking that is most likely to induce seismic events:

> Induced seismic events are unlikely to occur due to activities directly related to CSG, such as hydraulic fracturing, since the extraction activities occur within shallow sedimentary rocks that limit these seismic events from occurring. However, any reinjection of produced water does pose risks of causing induced seismicity. Reinjection of water in the USA has been associated with seismic events up to a magnitude 5.7 ML. 96

The SCER also identifies that the reinjection of produced water has the potential to cause ‘seismic events of sufficient magnitude to cause damage at the surface’. 97 The SCER also notes, however, that ‘While the reinjection of produced water is an issue, it is also an important leading practice for recycling produced water for beneficial use’. 98

**Well Integrity**

The integrity of the gas well is identified as critical to the protection of ground and surface water resources. 99 The available literature emphasises that making sure that wells are of high

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91 Williams et al. (2012) op. cit., p. 49.
93 Williams et al. (2012) op. cit., p. 105.
95 NSW Chief Scientist & Engineer (2013) op. cit., p. 86.
96 ibid., p. 90.
98 ibid.
99 ibid., p. 26; Williams et al. (2012) op. cit., p. 26. The SCER provide a detailed definition of ‘well integrity’ which states that it ‘Describes the application of technical, operational and organisational solutions to the construction, operation and decommissioning of wells so that the uncontrolled release of fluids, solids and gases into the subsurface or surface environment can be prevented over the full life cycle of the well’: COAG Standing Council on Energy and Resources (2013) op. cit., p. 80.
quality construction and do not leak is fundamental to best practice CSG production. The SCER explains that:

As a well is drilled, it will pass through the various [geological] formations including formations that separate aquifers from each other and from the coal seams. To prevent cross-flow of gas or water between different geological formations, companies apply a strategy of ‘zonal isolation’ with a system of steel casings and cement placed within a well.\(^\text{100}\)

The SCER emphasises that the design, construction, maintenance and decommissioning of a well needs to be done carefully at best practice level. It states that poor well integrity – ‘caused by ineffective cementing, the use of inappropriate materials, failed well casings or other well construction, operational or decommissioning shortcomings’ – could lead to the following potential impacts:

- Hydraulic connectivity between otherwise isolated aquifers with different water qualities causing contamination and potentially unwanted alterations to water flows;
- Contamination of water at the surface and subsurface by drilling and hydraulic fracturing fluids and geogenic (naturally occurring) compounds; and
- Migration of gas into surrounding aquifers, wells and water bores, and the surface.\(^\text{101}\)

The SCER also states that ‘Over-pressurisation of the well head due to poor operational practices or through encountering over-pressurised formations in the subsurface’ could potentially lead to ‘A blowout at the surface or in the subsurface which may cause injury to the drilling crew and contamination by allowing the escape of drilling and hydraulic fracturing fluids and gas into groundwater or the surface’.\(^\text{102}\)

### Fracking

As stated earlier, hydraulic fracturing or ‘fracking’ (sometimes also called ‘fraccing’) is a method used by the oil and gas industry to increase the rate and amount of oil or gas extracted from reservoirs. Hydraulic fracturing is the most common method used to increase the production from a coal seam gas well, but not all coal seam gas wells require fracturing.\(^\text{103}\) Although the media often focus on fracturing as the key issue of coal seam gas production, it is important to emphasise the point that coal seam gas wells do not always require fracting. Shale and tight gas wells do, however, require fracting.

Fracking involves injecting fluid made up of water, sand and chemicals down the well to ‘stimulate’ or ‘fracture’ the coal seam to allow the gas flow more freely. Summarising CSIRO information, the NSW Parliamentary Inquiry Report states that:

…fraccing involves the injection of fluid, comprised of water, sand and additives, under high pressure into a well that has been cased in steel but perforated at specific intervals to allow the fracture to occur in the coal seam. The sand acts as a proppant, keeping the coal seam open and allowing the gas to flow to the well and rise to the surface. It is considered to be

\(^{100}\) COAG Standing Council on Energy and Resources (2013) op. cit., p. 27.

\(^{101}\) ibid., p. 29.

\(^{102}\) ibid.

an efficient extraction practice which allows the flow of gas to occur up to 10 times faster, thus reducing production costs.104

Once the fractures are made the fracking fluid flows back to the wellbore and is pumped to the surface. The fracking fluid then needs to be stored for reuse or appropriately disposed of at an approved site.105 Figure 6 on the following page shows a schematic diagram of the fracking process.

According to the CSIRO, fracking is already used in Australia by the geothermal and gas industries. Fracking of petroleum wells, as distinct from CSG wells, has occurred in most states and most often in South Australia and Queensland. The rise of the CSG industry in Queensland and New South Wales has seen fracking of CSG wells occur in those states.106

**Extent of CSG Fracking in Queensland and New South Wales**
The extent of fracking of CSG wells in Queensland and New South Wales is difficult to determine precisely. The SCER states that: ‘Since 2000, around 8 per cent of wells in QLD have been hydraulically fractured. The industry estimates that between 10 and 40 per cent of wells yet to be drilled for current developments across Australia may need some method of flow enhancement, including hydraulic fracturing’.107 In regard to New South Wales, the NSW Parliamentary Inquiry states that they ‘received widely varying evidence on the extent of fracking’.108 The NSW Parliamentary Inquiry found that:

AGL Energy, being the only company to be in full production within New South Wales, recorded significant use, having fractured 131 of the 205 wells constructed under the Camden Gas Project. Metgasco claimed it has never used fracking in its coal seam gas operations and estimated that only five per cent of the coal seam gas wells in Australia are fracced. Santos also submitted that it has not used fracking in its New South Wales operations, but as the new operators of the Narrabri Gas Project, reported that 12 wells in this gas field had previously been fractured.109

**Potential Environmental Impacts of Fracking**
Potential environmental implications of hydraulic fracturing of CSG wells include the risk of creating new fractures that intersect adjacent aquifers and contaminate water resources with fracturing fluid chemicals, methane or geogenic materials. There is also the identified risk of spills when fracking fluids flow back to the surface. It is also suggested that hydraulic fracturing may lead to an increase in seismic activity although, as stated earlier, the reinjection of produced water into aquifers may be more likely to induce seismic events than fracking.110

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104 NSW Legislative Council (2012) op cit., p. 65.
105 NSW Chief Scientist & Engineer (2013) op. cit., p. 55.
108 NSW Legislative Council (2012) op. cit., p. 66.
109 ibid.
110 COAG Standing Council on Energy and Resources (2013) op. cit., p. 54; NSW Chief Scientist & Engineer (2013) op. cit., p. 86.
Figure 6: The Hydraulic Fracturing (Fracking) Process

Note: chemicals may also be injected into the well with the water and sand.

Source: APPEA (2013)\textsuperscript{111}

Use of Chemicals in Fracking Fluids

The use of chemicals in fracking CSG wells and the risk of contamination are causes of community concern. The CSIRO states that water and sand compose approximately 97 to 99 per cent of fracking fluids and added chemicals compose approximately 1 to 3 per cent.\(^\text{112}\) The CSIRO further states that the exact nature of fracking mixtures used by CSG companies varies from well to well.\(^\text{113}\) The SCER similarly states that:

\[
\ldots\text{chemical additives, which typically make up 0.1 to 2 per cent of the hydraulic fracturing fluid composition, vary depending on the application, the nature of the coal seam, the operator and, in some cases, the legislation and regulations applying to the area in which the well is being drilled.}\(^\text{114}\)
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The availability of the information detailing what chemicals are actually used in the fracking fluid is contested.\(^\text{115}\) The Australian Petroleum Production & Exploration Association (APPEA), the peak body representing the oil and gas industry in Australia, states that ‘Companies must identify the chemicals being used in any fracking operation and detail any likely interactions with the water and rock formations in the area being fracked’.\(^\text{116}\) The NSW Parliamentary Inquiry found, however, that Inquiry participants emphasised the lack of transparency around the chemical composition of fracking fluids. It determined that: ‘The Committee did not receive evidence that addressed the exact composition of fracking fluids and the Committee received broad information only on the quantities and names of chemicals used’.\(^\text{117}\)

The NSW Parliamentary Inquiry also noted that Inquiry participants were concerned about the lack of appropriate testing of fracking chemicals by the National Industrial Chemicals Notification and Assessment Scheme (NICNAS).\(^\text{118}\) This issue was also addressed in an edition of ABC’s *Four Corners*.\(^\text{119}\) The SCER states that ‘NICNAS has not assessed any chemicals for their use in hydraulic fracturing’ and notes that both the NSW Parliamentary Inquiry and the Senate Committee recommended that further research is needed in assessing the combination and cumulative effects of chemical mixtures to identify potential risks to human health and the environment.\(^\text{120}\)

The SCER states that the Australian Government has commissioned a multi-staged project to assess fracking chemicals that will be jointly undertaken by NICNAS, the CSIRO, the Department of Environment and Geoscience Australia.\(^\text{121}\) This project, titled the ‘National

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\(^{113}\) ibid.

\(^{114}\) COAG Standing Council on Energy and Resources (2013) op. cit., p. 61.

\(^{115}\) See NSW Legislative Council (2012) op. cit., pp. 67-69.


\(^{117}\) NSW Legislative Council (2012) op. cit., p. 69.

\(^{118}\) ibid., p. 71.


\(^{120}\) COAG Standing Council on Energy and Resources (2013) op. cit., p. 66.

\(^{121}\) See ibid.
Assessment of Chemicals Associated with Coal Seam Gas Extraction in Australia’, commenced in July 2012 and is expected to be completed by 2014. According to NICNAS, the National Assessment will examine human health and environment risks from chemicals used in drilling and fracking for CSG. NICNAS further states that:

The geological and groundwater conditions at each drilling site determine the processes and chemicals used to extract CSG. As part of the project, NICNAS is conducting a voluntary industry survey of companies involved in CSG extraction in Australia. The main aim of the survey is to identify the chemicals (and their functions) used in CSG extraction in Australia.

Notably, the SCER states that the addition of ‘BTEX’ compounds – benzene, toluene, ethylbenzene and xylene – to drilling and fracking fluids has been prohibited in Queensland, New South Wales, Victoria and the Northern Territory.

**Fugitive Emissions**

Natural gas is often presented as a transitional fuel in the move to a lower carbon economy because it produces less carbon dioxide than burning coal for comparable electricity generation. There is debate, however, over whether methane leaks during CSG operations – called ‘fugitive emissions’ – could mean that CSG has a greater greenhouse gas impact than was previously thought. Methane is a powerful greenhouse gas. As the O’Kane Report explains, methane has a global warming potential, defined by the Intergovernmental Panel on Climate Change as 21 times that of carbon dioxide.

Fugitive emissions of methane can happen during a number of stages of CSG production such as drilling, extraction, storage, piping and treatment. It is argued that there is a significant level of uncertainty over the amount of fugitive emissions across the lifecycle of production and the accuracy with which they are measured. The NSW Parliamentary Inquiry found that Inquiry participants presented different views on the likely level of fugitive emissions. The Committee determined that: ‘While it is impossible to reach a definitive

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124 COAG Standing Council on Energy and Resources (2013) op. cit., p. 65. BTEX chemicals are volatile organic compounds that can cause serious health effects. See NSW Legislative Council (2012) op. cit., pp. 69-70.
125 ibid., pp. 91-92.
126 ibid., p. 91.
128 See NSW Chief Scientist & Engineer (2013) op. cit., pp. 91-97; NSW Legislative Council (2012) op. cit., pp. 194-203.
129 NSW Legislative Council (2012) op. cit., p. 203.
conclusion as to the greenhouse gas emissions of Australian coal seam gas, the Committee
cconsiders it likely that at worst the greenhouse gas emissions produced from coal seam gas
would be equal to those produced by coal'.

It is argued that accurate estimation and measurement of fugitive emissions from CSG
activities would help to inform the debate over the greenhouse gas impact of CSG. Furthermore, fugitive methane emissions result in lost product and revenue for the CSG
industry, so it is in the industry's interest to minimise the emissions.

The O'Kane Report states that fugitive emissions are created by various industries and that
industry emissions are measured or estimated annually and reported under the National
Greenhouse Gas Emissions Reporting Scheme (NGERS). It further states that the relevant
Commonwealth departments are working to address 'numerous criticisms' related to the
application of NGERS measurement methods to the CSG industry so as to make the
methods more effective.

It is important to note that methane leaks also occur naturally in the environment and
through existing groundwater bores. The O'Kane Report explains that this makes measuring
fugitive emissions directly from CSG activities more complex and underlines the importance
of gathering baseline data prior to beginning CSG production:

The occurrence of natural methane leaks through fault lines raises the importance of both
obtaining baseline measurements of methane over a period of time (to account for seasonal
variations) and using sophisticated techniques to monitor the area, to be able to distinguish
between natural sources of methane, methane being emitted through other bores, and CSG
fugitive emissions.

Fugitive Emissions in the Media
Fugitive methane emissions attributed to unconventional gas productions – shale in the case
of the US and CSG in Australia – have received attention in the media. The US documentary
Gasland includes footage of householders being able to light methane coming through water
taps inside their homes. In Australia, footage of methane leaking water bores being set
alight have been shown in programs such as ABC's Four Corners. Unprecedented levels of
methane bubbling up in the Condamine River in Queensland have also received media
attention. Whether or not these examples of methane leakage can be attributed to

131 ibid.
132 NSW Chief Scientist & Engineer (2013) op. cit., p. 96
133 ibid., p. 91.
134 See ibid., p. 93.
135 ibid.
136 Gasland (2010) op. cit. For an opposing view see Australian Petroleum Production & Exploration
137 ABC Television (2013) ‘Gas Leak!’, Four Corners, 1 April, viewed 11 November 2013,
138 See for example J. McCarthy (2013) ‘Government Report Points the Finger at CSG as Cause for Bubbles in
the Condamine River’, The Courier Mail, 2 August, Courier Mail website, viewed 11 November 2013.
fugitive emissions from nearby shale or CSG production, or are naturally occurring, is contested by different stakeholder groups.\(^\text{139}\)

**Lack of Data and Data Sharing**

There is considerable scientific uncertainty over the long-term impact of unconventional gas production on the environment. Concerns centre on the lack of data – and a lack of sharing of known data – on groundwater systems, CSG activities and their potential impacts. The imperative to gather baseline data prior to the commencement of production is frequently emphasised, as is the need for regulators to consider cumulative impacts.

The NSW Parliamentary Inquiry findings articulate the views expressed in much of the available literature that more work needs to be done to understand the operation of groundwater systems, particularly in regard to the interconnection of aquifers in areas where CSG production is planned or underway.\(^\text{140}\)

The CSIRO states that groundwater impacts may not become evident for years and ongoing research will be important: ‘Prediction of specific impacts of CSG developments requires ongoing research because groundwater responses may take decades or centuries to move through aquifers, especially when groundwater flow velocities are slow’.\(^\text{141}\) Dr Matthew Currell, Lecturer in Hydrogeology at RMIT, similarly states that while industry proponents ‘may not like to hear it’ a ‘long period of data collection and hydrogeological investigation is needed to make confident predictions with groundwater models. Proper assessment of the impacts of large coal mining and coal seam gas developments on groundwater are going to need time and resources’.\(^\text{142}\)

The NSW Parliamentary Inquiry findings also emphasise the widely held view of the importance of gathering baseline data prior to the commencement of CSG activity.\(^\text{143}\) It also identifies that ‘there seems to be a dearth of information on the potential cumulative impacts of multiple coal seam gas projects’ and recommends that ‘the Commonwealth and State governments must take concerted action as a matter of urgency to develop models of cumulative impacts’.\(^\text{144}\)

Additionally, the available literature emphasises that the lack of data and lack of sharing of existing data may be hindering effective monitoring and compliance reviews of the coal seam gas industry.\(^\text{145}\) The NSW Parliamentary Inquiry further states that:

> The Committee notes that much of the data needed to answer key questions on potential water impacts is held by coal seam gas companies. It appears that some companies consider this data to be commercial in confidence and are unwilling to share it. The Committee


\(^{140}\) NSW Legislative Council (2012) op. cit., pp. 17-28.


\(^{143}\) NSW Legislative Council (2012) op. cit., p. 24.

\(^{144}\) ibid., p. 26, also see pp. 21-25.

believes that access to this data is crucial to assessing the cumulative impacts of the coal seam gas industry.\textsuperscript{146}

The O’Kane Report similarly highlights that existing data kept by industry, government agencies and researchers is not always accessible and needs to be shared.\textsuperscript{147} The Report emphasises that the ‘fundamental requirement’ to enable accurate monitoring and oversight of CSG activities is data.\textsuperscript{148} It states that: ‘A coordinated approach to data collection and sharing is required to ensure that all of the monitoring data from relevant activities is available to highlight potential impacts. This will require cooperation between different government organisations, industry and researchers to share information and expertise’.\textsuperscript{149}

\textbf{Agriculture and Land Access}

Coal seam gas deposits are often under prime agricultural land, such as the Darling Downs in Queensland, the Liverpool Plains in NSW, and potentially Gippsland in Victoria.\textsuperscript{150} As previously stated, the Crown owns the mineral and petroleum resources under privately owned land and the state government (on behalf of the Crown) licenses companies to explore for and extract gas. The gas companies negotiate access agreements with individual landholders and provide compensation for the disruption to and impact on the property. Ultimately, the landowners have no legal right to refuse the gas company access to their land (this subject is discussed in more detail in Chapter 3 of this paper).\textsuperscript{151}

There is concern among farmers, but not all farmers, that access and use of farmland and water resources by gas companies will be harmful to agricultural production and food security. There is further concern that compensation paid by the companies will not be adequate to address environmental damage such as the potential contamination and loss of water resources.\textsuperscript{152} Additionally, some farmers are concerned that CSG activity on their land or adjoining land will reduce the value of their properties.\textsuperscript{153} There is also apprehension over the rehabilitation of land once the industry is gone.\textsuperscript{154}

The surface footprint of CSG infrastructure is also of concern to landholders. The CSIRO explains that wells are generally laid out in a grid pattern about 750 metres apart and connected by a network of roads, pipelines and compressor stations.\textsuperscript{155} The development phase when the wells are drilled can involve substantial intrusion onto the property (e.g. trucks, light, erosion, noise and dust) and interruption of farming operations and domestic

\begin{flushleft}
\textsuperscript{146} NSW Legislative Council (2012) op. cit., p. 27.
\textsuperscript{147} NSW Chief Scientist & Engineer (2013) op. cit., pp. 117, 121-126.
\textsuperscript{148} ibid., p. 121.
\textsuperscript{149} ibid., p. 117.
\textsuperscript{151} NSW Legislative Council (2012) op. cit., p. 131.
\textsuperscript{152} ibid., pp. 131, 162.
\textsuperscript{153} ibid., pp. 155-159.
\textsuperscript{154} See Senate Rural Affairs and Transport References Committee (2011) op. cit., pp. 66-67.
\end{flushleft}
life.\textsuperscript{156} For farms that grow crops, there is concern that the large machinery farmers invest in for cropping will not have the space needed to operate if it is impeded by CSG infrastructure.\textsuperscript{157}

The Senate Committee Inquiry found that agriculture should not be placed at risk by poorly regulated gas extraction and lists some further concerns additional to the ones identified above. It states that:

\begin{quote}
The coal seam gas industry is a relatively short lived industry. It may have a life of only 25 to 30 years in most regions. However, if it is not properly regulated, that period of time is sufficient to do serious damage to agricultural productivity on some of the best farmland in Australia. Landholders are legitimately concerned about water supply, disturbance to livestock, erosion caused by access roads and pipelines, interruption to natural drainage flows, damage to soil, particularly from salt, and the spread of noxious weeds.\textsuperscript{158}
\end{quote}

Governments and the CSG industry state that agriculture and CSG production can successfully co-exist, with the land being used for multiple functions, when industry best-practice standards are adhered to (which is discussed in Chapter 4 of this paper).\textsuperscript{159}

**Impact of Surface Infrastructure on Environment**

In addition to impacting agricultural land, it is also identified that CSG production can impact on native vegetation, biodiversity and threatened species.\textsuperscript{160} The Williams Report states that potential impacts of the infrastructure footprint of CSG wells, roads, pipes and compressor stations, include the clearing of bushland, fragmentation of important remnant native vegetation, the spread of invasive species and the increased risk of bushfires.\textsuperscript{161} CSG operations in the Pilliga state forest in NSW have been used as an example of the industry’s impact on native habitat, in regard to clearing and fragmentation, and in regard to the poor management of spills of contaminated water and lack of regulatory oversight.\textsuperscript{162}

\begin{footnotesize}
\begin{enumerate}
\item Senate Legislative Council (2012) op. cit., pp. 162-163.
\item Williams et al. (2012) op. cit., p. 32.
\item ibid., p. 105. For further information see ibid., pp. 30-37, 105-106.
\end{enumerate}
\end{footnotesize}
Chapter 3: Victoria’s Current Regulatory Framework for Unconventional Gas

In Australia, it is the state and territory governments that have responsibility for the regulation of onshore mineral and petroleum resources including unconventional gas. State and territory responsibilities include licensing mineral and petroleum exploration and development, setting conditions on licences, assessing environmental impacts, monitoring and enforcing industry adherence to regulation, as well as the collection of royalties from mineral and petroleum production. This chapter provides an overview of the current regulatory framework for unconventional gas in Victoria and details of current exploration licences.

Because unconventional gas is a relatively new industry, with no current production in Victoria, existing Victorian regulatory frameworks may need to be further developed – to address the specific issues engendered by the industry – if it is determined that the state will have an unconventional gas industry. Regulatory developments are discussed in the following chapter.

The MRSD and Petroleum Acts

In Victoria, the licensing for exploration and production of CSG is regulated under the Mineral Resources Sustainable Development Act 1990 (MRSD Act). Licensing for the exploration and production of shale and tight gas is regulated under the Petroleum Act 1998. Victoria is different to other states in that it regulates unconventional gas through two Acts. In other states CSG is regulated under petroleum legislation.

Mineral and petroleum exploration and development in Victoria are also subject to a number of other Acts, including the Native Title Act 1993 (Cth), the Aboriginal Heritage Act 2006 (Vic) and the Environment Protection and Biodiversity Conservation Act 1999 (Cth).

Previously, the MRSD and Petroleum Acts were administered by the former Department of Primary Industries (DPI). When, on 9 April 2013, the DPI amalgamated with the Department of Sustainability and Environment to form the Department of Environment and Primary Industries, the administration of the Acts shifted to the Department of State Development, Business and Innovation (DSDBI). The MRSD Act and the Petroleum Act are now administered by the Earth Resources Regulation Branch in the Corporate Planning and Compliance Services Division of the DSDBI.

The following sections outline the provisions relating to the licensing for the exploration and production of CSG under the MRSD Act, and then the licensing for shale and tight gas under the Petroleum Act.

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165 Personal Communication with DSDBI Officer, 18 November 2013.
The MRSD Act and Coal Seam Gas

The MRSD Act regulates the grant of licences and other approvals for both exploration and production of minerals, coal and coal seam gas. The MRSD Act additionally provides for issues such as compensation for landholders, rehabilitation of land once production has finished, royalties for exploration and development, and enforcement.166 The MRSD Act provides for the issuing of four main types of licences. They are:

- Exploration licences – enabling the holder to carry out exploration activities on the land covered by the licence;
- Mining licences – enabling the holder to carry out mining, exploration, construction and any other activities incidental to mining on the land covered by the licence;
- Prospecting licences – enabling the holder to prospect or explore for minerals…; and
- Retention licences – enabling the holder to retain the rights to a mineral resource that is not currently economically viable to mine, but may be in the future. Retention licences are limited to 10 years and may be renewed twice.167

The licences are subject to conditions imposed by the Minister. The Regulatory Impact Statement for the MRSD Regulations 2013, prepared by Deloitte Access Economics, explains that the conditions can relate to 'the rehabilitation of the land, protection of the environment, protection of groundwater, the work to be undertaken, expenditure by the licensee, reporting requirements, payment of certain fees, bonds and levies and royalties, [and] access requirements'.168

In addition to holding a licence, the licensee is also required to have a ‘work plan’ that must be lodged with the DSDBI for approval. The Regulatory Impact Statement explains that the licensee:

…must lodge a work plan with DSDBI, have that work plan approved and possess the appropriate work authority before they can commence most exploration or mining activities. Work plans for mining activities require the completion of a rehabilitation plan, an environmental management plan and a community engagement plan.169

Exploration under the MRSD Act does not require a planning permit under the Planning and Environment Act 1987.170 Planning permission is required for mining under the MRSD Act, unless the project is assessed and approved under the Environmental Effects Act 1978.171

The Victorian Environmental Defenders Office (EDO) highlights that, under the MRSD Act, exploration and development projects are exempt from requiring approvals under the Environmental Protection Act 1970 (Vic) to discharge waste or undertake an activity that potentially damages the environment; and from requiring planning permits to remove native

167 ibid., p. 3.
168 ibid.
169 ibid.
170 Section 43(3) of the MRSD Act.
171 Section 42(6) and 42(7) of the MRSD Act.
vegetation. These exemptions are based on the premise that these matters will be dealt with through the work plans submitted to the Department.  

**Land Access Under the MRSD Act**

The EDO also provides a useful summary of the MRSD Act’s provisions relating to gas companies’ access to privately owned land. The EDO explains that to explore or produce minerals on private land under the MRSD Act, the licensee must either:

- obtain the consent of the owners and occupiers of the land affected;
- make and register a compensation agreement with those owners and occupiers;
- obtain a compensation determination from VCAT, to compensate the owners/occupiers; or
- purchase the land.

Therefore, although it is a requirement that the mining company seek the consent of the owner or occupier of private land, there is no requirement that they actually obtain it. The ability to obtain a compensation determination from VCAT allows them to circumvent opposition from the owner or occupier, and gives them a strong position from which to negotiate access agreements. The only exceptions to the above requirement are:

- for ‘low impact exploration work’ under an exploration or retention licence, in which case the informed verbal consent of the owner or occupier will suffice; or
- where the owner or occupier of the private land cannot be found despite the licensee making ‘all reasonable efforts’, in which case the Department Head can waive it.

**The Petroleum Act and Shale and Tight Gas**

The Petroleum Act regulates onshore petroleum exploration and development activities and applies to shale and tight gas. Like the MRSD Act, the Petroleum Act addresses licensing, approvals and other issues such as compensation, rehabilitation, royalties and enforcement. The Petroleum Act provides for the issuing of:

- Exploration permits – enabling the holder to explore for petroleum within the permitted area;
- Retention leases – enabling exploration and permit holders to retain petroleum discoveries that are not currently commercially viable but are likely to be within 15 years; and
- Production licenses – enabling exploration permit and retention license holders to produce their petroleum discoveries.

In regard to exploration permits, the Gas Taskforce Report explains that once a petroleum exploration permit is granted, the permit holder must develop an ‘operations plan’ – that includes things such as descriptions of planned drilling, well operation management and

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173 Environmental Defenders Office (2012) op. cit., pp. 13-14; See also sections 42(2)(c) – 42(2A) and 43(1)(e)-43(2B) of the MRSD Act.


environmental management plans – and have it approved prior to commencing any on the ground work.\textsuperscript{176}

The Reith Gas Taskforce Report further explains that a planning permit is not required for exploration as ‘Like that for minerals, the petroleum operations plan is referred to other agencies on an as needs basis on matters regarding native vegetation clearing (DEPI), groundwater extraction (Rural Water Corporation), and discharge/disposal/chemical use (EPA).\textsuperscript{177} Petroleum production, like minerals production under the MRSD Act, does not require planning permits if it has been the subject of an Environmental Effects Statement under the Environmental Effects Act.\textsuperscript{178}

Additionally, like the MRSD Act, no petroleum exploration or production can be carried out on private land unless compensation has been agreed with the land owner or settled through VCAT.\textsuperscript{179}

**Details of Unconventional Gas Licences in Victoria**

The tables below show the current Victorian unconventional gas licences issued by the DPI (now DSDBI). Table 4 shows the mining exploration licences that have identified coal seam gas as a target resource in their applications under the MRSD Act. Eighteen of these licences are in the Gippsland basin (a map is provided in Appendix 3), while three are centred around the town of Bacchus Marsh, and one is in northern Victoria (between Bendigo and Swan Hill). The only mining licence that has coal seam gas listed as one of its target resources is that owned by Hazelwood Power Corporation as part of its brown and black coal mining licence.

**Table 4: Mineral Exploration Licences with Coal Seam Gas Nominated as Target**

<table>
<thead>
<tr>
<th>Tenement</th>
<th>District</th>
<th>Municipality</th>
<th>Primary Owner</th>
<th>Date Granted</th>
</tr>
</thead>
<tbody>
<tr>
<td>EL4507</td>
<td>Melbourne</td>
<td>Wyndham City</td>
<td>Western Victoria Energy Pty Ltd</td>
<td>04/09/2000</td>
</tr>
<tr>
<td>EL4500</td>
<td>Gippsland</td>
<td>Cardinia Shire</td>
<td>Greenpower Natural Gas Pty Ltd</td>
<td>05/10/2000</td>
</tr>
<tr>
<td>EL4416</td>
<td>Gippsland</td>
<td>Wellington Shire</td>
<td>Ignite Energy Resources Pty Ltd</td>
<td>12/04/2001</td>
</tr>
<tr>
<td>EL4877</td>
<td>Gippsland</td>
<td>Baw Baw Shire</td>
<td>Sawells Pty Ltd</td>
<td>10/08/2005</td>
</tr>
<tr>
<td>EL5210</td>
<td>Gippsland</td>
<td>Baw Baw Shire</td>
<td>Resolve Geo Pty Ltd</td>
<td>03/06/2009</td>
</tr>
<tr>
<td>EL5212</td>
<td>Gippsland</td>
<td>South Gippsland Shire</td>
<td>Resolve Geo Pty Ltd</td>
<td>03/06/2009</td>
</tr>
<tr>
<td>EL5270</td>
<td>Gippsland</td>
<td>South Gippsland Shire</td>
<td>Clean Global Energy Ltd</td>
<td>09/06/2010</td>
</tr>
<tr>
<td>EL5276</td>
<td>Gippsland</td>
<td>South Gippsland Shire</td>
<td>ECI International Ptd Ltd</td>
<td>07/07/2010</td>
</tr>
<tr>
<td>EL5268</td>
<td>North West</td>
<td>Gannawarra Shire</td>
<td>BTB Mining Pty Ltd</td>
<td>20/08/2010</td>
</tr>
<tr>
<td>EL5294</td>
<td>South West</td>
<td>Moorabool Shire</td>
<td>Mantle Mining Corporation Ltd</td>
<td>23/03/2011</td>
</tr>
<tr>
<td>EL5320</td>
<td>Gippsland</td>
<td>Baw Baw Shire</td>
<td>ECI International Ptd Ltd</td>
<td>07/04/2011</td>
</tr>
<tr>
<td>EL5321</td>
<td>Gippsland</td>
<td>Baw Baw Shire</td>
<td>ECI International Ptd Ltd</td>
<td>07/04/2011</td>
</tr>
</tbody>
</table>


\textsuperscript{177} ibid.

\textsuperscript{178} See section 120 of the Petroleum Act.

Table 5 shows the current number of petroleum exploration permits (PEPs) and petroleum retention leases (PRLs) issued under the Petroleum Act along the coastline of the Gippsland and Otway basins with the potential for both conventional and unconventional gas resources, including tight gas and shale gas. The major players involved in these permits are Beach Energy, Bass Strait Oil, Cooper Energy, Bridgeport Energy, Lakes Oil, and Icon Energy. A map of PEPs and PRLs is provided in Appendix 4.

Table 5: Petroleum Exploration Permits and Petroleum Retention Leases with the Potential for Unconventional Resources

<table>
<thead>
<tr>
<th>Tenement</th>
<th>Basin</th>
<th>Titleholder</th>
<th>Parent Companies Involved</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEP150</td>
<td>Otway</td>
<td>Origin Energy Resources Ltd Mawson Petroleum NL</td>
<td>Cooper Energy (20%) Beach Energy (50%) Bridgeport Energy (15%) Bass Strait Oil (15%)</td>
</tr>
<tr>
<td>PEP151</td>
<td>Otway</td>
<td>Somerton Energy Pty Ltd Bridgeport (Eromanga) Pty Ltd</td>
<td>Cooper Energy (75%) Bridgeport (25%)</td>
</tr>
<tr>
<td>PEP163</td>
<td>Otway</td>
<td>Mirboo Ridge Pty Ltd</td>
<td>Lakes Oil</td>
</tr>
<tr>
<td>PEP166</td>
<td>Gippsland</td>
<td>Petro Tech Pty Ltd</td>
<td>Lakes Oil</td>
</tr>
<tr>
<td>PEP167</td>
<td>Otway</td>
<td>Bass Strait Oil Co Ltd</td>
<td>Bass Strait Oil Co Ltd</td>
</tr>
<tr>
<td>PEP168</td>
<td>Otway</td>
<td>Beach Energy Ltd Essential Petroleum Exploration Pty Ltd</td>
<td>Beach Energy Cooper Energy</td>
</tr>
<tr>
<td>PEP169</td>
<td>Otway</td>
<td>Mirboo Ridge Pty Ltd</td>
<td>Lakes Oil</td>
</tr>
<tr>
<td>PEP170</td>
<td>Gippsland</td>
<td>Icon Energy Ltd</td>
<td>Icon Energy Ltd</td>
</tr>
<tr>
<td>PEP171</td>
<td>Otway</td>
<td>Beach Energy Ltd Somerton Energy Pty Ltd</td>
<td>Beach Energy (75%) Cooper Energy (25%)</td>
</tr>
<tr>
<td>PEP174</td>
<td>Otway</td>
<td>Mecrus Resources Pty Ltd</td>
<td></td>
</tr>
<tr>
<td>PEP175</td>
<td>Otway</td>
<td>Bass Strait Oil Co Ltd</td>
<td>Bass Strait Oil Co Ltd</td>
</tr>
<tr>
<td>PRL1</td>
<td>Otway</td>
<td>Origin Energy Resources Ltd Beach Energy Ltd</td>
<td>Origin Energy (90%) Beach Energy (10%)</td>
</tr>
<tr>
<td>PRL2</td>
<td>Gippsland</td>
<td>Petro Tech Pty Ltd</td>
<td>Lakes Oil</td>
</tr>
<tr>
<td>PRL3</td>
<td>Gippsland</td>
<td>Petro Tech Pty Ltd</td>
<td>Lakes Oil</td>
</tr>
</tbody>
</table>

Source: The first three columns are sourced from personal communication with the DSDBI (25 October 2013). The last column is sourced from company websites, current as of 25 October 2013.

Beach Energy, which has interests in many projects in the Otway basin, notes that the basin ‘is prospective for conventional gas and oil as well as unconventional gas and liquids’.181

Bass Strait Oil’s onshore permits in the Otway basin target both conventional gas plays and the unconventional Casterton shale gas play, but are still at the early stage of exploration given recent Native Title resolution.182 The Casterton shale gas play straddles the South Australia/Victoria border; about 75 per cent of the play is in South Australia with the remaining 25 per cent in Victoria.183

Cooper Energy has interests in six exploration permits in the Otway basin, four of which are in Victoria. Development of an unconventional play in the basin is expected in 2014.184 Bridgeport Energy holds interests in two of these PEPs.185

Lakes Oil has interests in both the Gippsland and Otway basins. It has located tight gas in the Seaspray region of Gippsland and conducted 11 fracking operations, prior to the moratorium.186

Icon Energy has a 100 per cent interest in PEP170 in the Gippsland basin. It plans to drill two conventional gas wells, but has suspended work until the Victorian review of hydraulic fracturing has been finalised.187

Mecrus Resources has ruled out CSG in regard to exploration licences, but it is unclear what its target resources are under its PEP in the Otway basin.188

According to the Gas Market Taskforce report, CBM Resources (now Ignite Energy) fracked for CSG during exploration on 12 occasions in Gippsland.189

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Chapter 4: Developments in the Regulation of Unconventional Gas

This chapter provides an overview of developments in the regulation of unconventional gas in Victoria, including the moratorium on fracking and the issuing of new exploration licences, the Reith Gas Taskforce Report, and the Victorian Government’s plan for further community consultation and a continuation of the moratorium. Firstly, it provides a summary of developments at the Commonwealth and COAG level on the regulation of unconventional gas that are relevant to Victoria.

Commonwealth and COAG Regulatory Developments

National Partnership Agreement

In March 2012, the COAG National Partnership Agreement on Coal Seam Gas and Large Coal Mining Developments was made between the Commonwealth, New South Wales, Victoria, Queensland, South Australian and Northern Territory governments. The objective of the National Partnership Agreement is to strengthen the regulation of CSG and large coal mining developments by improving scientific knowledge and ensuring that future government decisions on development proposals are informed by strong scientific advice.190

Establishment of the Independent Expert Scientific Committee

In November 2012, the Commonwealth Government accordingly established the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC) under the Environment Protection and Biodiversity Conservation Act 1999 (Cth). The role of the IESC is to increase scientific knowledge and provide expert scientific advice to governments on the impact the industries may have on water resources. The IESC undertakes research to address critical gaps in scientific understanding, notably ‘bioregional assessments’ designed to gather information about the inter-relationships between ground and surface water and flora and fauna in priority regions.191

Under the National Partnership Agreement, the signatory states are required to seek the IESC’s advice when considering approvals for coal seam gas and large coal mining developments that are likely to impact on water resources.192 The states are, however, under no obligation to accept the advice or implement any of the recommendations made by the IESC.193

192 Williams et al. (2012) op. cit., p. 95.
**EPBC Act Water Trigger Amendment**

In June 2013, the Commonwealth Parliament passed an amendment to the Environment Protection and Biodiversity Conservation Act to make water resources a matter of national environmental significance in relation to coal seam gas and large coal mining developments. As the Commonwealth Parliamentary Library explains, this means that coal seam gas developments are required to be assessed and obtain federal approval when they have a 'significant impact' on water resources (the 'water trigger'). This is a separate process from state regulation and also must take into account advice from the IESC on water impacts.

**National Harmonised Regulatory Framework for Natural Gas from Coal Seams**

Also in June 2013, the COAG Standing Council on Energy and Resources (SCER) released the *National Harmonised Regulatory Framework for Natural Gas from Coal Seams* (‘the Framework’). This SCER document is referred to in Chapter 2 of this paper as one of the key publications that outlines potential impacts of the industry. The Framework sets out 18 leading practices to mitigate potential impacts and focuses on four key areas of the coal seam gas industry: well integrity; water management and monitoring; hydraulic fracturing; and chemical use. The Framework does not encompass shale and tight gas but there are calls for its applicability to other types of unconventional gas to be ascertained.

The SCER had agreed to develop a best practice framework in late 2011 in order to generate greater public confidence in the regulation of the coal seam gas industry and support commercial development. The SCER stated upon the release of the Framework that:

> The Framework delivers on a commitment by Australian governments to put in place a suite of leading practice principles, providing guidance to regulators in the management of natural gas from coals [sic] seams and ensuring regulatory regimes are robust, consistent and transparent across all Australian jurisdictions.

The Framework is based on the view that coal seam gas is, and will continue to be ‘an important component of eastern Australia’s domestic gas supply’ and will contribute export income to Australia’s economy when Queensland LNG projects commence production in

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195 St John (2013) op. cit. For further information see McCormick et al. (2013) op. cit.


2014-15. \(^{200}\) It further states, ‘However, Australia cannot reap the benefits from this development if the industry’s social licence and community confidence are not established and maintained’.\(^{201}\)

The Framework is also based on the view that the CSG industry and agriculture can co-exist if the leading practice regulatory settings it details are implemented, and that this will ensure community confidence in the industry.\(^{202}\)

The Framework recommends that ‘regulatory and legislative settings should be underpinned by the principle of co-existence’ where ‘a shared commitment exists between the resources industry, other land users, local communities and governments to multiple, merit-based and sequential land use that provides certainty for industry and improved community confidence in land use decision-making’.\(^{203}\) In a related project, the SCER is in the process of developing a ‘Multiple Land Use Framework’ which aims ‘to improve the efficiency and workability of the interactions between significant land uses’.\(^{204}\)

The Framework is designed to provide guidance on best practice to industry regulators, and states that it ‘does not require developing new, specific legislation in all jurisdictions, as many jurisdictions already have in place legislation and regulation… However, there may be areas where existing legislation or regulation does require change or adaption to be consistent with the leading practices identified in the Framework’.\(^{205}\)

**Victorian Regulatory Developments**

Victoria, as previously explained, is still in the very early stages of any potential unconventional gas industry. Exploration for unconventional gas resources in Victoria started in the early 2000s. While tight gas has been found near Seagray in Gippsland, the existence of coal seam or shale gas in Victoria is still yet to be demonstrated. Key developments regarding the regulation of unconventional gas in Victoria are outlined below.

**Inquiry into Greenfields Mineral Exploration and Project Development in Victoria**

In May 2012, the Victorian Parliament’s Economic Development and Infrastructure Committee tabled the report of its *Inquiry into Greenfields Mineral Exploration in Victoria*.\(^{206}\) The Committee report recommended that the regulation of Victoria’s exploration, mining


\(^{201}\) ibid., p. 6.

\(^{202}\) ibid.

\(^{203}\) ibid.


and extractive industries be reformed to help strengthen the state’s resources sector.\textsuperscript{207} The report included some consideration of potential coal seam gas in Victoria and recommended ‘That the Victorian Government establishes an appropriate process to enable open consultation with stakeholders, including local communities, for issues regarding future coal seam gas exploration and development’.\textsuperscript{208} The Committee report also noted the work being undertaken by COAG through the National Partnership Agreement to address public concerns and strengthen the science underpinning the regulation of the industry.\textsuperscript{209} The Victorian Government supported the Committee’s recommendation and stated that it would continue to build on existing consultative processes and to implement the outcomes of the National Harmonised Framework.\textsuperscript{210}

**Hold on Fracking and New Exploration Licences**

Importantly, on 24 August 2012, the Victorian Coalition government announced a hold on further exploration and development of coal seam gas until regulatory frameworks are more developed.\textsuperscript{211} The then Minister for Energy and Resources, the Hon. Michael O’Brien, stated in the accompanying media release that the government was introducing a number of reforms to strengthen onshore gas regulation and protect communities.\textsuperscript{212}

These reforms included a hold placed on approvals to undertake fracking as part of onshore gas exploration and a hold on the issuing of new exploration licences for CSG until the (then to be completed) National Harmonised Framework proposals had been considered. The Minister said that ‘industry development relies on the quality of the engagement between exploration companies and the local communities where this activity takes place, and it relies on the community having the confidence that government regulation keeps pace with an evolving industry’.\textsuperscript{213} He further said that ‘Work is underway to determine the Victorian based scientific studies that will be funded by the National Partnership Agreement. This work will be supplemented by a Gippsland regional scale study by the Commonwealth Government’s Independent Expert Scientific Committee into the impact of mining activity on water resources’.\textsuperscript{214}

**Mineral Resources (Sustainable Development) Amendment Bill 2013**

On 29 October 2013, the Victorian Coalition Government introduced the Mineral Resources (Sustainable Development) Amendment Bill 2013 to address recommendations in the Economic Development and Infrastructure Committee’s report of its *Inquiry into Greenfields Mineral Exploration in Victoria*. In the Statement of Compatibility, the Minister for

\textsuperscript{207} ibid.
\textsuperscript{209} ibid., pp. 43-44.
\textsuperscript{212} ibid.
\textsuperscript{213} ibid.
\textsuperscript{214} ibid.
Energy and Resources, the Hon. Nicholas Kotsiras, states that the main purpose of the Bill is to ‘reduce regulatory burden on the minerals and extractive services’.\(^{215}\)

Notably, the Bill amends section 7 of the MRSD Act, which provides that the Minister may exempt land from being subject to an exploration or mining licence. The Bill replaces the current section 7(3) of the Act which provides that ‘In deciding whether to grant an exemption, the Minister must take into account the social and economic implications of the decision’ with a new section 7(3).\(^{216}\)

The new section 7(3) provides that: ‘In deciding whether to grant an exemption, the Minister must take into account – (a) the known or potential value of the mineral resources and the impact that the proposed exemption may have on that value; and (b) the social and economic implications of the decision’.\(^{217}\)

As the Minister explains in the second reading speech, ‘This will provide greater consideration of mineral resources before precluding potentially mineral-rich land from future development’.\(^{218}\) It has been reported in the media that Gippsland community members opposed to coal seam gas development perceive that the proposed change will make it harder for them to obtain land exemptions.\(^{219}\)

**Reith Gas Market Taskforce Report**

The Gas Market Taskforce chaired by the former Howard Government Minister, the Hon. Peter Reith – which has been referred to a number of times in this paper – was established in December 2012 by the Victorian Coalition Government to examine issues faced by the eastern gas market. The members of the Taskforce also included: Mr Craig Arnold (Dow Chemicals); Mr David Byers (APPEA); Mr Frank Calabria (Origin Energy); Ms Cheryl Cartwright (Australian Pipeline Industry Association); Mr Mark Collette (Energy Australia); Mr Angus Taylor (Port Jackson Partners); and Mr Innes Willox (Australian Industry Group).\(^{220}\)

The Taskforce states that it was specifically asked to ‘provide policy options to the Victorian Government on improving the operation and efficiency of the eastern Australian gas market’ and that this included ‘suggesting ways of facilitating market transparency and transmission capability, and increasing gas supply to meet rising demand at competitive prices’.\(^{221}\)

On 1 November 2013, the Gas Market Taskforce presented its Final Report and Recommendations – also known as the ‘Reith Report’ – to the Victorian Government. The Report, as explained earlier in this paper, supports the development of an unconventional gas industry in Victoria. It argues that gas prices are rising and that the appropriate government response is to increase the supply of gas. In the Foreword to the Report, Reith states that:

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\(^{215}\) Victoria, Legislative Assembly (2013) Debates, Book 14, 30 October, p. 3676. Note: at the time this publication was prepared the Bill had not progressed past the second reading speech.

\(^{216}\) Clause 5, Mineral Resources (Sustainable Development) Amendment Bill 2013.

\(^{217}\) ibid.

\(^{218}\) ibid.


\(^{221}\) ibid.
Victoria has enjoyed cheap and reliable natural gas for many years but those days are fading fast. Prices are rising, known conventional gas resources in Bass Strait will not last forever and there are prospects of onshore gas. Victorians should be under no illusions. Rising gas prices will have a negative impact on Victoria’s manufacturing base. Jobs and investment are at risk. Costs of living will rise and could rise for longer if not addressed.\footnote{ibid., p. 1.}

Reith further states that ‘The only sensible course of action is for the Victorian Government and other eastern states to promote production of additional gas supply. Alternative proposals, such as government reservations or subsidies will not address the essence of the issue either in the short or long term’.\footnote{ibid.} He concludes that the Taskforce found that an onshore gas industry in Victoria ‘can not only provide economic benefits to farmers, revitalise regional communities and create jobs but at the same time the gas industry can be managed to conserve our environment’.\footnote{ibid.}

The Report makes 19 recommendations which include (but are not limited to) recommendations that the Victorian Government:

- Lift the holds on fracking and the approval of new coal seam gas licences;
- Strengthen and clarify the legislation and regulations underpinning onshore gas exploration and development, including the full implementation of the 18 leading practices outlined in the National Harmonised Regulatory Framework;
- Appoint a Gas Commissioner (like Queensland has done) to consult with landholders and build community confidence in the unconventional gas industry;
- Develop a comprehensive water science and licensing program;
- Adopt a ‘Royalties for Regions’ program; and
- Raise the legislated upper limit for compensation for landholders’ loss of amenity during gas production from $10,000 to $20,000 and introduce indexation of this limit at CPI.\footnote{ibid., pp. 1, 4-8.}

\textbf{Community Consultation Process and Continuation of Hold on Fracking}


The Premier also stated that ‘The moratorium on hydraulic fracturing will remain in place until at least July 2015 while the community consultation process is conducted’.\footnote{ibid., p. 2.}
The community consultation process will be facilitated by the Minister for Energy and Resources and will begin in April 2014. The Premier said that: “This 12 month community consultation process will include public submissions, thorough facilitated community meetings and workshops with key stakeholders such as farmers, environmental groups, community groups and individuals across Victoria.”229 The terms of reference or ‘consultation focus areas’ of the community consultation process will consist of:

1. The findings of the Reith Gas Market Taskforce Report;
2. Local and state-wide economic, environment, employment and community impacts of a potential Victorian onshore gas industry;
3. The potential for current land and water use, prime agricultural land, environment, liveability and health of Victorian communities to co-exist with a possible onshore gas industry;
4. The robustness and operation of regulations and legislation governing exploration licences and industry engagement with landholders and local community;
5. Better understanding of technologies and processes for extracting onshore gas, including drilling and hydraulic fracturing processes and their impacts.230

The Premier also stated that one of the key features in the Government’s consideration of issues surrounding onshore gas would be any possible impacts on the water table and aquifers, and that a major benchmarking study of groundwater across the state will be undertaken in conjunction with the Commonwealth in May 2015.231

On 27 November 2013, the Hon. Peter Ryan, Deputy Premier, Leader of the Nationals and Minister for State Development, made a speech in the Legislative Assembly regarding gas exploration.232 The speech provided some additional details on the Coalition Government’s policy on unconventional gas. In regard to the groundwater study, Ryan said that:

It will comprise two parts: the first is an investment of some $1.5 million in the compilation and verification of existing data on water assets across Victoria; the second part will see the engagement of Geoscience Australia with a view to a comprehensive bioregional assessment of the Gippsland and Otway basins in particular. The work of Geoscience Australia will also serve the rest of the state by providing us with an all-important benchmark study.233

In regard to the moratorium on fracking, Ryan added that there will also be a moratorium on the issuing of new coal seam gas, shale gas and tight gas exploration licences until at least July 2015. He added that ‘where there are existing licences that expire between now and July 2015, they will be renewed subject to compliance with all the relevant regulatory controls and issues around aquifers and any other prospect of concern with regard to our water resourcing’.234

229 ibid., p. 1.
230 ibid.
231 ibid., pp. 1-2.
233 ibid., pp. 4188-4189.
234 ibid., p. 4189.
Chapter 5: Stakeholder Views

This chapter provides the views of three key stakeholder groups on the development of an unconventional gas industry in Victoria: the Australian Petroleum Production & Exploration Association, the Lock the Gate Alliance and the Victorian Farmers Federation.

**Australian Petroleum Production & Exploration Association**

The Australian Petroleum Production & Exploration Association (APPEA) is the peak national body representing Australia’s oil and gas industry and uses ‘the voice of Australia’s oil and gas industry’ as its slogan.\(^{235}\) The APPEA supports the development of an unconventional gas industry across Australia and in Victoria. It emphasises that natural gas is playing and will continue to play an important role in delivering economic growth and energy security to Australia, both domestically and via exports to Asia. It advocates for market-based energy policies and reduction in ‘red and green tape’ that ‘continues to limit the development of Australia’s immense gas resources’.\(^{236}\)

In regard to the environment and agriculture, the APPEA states that: ‘The Australian oil and gas industry has proved time and again that it can operate in sensitive environments and co-exist with other land uses’. It further states that: ‘Oil and gas is a highly regulated industry that operates under strict guidelines and is answerable to several federal and state government agencies. Exploration and production operations are guided by strong rules on environmental management, water management, land access and other issues’.\(^{237}\)

The APPEA states that fracking is ‘a well established, tightly regulated technology’ that ‘has been used safely to enhance oil and gas production for 65 years in more than 2 million wells worldwide’ and that ‘chemical additives’ are ‘used in such diluted forms that they are rendered harmless to the environment’.\(^{238}\) The APPEA additionally states that:

> Academic and government studies in the US, the UK and New Zealand have shown that fraccing is safe. Given the nature and dilution of chemicals used in Australian operations, fracking does not impair water quality. Indeed, even in the US where stronger chemicals have been used, studies have repeatedly shown fraccing has not affected water quality.\(^{239}\)

The APPEA highlights that the unconventional gas industry creates jobs. It states that ‘More than 27,000 people including contractors are now working in Queensland’s natural gas

industry’ and that ‘More than 300 people work in the NSW’s [sic] gas industry with the potential for 20,000 jobs over the next two decades’.240

On 21 November 2013, the APPEA issued a media release in response to the Victorian Government’s release of the Reith Gas Taskforce Report and its announcement that it would be undertaking further community consultation before lifting the hold on fracking. The media release, titled ‘More Delay and Uncertainty as Victoria Rebuffs Gas Market Review’, states that:

Today’s decision by the Victorian Government to ignore Gas Market Review Taskforce advice to take immediate action to facilitate new gas supplies and make the most of eastern Australia’s sizeable natural gas resources creates considerable uncertainty around the entire eastern Australian gas market.241

The APPEA’s media release continues on to state that the decision ‘will further delay diversifying the development of natural gas resources in that state and it will result in higher than necessary energy prices’. It asserts that:

The message to companies seeking to do business in Victoria; seeking to source natural gas, create jobs, revitalise rural communities, add to government revenue streams and provide additional income to farmers, is unfortunately crystal clear. The Victorian Government is paying more attention to short-term politics than science-based evidence and is clearly not displaying enough focus on attracting investment and building the economy, nor the consequences of failing to do so. Protracted decision making processes mean no decision will be made to progress Victoria’s onshore gas industry for at least another two years. It’s an unacceptable outcome given it can take companies up to five years to get projects through approval processes to commission.242

Lock the Gate Alliance

The Lock the Gate Alliance states that it ‘is a national grassroots organisation made up of thousands of individuals and over 160 local groups who are concerned about inappropriate mining’. Its slogan is ‘Australians uniting to protect our land and water’.243

The Lock the Gate Alliance states that it aims ‘to protect Australia’s natural, environmental, cultural and agricultural resources from inappropriate mining and to educate and empower all Australians to demand sustainable solutions to food and energy production’. The Alliance emphasises that decision-making should be guided by ‘robust scientific assessment, the precautionary principle and the principle of intergenerational equity’.244 It argues that the ‘ever expanding network of wells’ and associated infrastructure of the coal seam gas


242 ibid.


244 ibid.
industry means that large tracts of farmland become unavailable for food production and forests and native bushland will be cleared and fragmented.245

The Lock the Gate Alliance encourages landholders to ‘lock the gate’ to coal seam gas companies, as although ‘The law is strongly in favour of coal seam gas and mining companies… Locking the gate is a form of peaceful non-cooperation that shows companies and the government that landholders are determined to protect their land, water and health…’246

It states that coal seam gas is an unsustainable fossil fuel and the industry is delaying the development of renewable energy sources:

Coal seam gas is an unsustainable fossil fuel and there are clean energy alternatives that are commercially and economically available to be developed in Australia right now. The roll out of the unsustainable coal seam gas industry is a matter of politics, not necessity. Investment in the coal seam gas industry is delaying investment in clean, safe and sustainable energy.247

The Alliance also states that coal seam gas ‘is not proved as safe for human health or for the environment’ and that:

Testing of water and soil in the Pilliga forest has demonstrated that coal seam gas is also environmentally unsafe. Testing of samples taken from areas near coal seam gas operations detected heavy metals up to 37 times higher than natural levels and five times drinking water. The NSW EPA issued fines and warnings to two coal seam gas operators for pollution of the Pilliga state forest. Other risks that have been observed include unexpected well blow-outs resulting in venting of polluted foam into the air close to a drinking water canal, gas bubbling up through the Condamine river close to coal seam gas operations, and a spate of ongoing symptoms consistent with gas exposure experienced by residents living among operational coal seam gas wells.248

In regard to jobs, the Lock the Gate Alliance states that the ‘resources sector is capital, rather than labour intensive’ and that ‘The coal seam gas industry employs less than 20,000. Of this number, only 5,514 are direct employees, the rest are contractor positions and are not necessarily full time equivalent positions’.249 The Alliance additionally states that ‘coal seam gas projects can crowd-out existing industry and negatively impact on existing land-users such as farmers and tourism operators, a down-turn in existing industries will lead to job losses. New jobs cannot come at the expense of existing jobs’.250

The Lock the Gate Alliance has two groups in Victoria: the ‘Gippsland Alliance’ and the ‘Otway Basin Alliance’. The Gippsland Alliance and the Otway Basin Alliance are

247 ibid.
248 ibid.
249 ibid.
250 ibid.
collaborations between more than 30 different community groups across Victoria concerned about coal and gas mining.\textsuperscript{251}

The Gippsland and Otway Basin Alliances state that: ‘Gippsland and the Otway Basin are currently covered by over 400,000 hectares of approved coal, coal seam gas, tight gas and shale gas exploration licences’.\textsuperscript{252} They emphasise that:

Gippsland is one of the main food bowls of Victoria, with rich productive soils, clean abundant water, pristine beaches, and beautiful green rolling hills and mountains. The Otway Basin is also one of our most fertile food growing regions. It also takes in the Surf Coast, Great Otway National Park and the Great Ocean Road, some of Victoria’s greatest tourist attractions.\textsuperscript{253}

The Gippsland and Otway Basin Alliances state that ‘Rural Victoria is too important to sacrifice to new coal and onshore gas developments’.\textsuperscript{254}

**Victorian Farmers Federation**

The Victorian Farmers Federation (VFF) states that it ‘is the largest state farmer organisation in Australia, representing over 10,000 members who live and work on more than 6,000 farm businesses situated across Victoria’.\textsuperscript{255} The VFF further states that it has approximately 200 branches across the state.\textsuperscript{256}

The VFF have formulated the following list of policy principles in regard to mining and gas extraction on farms:

- Farmers should hold the right of veto over mining activities on their land.
- Landowners must receive appropriate compensation & payments for all mining activities on their land.
- There must be no permanent adverse off-site impacts from minerals development on landholders. For example on water supply or quality.
- Farmland must be rehabilitated to its previous productive use at the end of the life of a mining development.
- Information on mining issues must be made available to VFF members.
- The rights of landholders must be protected in minerals legislation.\textsuperscript{257}

The VFF states that to implement these policy principles a number of specific changes should be made to the Mineral Resources Sustainable Development Act, and includes the following details:

- Landholders be given a right of veto over mining activities on their land:

\textsuperscript{252} ibid.
\textsuperscript{253} ibid.
\textsuperscript{254} ibid.
\textsuperscript{256} ibid.
\textsuperscript{257} Victorian Farmers Federation (2013) *The VFF’s Mining and Gas Policy Principles*, Melbourne, VFF.
We consider landholders have a right to determine what their land is used for, and this right should be enshrined in minerals legislation. While the Crown undoubtedly owns the minerals, the land (including the top 15 metres of soil) is often privately owned. In most cases modern mining requires the removal of this soil to access minerals, which landholders should have the power to stop.

- Landholders be given the right to sign off on rehabilitation plans:
  Despite being the major stakeholder in the rehabilitation of land, mining companies do not need to seek agreement from landholders to plans for the rehabilitation of their land. Currently, rehabilitation plans only have to be developed ‘in consultation’ with landholders. The VFF believes landholders should have the right to sign off on rehabilitation plans. This would ensure genuine input from farmers, and ensure that rehabilitation will suit the landholder’s preferences for future land use…

- Increase the period of time in which claims can be made following rehabilitation, from three years to five years:
  When land is rehabilitated following a mining development there can be on-going issues that need to be addressed. The VFF is concerned that a three year limit on claims creates a potential liability for landholders for whom rehabilitation works prove insufficient. For example, land subsidence, lost productivity, and mineral leachates may take more than three years to become evident and longer still to fully address…

Further changes to the MRSD Act advocated by the VFF include: the removal of the 10 per cent cap on solatium payments – compensation for intangible values of land or assets (e.g. personal values associated with land) – so as to allow adequate compensation for the inconvenience and stress a farmer experiences when faced by minerals exploration or development on their land; and the renewal of the role and powers of the Mining Warden.259

The VFF additionally states that it supports the establishment of the Earth Resources Ministerial Advisory Council: ‘We support this decision given the public concerns about minerals development, including within the agricultural industry. These concerns need to be addressed in order for agriculture and mining to co-exist given the obvious competition for land.’ 260

258 ibid.
259 ibid.
260 ibid.
Chapter 6: Other Jurisdictions

This final chapter provides information on key domestic and international jurisdictions that have begun development of unconventional gas resources, including Queensland, New South Wales, the United States and the United Kingdom.

Queensland

As has been stated earlier in this paper, the coal seam gas industry in Australia is most established in Queensland where it has developed since the early 1990s. Production first began in the Bowen basin with significant growth in the Surat basin since 2005-6. Coal seam gas in Queensland is covered under a variety of environmental, mining and water legislation. The main Acts are the Petroleum and Gas (Production and Safety) Act 2004 the Environmental Protection Act 1994.

In 2011–12, production of coal seam gas in Queensland was 254 PJ with 139 PJ produced from the Surat basin and 115 PJ from the Bowen basin. There were 3956 active CSG wells in Queensland as at 31 December 2012, with 720 of those wells drilled in 2011–12. Operators in Queensland include Arrow Energy, Bow Energy, Molopo Energy, Origin Energy, Queensland Gas Company, Santos, Senex Energy and Westside Corporation.

Growth in the Queensland coal seam gas industry has led to developments of export capacity in Gladstone, with as much as 95 per cent of the proven and possible coal seam gas reserves committed to LNG export.

The Queensland Government has an ‘adaptive environmental management regime’ whereby the environmental conditions placed on a gas project can be altered as new information or research becomes available.

Monitoring and compliance relating to coal seam gas is administered through the CSG Compliance Unit of the Department of Natural Resources and Mines. The unit conducts CSG site inspections, landholder and community consultation, and groundwater quality sampling in areas with CSG activity. Also under the Department of Natural Resources and Mines is the Office of Groundwater Impact Assessment which is responsible for assessing and managing the impacts of water extraction, as well as storing baseline and monitoring

262 ibid., p. 5.
data. The CSG companies are required to report baseline groundwater data to the Office, and prepare a baseline assessment plan.

The GasFields Commission, set up under the *GasFields Commission Act 2013*, manages the ‘co-existence’ of landholders, regional communities and industry. Land access is regulated through the *Land Access Code* which sets out guidelines for communication between operators and landholders, while also imposing mandatory conditions on the conduct of authorised activities on private land.

Major coal seam gas projects require an environmental impact statement as part of the application process, which is administered through the Queensland Coordinator General. All CSG companies must submit an environmental management plan and CSG water management plan.

The Environmental Protection Act 1994 bans the use of evaporation dams for CSG water disposal (other than in exceptional circumstances) and prohibits BTEX chemicals in fracking fluids. CSG companies must notify the Government and landholders if activities include fracking or have negatively affected an aquifer (including the connection of two or more aquifers). Regulations also include the *Code of Practice for Coal Seam Gas Well Head Emissions Detection and Reporting*.

Some agricultural land in Queensland is protected from potential CSG development through the *Strategic Cropping Land Act 2011*, and associated Strategic Cropping Land Policy. This policy applies to developments with a footprint of more than 3000m² that have the potential to impact on strategic cropping land. Strategic cropping land is identified using eight criteria, including characteristics such as slope, rockiness, salinity and soil water storage.

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New South Wales

It is argued that the development of domestic supplies of natural gas is most important to New South Wales, given its reliance on gas produced in Queensland and Victoria. However, community resistance to the development of unconventional resources has been strong, particularly given the proximity of some coal seam gas reserves to residential areas of Sydney. In turn, the NSW Government has implemented a variety of oversight and regulatory mechanisms to monitor the industry and alleviate community concerns.

The main laws governing coal seam gas in NSW include the *Petroleum (Onshore) ACT 1991* and the *Protection of the Environment Operations Act 1997*.

The NSW Environmental Protection Authority (EPA) is the lead regulator of the health and environmental impacts of coal seam gas, and is responsible for compliance and enforcement under the Protection of the Environment Operations Act. As of 28 June 2013, all CSG operators must hold an environmental protection licence from the EPA for exploration, assessment and production activities. The EPA works closely with the Office of Coal Seam Gas, which was created within the Department of Trade & Investment in February 2013 and is responsible for administering and monitoring CSG titles and activity approvals under the Petroleum (Onshore) Act 1991.

The NSW Government’s Strategic Regional Land Use Policy is administered through the Department of Planning and Infrastructure. The policy was introduced in 2012 to manage the proximity of coal seam gas activity to quality agricultural land and provides for exclusion zones where coal seam gas activity is prohibited within two kilometres of residential areas in certain parts of the state. Agricultural Impact Statements must also be included in applications for mining and petroleum (including coal seam gas) exploration under the *Environmental Planning and Assessment Act 1979* (NSW).

The Land and Water Commissioner provides guidance to landholders and the community on Strategic Regional Land Use Plans, as well as applications for exploration licences and land access agreements. The NSW Office of Water assesses the potential impact of industry on water resources, including water table levels, water pressure and water quality impacts on dependent ecosystems, culturally significant sites and existing water users. Approved developments require water access licences for extracted water under the

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Aquifer Interference Policy. The policy also covers the disposal of extracted water. Notably, under the Water Management (General) Regulation 2011, fossicking and prospecting activities (including for coal seam gas) do not require a water access licence if they extract less than three megalitres per licence/permit (not bore) per year. In addition, a number of controls have been introduced that aim to ensure best practice in the industry, including a Code of Practice for Coal Seam Gas Fracture Stimulation, a Code of Practice for Coal Seam Gas Well Integrity, a Code of Practice for Coal Seam Gas Explorers and Community Consultation Guidelines. An Industry Fund has been established to encourage coal seam gas operators to invest in local communities.

As noted in Chapter 2 of this paper, the NSW Chief Scientist and Engineer was commissioned to conduct an independent review of coal seam gas activities in NSW in February 2013, with an initial report published in July 2013 and a final report expected in late 2014.

The AGL Camden project is the only coal seam gas project currently operating in NSW, and produces approximately five per cent of NSW’s gas needs. It has been operating outside Sydney since 2001. Exploration for coal seam gas continues across the State.

United States

Development and Growth of the Shale Gas Industry

The United States is the largest producer of unconventional gas in the world. In particular, the US has an established shale gas industry which is growing rapidly. The development of shale gas in the US is the product of decades of federal government investment in innovation and technology.

The Unconventional Gas Research Program was funded by Congress in 1976 and ran until 1992. It included the Eastern Gas Shale Project that was tasked with identifying the recoverable reserves of shale gas. This program was run by the predecessor to the current Department of Energy (DOE) and was completed through contracts with universities, research institutions, and industry. Research into unconventional gas was also conducted through the Gas Research Institute, which was funded through a tax on

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287 See Schedule 5, clause 7 of the Water Management (General) Regulation 2011 (NSW).
289 NSW Chief Scientist & Engineer (2013) op. cit.
The shale gas boom, however, has really only occurred in the past decade. In 2001, shale gas production represented 2 per cent of US domestic gas resources, and by 2011 it represented 34 per cent of domestic production. According to the US Energy Information Administration’s (EIA) 2013 Annual Energy Outlook, shale gas production is expected to grow by 113 per cent from 2011 to 2040, and represent 50 per cent of US domestic natural gas production. The EIA states that growth in all unconventional gas resources will see the US becoming a net exporter of natural gas by 2019.

The US resource economics organisation, Resources for the Future, notes that the boom largely occurred due to a confluence of high gas prices, low conventional gas outputs, and a growing economy over the period 2003 to 2008. According to a joint report by the Organisation for Economic Co-operation and Development (OECD) and the International Energy Agency (IEA), the development of shale resources in this period has subsequently put downward pressure on gas prices, to the extent that the US now has some of the lowest gas prices in the world.

Multinational company IHS, which includes US oil and gas consultancy services, estimates that along the full value chain, the unconventional energy industry ‘supported 2.1 million jobs, generated nearly $75 billion in federal and state tax revenues, and contributed $283 billion to US gross domestic product (GDP)’ in 2012. IHS states that these contributions

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293 ibid., p. 4.
294 ibid., p. 5.
295 ibid., p. 6.
are expected to grow to 3.3 million jobs, $125 billion in tax revenues, and $468 billion per annum to GDP by 2020.\textsuperscript{302}

According to the previously mentioned OECD/IEA report, the growth in the shale gas industry has led to energy security and economic growth, as well as a reduction in US greenhouse gas emissions as less coal is being used to generate electricity. The report states that this allows the US to export its surplus coal (and associated emissions) to the European Union.\textsuperscript{303}

**Shale Gas and the Fracking Controversy**

The shale gas boom in the United States has been accompanied by controversy, which has influenced the debate on unconventional gas on a global scale.\textsuperscript{304} In particular, community groups have been concerned that the US shale gas industry has been insufficiently regulated and has subsequently contaminated water supplies.\textsuperscript{305}

In the US, pollution is regulated on a national scale by three main pieces of legislation: the Clean Air Act, the Clean Water Act and the Safe Drinking Water Act. In particular, the Safe Drinking Water Act regulates the underground injection of fluids that could affect drinking water.

In 2005, the Safe Drinking Water Act was amended to exclude ‘the underground injection of fluids or propping agents (other than diesel fuels) pursuant to hydraulic fracturing operations related to oil, gas, or geothermal production activities’ from regulation under the Act.\textsuperscript{306} This not only made it legal to inject chemicals underground for the purposes of fracking, but also removed the regulatory oversight the Environmental Protection Authority (EPA) had over the fracking process.\textsuperscript{307}

The EPA otherwise regulates the discharges and wastewater from unconventional extraction using the same permit system as applies to conventional oil and gas extraction, and continues to investigate the environmental impacts of mining practices.\textsuperscript{308}

However, the lack of information available on what chemicals were being injected into shale beds, and corporations’ unwillingness to share such information, led to a 2011 US House of Representatives Energy and Commerce Committee inquiry into the chemicals used in hydraulic fracturing. The Committee found:

\textsuperscript{302} ibid.
\textsuperscript{303} OECD/IEA (2013) op. cit.
\textsuperscript{305} See for example: Gasland (2010) op. cit.
\textsuperscript{306} These amendments were made by the Energy Policy Act of 2005, s 322, and have been known as the ‘Halliburton Loophole’.  
Between 2005 and 2009, the oil and gas service companies used hydraulic fracturing products containing 29 chemicals that are (1) known or possible carcinogens, (2) regulated under the Safe Water Drinking Act for their risks to human health, or (3) listed as hazardous air pollutants under the Clean Air Act. These 29 chemicals were components of more than 650 different products used in hydraulic fracturing.309

Further,

In many instances, the oil and gas service companies were unable to provide the Committee with a complete chemical makeup of the hydraulic fracturing fluids they used ...in most cases the companies stated that they did not have access to proprietary information about products they purchased “off the shelf” from chemical suppliers. In these cases, the companies are injecting fluids containing chemicals that they themselves cannot identify.310

Also in 2011, the Obama administration formed a Natural Gas Subcommittee of the Energy Advisory Board tasked with ‘improving the safety & environmental performance of hydraulic fracturing’.311 In the same year, the EPA began research into the potential impacts of fracking on drinking water resources, which is expected to be completed in 2014.312

While these developments have increased the scrutiny of fracking processes on a national scale, natural resources are regulated on a state level in the US. The State Review of Oil & Natural Gas Environmental Regulations (STRONGER) was started by the EPA in 1999 as a collaboration between oil and gas industry stakeholders, state government environmental programs and environmental community groups to co-ordinate the state review process.313 In 2010, STRONGER issued guidelines on hydraulic fracturing, and these were updated in 2013 following an extensive review of industry practice.314

Information on the state regulation of wells, and the chemicals used by companies during the fracking of those wells, can now be found on the FracFocus website. FracFocus is the national fracking chemical registry and has been operational since April 2011.315

310 ibid., p. 2.
314 ibid.
United Kingdom

The identified unconventional gas resources in the United Kingdom centre around shale gas. No significant production has occurred as yet. Fracking for shale gas has only occurred at one site in Lancashire in 2011 and was carried out by the company Cuadrilla Resources. Two earthquakes of low magnitude occurred in the site area in 2011 which were found to have been caused by direct fluid injection into an adjacent fault zone during the fracking treatments. Following these events, fracking for shale gas was suspended from mid-2011 in the UK. The moratorium was lifted in December 2012 and exploration has continued but no further fracking has yet occurred.

There is public concern in the UK about the effects of fracking and induced seismicity. There are ongoing protests and blockades around exploratory drilling sites. For example in August 2013, a Green MP was arrested after participating in a blockade at a Cuadrilla exploratory drilling site.

UK regulators have learnt from the US experience, and state that rigorous regulation is the cornerstone of successful mining of shale gas. The British Geological Survey (BGS) states that ‘Understanding the risks is a very important step in the design and approval process and very strict controls and regulations are in place to reduce the risks to an acceptable level’.

Exploration licences for unconventional resources are issued by the Department of Energy and Climate Change through the Petroleum Act 1998 (UK). Licensees intending to drill through coal seams for methane must also seek approval from the Coal Authority. Operators using fracking methods that have the potential to pollute groundwater must also obtain an environmental permit under the Environmental Permitting Regulations 2010. An environmental permit will also be required if surface activities (such as wastewater disposal) pose a risk of pollution. The Environment Agency has the power to stop activities such as drilling of a borehole even when such activities are not subject to an environmental permit. An operator must also seek land access approval from the relevant local authority.

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321 ibid.
To support this permit scheme, the BGS has been tasked with a number of research priorities, including undertaking baseline assessments of groundwater methane in order to adequately measure the impact of future mining operations.322

# Appendix I: Gas Extraction Comparisons

<table>
<thead>
<tr>
<th>Source rock (Organic material origin)</th>
<th>Coal seam gas</th>
<th>Shale gas</th>
<th>Tight gas</th>
<th>Conventional gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source rock (Organic material origin)</td>
<td>Coal (Peat)</td>
<td>Low permeability fine grained sedimentary rocks (Silt mudstones &amp; shale mudstones) (Algae, plant, and animal derived organic debris deposited as muds in estuaries and in deep basins)</td>
<td>Various source rocks have generated gas that has migrated into low permeability sandstone and limestone reservoirs</td>
<td>Porous and permeable reservoir rocks, such as sandstones (Algae, plant, and animal derived organic debris deposited as muds in estuaries and in deep basins)</td>
</tr>
<tr>
<td>Depth</td>
<td>300-1000 m</td>
<td>&gt; 1000 m</td>
<td>1000 – 6000 m</td>
<td></td>
</tr>
<tr>
<td>Gas occurrence</td>
<td>Adsorbed on coal organic matter including pores of coal</td>
<td>Stored within pores and fractures but may also be adsorbed on organic matter</td>
<td>Within pores and fractures</td>
<td>In geological structures or traps (e.g. anticlines)</td>
</tr>
<tr>
<td>Gas composition</td>
<td>Usually &gt; 95% methane. Small amounts of CO2 and other gases may be present</td>
<td>Mostly methane but may also contain significant higher quantities of higher hydrocarbons (condensate)</td>
<td>Mostly methane</td>
<td>70-90% methane 0-20% ethane, propane, butane Trace pentane 0-8% carbon dioxide 0-5% nitrogen 0-5% hydrogen sulphide</td>
</tr>
<tr>
<td>Extraction technology</td>
<td>Vertical or directional wells; hydraulic fracturing is sometimes required</td>
<td>Hydraulic fracturing and horizontal wells are usually necessary</td>
<td>Large hydraulic fracturing treatments and/or horizontal drilling are required</td>
<td>Vertical wells; natural pressure drives gas to the surface</td>
</tr>
<tr>
<td>Water usage</td>
<td>Water must be pumped from seams to reduce reservoir pressure and allow gas to flow. If hydraulic fracturing is necessary, water is required for the fracturing process.</td>
<td>Water is required for hydraulic fracturing</td>
<td>Water is required for hydraulic fracturing</td>
<td>Little or no water produced initially but water production rates increase with time</td>
</tr>
<tr>
<td>Extraction challenges</td>
<td>Removal of seam water and its subsequent disposal</td>
<td>Overcoming low permeability Minimising the amount of water required for hydraulic fracturing Reducing infrastructure footprint</td>
<td>Reducing infrastructure footprint</td>
<td>Often located offshore</td>
</tr>
</tbody>
</table>

Appendix 2: Modelling of the Cost of Gas Supply

The black line represents the weighted average cost of supply. The breakeven costs for the 'ex-liquids' groups are calculated ignoring the more favourable breakeven economics of combined gas and hydrocarbon liquids production. The fields without this nomenclature take the favourable breakeven economics of liquids production from the field into account (thus ex. liquids calculations are more expensive).
Appendix 3: Mining Exploration Licences with a Target Resource of CSG in Gippsland

Appendix 4: Petroleum Exploration Permits with Potential for Unconventional Gas

Works Cited


