Australia's Unconventional Energy Options

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Australia's Unconventional Energy Options

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CEDA – the Committee for Economic Development of Australia - is a national, independent, member-based organisation providing thought leadership and policy perspectives on the economic and social issues affecting Australia.

We achieve this through a rigorous and evidence-based research agenda, and forums and events that deliver lively debate and critical perspectives.

CEDA's expanding membership includes more than 800 of Australia's leading businesses and organisations, and leaders from a wide cross-section of industries and academia. It allows us to reach major decision makers across the private and public sectors.

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Foreword

It is with pleasure that I present this third and final policy perspective in CEDA's Australia's Energy Options series – *Australia's Unconventional Energy Options*.

Unconventional energy is the focus because Australia has significant unconventional energy reserves that could provide substantial economic benefit and a lower greenhouse gas emission energy supply compared to coal, in the interim, while renewable options are still in their infancy.

However, regulation and management of community concerns around environmental and land access issues have failed to keep pace with industry progress in developing this resource.

CEDA's previous two policy perspectives in this series focused on renewables and efficiency, and nuclear energy.

The combination of these three areas have been chosen because they provide the components of what could supply Australia with a secure, low cost and clean energy future.

Australia is extremely fortunate to have an abundance of development opportunities in each, with large unconventional gas and uranium reserves and the potential to harness solar, wind, wave and geothermal renewable energy sources.

The combination of these could provide significant energy generation to meet demand both domestically and for export markets, bringing substantial benefits for our economy as the world moves to cut greenhouse gas emissions.

However, in the case of unconventional energy, its full potential will only be realised if it continues to have a social licence to operate. Government and industry must ensure the right balance is struck between meeting community expectations and protecting the environment, and allowing this resource to be developed without unnecessary hindrances.

Superficial arguments that pit farmers or environmentalists against miners – something we have regularly seen in mainstream media - completely miss the point, and are holding back the discussions that need to take place to progress this issue.

Coal seam, tight and shale gas make up the three main types of unconventional gas sources – unconventional due to the non-traditional and more difficult geological source rocks from which this gas is extracted.

The key issues discussed in this policy perspective that must be properly examined and addressed in Australia concern:

- Property rights;
- Water management;
- The robustness of the current legislative and regulatory regime;
- How we can ensure lessons learnt in other countries with more advanced development of these resources are not lost here; and
- How Australia can best capitalise on the economic opportunities presented by unconventional energy.

CEDA is consequently calling for improvements in community consultation and land access negotiation processes, and for industry to adopt internationally recognised best practice standards.

In addition, specifically around water management, CEDA is calling for:

- Unconventional energy water use to be integrated into regular water allocation frameworks;
- Industry to be required to develop a risk management framework that applies stringent precautionary measures until more is known about the long term implications for water resources of unconventional energy extraction; and
- Water management requirements for unconventional energy extraction to be made long enough to ensure industry is responsible for all consequences of the activity.

I would like to thank the five contributing authors - Professor Quentin Grafton, Rebecca Nelson, Deb Kerr, Dr Tina Hunter and Dr Ken Medlock - for their work in helping CEDA drive an informed and rigorous debate on Australia's future energy options.

I would also like to thank our sponsors Rio Tinto and ElectraNet for helping make this project possible.

Professor the Hon Stephen Martin
Chief Executive
CEDA

Overview

In the following policy perspective CEDA examines the challenges and opportunities associated with the development of unconventional energy sources in Australia, and identifies key areas where improvements need to be made.

Introduction

The growth in global demand for energy and efforts to mitigate greenhouse gas emissions are encouraging innovation, price and government policy action to change the energy supply mix. Recent and on-going innovations have dramatically expanded the technologically and economically feasible global resources of gas. These resources can play a significant role in mitigating global greenhouse gas emissions. If Australia is going to play its role in meeting global energy demand while assisting in mitigating climate change, it must ensure that all energy options are utilised, no matter how unconventional they may be.

The International Energy Agency (IEA) estimates that coal consumption will increase by 17 per cent between 2010 and 2020.[1] However, secure, relatively cheap gas can act as an environmentally superior substitute as its carbon dioxide emissions in energy production are up to 45 per cent less than coal.[2]

The most recent case of innovation transforming the global energy supply mix has been in technological advances that enhance the capability to extract natural gas from previously unviable sources. Geologists have been aware of the existence of oil and gas in geological formations such as shale and coal for decades.

The gas held in shale or coal formations, as well as tight gas, is generally referred to as unconventional gas resources. Techniques did not exist for the extraction of these resources on a widespread scale until the last few decades. Innovations, such as developments in hydraulic fracturing and directional drilling, have resulted in estimates of extractable US reserves in 2011 being almost seven times greater than reserves estimated in 2008, which were more than seven times higher than estimates made in 2002.[3]

The US also provides evidence of the potential role gas can play in mitigating greenhouse gas emissions, where the availability of increasingly competitive gas has seen a major transition from coal to gas generated energy. This has been a major contributor to the seven per cent reduction in carbon dioxide emissions from the US economy over the past five years. Extracting shale gas has also had a significantly positive impact on the US economy, employing over 600,000 jobs in 2010, a number set to grow to nearly 870,000 by 2015, while contributing more than $118 billion to GDP.[4]

The expansion of gas supply has transformed global energy security, with many countries potentially shifting from being net importers, to having major reserves of previously inaccessible energy. For instance, expansion in gas reserves could result in the US shifting from being a net energy importer to being an energy exporter, potentially rivalling Saudi Arabia by 2020.[5] North America has already become a net energy exporter. The benefits of improved extraction technologies are not limited to the US, with potentially substantial deposits in countries that are traditionally net energy importers such as China or France.[6]

Australia's potential energy resources have substantially expanded. Australia has identified resources of more than 150 trillion cubic feet of coal seam gas, almost 400 trillion cubic feet of shale gas and 20 trillion cubic feet of tight gas. Coal seam gas alone represents 175 years of reserves at current production levels compared to just 66 years for conventional gas reserves.

It is important that Australia sustainably exploits this energy source, as it will help ensure the nation's domestic energy security, while fuelling the economic growth of developing neighbours. As a relatively unique industrialised net energy exporter, Australia plays an outsized role in assisting global energy security.

However, like any energy source that has not traditionally been exploited there are unique concerns about extracting unconventional gas. It is important for both government and industry to deal with community concerns about new energy sources so they can be economically exploited and integrated into Australia's energy supply mix. The challenges of climate change and the nation's ongoing economic prosperity in a greenhouse gas emission constrained future are too important to ignore any potential solution.

A rapidly changing environment

Australia has been extracting a limited amount of coal seam gas since the 1960s. However, the technological advances pioneered in the US have resulted in rapid development of the coal seam gas fields of the Bowen-Surat Basins, where gas will be exported through LNG processing facilities being developed at Gladstone and Curtis Island. Australia has also been identified as having the fifth largest potential shale gas reserves in the world, predominately located in Western Australia and the Northern Territory, but with significant reserves in the South Australian Cooper-Eromanga Basin.

In Queensland alone, if the coal seam gas industry reaches its forecast potential, it will be responsible for more than 20,000 jobs, provide $243 billion in tax to the Australian Government and result in real incomes in Queensland rising by $28,300 per person over the period from 2015 to 2035.[7] All forms of gas extraction are poised to position Australia as the second largest exporter of this resource in the world by 2020.

These energy reserves will only be exploited if industry is able to exercise its legal property rights while addressing valid community concerns about this and other issues. The rapid expansion of unconventional gas extraction has brought the industry into contact with a wider segment of Australian society. Community concerns have centred on the appropriateness of the legislative framework, ensuring all costs and benefits associated with the activity are attributed to the correct parties, and the interactions between new and existing users of natural resources. If valid community concerns about the activities involved in extracting unconventional energy sources persist, then it is possible that Australia will not develop its unconventional energy reserves to their full potential.

Conflict over use of land and other unresolved policy issues, and the rapid pace of expansion have the potential to undermine community acceptance of unconventional energy extraction. This would represent a major missed economic opportunity and would also weaken the nation's efforts to mitigate climate change.

Contributions

The contributions in this policy perspective are focused on important issues necessary for the economically efficient exploitation of unconventional gas reserves. They are:

- The challenges and opportunities for Australian unconventional gas production are discussed by Professor Quentin Grafton, Executive Director and Chief Economist, Bureau of Resources and Energy Economics (BREE), Department of Resources, Energy and Tourism;
- The international implications of expanded shale gas production are described by Professor Kenneth B Medlock III, Deputy Director, Energy Forum, James A Baker III Institute for Public Policy, Rice University;
- The critical ground water management issues are discussed by Rebecca Nelson, Program Leader, Comparative Groundwater Law and Policy Program, Stanford University;
- Property rights issues are discussed by Deborah Kerr, Manager, Natural Resource Management, National Farmers' Federation; and
- The principles for an appropriate regulatory regime to address community concern and business needs are discussed by Dr Tina Hunter, Fellow, Tim Fischer Centre for Global Trade and Finance, Bond University.

Policy issues

Several critical policy issues emerge from the consideration of the contributions by these authors.

In the case of conflict over land use, the legalities are clear. Mining companies have very strong legal property rights over their ability to access and extract unconventional energy. However, the legal frameworks which grant these property rights have been developed for energy extraction predominately in remote areas with little interaction with the broader community. OECD guidelines articulate community engagement strategies that can help ensure business is able to maintain its social licence to operate.

Negotiating access arrangements is a significant issue for many agricultural users of land. Given mining operations can have a substantial negative impact on farmers, the existing regime is too complex and difficult to govern the interaction between the two groups. A better framework that determines explicit rights and responsibilities could enable unconventional energy sources to be perceived as a potential benefit for agricultural businesses, providing an offsetting cash flow.

There is also scope for industry to improve the quality of its activities to minimise disruption and environmental risks. In the case of unconventional gas, best practice has been estimated to be less than 10 per cent of total costs.[8] While these practices are more expensive, they will help ensure continued community support for extraction.

Recommendations 1

Government and industry undertake specific actions to ensure the legal rights of miners are buttressed by a social licence to operate. This should include:

- Establishment of a framework for land access negotiations to facilitate collaboration between industry and other users of land. As unconventional gas reserves are located onshore, state governments are responsible for simplifying the process surrounding access arrangement negotiations. However, the Federal Government should ensure there are consistent requirements across the different jurisdictions;
- Establishment of clear and well-resourced processes for community consultation based on OECD guidelines that include providing timely, reliable, easy to find and understandable information to the community. In addition, an independent and public process for evaluating the success or failure of community engagement programs should be implemented and shortfalls identified through this process addressed; and
- Adoption of better and best practice management by industry that includes careful monitoring of wellbores and their integrity, water, air quality and noise levels associated with mining activity.

Producing unconventional energy is a thirsty business. The use and treatment of water by the mining industry represents a major source of community concern and is a critical challenge to the widespread acceptance of unconventional energy sources. To ensure economically efficient and sustainable unconventional energy extraction occurs, it is important that those who benefit from its extraction pay for all costs associated with the activity.

Currently unconventional energy sources operate under a complex web of federal and state laws and policies. Different requirements are in place through arrangements under petroleum and gas licensing regimes, environmental protection legislation and some water legislation. While there is concern about the raw volume of water being extracted in Australia, the real issue is the nature and extent of the impact of extracting this water on current and future users and on the environment. These factors will vary depending on the unique features of groundwater resources and the unconventional energy extraction requirements.

Despite statements to the contrary, Australian water laws have traditionally allowed exemptions for produced water. For instance, in Queensland the petroleum and gas legislation explicitly enables coal seam gas proponents to withdraw an unlimited amount of groundwater as part of their activities without requiring them to hold a water entitlement. The fragmented legislative framework undermines the ability of broader water policy to protect the security of existing water entitlements, prevent environmental degradation from overuse, and allocate water fairly. Being exempt from water management exposes unconventional energy companies to the accusation that they are being unfairly privileged compared to other water users and sets the scene for unnecessary conflict. In addition, exempting unconventional energy users from water management diminishes their ability to trade produced water and find productive uses for this by-product of their activities.

Another challenge for extracting unconventional energy is that its consequences are uncertain. Coal seam gas developments can involve many hundreds or even thousands of wells distributed on a regional scale. Their impact needs to be understood so that the users of the water resource carry the costs associated with their activities. Developing this understanding can be done via a moratorium on activity, but this would stifle innovation aimed at minimising risks. However, the irreversible nature of some forms of environmental damage associated with unconventional gas extraction requires a robust risk assessment framework within which to operate.

Recommendations 2

To ensure that water policy successfully incorporates the full impact of unconventional energy extraction:

- Government must mandate through legislation that unconventional energy water use be integrated into regular water allocation frameworks;
- Industry be required by government to develop an integrated risk management framework that applies temporary precautionary measures that are progressively relaxed, if appropriate, as more information becomes available about potential impacts from unconventional energy activity; and
- A time frame that is long enough to incorporate all the consequences of unconventional gas extraction be adopted for water policy management. This should be over the lifecycle of the mining activity, up to three or four decades, rather than the shorter timeframes traditionally employed in water management.

The regulatory framework in eastern Australia has been categorised by catch-up regulation and widespread community opposition to unconventional gas resource activities. Substantial community concern has been generated because of the perceived lack of effective regulation overseeing the development of unconventional gas resources. Having a seamless regulatory framework could help reduce the administrative burden imposed on businesses operating in numerous states, while assisting in maintaining community confidence that the industry is regulated in a responsible and sustainable manner.

Conclusions

The experience of unconventional gas highlights why CEDA is advocating that Australia needs to develop robust regulatory frameworks for all energy sources prior to their widespread utilisation. Technological innovation can radically re-order the economics of energy supply, particularly in an era of extensive research and development in energy generation. Likewise, government policies to mitigate greenhouse gas emissions must be flexible, adaptable and reviewed to make sure they are relevant and achieving the desired outcome as technology evolves.

The contributions to this policy perspective suggest that, irrespective of how well established the energy supply is internationally, Australia should develop appropriate regulatory frameworks to enable its extraction and integration prior to its utilisation domestically. This would ensure government is providing business with the certainty it requires to invest in long term infrastructure. It also provides the community with the certainty that business is responsibly using the nation's natural endowment of resources.

Nathan Taylor
CEDA Chief Economist

Endnotes

1 International Energy Agency (IEA) 2012, *Golden Rules for a Golden Age of Gas*, IEA, Paris.

2 Grafton, Q., *Challenges and opportunities for Australian unconventional gas production*, CEDA.

3 Medlock III, K. B. *International implications of expanded shale gas production*, CEDA.

4 IHS, *The economic and employment contributions of shale gas in the US*, accessible from http://www.ihs.com/info/ecc/a/shale-gas-jobs-report.aspx

5 Citi GPS, Morse, E. L., *Energy 2020: North America, the New Middle East?* Accessible here: http://csis.org/files/attachments/120411_gsf_MORSE_ENERGY_2020_North_America_the_New_Middle_East.pdf

6 US Energy Information Administration, *World Shale Gas Resources: An Initial Assessment of 14 Regions Outside the United States* (EIA, 2011), 4.

7 Ferguson, M., 2012, speech to *CEDA State of the Nation Conference: The Security of Energy Markets*, accessible from here: http://minister.ret.gov.au/MediaCentre/Speeches/Pages/CEDAConference.aspx

8 International Energy Agency (IEA) 2012, *Golden Rules for a Golden Age of Gas*, IEA, Paris.

1. Challenges and opportunities for Australian unconventional gas production

Professor Quentin Grafton

This chapter examines the economic opportunities of unconventional energy for Australia, both domestically and globally, and its potential to reduce greenhouse gas emissions by replacing higher emission energy sources.

Quentin Grafton is Executive Director and Chief Economist of the Bureau of Resources and Energy Economics, Professor of Economics at the Crawford School of Public Policy and Public Policy Fellow at the Australian National University.

Quentin received his PhD in Economics from the University of British Columbia in 1992. He has published about 100 scholarly articles, some in the world's leading academic journals (such as Science), numerous chapters in books and has co-authored or edited a dozen books.

He is the recipient of several prestigious awards including, in September 2011, the Eureka Prize for Water Research and Innovation that honours Australia's leading researchers and scientists.

Introduction

Natural gas, whether conventional or unconventional, originates from organic material laid down millions of years ago. In conventional gas production the reservoirs are, typically, located at great depth underneath the surface and the gas is brought to the surface with wells that are "cased" to prevent gas escaping before it reaches the wellhead. In unconventional gas production, the gas may come from different geological structures (such as coal seams) for conventional production, but the most important difference is how the gas is extracted.

Developments of unconventional gas production in the US, and its current developments in Australia, have generated substantial controversies in terms of possible environmental consequences and land access issues. To put these concerns in context, this chapter provides an outline of the differences between conventional and unconventional gas, a review of recent developments in Australian gas production, and an evaluation of the ability for gas to substitute for more carbon-intensive fossil fuels.

Conventional and unconventional gas

Whether produced by conventional or unconventional methods, the gas that reaches the surface contains between 70 and 90 per cent methane (CH_4), but may contain a variety of other hydrocarbons such as ethane (C_2H_6), propane (C_8H_8), butane (C_4H_{10}) and pentane (C_5H_{12}) as well as carbon dioxide, hydrogen sulfide (H_2S) and also water vapour.

The main types of unconventional gas production are:

- Shale gas (gas trapped with sedimentary rocks such as clays and muds);
- Tight gas (gas trapped in limestones, sandstones and in sand-like layers of rock); and

- Coal seam gas or coal-bed methane (gas held on the outer surface of underground coal deposits).

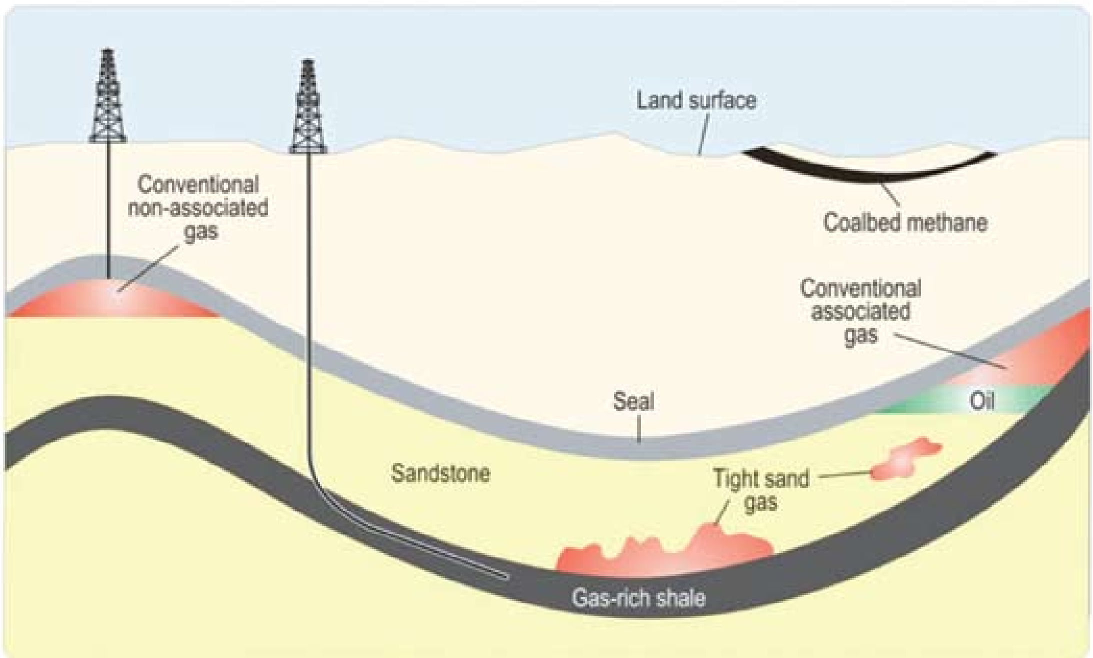
The differences and environmental challenges between conventional gas production and the three principal forms of unconventional gas production are highlighted in Table 1, while Figure 1 illustrates the sub-strata differences in terms of the gas deposits.

TABLE 1
GEOLOGY, PRODUCTION AND WATER ISSUES OF GAS

	Conventional Gas	Coal Seam gas	Shale Gas	Tight Gas
Geology	Within permeable sandstones	Coal seams	Within pores of shale/ mud/clay formations	Within pores of low permeable limestones and sandstones
Production	Natural pressure	Dewatering and in some cases hydraulic fracturing	Hydraulic fracturing required	Hydraulic fracturing required
Water issues	Negligible	Potentially substantial effects from water displacement underground and water storage on surface	Potential impacts may arise from water used for fracturing and possibly from hydraulic fracturing	Potential impacts may arise from water used for fracturing and possibly from hydraulic fracturing

Source: Adapted from Williams, J., Pittock, J., 2012. *Unconventional Gas Production and Water Resources: Lessons from the United States on Better Governance*, Crawford School of Public Policy, the Australian National University.

FIGURE 1
UNCONVENTIONAL GAS PRODUCTION



Source: US Energy Information Agency, 2011, Today in Energy.

All forms of gas production involve some environmental risk, but these risks can be effectively managed with best practices. Best management practices include careful monitoring of:

- Well-bores and their integrity;
- Water injection, extraction and storage;
- Air quality and noise levels; and
- Traffic of vehicles in gas production.

Good management also requires:

- Full community engagement over local concerns, such as land access protocols, traffic congestion, disclosure of the chemicals used or generated in gas production; and
- Effective risk management plans in terms of venting of gas, water contamination and other factors that may negatively affect the environment, landowners and communities.

Best practices raise the costs of unconventional cost production, but have been estimated by the International Energy Agency (IEA) to be less than 10 per cent of total costs.[1] While this reduces the profits of the upstream gas industry, good management practices are necessary for the long term sustainability of the unconventional gas industry.

Hydraulic fracturing

During the production of shale and tight gas, the absorbed gas is released from the surrounding rock by a process called hydraulic fracturing, or fracking. Through this process large quantities of water (sometimes more than 10 million litres per well for shale gas) are combined with sand and chemicals and pumped down a well that fractures the rock and enables the gas to flow to the surface. The gas recovery process is helped by the use of horizontal drilling as it allows greater access to the rocks where the gas is trapped and can be done at much lower cost than drilling a series of vertical wells.

Fracking has been practised for about a century in North America, but in the past decade or so it has become controversial due to the rapid growth of the unconventional gas industry, especially in locations that previously had no gas or oil production. In addition to concerns over contamination of aquifers from the chemicals added to fracking fluid, issues have also been raised about contamination of water supplies from fugitive gas after fracking, and seismic activity and tremors associated with the drilling and fracking process.

In response to environmental and community concerns some American states, such as Colorado, have imposed regulations that require the public disclosure of the fracking fluids while others, such as New York, have banned fracking on state land, although it is still permitted on private land. In May 2012 the Bureau of Land Management – responsible for the management of the land owned by the US Federal Government in the west of the country – announced new regulations governing unconventional gas production including the disclosure to the regulator of fracking fluids after drilling.

What about Australia?

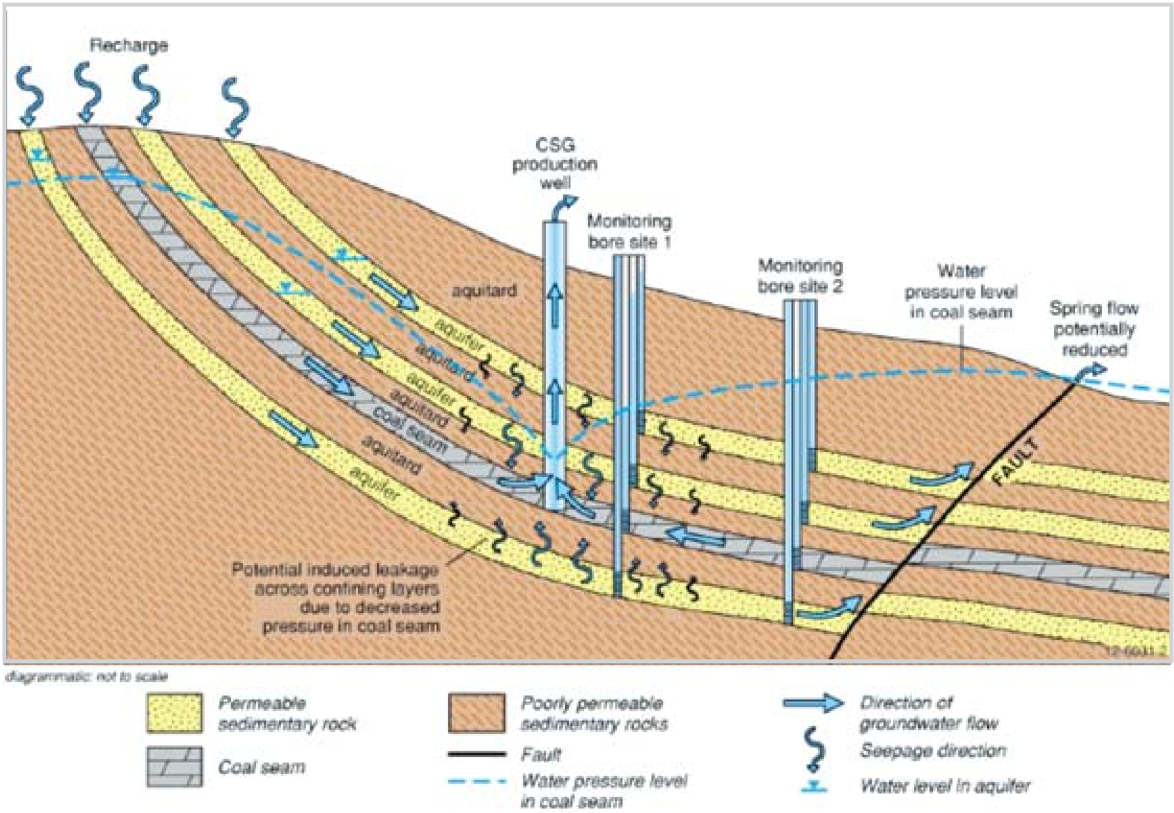
Coal seam gas

During the extraction of coal seam gas, the removal of water from the coal-beds reduces the pressure within the coal and allows the gas to escape to the surface via the vertical wells. In some cases, especially with coal beds at greater depth, it may also be necessary to undertake fracking to release the gas to bring it to the surface.

The dewatering of coal beds poses environmental risk through contamination of water supplies via perforations of casings in wells and from discharges when the water reaches the surface if it is not properly contained. In Australia, the water from coal beds can contain high levels of salt. The adequate containment and treatment of the saline water brought to the surface as part of coal seam gas production is both an important cost of production and an environmental risk.

The process of coal seam production and the implications for water recharge and possible contamination are illustrated in Figure 2. While groundwater contamination is possible, it is unlikely provided that wells are constructed using best practice principles and are of high integrity. This is because groundwater aquifers are, typically, much closer to the surface than the coal seams and rocks of poor permeability are located between the seams and aquifers.

FIGURE 2
COAL SEAM GAS PRODUCTION



Source: Williams, J., Pittock, J., 2012. *Unconventional Gas Production and Water Resources: Lessons from the United States on Better Governance,* Crawford School of Public Policy, the Australian National University.

Another concern with coal seam gas production is the large number of wells that need to be drilled to extract the gas. While each well has a tiny surface footprint, thousands of wells need to be drilled to generate sufficient volumes of gas for large-scale industrial use or for export in the form of liquefied natural gas (LNG). This requires proper co-ordination of developments of gas fields and best practices in terms of engagement with landowners and land access protocols to mitigate the impacts of gas production on people and the landscape.

LNG

LNG is natural gas that has been super-cooled to reduce the gas to a fraction of its original volume. This liquefaction process allows gas to be transported by sea-going vessels and delivered to receiving terminals where the LNG goes through a process of re-gasification for use by industry, domestic consumers and for electricity generation. A significant benefit of LNG is that it allows countries without access to gas pipelines or domestic supplies (such as Japan and South Korea) to import gas, and for countries, such as Australia, that are unable to pipe their gas economically to overseas markets, to export gas.

The seaborne transportation of LNG began in 1959 (see Figure 3) and today represents about 250 million tonnes (Mt) a year in global trade that is worth over US$100 billion a year. Between 2010 and 2011 LNG trade grew by eight per cent, and between 2006 and 2011 it increased by more than 50 per cent.[2]

> "A significant benefit of LNG is that it allows countries without access to gas pipelines or domestic supplies (such as Japan and South Korea) to import gas, and for countries, such as Australia, that are unable to pipe their gas economically to overseas markets, to export gas."

The world's largest LNG supplier is Qatar and it accounted for 31 per cent of exports in 2011. The next three largest exporters were Malaysia (10 per cent), Indonesia (nine per cent) and Australia (eight per cent), as shown in Figure 4. However, Australia is projected to become the second largest exporter by 2016 and possibly the largest LNG exporter by 2020, with exports projected to be in excess of 80 Mt. The largest LNG importers are Japan (33 per cent of global total), South Korea (15 per cent) and the United Kingdom (eight per cent), as shown in Figure 5.

LNG exports are very important to the Australian resources and energy sector. In 2011, exports were worth over A$10 billion. In total, there are seven LNG projects under construction in Australia (see Table 2) that have a combined value of over US$170 billion in terms of capital expenditure.[3] Existing LNG projects in Western Australia and the Northern Territory are sourced from conventional gas fields offshore. By contrast, the three LNG plants under construction at Gladstone in Queensland have been developed to source gas onshore from coal seam gas. These projects will be the first in the world to use coal seam gas as the principal feedstock. In total, coal-seam gas represents about one quarter of Australia's economically demonstrated resources of gas from all sources.[4]

FIGURE 3
HISTORY OF LNG

Milestones in the development of LNG

19th century

British scientist Michael Faraday experiments with liquefying various gases, including natural gas.

1873

German engineer Karl Von Linde builds the first practical compressor refrigeration machine in Munich, Germany.

1912

The first LNG plant is built in West Virgina and starts operating in 1917.

1941

The first commercial liquefaction plant in built in Cleverland, Ohio.

1959

The world's first LNG tanker, The Methane Pioneer, carries cargo from Lake Charles, Louisiana, to Canvey Island, UK.

1964

The UK becomes the first commerical importer and Algeria the first commercial exporter, as LNG trade between the two countries starts.

1969

Japan, now the world's largest LNG importer and consumer, buys its first LNG cargoes, supplied from a plant in Alaska, USA.

1999

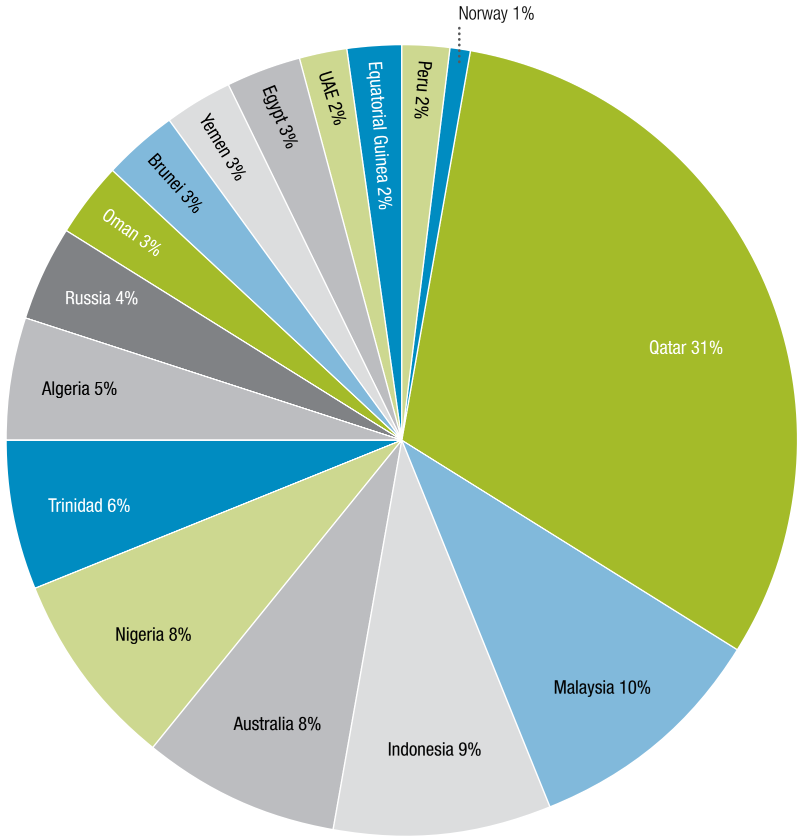
The western hemisphere's first liquefaction plant comes on stream in Trinidad in the Caribbean.

2011

Qatar becomes the largest LNG exporter in the world, with a capacity of 77 million tonnes a year.

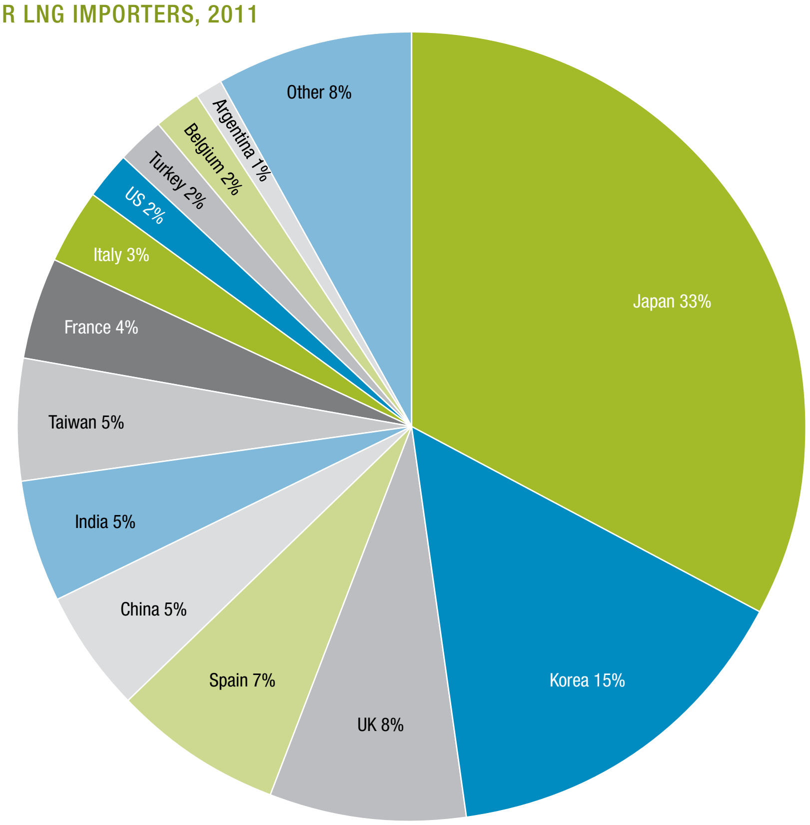
Source: Silverstone Communications 2012, *Everything you wanted to know about gas … but were afraid to ask*, Thumbprints, Malaysia.

FIGURE 4
MAJOR LNG EXPORTERS, 2011



Source: International Gas Union (IGU) 2012, *Global Vision for Gas: The Pathway towards a Sustainable Energy Future*

FIGURE 5
MAJOR LNG IMPORTERS, 2011



Source: International Gas Union (IGU) 2012, *Global Vision for Gas: The Pathway towards a Sustainable Energy Future*

TABLE 2
AUSTRALIAN LNG PROJECTS (IN OPERATION, UNDER CONSTRUCTION AND PLANNED)

Basin/project	Investment (US$b)	Trains	Expected start date	Total capacity (Mt)
Western market				
LNG projects in operation				
North West Shelf	27	5		16.3
Pluto	14.9	1		4.3
Total in operation				20.6
LNG projects in construction				
Gorgon Trains 1–3	43	3	2015	15
Wheatstone/Julimar	29	2	2016	8.9
Prelude FLNG	10+	1	2016	3.6
Ichthys	34	2	2017	8.4
Total in construction				35.9
LNG projects planned				
Pluto 2 and 3 (additional gas required)		2		8.6
Gorgon Train 4 and 5		2		10
Wheatstone 3–5		3		13.4
Browse LNG		3	2017	12
Bonaparte FLNG		1	2018	2
Sunrise FLNG		1		4.1
PTTEP FLNG		1		2
Timor Sea LNG project	2.1	1		3
Total planned				55.1
Eastern market				
CSG LNG projects in construction				
QCLNG	20	2	2014	8.5
GLNG	19	2	2015	7.8
APLNG	23	2	2016	9
Total under construction				20.8
CSG LNG projects planned				
QCLNG Trains 3–4		2		7.8
APLNG Trains 3–4		3		9
Fishman's Landing train 1–2	2.2	2		3
Arrow trains 1–4		4		18
Total planned				42.3
Northern market				
LNG Projects in Operation				
Darwin LNG	3.3	1		3.6
Total in operation				3.6
Australian total in operation				24.2
Australian total in construction				56.7
Australian total planned				97.4

Source: Bureau of Resources and Energy Economics (BREE), *Gas Market Report 2012*, BREE, Canberra.

Australian gas developments

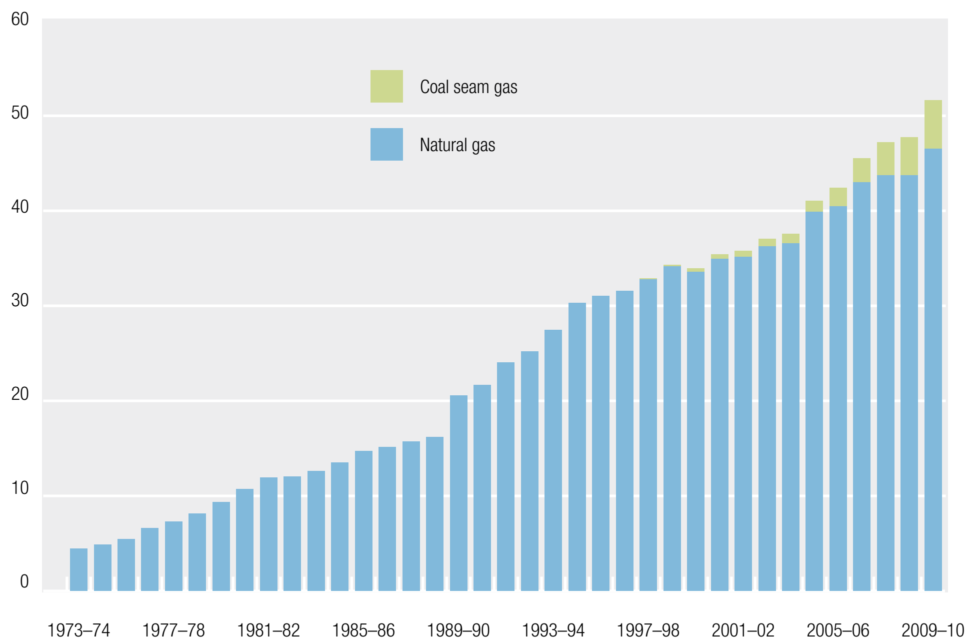
There have been significant developments in the Australian gas market over the past 25 years that include rapid growth in consumption, the start of exports from the North West Shelf project and, most recently, the emergence of coal seam gas in eastern Australia.

Growth in domestic consumption

In the period between 1989–90 and 2009–10, Australia's gas production increased at an average annual rate of around 3.6 per cent (see Figure 6). Of the major consuming states, the fastest rate of growth was in Queensland at an average annual rate of 12 per cent, followed by Western Australia at around six per cent a year. Over this 20 year period, the fastest consumption growth has been in the mining industry, where consumption increased at an average annual rate of seven per cent. Much of the increase in gas consumption by the mining sector can be attributed to the growth in LNG production which, itself, is a gas intensive process. Gas consumption in the electricity generation sector has also increased substantially, at an average annual rate of almost five per cent.

Increases in gas fired electricity generation in Australia over the past decade is, in part, attributable to the expectation that the introduction of a carbon price, that came into force on 1 July 2012, would help make gas more cost competitive to carbon-intensive fuels, such as coal. The ability of open-cycle gas plants to manage intermittency power generation issues associated with electricity generation from renewable sources also makes gas a fuel of choice in terms of meeting peak

FIGURE 6
AUSTRALIAN TOTAL AND COAL SEAM GAS PRODUCTION (1973–74 TO 2009–10)



Source: Bureau of Resources and Energy Economics (BREE), *Gas Market Report 2012*, BREE, Canberra.

electricity demand. As a result of these advantages, over the three-year period to October 2011, there was 12 times more gas-fired electricity generation capacity commissioned in Australia than coal-fired electricity generation capacity.

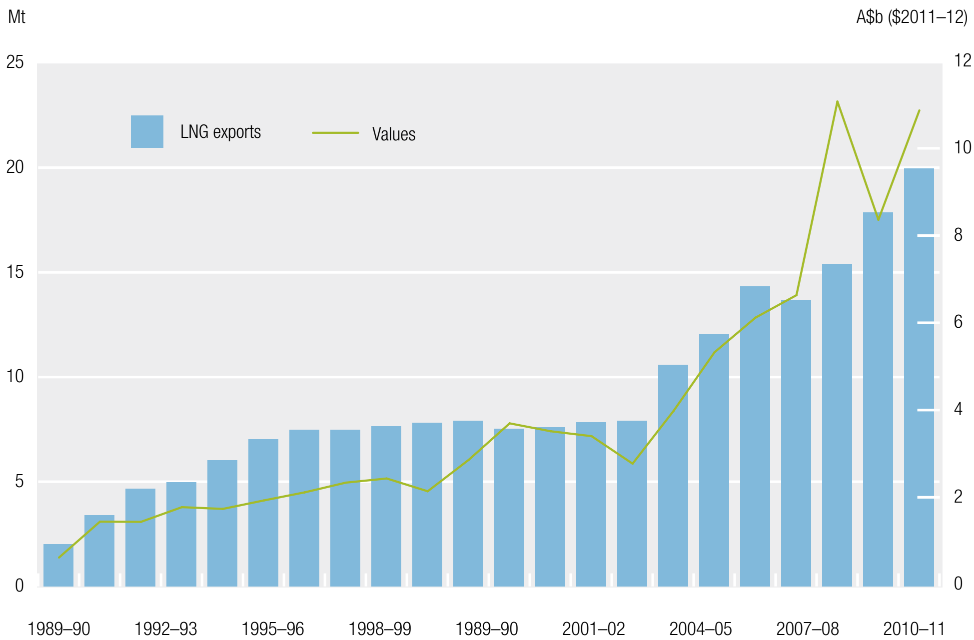
Australian LNG exports

Australia's LNG exports have grown substantially since the first shipments were made in 1989 from Western Australia. At that time there were two LNG trains that had a combined capacity of around five Mt a year (see Figure 7). The development of these LNG trains was underpinned by the signing of 20-year sales agreements with eight Japanese power and utility companies. Additional trains were added in 1992 (additional 2.5 Mt of capacity), 2004 (4.4 Mt) and 2008 (4.4 Mt), that increased the LNG export capacity of the North West Shelf to 16.3 Mt. The development of the last two trains was underpinned by off-take agreements to Japanese, South Korean and Chinese customers.

In 2006, Australia's second LNG project began operation at Darwin, sourcing gas from the Bayu Undan field, which is located 500 kilometres northwest of Darwin, in the Joint Petroleum Development Area managed by both Australia and Timor Leste. The Darwin LNG plant has a production capacity of around 3.6 Mt a year. All of the LNG that is produced at the Darwin LNG plant is exported to Japanese power and utility companies under long term sales contracts.

A third LNG project, Pluto, started operation in 2012 and is located near the North West Shelf project in Western Australia. The Pluto project has a capacity of around 4.3 Mt a year and, like the other two LNG operations, its development has been enabled by the signing of a binding long term agreement with Japanese power and utility companies.

FIGURE 7
AUSTRALIAN LNG EXPORT 1989–90 TO 2010–11 (VOLUME AND VALUE)



Source: Bureau of Resources and Energy Economics (BREE), *Gas Market Report 2012*, BREE, Canberra.

Gas as a transitional fuel

Gas production and combustion generates greenhouse gas (GHG) emissions. However, by comparison to other fossil fuels, such as coal and oil, gas combustion generates substantially lower carbon dioxide emissions. As a result, the substitution of gas for coal can reduce overall GHG emissions.

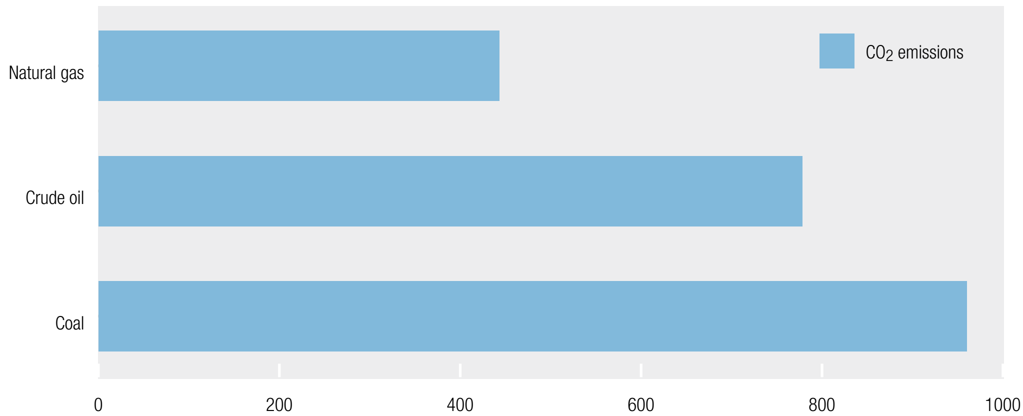
The IEA estimates that coal consumption will increase by 17 per cent between 2010 and 2020.[5] If gas can substitute for some of the expected increase in coal consumption then the increase in GHG emissions will be lower than in a scenario where coal substitution did not occur. In this sense, gas can act as a transitional fuel over the coming decades and replace more carbon-intensive fuels, such as coal.

Figure 8 indicates that equivalent carbon dioxide emissions, at least in terms of electricity production, are less with gas, relative to coal and oil, and indeed are up to 45 per cent less than coal. Gas also has much lower concentrations of other pollutants such as nitrogen oxide and sulphur oxide per tonne of oil equivalent than crude oil or coal.

The extent that gas can reduce the increase in GHG emissions depends on the assumptions made about the degree of substitution between fossil fuels and renewable energy sources into the future. The IEA has undertaken such an analysis whereby it compares a "low conventional" gas scenario that arises because of low public support for unconventional gas production to a "golden rules" gas scenario where there are adequate environmental protections in place to promote unconventional gas production to its economic and technical potential.

The IEA comparison shows that the golden rules scenario results in greater gas production and lower coal consumption than the low conventional case. According to the IEA, the golden rules case results in 1.3 per cent lower global annual carbon dioxide emissions by 2035. The implication of the IEA analysis is that, while gas as

FIGURE 8
CARBON DIOXIDE EMISSIONS DURING ELECTRICITY GENERATION BY FOSSIL FUEL (GRAMS PER KWH)



Source: International Gas Union (IGU) 2012, *Global Vision for Gas: The Pathway towards a Sustainable Energy Future.*

a transitional fuel is not sufficient by itself to meet agreed-to-targets for emissions reductions, it is able to lower GHG emissions over what they would be in the absence of growth in unconventional gas production.

The ability of gas to be a transitional fuel is particularly important for Australia because it has the highest per capita carbon dioxide emissions of any developed economy. This is because about three-quarters of Australian electricity is currently generated from coal.

If there is substitution of coal with gas as a fuel source in electricity generation plants over the next two decades, Australia will be able to lower the increases in GHG emissions that would otherwise occur until renewable energy sources and methods of carbon capture and storage become cost competitive. To illustrate the effect of coal to gas fuel substitution, a comparison can be made using emissions factors obtained from the Australian Energy Technology Assessment (BREE 2012)[6] and World Energy Outlook 2011 (IEA 2011).[7] This comparison contrasts the electricity fuel mix and the carbon emissions projected in 2035 for Australia (BREE 2011)[8] to the actual electricity fuel mix in 2008–09 under the assumption that there is the same level of electricity generated in 2035 in both scenarios.

Net carbon dioxide emissions are about 15 per cent less in the case should gas substitute one-for-one for reductions in coal-fired electricity generation under the assumption that gas and coal represent about 36 and 39 per cent, respectively, of electricity generation in 2035 compared to the base case that assumes the 2008–09 electricity fuel mix remains unchanged to 2035, and gas and coal account for 16 and 74 per cent, respectively, of electricity generation. As in the global case, substitution from coal to gas is not sufficient for Australia to achieve its GHG emissions targets. Nevertheless, gas as a transitional fuel does provide for substantial reductions in emissions that would otherwise not occur in the absence of substitution from coal to gas.[9]

Conclusion

Australia has large conventional and unconventional gas reserves that are being used to supply the domestic market and to generate exports of gas in the form of LNG. More than $170 billion worth of investments in production, pipelines and LNG facilities could make Australia the world's largest LNG exporter by 2020.

The growth in Australian gas production and exports has generated legitimate concerns about environmental impacts, land access, and also monitoring and controls, especially in terms of coal seam gas production. The US experience in unconventional gas production over the last decade indicates that past practices have been inadequate, but also that regulations are improving to respond to a range of environmental and landowner concerns.

Best and better practices are needed in Australia to secure public confidence in unconventional gas production. Improved gas production protocols, practices and regulatory oversight should help grow domestic gas supplies and reduce environmental risks. Without better practices, a lack of community support may compromise the planned growth in Australia's unconventional gas industry and reduce the ability of gas to act as a transitional fuel to mitigate carbon dioxide emissions.

Glossary

Coal seam gas (CSG)

Gas found in coal seams that cannot be economically produced using conventional oil and gas industry extraction techniques. CSG is also referred to as coal seam methane (CSM) or coal bed methane (CBM).

Conventional gas

Gas that is produced using conventional oil and gas industry extraction techniques.

Economic demonstrated resources (EDR)

Gas resources that can be produced using existing technologies and are viable at current market prices.

Liquefied natural gas (LNG)

Gas that has been converted into liquid form by refrigeration in a liquefied natural gas plant to around –162°C for ease of storage and transport.

LNG train

A unit of gas purification and liquefaction facilities found in a liquefied natural gas plant. The train is used to describe the facility because the gas moves through the plant as it is purified, chilled and pressurised.

Natural gas

Natural gas is primarily methane gas that has been processed to remove impurities to a required standard for consumer use. It may contain small amounts of ethane, propane, carbon dioxide and inert gases such as nitrogen. Natural gas is commercially extracted from oil fields and natural gas fields.

Shale gas

Gas found in shale layers that cannot be economically produced using conventional oil and gas industry extraction techniques.

Endnotes

1 International Energy Agency (IEA) 2012, *Golden Rules for a Golden Age of Gas*, IEA, Paris.

2 International Gas Union (IGU), *World LNG Report 2011*.

3 Bureau of Resources and Energy Economics (BREE) 2012, *Mining Industry Major Projects*, BREE, Canberra.

4 BREE and Geoscience Australia 2012, *Australian Energy Resource Assessment*, Gas Chapter, p 17.

5 International Energy Agency (IEA) 2012, *Golden Rules for a Golden Age of Gas, p 79*, IEA, Paris.

6 Bureau of Resources and Energy Economics (BREE) 2012, Australian Energy Technology Assessment 2012, BREE, Canberra.

7 International Energy Agency (IEA) 2011, World Energy Outlook, IEA, Paris.

8 Bureau of Resources and Energy Economics (BREE) 2011, Australian Energy Projections to 2034–35, BREE, Canberra.

9 An interdisciplinary study at the MIT, *The Future of Natural Gas*, published in 2011 concluded that substitution from coal to gas in the US electricity sector could reduce carbon dioxide emissions by up to 20 per cent.

2. Unconventional gas and produced water

Rebecca Nelson

This chapter provides analysis of the groundwater management issues associated with unconventional energy, particularly coal seam gas, and identifies key areas where there are commonly gaps in regulation and policy across Australia.

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Introduction

Producing unconventional gas, particularly coal seam gas (CSG), is a thirsty business. It involves releasing the gas by dewatering or depressurising the aquifer containing the gas. Depending on the physical context and production processes, this can cause a variety of water impacts – depleting aquifers and streams connected to those aquifers, changing groundwater quality, changing the water quality and flow regimes of any rivers into which "produced water" is disposed, and affecting the structure of any aquifers subject to hydraulic fracturing to increase gas production. Public concerns and government inquiries[1] show that these potential water impacts are a key challenge to gaining acceptance for unconventional gas developments – and realising the potential contribution of Australia's CSG and our largely untouched shale gas and tight gas reserves to our energy supplies. This is the case for good reason: in some cases, not dealing with these impacts risks inadvertently allowing severe and potentially irreversible impacts on the environment and other water users. Though unconventional gas production is currently focused on CSG in Queensland and New South Wales, CSG exploration occurs across Australia. The lack of robust law and policy for controlling these risks across all jurisdictions with potential reserves also precludes the creation of a secure and certain investment environment for aspiring proponents of unconventional gas projects.

A complex web of federal and state laws and policies deals with the water impacts of CSG, with different requirements in place through arrangements under petroleum and gas licensing regimes, environmental protection legislation, and some water legislation. This policy perspective provides a high-level review of major issues associated with unconventional gas (chiefly CSG) and water in Australia. It then focuses on key issues that forward-looking Australian regulation and policy related to extracting produced water should address at an early stage in the nation-wide development of the industry. This is an aspect of CSG activities that has attracted less public concern than contamination fears, but is potentially much more significant, particularly in light of current regulatory efforts to limit groundwater use in the Murray-Darling Basin.

This review recommends that law and policy dealing with the extraction of produced water should:

- Include produced water within regular water licensing frameworks that cover other groundwater-using activities, like irrigation and regular industrial uses, to ensure comprehensive water management and equity in relation to water use;
- Assess the impacts of withdrawing produced water before a particular development occurs, in a way that:
  - Is comprehensive as to the range of water users and values that could be affected;
  - Uses regional models capable of assessing cumulative impacts, funded by CSG proponents;
  - Uses public and private data;
  - Involves collaborative, strategic data collection between companies and governments at a regional scale;
  - Applies a middle-road, "slow down and learn" approach to risk assessment, that neither bans production, nor charges ahead in the face of potentially very serious and uncertain impacts;
- Require CSG proponents to mitigate water impacts felt by people who use groundwater or surface water connected to affected aquifers, as well as environmental flows in affected rivers, springs, and other impacted groundwater-dependent ecosystems – in a way that is robust in light of time-lagged and cumulative impacts.

This review draws from the US experience relating to CSG and shale gas. Although key differences separate the Australian and US regulatory contexts,[2] the US experience can usefully indicate key points of contention that law and policy must aim to resolve, as well as highlight potentially valuable policy mechanisms for doing so. These mechanisms include water allocation laws that cover CSG activities, laws that better protect holders of rights to surface waters that are affected by CSG development, and broad requirements to mitigate water impacts.

Water impacts of unconventional gas operations

In some cases, unconventional gas operations can have dramatic impacts on water quantity and quality, which means that they can dramatically affect other water users and the environment. Since there is probably no way of achieving no net impact, law and policy need to determine which impacts are acceptable and which are not, and allocate the burden of reducing or dealing with impacts. Some impacts may be irreversible, so the cost of failure – that is, inadvertently permitting unacceptable impacts – is high. This section gives an overview of the nature of these potential impacts; the rest of this piece focuses on dealing with them. While the impacts described here are common to different types of unconventional gas operations, many are more problematic for CSG than for shale gas, since CSG operations produce much more water, from shallower aquifers that are more likely to be shared with people and ecosystems, or draw from saline sources, which then poses a disposal problem.

Extracting large amounts of produced water can deplete aquifers and may lower water tables in coal-bearing or connected aquifers, potentially reducing future water supplies for other consumptive uses, like agricultural and urban uses. It can also impact on species, ecosystems and water systems that are connected to groundwater, which can include rivers, wetlands, springs, riparian and floodplain vegetation, and aquifer habitats themselves, which can harbour organisms like microbes and invertebrates that may contribute to valuable ecological processes. In the US, groundwater levels in coal-bearing aquifers in the Powder River Basin have declined by hundreds of feet; the stream-depleting effects of CSG development are the subject of ongoing interstate and intrastate litigation there and elsewhere in the US.[3]

Despite some popular focus on the raw volumes of water extracted (in Australia, likely to be around 300GL/yr over the next two to three decades; in the US, around 177GL in 2008),[4] it is the nature and extent of the impacts of extracting this water on current and future users and the environment, which really matter. Those factors vary from place to place, depending on:

- How much "renewable" (as opposed to "fossil", non-recharged) water is available;
- How much is accessible and used by other people and ecosystems; and
- How sensitive they are to changes in availability.

The water efficiency of CSG operations (that is, the quantity of water produced per unit of energy available from extracted gas) can also vary dramatically – by almost 200 times between basins,[5] because on a local or regional scale, some operations are much thirstier than others.

Once extracted, dealing with produced water presents a further challenge. It can be discharged to streams or evaporation/disposal pits, reinjected into a suitable aquifer, or re-used for urban, agricultural or industrial purposes.[6] Each option is used to some degree in both Australia and the US,[7] and each has advantages and disadvantages. Stream disposal is cheap, but can make stream systems that are naturally ephemeral flow year-round, causing stream-bank erosion and instability, invasion of weedy non-native plants, increased sediment loads, and changes in the ecology of in-stream and riparian areas.[8] Evaporation ponds are also cheap, but concentrate salt and other contaminants.[9] While an attractive way to avoid waste, re-using produced water is commonly hindered by long distances to potential re-users; intermittent, varying, and temporary production; high costs and disturbance (pipelines or truck movements) associated with transporting water for treatment; and obstacles to disposing potentially toxic treatment brines.[10] Limited post-construction re-use occurs in Australia for purposes including irrigation, livestock watering, power station use, coal washing, on-site re-use, and even irrigated timber plantations.[11] In the US, less than five per cent of CSG water is re-used.[12] Re-injection is reasonably common in the US, but is not currently widely practised in Australia, and the degree to which this could help minimise aquifer depletion and depressurisation is uncertain, particularly because the suitability of re-injection can be limited by site-specific hydrogeological and geochemical factors.[13] Re-injection can be suitable where CSG water is produced in low volumes and is of poor quality. However, surface options are economically more attractive for larger volumes of higher-quality water.[14]

CSG operations can also reduce the quality of water in aquifers and rivers. Highly saline produced water can contaminate freshwater receiving bodies; conversely, treated water can "pollute" naturally turbid receiving streams, where ecosystems rely on these natural conditions.[15] Other potential sources of water pollution are treatment brines; hydraulic fracturing fluids; cross-connections between aquifers of different quality caused by hydraulic fracturing; surface spills of diesel and other substances used on site; poorly constructed bores; and poorly maintained equipment.[16] Sometimes the picture is complicated by naturally occurring contaminants.[17] Poor well construction and surface spills of fracturing fluid and diesel caused by operator error or poor training are important causes of pollution in the US shale gas context. However, despite intense public concern, groundwater contamination caused by hydraulic fracturing chemicals has not been supported by scientific evidence.[18]

Some water impacts may be irreversible. For practical purposes, making new connections between aquifers by hydraulic fracturing; causing aquifers to compact by extracting large volumes of water; losing pressure in artesian aquifers; contaminating groundwater; losing groundwater-dependent species and ecosystems; and depleting "fossil" aquifers, like the Great Artesian Basin in Australia or the San Juan Basin in the US,[19] may all fall into this category.

Key water law and policy issues surrounding withdrawing produced water

Resolving how law and policy deal with the extraction of produced water will be a crucial part of creating the security and certainty needed to facilitate an appropriate level of investment in CSG and other types of unconventional gas. Extracting produced water raises three key law and policy issues that are subject to ongoing debate:

- First, and most fundamentally, whether to apply standard water licensing arrangements to produced water;
- Second, how to assess the impacts of extracting produced water, particularly in light of its sometimes uncertain and cumulative impacts; and
- Third, how to impose requirements to mitigate adverse impacts on other water users and the environment.

Including produced water in water allocation systems

Before contemplating precisely how to assess and manage the impacts of withdrawing produced water, a basic regulatory issue arises – whether water laws should require a water licence to cover this water, or exempt produced water from this requirement, and leave regulation to mining and petroleum and environmental laws. Unfortunately, despite policy statements to the contrary, Australian water laws have traditionally allowed exemptions for produced water. Queensland remains a case in point: its petroleum and gas legislation explicitly enables CSG proponents to withdraw an unlimited amount of groundwater as part of their CSG activities, without requiring a water entitlement.[20] Making such exemptions is like drilling holes in the bucket containing the common resources to be managed. Where CSG water comprises a high proportion of total water withdrawals, there may be more hole than bucket, putting at risk the environment and other water users.

> "Making such exemptions is like drilling holes in the bucket containing the common resources to be managed. Where CSG water comprises a high proportion of total water withdrawals, there may be more hole than bucket, putting at risk the environment and other water users."

Fundamentally, water laws aim to protect the security of water entitlements, prevent environmental degradation from over-use of water, and allocate water fairly.[21] The pursuit of these goals can be seriously undermined by selectively regulating water withdrawals,[22] particularly those involving significant volumes of water, like CSG operations. Such a selective approach omits significant activities from water plans that seek to manage and often cap the impacts of water extraction as a whole,[23] making it more difficult to ensure that CSG activities do not threaten the security of existing entitlements and cause harm to water environments. This is because the water impacts of CSG projects are cumulative not just with other CSG projects, but also with other water-using activities. It also opens up CSG activities to criticism for benefiting from unfair privileges that are not available to other water-using activities, which use much smaller volumes of water on an individual use or project basis. This breeds unnecessary conflict. This is not to say that other legislation has no way of managing some of these adverse impacts – examples of those are given in the assessment section below – just that there are distinct disadvantages to this fragmentation from the point of view of comprehensive water management, efficient administration, and public perceptions of what equity requires in relation to water use. In addition, exempting produced water adds to other factors (for example, water provision and recycling regulations) that can obstruct re-use, since the sale and use of produced water for activities like agriculture requires a water entitlement.

Some recent Australian water laws and policies have included produced water from CSG activities. Recent NSW water laws require a water access licence for significant volumes of water produced in the course of extracting or exploring for minerals, petroleum, or gas.[24] NSW policy about licensing "aquifer interference activities" is still developing.[25] At a larger scale, the proposed plan for managing water in the Murray-Darling Basin counts produced water under "environmentally sustainable diversion limits", effectively subjecting unconventional gas developments to the same basin-based extraction limits that cover other users.[26] Unfortunately, this plan uses a high threshold for recognising connectivity between groundwater and surface water resources, such that it could well ignore significant stream-depleting effects associated with CSG activities.[27]

Fitting CSG within water allocation frameworks reinforces the need to fix some recognised gaps and flaws in Australian water law and policy that are accentuated in the CSG context, some of which risk harm to water users and ecosystems. In addition to the traditional focus on "permanent" water sources, water plans and licensing arrangements will need to accommodate temporary withdrawals of produced water.[28] Where withdrawing produced water could deplete surface water, water laws should recognise this effect – something they do notoriously poorly in the case of groundwater extraction generally.[29] The implementation of existing legal protections for groundwater-dependent ecosystems also needs boosting, consistent with national water reforms over the past decade, particularly in light of the potentially enormous volumes of produced water.[30]

The varying experiences of US states with this issue confirm two things: first, properly regulating CSG proponents like other water users is possible and desirable, even though CSG development operates in a slightly different context. Some states, for example Colorado, Wyoming and New Mexico (to an extent) require water authorisations for produced water withdrawals in the same way as for other uses.[31] Second, excluding unconventional gas from water licensing requirements breeds conflict with other water users and litigation. A dramatic example of this is currently playing out in litigation between Montana and Wyoming. Montana asserts that Wyoming failed to adequately control produced water withdrawals in its portion of the Powder River Basin, with allegedly illegal impacts on an interstate river.[32] Individual water users who claim they have been adversely affected by produced water withdrawals have also produced a substantial body of intrastate lawsuits across the Rocky Mountain states.[33] Mindful of this potential for conflict, Australian states should include produced water withdrawn by unconventional gas activities within standard water allocation frameworks, to ensure that potential impacts on the environment and other water users (including surface water users) are adequately considered.

Assessing impacts of withdrawing produced water

Whether under environmental, petroleum, or water frameworks, the impacts of withdrawing produced water should be assessed:

- Comprehensively, covering a wide range of water users and values, using regional models capable of assessing cumulative impacts, and using a wider set of existing data;
- Prospectively, before development occurs, and on an ongoing basis, on account of the time lags that can characterise these impacts;
- Having all the existing information about potential impacts to hand, including information held by companies; and
- Having regard to a "slow down and learn" approach to risk assessment, in response to uncertainty.

Comprehensive assessment

The large scale, cumulative nature, and broad range of impacts associated with withdrawing produced water warrant especially comprehensive assessment, to a greater extent than happens now. CSG developments can involve hundreds or thousands of wells distributed at a regional scale, with implications for both science and regulation. Scientists require a "regional-scale, multi-state and multi-layer model" of both groundwater and surface water to help assess impacts and develop mitigation programs.[34] Paying for such models becomes a key issue. Over decades, national water policy has repeatedly and sensibly recommended that water users should bear the costs of managing the resource from which they benefit,[35] including specifically in relation to CSG.[36] This recommendation, which has been largely ignored, is consistent with miners' responsibility to pay for monitoring systems, and with the publicly-held nature of both water and natural gas resources. Importantly, it also avoids the potential for a mismatch between the resources necessary for modelling and those available through a government budget subsidy.

> "The large scale, cumulative nature, and broad range of impacts associated with withdrawing produced water warrant especially comprehensive assessment, to a greater extent than happens now."

Concerns about cumulative impacts have created useful regulatory tools that are novel, but arguably not sufficiently comprehensive. For example, Queensland's water legislation provides for "cumulative management areas" where the impacts from multiple gas fields overlap. The Queensland Water Commission assesses and reports on impacts in such areas, and establishes binding management arrangements. Its first such report, released in May 2012 in draft form for the Surat Cumulative Management Area, predicts long term groundwater level declines of up to 200 metres, and significant impacts on five culturally and ecologically significant spring complexes, and proposes options for mitigating these impacts on springs.[37] However, reflecting its guiding legislation, it is less comprehensive than ideal. It uses incomplete information on cultural heritage and cultural values of springs; and overlooks ecological impacts other than those on springs that exceed a threshold level of groundwater decline. In contrast, Queensland's water licensing provisions take a more comprehensive view of ecological impacts, considering effects on natural ecosystems, rivers, and aquifers in general – reinforcing the argument for integrating CSG water into standard water allocation frameworks.[38]

Two further assessment tools could be used to assist in dealing with large-scale cumulative impacts. The first is strategic assessments under federal environmental laws, an alternative to case-by-case assessment, which can reduce overall administrative burdens, but has so far not been used in the CSG context. The second is planned joint Commonwealth-state bio-regional assessments, which will analyse potential risks to water resources over large areas that may be subject to CSG developments.[39]

Prospective and ongoing assessment

Arrangements for assessing impacts and allocating monitoring and mitigation responsibilities should be clear and prospective, applying before development occurs – or risk impacts that go unaddressed because they are irreversible, or because they manifest after operations cease, and developers have moved on. This imperative flows from the time lags that can characterise the impacts of withdrawing produced water. Days to decades, or longer, can occur between withdrawing groundwater at one location, and experiencing impacts on water table levels at other locations where people or ecosystems use groundwater from the same aquifer. While people react quickly when their bores dry up, there can be further time lags before ecosystems start to manifest signs of these impacts.

> "Governments should take a robust approach to environmental licensing requirements, resisting pressure to allow unconventional gas developments to proceed without proper impact assessments. They should also ensure that monitoring and mitigation obligations apply to proponents for long enough to ensure that impacts felt into the future can be addressed, with financial surety to support these obligations."

Governments should take a robust approach to environmental licensing requirements, resisting pressure to allow unconventional gas developments to proceed without proper impact assessments. They should also ensure that monitoring and mitigation obligations apply to proponents for long enough to ensure that impacts felt into the future can be addressed, with financial surety to support these obligations. This might mean requiring proponents to contribute to a fund for long term monitoring of affected areas, long after operations cease.

Using existing information to reduce uncertainty

Uncertainty besets important aspects of withdrawing CSG water, which complicates regulation and increases public concerns. While some uncertainty is inevitable, CSG proponents can do much to share data and collect data more collaboratively and strategically to reduce uncertainty.

Often only low levels of baseline information are available in relation to the water conditions, geology, ecology, and cultural values of areas that may be affected by CSG operations. In addition, the nature of CSG production means that there is some uncertainty about the precise locations of future wells and projected volumes of produced water.

Some of these difficulties can be addressed by collecting better information; others are inherent in the nature of CSG operations. The low-hanging fruit is the information held by companies. Key information that would help to reduce uncertainty may be unavailable to agencies, on account of its private, commercial nature – a fact bemoaned by many.[40] New Australian federal reporting requirements for groundwater data include volumes produced during "mine dewatering"[41]: this should be clarified to encompass produced water from CSG operations. Globally, intense public concerns about the transparency of information related to unconventional gas developments have led the International Energy Agency to recommend that proponents measure and disclose operational data on water use, wastewater emissions, and fracturing fluid additives.[42] CSG proponents could also go much further, sharing existing geological and environmental data that would assist modelling efforts, and collaborating with governments to collect information strategically, on a regional scale, in a way that would help to reduce uncertainty associated with cumulative impacts. There is some Australian precedent for productive alliances between government, industry and academia.[43]

A "slow down and learn" approach to uncertainty

The sources of uncertainty outlined above may make it impossible at the time of licensing to fully assess the nature of the impacts of a development and the significance of these impacts, or to set out conditions designed to address these impacts. The cumulative and time-lagged nature of water impacts exacerbates these uncertainties. This situation requires an approach to risk assessment that recognises the potential for irreversible impacts, but does not unnecessarily stifle development.

Some have argued that a moratorium on CSG development is the only appropriate response to such uncertainty.[44] Others have more usefully presented structured approaches to dealing with uncertainty. Resources economist Alan Randall argues convincingly that uncertainties associated with CSG developments are unsuited to both an "ordinary risk management" approach (which takes a "safe until proven harmful" line and requires knowledge of the probability of known outcomes) and also a "blunt" and politically shaky moratorium-focused approach, which would "systematically repress innovation".[45] Rather, he argues for "integrated risk management", an iterative, science-driven process of "screening, pre-release testing and post-release surveillance", which involves temporary precautionary measures that are progressively relieved as more is discovered about potential harms.[46] As Randall points out, this "slow down and learn" approach is preferable to more reactive ideas of adaptive management, which involve "waiting until problems reveal themselves and seeking to resolve them by trial and error"[47] – clearly inappropriate where time lags and the risk of irreversible consequences are involved. This integrated risk management approach is best carried out at a regional scale, at which cumulative impacts can be assessed. It could be linked with planned Commonwealth-state bio-regional assessments and water plans, with the intention of guiding licensing decisions, in the same way as overarching water plans guide water licensing decisions. There is also a compelling argument for connecting such an approach to management plans for other natural resources that could be affected by CSG developments.[48]

> "Mitigation arrangements are an emerging component of law and policy related to CSG in Australia, which needs further development. The more extensive US experience in this area, including through normal water allocation frameworks, confirms the importance of approaching mitigation requirements in a broader way than currently occurs in Australia, and with a longer time horizon."

Mitigating water impacts

Requirements to offset some or all of the impacts of withdrawing produced water are vital to reducing the net water impact of unconventional gas development. To be effective, these arrangements must deal with impacts on people and ecological groundwater users, and they must be robust in the face of uncertain and cumulative impacts and time lags. Mitigation arrangements are an emerging component of law and policy related to CSG in Australia, which needs further development. The more extensive US experience in this area, including through normal water allocation frameworks, confirms the importance of approaching mitigation requirements in a broader way than currently occurs in Australia, and with a longer time horizon.

The 2004 National Water Initiative foreshadowed that "obligations to remediate and offset impacts" may be required in relation to petroleum and mining activities.[49] State requirements to mitigate, or "make good" certain types of water impacts take different forms, but tend to focus on water supply issues, with overly narrow protection in relation to ecological impacts. For example, CSG proponents in Queensland must undertake baseline assessments of bores in their tenure areas, to determine likely subsequent impacts.[50] If an existing bore fails to provide a reasonable quantity or quality of water because of CSG activities, the proponent must "make good" the impairment, for example, by deepening the bore, constructing a new one, providing an alternate water supply, or providing compensation.[51]

> "Although Queensland's 'make good' obligations theoretically extend beyond the life of CSG operations, it is unclear how their delivery would be guaranteed long after production ceases."

Some US states extend mitigation agreements to the owners of affected springs,[52] users of surface water and holders of environmental flow rights, which are affected by produced water extraction. In Colorado, for example, CSG producers must ensure that their activities do not cause "material injury" to the water rights of surface water users, or instream flow rights that pre-date the CSG development.

In addition to dealing with impacts to both people and ecological groundwater users, mitigation arrangements should take into account the cumulative and time-lagged nature of impacts of withdrawing produced water. Although Queensland's make good obligations theoretically extend beyond the life of CSG operations, it is unclear how their delivery would be guaranteed long after production ceases. It is also unclear how to ensure compensation for bore owners affected to a cumulatively significant level by groundwater uses that include a single CSG development, or where no cumulative management area has been declared. Montana provides one avenue to deal with these challenges. Its Coal Bed Methane Protection Program uses natural gas production taxes to provide compensation to water rights holders damaged by CSG developments, who are not otherwise compensated by CSG developers.[53] Such a fund could help where impacts are felt long after production ceases and where cumulative impacts would otherwise go unaddressed.

Conclusion

Withdrawing produced water poses a number of important challenges for Australian law and policy for CSG. Whether to integrate produced water into regular water allocation frameworks is a fundamental issue. Considerations of national policy, the requirements of comprehensive resources management, and public perceptions of equity all recommend this course. Recent NSW law as well as some western US states have taken this path. Assessing the impacts of produced water withdrawals is complicated by the interacting factors of uncertainty, time lags, and cumulative impacts. An "integrated risk management" framework offers promise for dealing with these challenges by running a middle course between ordinary risk assessment procedures and blunt calls for moratoria on CSG development. Finally, mitigation arrangements in Australia aim to deal with impacts of withdrawing produced water on consumptive groundwater users, but this narrow scope does not sufficiently cover those potentially affected, or the full range of ecosystems that may be impacted. These arrangements should be broadened to ensure that potential impacts are reduced or offset as far as possible.

Endnotes

1 See, for example, inquiries by the Federal Senate Standing Committee on Rural and Regional Affairs and Transport, the NSW Legislative Council General Purpose Standing Committee No. 5, the Council of Australian Governments' Standing Council on Energy and Resources 2011, *Coal Seam Gas Policy Statement*, accessed at http://www.scer.gov.au/workstreams/general-council-publications/policy-statements/, and the establishment of the Interim Independent Expert Scientific Committee on Coal Seam Gas and Coal Mining (accessed at http://www.environment.gov.au/coal-seam-gas-mining/index.html).

2 For example, differences relate to water allocation systems, the division of regulatory responsibilities between federal, state and tribal governments, ownership of gas resources, and the absence of explicit ecological considerations in much US water allocation law.

3 Mudd, MB 2012, *Perspectives on Montana v. Wyoming: An Opportunity to Right the Course for Coalbed Methane Development and Prior Appropriation*, Golden Gate University Environmental Law Journal, vol. 5, pp. 297, 312; National Research Council (U.S.). Committee on Management and Effects of Coalbed Methane Development and Produced Water in the Western United States 2010, *Management and Effects of Coalbed Methane Produced Water in the Western United States*, National Academies Press, Washington, DC, pp. 115, 116 (CSG operations in Colorado's Raton Basin are estimated to dewater streams by approximately 3084ML/yr); SS Papadopulos and Associates Inc and Colorado Geological Survey 2008, *Coalbed Methane Stream Depletion Assessment Study – Raton Basin*, Colorado, available from: http://geosurvey.state.co.us/water/CBM%20Water%20Depletion/Documents/RatonCBMdepletion_FINAL.pdf.

4 National Water Commission 2012, Coal Seam Gas: Update, available from: http://www.nwc.gov.au/reform/position/coal-seam-gas; United States Environmental Protection Agency 2010, *Coalbed Methane Extraction: Detailed Study Report* (EPA-820-R-10-022), USEPA, Washington, DC, available from: http://water.epa.gov/lawsregs/lawsguidance/cwa/304m/upload/cbm_report_2011.pdf, pp. 3–8. Note that there has been significant contention over estimated volumes for Australia. For a convenient summary of various estimates, see Coal Seam Gas By The Numbers: Coal Seam Gas and Water, accessed at http://www.abc.net.au/news/specials/coal-seam-gas-by-the-numbers/water/.

5 RPS Australia East Pty Ltd 2011, *Onshore Co-Produced Water: Extent and Management*, National Water Commission, Canberra, pp. 10–11.

6 Ibid, pp. 18, 20.

7 See generally ibid; National Research Council, *Management and Effects of Coalbed Methane Produced Water in the Western US*, p. 93.

8 National Research Council, *Management and Effects of Coalbed Methane Produced Water in the Western United States*, pp. 145–147. While there has been some suggestion of using this water to deliver environmental flows, environmentally valuable sites, like wetlands, which could benefit from the water, are often distant from the site of production, and so would require infrastructure for delivery of the water: RPS, *Onshore Co-Produced Water*, p. 21.

9 RPS, *Onshore co-produced water,* p.22.

10 Ibid, pp. 17–18; National Research Council, *Management and Effects of Coalbed Methane Produced Water in the Western US*, pp. 101–102.

11 RPS, *Onshore Co-Produced Water*, pp. 20–21.

12 National Research Council, *Management and Effects of Coalbed Methane Produced Water in the Western US*, pp. 106, 110.

13 RPS, Onshore Co-Produced Water, p. 21; National Research Council, *Management and Effects of Coalbed Methane Produced Water in the Western US*, p. 98.

14 National Research Council, *Management and Effects of Coalbed Methane Produced Water in the Western US*, pp. 110–111.

15 RPS, *Onshore Co-Produced Water*, p. 25.

16 See generally Crawford School of Public Policy & United States Studies Centre 2012, *Unconventional Gas Production and Water Resources: Lessons from the United States on Better Governance – A Workshop for Australian Government Officials*, Australian National University and University of Sydney, Canberra.

17 See, for example, Molofsky, LJ et al 2011, 'Methane in Pennsylvania Water Wells Unrelated to Marcellus Shale Fracturing', *Oil and Gas Journal*, vol. 109, no. 19, p. 54 (finding that problems associated with methane in water wells in Pennsylvania derive from naturally occurring methane, rather than hydraulic fracturing of the Marcellus shale).

18 Crawford School of Public Policy and United States Studies Centre, *Unconventional Gas Production and Water Resources*, pp. 15–18.

19 National Research Council, *Management and Effects of Coalbed Methane Produced Water in the Western US*, p. 123.

20 *Petroleum and Gas (Production and Safety) 2004* (Qld) sec. 185(3).

21 See, for example, *Water Act 2000* (Qld) sec. 10(i), (iv), (vi).

22 Even stock and domestic water use, traditionally a sacred cow, attracts this criticism. See, for example, Bracken, N 2010, 'Exempt Well Issues in the West', *Environmental Law* vol. 40, p. 141; Sinclair Knight Merz, CSIRO & Bureau of Rural Sciences, 2010 *Surface and/or Groundwater Interception Activities: Initial Estimates*, National Water Commission, Canberra.

23 NSW Office of Water 2011, 'The NSW Aquifer Interference Policy – Protecting Our Groundwater Systems', available from: http://www.water.nsw.gov.au/ArticleDocuments/34/aquifer_interference_infosheet.pdf.aspx, p. 2.

24 *Water Management Act 2000* (NSW) sec. 60I (inserted by *Water Management Amendment Act 2010* [NSW] sec. 16); Water Management (General) Amendment (Aquifer Interference) Regulation 2011 (NSW) Sch. 7, cl. 27. This requires a water access licence for these activities, where they remove more than 3ML/yr.

25 NSW Office of Water, 'The NSW Aquifer Interference Policy'; NSW Government 2012, *Draft Aquifer Interference Policy – Stage 1: NSW Government Policy for the Licensing and Approval of Aquifer Interference Activities*, NSW Government, Sydney.

26 Murray-Darling Basin Authority 2012, *Proposed Basin Plan Consultation Report*, Murray-Darling Basin Authority, Canberra, p. 146.

27 Nelson, R 2012, *Submission to the House of Representatives Standing Committee on Regional Australia's Inquiry on "Certain Matters Relating to the Proposed Murray-Darling Basin Plan": Groundwater SDLs* available at http://aph.gov.au/Parliamentary_Business/Committees/House_of_Representatives_Committees?url=ra/murraydarling2/subs/sub22.pdf. For an example of an Australian investigation into stream depletion concerns in relation to CSG specifically, see Moran C & Vink S 2010, *Assessment of Impacts of the Proposed Coal Seam Gas Operations on Surface and Groundwater Systems in the Murray-Darling Basin*, Australian Government, Canberra.

28 Water plans must already be periodically reviewed to adapt to changing water availability, and water entitlements may be surrendered or revoked: temporary water sources are an extension of these themes.

29 National Water Commission 2011, *The National Water Initiative – Securing Australia's Water Future: 2011 Assessment*, National Water Commission, Canberra, p. 100.

30 Ibid, p. 115; see generally, Tomlinson, M 2011, *Ecological Water Requirements of Groundwater Systems: A Knowledge and Policy Review*, National Water Commission, Canberra.

31 National Research Council, *Management and Effects of Coalbed Methane Produced Water in the Western US*, pp. 80, 85.

32 See generally, Mudd, 'Perspectives on Montana v. Wyoming'.

33 Klahn, SA & Tuholske, J 2010, 'Coalbed Methane Produced Groundwater: A Survey of Western Water Law Regulation', *The Water Report*, iss. 77, pp. 3–5.

34 Geoscience Australia & Habermehl, MA 2010, 'Summary of Advice in Relation to the Potential Impacts of Coal Seam Gas Extraction in the Surat and Bowen Basins, Queensland: Phase One Report Summary', available from: http://www.environment.gov.au/epbc/notices/pubs/gladstone-ga-report.pdf p. 7.

35 See, for example: Agriculture and Resource Management Council of Australia and New Zealand & Standing Committee on Agriculture and Resource Management 1996, *Allocation and Use of Groundwater: A National Framework for Improved Groundwater Management in Australia – Policy Position Paper for Advice to States and Territories*, Task Force on CoAG Water Reform, Canberra, pp. 12–14; National Water Commission 2011, *National Water Initiative,* p. 80.

36 National Water Commission, 'Principles for Managing CSG and Water'. There is precedent for such arrangements in Australia, for example, petroleum tenure holders fund the Queensland Water Commission's CSG functions through a levy: *Water Act 2000* (Qld) sec. 360FA.

37 Queensland Water Commission, 2012. *Draft Underground Water Impact Report: Surat Cumulative Management Area*, available from: http://www.qwc.qld.gov.au/csg/pdf/underground-water-impact-report.pdf.

38 For example, the considerations that are relevant to the granting of a licence include the effects of taking water on "natural ecosystems", and on the "physical integrity of watercourses, lakes, springs or aquifers": *Water Act 2000* (Qld) s 210(1)(e), (f).

39 Interim Independent Expert Scientific Committee on Coal Seam Gas and Coal Mining, 'Bioregional Assessments', available from: http://www.environment.gov.au/coal-seam-gas-mining/bioregional-assessments.html.

40 Geoscience Australia & Habermehl, MA, 'Summary of Advice in Relation to the Potential Impacts of Coal Seam Gas Extraction in the Surat and Bowen Basins, Queensland', p. 6; RPS, *Onshore Co-Produced Water,* pp. 31-32; Senate Standing Committee on Rural Affairs and Transport References Committee, Parliament of Australia 2011, *Interim Report: The Impact of Mining Coal Seam Gas on the Management of the Murray-Darling Basin,* Parliament of Australia, Canberra, Recommendation 11.

41 Bureau of Meteorology 2012, *Water Information Bulletin*, iss. 8, p. 19. For a discussion of Queensland's reporting framework, see Swayne N 2012, 'Regulating Coal Seam Gas in Queensland: Lessons in an Adaptive Environmental Management Approach?' *Environmental and Planning Law Journal*, vol. 29, pp. 163–185.

42 International Energy Agency 2012, *Golden Rules for a Golden Age of Gas: World Energy Outlook Special Report on Unconventional Gas*, OECD/IEA, Paris, p. 43.

43 For example, the Gas Industry Social and Environmental Research Alliance and the Centre for Coal Seam Gas at the University of Queensland.

44 Letts L 2012, 'Coal Seam Gas Production – Friend or Foe of Queensland's Water Resources?', *Environmental and Planning Law Journal* vol. 29, pp. 101, 103.

45 Randall, A 2012, 'Coal Seam Gas – Toward A Risk Management Framework for a Novel Intervention', *Environmental and Planning Law Journal* vol. 29, pp. 152, 157–160.

46 Ibid pp. 160–161.

47 Ibid pp. 161–162.

48 Crawford School of Public Policy & United States Studies Centre, *Unconventional Gas Production and Water Resources*, pp. 31-39.

49 *Intergovernmental Agreement on a National Water Initiative* (NWI) (2004) cl. 34.

50 *Water Act 2000* (Qld) sec. 397.

51 *Water Act 2000* (Qld) sec. 376(b)(iv), 387, 409, 421, Ch. 3 Pt. 5.

52 National Research Council, *Management and Effects of Coalbed Methane Produced Water in the Western US*, p. 77, in relation to Montana, where CSG operators must offer mitigation agreements to impacted well and spring owners.

53 Mudd, 'Perspectives on Montana v. Wyoming', pp. 331–332; Valorz, NJ 2010, 'The Need for Codification of Wyoming's Coal Bed Methane Produced Groundwater Laws' *Wyoming Law Review*, vol. 10, pp. 115, 130-132.

3. Property rights, agriculture and the coal seam gas industry

Deborah Kerr

This chapter addresses the key issue of property rights and in particular, land access for unconventional energy activities on agricultural land and community engagement.

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Introduction

Coal Seam Gas (CSG) has existed for a number of years but has recently experienced rapid expansion due to technological innovation. This expansion is bringing the industry into contact with a much wider segment of Australian society than has historically dealt with energy extraction, with ramifications for an even wider segment of the community. It is important to get the property rights of the various parties right before conflicts emerge so that the potential advantages can be maximised. It is also important to learn from the experience of the CSG industry so that other energy sources, as they emerge and begin to interact with the community, are appropriately dealt with and their potential benefit to the economy, environment and society are maximised.

Government and industry can do a number of things to ensure an ongoing social licence to operate buttresses the legal rights of miners. The recommendations in this paper seek to move to a process that provides greater certainty for all parties. It is necessary given the complexity of negotiating access arrangements and the multi-faceted impacts of unconventional energy extraction, particularly for the community who have historically not had substantive engagement with resource extraction industries. The recommendations in this paper are:

- Establish a framework for land access negotiation that will facilitate collaboration between industry and farmers, and where all rights and obligations are explicitly and clearly articulated;
- Ensure timely reviews and a right of redress to ensure all parties appropriately execute their responsibilities;

- Ensure farmers are seen as a valuable resource that may lead to mutually beneficial outcomes; and
- Establish a clear, flexible and well-resourced framework for community consultation.

Industry should work to ensure that the community understands both the risks and the benefits. As the new kid on the block, it is incumbent on the CSG industry to engage the broader community. After all, it is the broader community that votes, and votes in contested regional seats, not in potential well fields.

There is potential for CSG, and other energy sources, to be viewed favourably by the agricultural sector and the community more broadly. These industries have the potential to bring substantive economic and social benefits, but this is dependent on their social licence to operate underpinning their legal right. Social licence will be jeopardised if CSG companies focus on exploiting their legal rights rather than engaging landholders and the community. Foremost, CSG companies must introduce a new framework for engagement that recognises the inherent differences between farming in remote regions and Australia's valuable arable lands.

"Social licence will be jeopardised if CSG companies focus on exploiting their legal rights rather than engaging landholders and the community. Foremost, CSG companies must introduce a new framework for engagement that recognises the inherent differences between farming in remote regions and Australia's valuable arable lands."

The interaction between CSG mining and farming

The mining industry has existed since the 1800s, and at least in some areas, has successfully coexisted with agriculture and the broader community. Australia's offshore petroleum industry started in the 1960s[1] and has operated successfully since that time. While the onshore petroleum industry started in 1900[2], the CSG industry is a much newer entrant, with the first commercial CSG projects coming online in 1996.[3] The industry expanded rapidly in Queensland and exploration is now occurring in other states, for example the Exxon Mobil and Ignite Energy CSG exploration in Victoria. The primary concern with CSG and unconventional gas sources such as shale gas more broadly, is how the sector interacts with other users of the land. These concerns are centred on the potential negative consequences of CSG extraction and the interaction between the companies and the community.

There are fundamentally different business models in operation between farmers and CSG producers and this would appear to be a natural source of conflict unless managed appropriately. Farmers are strongly grounded in their region, and one family may own the same farm for generations. They generally undertake their daily lives and conduct their farming enterprises with little interference from others. These "new" extractive industries are contesting farmers long held views that they have a right to decide who has access to their property and a right to decide what happens on their land. While miners may have a legal right to access property, farmers have a perceived right to exclude them based on governments having historically failed to act on their ownership of underground resources in many closer settled agricultural areas of Australia. This perceived right could become a legal one through political action.

The interaction of CSG companies with farmers and communities has not been an ideal partnership and is now one characterised by conflict and a loss of social licence, with a spill over effect to the mining industry. Agriculture knows all too well that the loss of social licence has the potential to jeopardise business activity – as can be seen by the impacts from animal welfare activists in response to a range of animal welfare issues such as live exports, caged hens, sow stalls, bobby calves and mulesing.

The interactions between the CSG industry and the broader community may have the potential to truncate the existing social licence to operate, and thereby minimise the economic, environmental and social value the sector could bring to Australia. Importantly, it will be difficult for the CSG industry to overcome today's farmer and community bias derived from the past behaviour of the industry.

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Evolution of property rights

Australia's property rights were conferred when the British Government occupied it as a penal settlement in 1778 and declared the land as belonging to no one or *terra nullius*.[4] At this time, the British Common Law was that the minerals belonged to the landholder with the exception being gold and silver – the "Royal" minerals.[5] Landholders had the right to prevent anyone occupying the land to extract minerals.

Government decisions assigning rights to minerals and petroleum to the Crown attenuated this common law position.[6] From 1855, state and territory parliaments legislated for these rights in future grants of freehold land. Depending on the jurisdiction, governments have legislated to assign either wholly or in part to the Crown the rights to minerals and petroleum resources.

To understand the rights of farmers and the mining and petroleum companies, it is necessary to look at property rights in more detail. Property rights are "rights that govern the use and ownership of a resource" and are a term most commonly applied to land.[7] While legislation recognises and protects property rights[8], there is also an associated "bundle" of rights, obligations and duties.[9] Six characteristics describe property rights: duration, flexibility, exclusivity, quality, transferability, and divisibility[10] – with the exclusivity characteristic most relevant to this discussion.

These characteristics are also relevant to water rights in Australia[11], which are also "vested" in the Crown. Initial water legislation[12] provided irrigators access to water through the issue of water licences. Because irrigators enjoyed these licences for some 80 years without interference and providing the government water charges were paid, there was an expectation of property rights attached to these licences. However, these perceptions were incorrect. Early 20th century state and territory legislation included a right for the Minister of the day to cancel licences without redress but because this power was never invoked, irrigator property right expectations were reinforced.[13]

This concept is important in the recent activation of CSG exploration and production tenements in the closer settled areas of Australia where farmers had no expectation that the Crown would exercise its petroleum rights and when farmers were likely never aware of the presence and/or extent of underground resources. Indeed, in a real sense no economic resources existed until technological innovation made it both accessible and profitable.

Mining and petroleum property rights

With government ownership of mining and petroleum resources, access by the relevant industries is similar to water – by licences. State and territory governments may grant companies a licence that gives them the right to enter land to explore and subsequently to extract minerals or produce petroleum (with conditions). The companies holding these rights see this as a property right.[14] The right is exercisable providing companies abide by the conditions applied by governments to the licence or right.

The Prime Minister recently challenged the minerals industry by saying "governments only sell you the right to mine the resource".[15] This view begs the question of when ownership transfers from governments to companies. For minerals, it would seem that, with some specific exceptions, "ownership" generally transfers from the Crown to the company with the issue of a licence.[16] In relation to onshore petroleum, ownership changes at the wellhead, which is also when royalties are calculated and paid.[17]

While governments can define and protect property, they can also constrain it.[18] Respect for property rights is an expectation and a belief, which makes "day-to-day use of property efficient and relatively harmonious".[19] A potential conflict arises if the exercise of petroleum property rights acts against the perceived property rights of farmers. Since governments act in response to community views, the existing rights of petroleum producers can be altered, for example through conditions on their production licences.

Attenuation of land property rights

Today's conflicts between farmers and the rights of mining and petroleum companies might also be considered in the light of perceptions of many farmers, that is "to whomsoever the soil belongs, he owns also to the sky and to the depths".[20] However, this maxim is a reflection of social myth, rather than a legal, historical, or philosophic truth[21] and one that might help to explain the contemporary view of many farmers.

Attenuation or modification of property rights is a limitation on the way in which property rights are used.[22] Attenuation will reduce the value of the property right to its owner as it reduces flexibility in the use of the property rights, including through regulation.[23] Un-attenuated property rights are akin to "private chattel ownership where the owner has completely free rights of use, exclusion of all others to any use, and complete alienation".[24] Again, this perception is important, as farmers over consecutive generations have regarded their ownership of their farm as akin to private chattel ownership.

Since settlement, a number of decisions have attenuated farmers' land and water property rights despite contemporary views to the contrary. Two notable examples include the High Court decision to recognise native title and the cap on water diversions in the Murray-Darling Basin. Attenuation of land property rights has also become a focus of the regulators, for example land clearing bans. This goes to show that property rights, no matter how legally well established even to the point of being in the Constitution, can be altered to reflect changes in social attitudes and community expectations.

Farmers see the CSG and mining industries as an additional attenuation of agricultural land ownership, but more rightly, it is the enactment of an existing property right of governments. Moreover, farmers are no longer clear about their property rights.[25]

While modification of property rights is not compensated, governments recognise that removal of *all* property rights in relation to land must be fully compensated – and have legislated accordingly, for example the *Land Acquisition (Just Terms Compensation) Act 1991* (NSW).

The CSG industry does not remove all property rights, but the existing rights and freedom of use is impaired for farmers. Consequently, state governments have legislated to require that CSG companies provide recompense to farmers. While there are questions as to the adequacy of these arrangements, there is little agreement on how this might be resolved without affecting the commercial nature of these decisions. Perhaps one opportunity is to establish a simple scoring system that compares the different approaches by companies to both land access and compensation arrangements, but not the individual contracts.

Land access for CSG activities

CSG companies require access for exploration and production of gas – the latter including "co-produced" water. Acquisition of land is not required for these activities and ultimately most activity will be in the shorter term development phase rather than the longer term production phase.

Where deployed, CSG well fields will have a major footprint across the landscape through its associated infrastructure. In the development phase, it involves substantial intrusion onto a property, countering the belief of farmers that only they are able to determine who enters and what occurs on their land. While land access agreements are supposed to facilitate CSG industry access and sounds like a simple enough exercise, the reality is far more complicated.

The extent of the CSG industry intrusion is wide ranging from the impost of the land access negotiation, to the impact of the development on the property (noise, dust, erosion, spills and other related matters), to interference with farm activities, and finally to managing the day-to-day land access. Impacts directly to the farm business might include the need to negotiate normal farm operations such as chemical application, movement of stock, and disturbance to calving or lambing.

Impacts from the management of the land access can include time delays, time away from the farming operation, construction over-runs, the need for land in addition to the agreement, transport access 24 hours per day, additional transport activity, issues associated with water, lights from the drilling sites, and the need for firebreaks.

In reality, many of these issues may not have been considered in a land access agreement, along with remediating actions such as low impact development to minimise impacts of the development of the well field and associated infrastructure. High impact sites require clearing and levelling of the proposed well site. By contrast, low impact sites do not appear to be visible post the "spudding"[26] of the well.

To assist in management of these issues, it is recommended that there are timely reviews of land access arrangements and to provide an opportunity for a "right of redress" to ensure that all parties execute their responsibilities.

CSG companies must regard farmers as an asset and a resource – one that may result in good solutions for both parties with potentially reduced development costs. Not to do so is inadvertently avoiding opportunities for mutual benefit. For example, one farmer expressed concern about the high impact of the installation of pipelines and was able to negotiate the installation of pipes with minimum disturbance to the land surface, extending the notion of low impact from the well site to the pipelines as well.

The same mining and petroleum legislation that regulates the issue of exploration and production licences also contains the framework for how the companies obtain access to private land, and contains the compensation provisions. This does not mean that the companies, their employees or sub-contractors have unfettered access to farms.[27] The state or territory legislation is prescriptive regarding the inclusions in the negotiation process. Generally, the process includes entry notice (even for preliminary activities), negotiation, and an access agreement for advanced activities.

If no agreement can be negotiated or there is dispute, the legislation also provides for a negotiation and dispute resolution process, for example in Queensland, the Land Court will make the final determination. The outcome is binding on the company and the farmer. At present, the entry notice and the land access agreement are the only existing tools by which farmers can negotiate about how the CSG company interacts with them. Historically, companies have poorly conducted this process and in some cases, poor behaviour has been evident.

There has been improvement more recently, with some companies going beyond their legal obligations, for example negotiating a land access agreement with neighbouring landowners who will not have a gas well but who may suffer the negative impacts of the development such as noise, dust and traffic.

Negotiating a land access agreement is difficult for farmers, as many do not have the skills, knowledge or expertise. This issue is not constrained to the CSG industry. In native title claims and access negotiations, it was observed that *"pastoralists do not seem to know how to go about negotiating knowledge, land and ownership"*.[28]

Australia's farmers are very good at producing food and fibre. With some exceptions, negotiating land access is not an area of core competency and it is both time and resource intensive for the farmer and the company. Those farmers who have succeeded have spent considerable time understanding the legislation and educating themselves to be in a position of power in the negotiation rather than assuming the role of a "victim of circumstance".

To overcome some of these issues, it is recommended that the current framework for land access negotiation be further refined to facilitate collaboration between the CSG industry and farmers, in which all rights and obligations are explicitly and clearly articulated.

In some situations, farmers may be required to negotiate separate land access arrangements with multiple entities for the same[29] or different developments further exacerbating their stress, anxiety and confusion. There may be a number of solutions for this. One might be the use of template contracts with easily replaceable schedules that provide the detail required for individual farms. Another could be the negotiation of broad local contracts detailing common issues for all farmers, which could then be individualised to each farm. Another alternative is for farmers to use commercial negotiators with expertise in CSG contracts. Individual companies, notably Origin and Santos, are doing additional work in an attempt to provide a better framework for compensation arrangements.

In both Queensland and NSW, the state farming organisations have developed and run workshops to assist farmers understand their rights and obligations – with the key message being to ensure they seek legal advice. Expansion of these initiatives may benefit farmers in other states flagged for CSG and other unconventional gas development.

Many farmers (and others) in the CSG areas are calling for individual farmers to have the right to veto land access. The law regarding this varies in each jurisdiction. In NSW, the *Onshore Petroleum Act 1991* (NSW) sets out the restrictions applying to cultivated land, including production or construction of infrastructure.[30] However, it appears that exploration is not included in these restrictions and the company can appeal application of this section to the Minister. By contrast, restrictions may apply to the location of production and associated infrastructure in relation to substantial farm improvements, for example, these cannot be located within 200 metres of a home.[31]

However, generally most legislation is unlikely to have such provisions. More likely are clauses relating to restrictions in the event of permanent impact, where it is dangerous and required to preserve life and property.[32]

Regardless of the current legislative provisions, many farming organisations support calls for veto rights for farmers, primarily to support and strengthen the power of famers in a negotiation for land access agreements.

The changing nature of engagement

As noted earlier, the activation of the Crown's right to these resources has been markedly tardy. However, over the last 20 years extraction technology and innovation has enabled access to these resources to be cost effective and economically viable. Subsequently, there has been a greater expansion of these activities into the closer settled areas.

Historically, the land access negotiation was easy, as mining companies have operated largely in the remote rangelands of Australia, characterised by a small number of very large properties. The mining companies have also been able to win small remote community support through significant economic investment or other community benefits such as donations to local sporting clubs. With most historic petroleum development offshore, there has been no potential for conflict with farmers.

The mining and petroleum companies have brought this remote area engagement mindset into the closer – and long – settled areas, where most of the more valuable arable land is located. This approach has consequently proved a failure in terms of the community and farmers.

In response, open cut miners will acquire the directly affected farms, and sometimes neighbouring farms, offering farmers a premium of between 15–40 per cent more than the value of the land as recompense.[33] This is understandable as the land is permanently alienated from agriculture with subsequent use likely to be conservation.[34] Sometimes CSG companies seek to acquire land in an attempt to avoid the community backlash, resulting in unnecessary costs for the company.

Perhaps a new approach is long overdue. There is a massive body of literature on how to undertake consultation and engagement, but the most useful advice comes from the OECD handbook on consultation with the salient points for the CSG industry being:

- Establish clear goals and rules including defining the limits for community involvement;
- Adequately resource and support community engagement;
- Provide timely, complete, objective, reliable, relevant, easy to find and understandable information;
- Allow the community sufficient time and flexibility to allow for new ideas and mechanisms for integration; and
- Implement an independent and public process of evaluating the success or failure of community engagement programs and act to address shortfalls.[35]

However, as noted earlier, even if the industry undertakes best practice engagement from now on, there will continue to be a legacy effect arising from the initial poor engagement.

The political response

Farming represents a substantial commitment to a place and region. Typically, farmers pass their land onto future generations and this is a substantive motivator. In contrast, CSG and other unconventional energy sources may be perceived as exploiting a finite resource. There are concerns they are depleting environmental assets in the process of pursing an economic opportunity, and the cost of this will not impact on them.

> "Farming represents a substantial commitment to a place and region. Typically, farmers pass their land onto future generations and this is a substantive motivator. In contrast, CSG and other unconventional energy sources may be perceived as exploiting a finite resource."

The major concerns of farmers and communities are the unknown impacts on underground water resources, well integrity, fracking and its associated chemicals, management of co-produced water and brine, and other environmental, health and amenity concerns. These concerns may be a fundamental reason for farmers and environmental organisations joining forces in an effort to at best overturn, or at least delay, CSG exploration and development. The establishment of new advocacy groups, such as Lock the Gate, back the common calls for moratoriums until society is better informed.

Exploration is about collating the knowledge so that companies can make informed decisions about their investment, and governments about whether to grant production licences and under what conditions. Indeed, in many respects the agriculture sector operates on minimising risk not zero risk. It is therefore untenable to ask the CSG companies and governments that they must know all the impacts of exploration before this can take place.

Transparency and confidence in good decision-making is fundamental to give confidence to the broader community about the CSG industry. At present, many farmers and communities are concerned about the perceived lack of separation between the regulator who issues petroleum licences and government, which receives royalties from them.

The CSG industry risks revocation of their social licence and is very cognisant of its fragility – notably holding two sessions on this issue at its recent conference in Adelaide.[36] While the CSG industry social licence is one that is front of mind during the development phase, the industry does need to consider its social licence as a longer term strategy.

Politically, governments have acted in a number of ways. The Council of Australian Governments (COAG) Standing Council on Energy and Resources agreed to develop a national harmonised framework for CSG aimed at providing confidence to community about well integrity, co-produced water, fracking and chemical use. The project will also look at legislative inconsistencies and develop a multiple land use framework. At the same time, the Australian Government established an Independent Expert Scientific Committee to look at providing robust independent scientific advice to governments in relation to significant impacts on water resources.

This body of work focuses primarily on CSG and does not address future resource and energy development, including shale gas, geothermal energy, and underground coal gasification. Governments must also ensure that the outcomes of work currently underway will also deal with future energy developments.

As Australia has only a small area of arable land[37] without irrigation[38], farmers are calling on governments to protect this land from mineral and petroleum extraction. There is real or perceived concern that these activities may permanently remove land from agriculture through impacts on the land surface and groundwater resources, therefore preventing its use for agriculture or through changing the subsequent land use to conservation, for example as part of an offset requirement.

At a state level, the Queensland and NSW Governments are implementing policies designed to address these concerns, with other Governments yet to act. A major concern is that many of these projects will be designated as “state significant” and bypass these new processes designed to provide confidence in the process. Both governments have also introduced independent bodies to engender community and farmer confidence, for example the NSW Land and Water Commissioner and the Queensland GasFields Commission. Time will tell whether the political responses are the right solutions.

Emerging energy and alternative income

Farmers see that they have a legitimate and important role to play in global food security. Each Australian farmer produces enough food to feed 600 people, 150 at home and 450 overseas.[39] Australian farmers produce almost 93 per cent of Australia's daily domestic food supply.[40] Any activity that affects farmers' real or perceived societal value they see of themselves is likely to cause concern. Conversely, the CSG industry contributes to the energy needs of Australia. Gas keeps people warm and powers industry. Gas is also important for the current and future energy needs of farmers.

While today's focus is on gas, renewable energy is likely to become increasingly important. These existing and emerging energy sources, such as solar, geothermal, underground coal gasification and wind farms will also require access to private land. In some cases, there might be concentrations such as the Dalby, Chinchilla and Wandoan area of Queensland, which has been dubbed the "energy triangle". The potential for multiple energy sources is also likely in other agricultural regions. Such debate brings into question the existing use of land for agriculture and conservation versus future use of private land and agricultural landscapes for multiple uses. The COAG framework will prove important to deal with these situations.

> "Australian farmers produce almost 93 per cent of Australia's daily domestic food supply. Any activity that affects farmers' real or perceived societal value they see of themselves is likely to cause concern. Conversely, the CSG industry contributes to the energy needs of Australia. Gas keeps people warm and powers industry. Gas is also important for the current and future energy needs of farmers."

Farmers may see these emerging energy industries negatively, while others may regard these as positive opportunities. Some farmers and communities do not wish any interface with these industries. Conversely, energy industries are potentially a lucrative proposition for farmers and a means of diversifying their income stream, as well as looking for opportunities to utilise the co-produced water to improve their business profitability or seek its reinjection to guarantee future water supplies. Others may see such industries as their future superannuation fund or a means to secure family wealth for successive generations. For the potential benefits to be realised, robust property rights for all land users need to be firmly established and agreed. Not just the legislative rights, because as shown in this paper, these are subject to political persuasion.

Conclusion

While the CSG industry has been developing in Queensland for around 20 years and Queensland holds around 95 per cent of the current CSG resource, exploration is now occurring in other states, bringing with it an increase in concerns.

For farmers, who for successive generations have enjoyed sole access and use of land, the imposition of an additional, albeit, legitimate access to the land for exploration and production of minerals and petroleum, has created a significant impost to business and their lifestyle as it was once enjoyed. It is a major change to their business operations. Many farmers may see negotiating land access as a threat and risk rather than an opportunity.

Governments have reacted by implementing a range of initiatives seeking to underpin farmer and community confidence in the industry. This paper has made a number of recommendations that could assist in creating a more positive environment for farmers and the CSG industry in the future. A measure of the successful integration of the CSG industry into the agriculture landscape will see CSG wells advertised as an asset in the sale of a farm, but sellers do not yet contemplate this and buyers are wary.

Endnotes

1 Hunter, T. 2009, "It's time: petroleum policy change for sustainable development in the Australian offshore upstream petroleum sector", *Journal of Applied Law and Policy*, pp. 31–54, available from: http://epublications.bond.edu.au/law_pubs/313

2 For a history, see the Australian Petroleum Production and Exploration Association website, accessed from: http://www.appea.com.au/oil-a-gas-in-australia/history/2000-present.html, (9 July 2012)

3 Ibid

4 Toner, J. 2006, "Property rights: an analysis of their implications for understanding land rights in Australia", *Extension Farming Systems Journal*, vol. 1, no. 2

5 Hepburn, S. 2011, *Why miners have a right to what's under your land.* Available from: http://www.beefcentral.com/p/news/article/901. (3 June 2012).

6 Hunter, T. 2012, *Land use and CSG: what rights do property owners have?* Available from: http://www.crikey.com.au/2012/02/20/land-use-and-csg-what-rights-do-property-owners-have/. (3 June 2012).

7 Toner, J 2005 "Property rights: an analysis of their implications for understanding land rights in Australia", *Extension Farming Systems Journal*, vol.1, no.1, pp. 79084.,

8 Pollock, F., cited in Toner, J., p. 82.

9 Chambers, R., cited in Toner. J., p. 82.

10 Scott, A. 1998, "Evolution of Individual Transferable Quota as a Distinct Class of Property Right", in *The Economics of Fishery Management in the Pacific Islands Region*, eds H Campbell, K Menz and G Waugh, Australian Centre for International Agricultural Research, Canberra, pp. 51–67.,

11 Advice on Water Property Rights, *NSW Irrigators' Council Report.*

12 *Water Acts 1912 (NSW).*

13 See the 1993 COAG Water Reforms and the 2004 National Water Initiative.

14 Senate Committee on "Rural Affairs and Transport References Committee", August 2011 p.21, available from: http://parlinfo.aph.gov.au/parlInfo/download/committees/commsen/28f4dc8f-f617-42fc-aee6-ba38dafbfdc5/toc_pdf/Rural%20Affairs%20and%20Transport%20References%20Committee_2011_08_09_338_Official_DISTRIBUTED.pdf;fileType=application%2Fpdf#search=%22committees/commsen/28f4dc8f-f617-42fc-aee6-ba38dafbfdc5/0000%22, (6 June 2012).

15 Gillard, J. 2012, Speech to *Minerals Industry Parliamentary Dinner*, Canberra 31 May 2012, available from: http://www.pm.gov.au/press-office/speech-minerals-industry-parliamentary-dinner-canberra, (3 June 2012).

16 Chris McCombe, Minerals Council of Australia, (20 June 2012).

17 Rick Wilkinson, Australian Petroleum Production and Exploration Association, (25 June 2012).

18 Ibid

19 Ibid

20 The maxim was tested in *Bernstein of Leigh v Skyviews & General Ltd* (1978) 1 QB 479

21 Martin, P. & Verbeek, M. 2002, "Property rights and property beliefs,", Property: Rights and Responsibilities Current Thinking, *Land & Water Australia*, 2002.

22 Scott, A. op cit.

23 Ibid.

24 Ibid.

25 Sinclair Knight Mertz (SKM) 2012, *The Multiple Land Use Framework Research Study Briefing Paper*, Department of Resources Energy and Tourism, unpublished.

26 "spudding" is the term for drilling and sealing the well.

27 Hunter, T. op cit

28 Verran, H. 1998, "Re-imaging land ownership in Australia", *Postcolonial Studies*, Vol. 1, No. 2, pp. 237- 254, available from: http://www.dourish.com/classes/readings/Verran-ReimaginingLandOwnershipAustralia-PostcolStudies.pdf, (3 June 2012).

29 Ibid

30 *Onshore Petroleum Act 1991* (NSW) sec 71

31 *Onshore Petroleum Act 1991* (NSW) sec 72

32 For example, see *Petroleum and Gas (Production and Safety) Act 2004* (Qld) Sec 503

33 Lane, T. 2012, "Managing the Future of Australian Farm Land", *Proceedings of Australian Farm Institute Conference* (29–30 May 2012).

34 Many governments now require rehabilitated mine sites to be replanted as offsets and added to the conservation estate.

35 Gramberger, M. 2003, *Citizens as Partners: OECD Handbook on Information, Consultation and Public Participation in Policy Making*, OECD, Paris.

36 APPEA 2012, "The Energy Revolution Conference", in *Australian Petroleum Production and Exploration Association Conference,* Adelaide, (13–16 May 2012).

37 Only six per cent of Australia's land is classified as arable.

38 Australian Actions to Combat Desertification and Land Degradation DSEWPC 2008, *Commonwealth Intergovernmental Working Group for the UNCCD Repor*t. Available from: http://www.environment.gov.au/land/publications/actions/domestic1.html, (3 June 2012).

39 Keogh, M. 2009, "Australia's response to world food security concerns", *proceedings of the* 1st NFF Annual Congress, Australian Farm Institute.

40 *Farm Facts*, available from: http://www.nff.org.au/farm-facts.html, (6 June 2012).

4. Australia's unconventional gas resources

Dr Tina Hunter

This chapter provides an assessment of the current regulatory regime for unconventional energy activities, identifies gaps and recommends changes to ensure community support.

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What is unconventional gas?

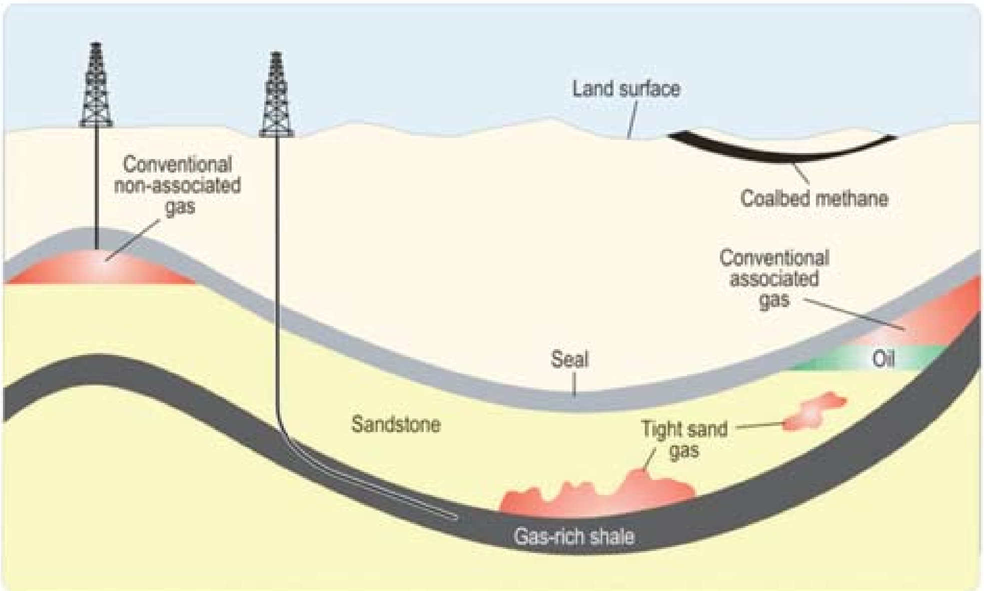
Petroleum is divided into two types of resources: oil and gas. Traditionally both oil and gas have been extracted from sedimentary rocks, including sandstone and limestone. This extraction is relatively easy due to the porosity and permeability of these sediment types. The petroleum that is extracted from these sedimentary source rocks is known as conventional petroleum (oil or gas).

For many decades geologists have been aware of the existence of oil and gas sedimentary geological formations such as shale and coal and other low porosity sedimentary rocks. Shale gas (SG) typically occurs in shale formations with low porosity and permeability, retarding the capacity of the gas to flow freely from the formation. Water and low porosity/permeability in coal formations retards the capacity of coal seam gas (CSG) to flow freely from the coal formations. Tight gas (TG) refers to natural gas reservoirs locked in extraordinarily impermeable hard rock, making the underground formation extremely “tight”. However, techniques did not exist for the extraction of these petroleum resources from such geology until the last few decades, where developments in hydraulic fracturing and directional drilling have enabled the recovery of gas from these formations. The gas resources held in shale and coal formations as well as TG are generally referred to as unconventional gas resources (UGR). Shale and CSG are the two dominant types of UGR in Australia.

It is important to note that the gas recovered from all types of geological formations is the same: naturally occurring hydrocarbon gas, primarily comprising methane with small amounts of ethane, propane and butane. The name unconventional is not given to SG and CSG because of the gas that is recovered. It is exactly the same as gas recovered from conventional oil and gas sources. Rather, the unconventional name comes from the unconventional geological source rocks where the gas comes from. Thus, the gas recovered from shale and coal formations is known as unconventional gas.

As demonstrated in Figure 1 below, different forms of UGR occur in differing geological formations and at different depths. Generally, CSG from coal formations occurs at shallow depths, usually 250-850m.[1] The depth of TG in Australia varies, but generally lies between 1400-3500m depth.[2] Shale gas generally occurs 2000m below CSG formations.[3]

FIGURE 1:
GEOLOGY OF UNCONVENTIONAL GAS RESOURCES



Source: US Energy Information Agency, 2011, Today in Energy.

Current legal framework regulating the development of Australia's UGR

It is important to note that UGR are developed in Australia as part of an overall strategy for developing gas resources for one of two markets: the domestic gas market, or for the international market.

For development of domestic consumption, the gas is extracted as UGR, and then supplied into local pipelines to feed into the domestic gas and electricity markets. The regulatory structure for the supply of domestic markets is relatively simple: the regulation of the exploration and extraction of petroleum, and the pipelines that supply the gas to market.

For international markets, the extraction of the UGR is just one part of the development chain, it also involves the movement of the gas to a processing plant, processing the gas into transportable form, and shipping the gas to market (generally Asian ports). This process can be illustrated as:

The supply of UGR for export markets creates a complex web of regulation for each of the segments of the process: extraction, transport, processing and the regulation of port facilities. While these are important regulatory stages in ensuring the extracted gas gets to the international market, this assessment is confined to the regulation of the extraction of UGR in Australia.

Regulation of UGR: The existing state framework

UGR in Australia are a form of petroleum. This petroleum consists of oil and gas that is extracted from the earth, generally from sedimentary rocks. The unconventional nature of onshore gas in Australia is the source rock that the gas arises from, rather than the unconventional nature of the gas itself.

Without exception, all UGR in Australia occur on land. The recovery of UGR are generally divided into geographic regions according to the source rock for the gas:

- CSG is primarily found in eastern Australia in the:
  – Bowen/Surat Basins (Qld)
  – Gunnedah Basin (NSW)
  – Sydney Basin (NSW)
- SG resources are found in central and Western Australia in the:
  – Canning Basin (WA)
  – Perth Basin (WA)
  – Amadeus Basin (NT)
  – Georgina Basin (NT)
  – Beetaloo Basin (NT)
  – Cooper-Eromanga Basin (SA)

Since all of the UGR are found onshore, the exploration for and extraction of UGR is regulated by the states. This is because there is no enumerated power for the Commonwealth to regulate petroleum and mineral activities under the Australian constitution.[4] In contrast, each Australian state has the capacity to regulate all other activities for the "peace, welfare and good government" of that state.[5] As such, the exploration for, and extraction of UGR in Australia is governed by the following Acts (and petroleum defined in the section following):

- *Petroleum and Geothermal Energy Act 2000* (SA) – s 4;
- *Petroleum and Geothermal Energy Resources Act 1967* (WA) – s 5
- *Petroleum Act* (NT) – s 5;
- *Petroleum Act 1923* (Qld) and *Petroleum and Gas (Production and Safety) Act 2004* (Qld) – s 10;
- *Mineral Resources Act 1995* (Tas) – s 3 (any petroleum product except shale)
- *Petroleum (Onshore) Act 1991* (NSW) – s 6; and
- *Petroleum Act 1998* (Vic) – s 6.

Although each of the onshore petroleum Acts of the states defines petroleum in a slightly different manner, each definition has a common thread. Generally each of the Acts (with the exception of Tasmania) defines petroleum as:

- *Any naturally occurring hydrocarbon, whether in a gaseous, liquid or solid state; or*
- *Any naturally occurring mixture of hydrocarbons, whether in a gaseous, liquid or solid state; or*
- *Any naturally occurring mixture of one or more hydrocarbons, whether in a gaseous, liquid or solid state, and one or more of the following, hydrogen sulphide, nitrogen, helium and carbon dioxide*.[6]

Is the existing petroleum regulatory framework designed for the regulation of UGR?

While the current onshore petroleum Acts of the various states apply to the exploration for and extraction of petroleum, historically these Acts have been applied to conventional petroleum. However, as the potential of the extraction of UGR has been recently developed, primarily due to the development of technology from the United States, there has been the development of UGR under the various Australian onshore petroleum Acts. The development of UGR under the various onshore petroleum Acts can be generally divided into eastern and central/Western Australia.

Regulation of petroleum activities in eastern Australia

The development of UGR in eastern Australia has been rapid and tumultuous. The regulatory framework in eastern Australia has been categorised as catch-up regulation and widespread community opposition to UGR activities. Much of this opposition has been directed toward the government as regulators, given the perceived lack of strong regulation in the development of these resources.

Queensland

The extraction of UGR (through the extraction of CSG) first occurred on the east coast of Australia, particularly in Queensland. Although systematic extraction of petroleum has occurred in Queensland since 1960, CSG has become a significant source of gas in Queensland, supplying over 75 per cent of the gas market and providing over 98 per cent of the proved and probable gas resources in Queensland.[7] Much of Queensland's CSG is earmarked for export markets, with huge developments currently occurring in the Bowen and Surat Basins, and concurrent pipeline, LNG processing and port facilities being developed in Central Queensland around the Gladstone region. These developments have placed great strain on the current regulatory framework.

The Queensland regulatory framework that was initially in place for the extraction of CSG was the *Petroleum Act 1923* (Qld). This framework was seen as painfully inadequate for the regulation of the development of CSG, leading to the introduction of the *Petroleum and Gas (Production and Safety) Act 2004* (Qld) (PGPSA). This Act was meant to replace the antiquated *Petroleum Act 1923* (Qld), however some tenements that were granted under the 1923 Act have native title conditions attached to them, so are unable to be regulated under the PGPSA. As such, there are two Acts applying to the regulation of the extraction of CSG in Queensland, although all regulation primarily occurs under the PGPSA.

At present in Queensland, the regulatory approach to CSG extraction and the impact of CSG projects is based on the philosophy of adaptive environmental management. [8] This method of "learning by doing" is implemented in Queensland primarily through the imposition of layered monitoring and reporting duties on the CSG operator alongside obligations to compensate and "make good" harm caused.[9] This regulatory approach clearly demonstrates that Queensland continues in a "learning phase" of regulation, with this approach recognising the uncertainty surrounding the impacts of CSG activities.[10] It also seeks to put in place a system "to monitor and instigate change where necessary".[11] Such adaptive management frameworks are "widely used to address unknown and unintended impacts when making important management decisions" regarding environmental impacts of CSG extraction activities.[12] Such adaptive management techniques are regulated under a plethora of legislation, especially the *Environmental Protection Act 1994*, where a plethora of legislative changes have been made to accommodate such an adaptive management approach.

The current Queensland regulatory framework is supported by the introduction of a number of supporting legislation and codes of practice. These include:

- *The Environmental Protection Act 1994* (Qld) – the EPA has the extremely broad objective of achieving "ecologically sustainable development" in Queensland by setting out a program for the identification and protection of important elements of the environment and by creating a range of regulatory tools for controlling the activities of individuals and companies.
- *Strategic Land Cropping Act 2011* (Qld) – a legislative and planning framework designed to protect Queensland Strategic Cropping Land (SCL) from

developments (including CSG activities) that lead to permanent impact or diminished productivity on important cropping lands;

- *Land Access Code (LAC)* – the LAC is developed as a requirement under Section 24A of the *Petroleum and Gas (Production and Safety) Act 2004 (PGPSA)*. The LAC is committed to balancing the interests of the agricultural and resource sectors to address issues related to land access for resource exploration and development. It identifies good relationships between these groups as being paramount, and seeks to ensure negotiations for access is assisted by adequate consultation and negotiation that will improve transparency, equity and cooperation across the sectors involved.[13]

NSW

Similar to Queensland, NSW has experienced a rapid growth in the development of the CSG industry. The CSG industry in NSW is an emerging industry, largely focussed on exploration and assessment activities, particularly in the Hunter Valley, Gunnedah and Liverpool Palins, Gloucester, Western and Southern Sydney, and Casino, in north west NSW. Only one facility (at Camden, near Sydney) is presently in production.

The extraction of CSG in NSW is regulated under the *Petroleum (Onshore) Act 1991*. While this Act is designed to regulate conventional petroleum activities, it has struggled (along with the *Environmental and Planning Assessment Act 1979* [NSW] and environmental protection legislation) to regulate this burgeoning industry. As a result of the rapid increase in CSG exploration and assessment activities, the NSW Government has implemented several changes relating to the extraction of UGR in that state.

The NSW Government has developed a strategic regional land use policy that addresses the growth of the coal and CSG industries and potential land use conflicts associated with their development.

The policy:

- Recognises the potential impacts of these industries on the environment, agricultural land and water resources; and
- Aims to develop strategic regional land use plans in specific regions, starting with the Upper Hunter and the Liverpool Plains, where initial pressures from mining and CSG extraction are being experienced.

The NSW Government has also established an inter-agency working group which, in collaboration with industry, relevant NSW Government agencies and Queensland Government agencies:

- Has reviewed the regulatory framework and environmental impacts associated with the CSG industry; and
- Coordinates environmental impact assessment and regulation of the industry.

Following on from the working group's review, the NSW Government has announced:

- An extended moratorium on the use of fracking during CSG drilling, pending a review by the NSW Chief Scientist of the practice of hydraulic fracturing;
- An immediate ban on the use of BTEX chemicals (benzene, ethyl benzene, toluene and xylene) as additives during fracking;
- A regulation that requires any person or company proposing to extract more than three megalitres of water per year from groundwater sources to hold a water access licence;
- A draft Aquifer Interference Policy to provide a framework to assist regulatory authorities to assess applications for water access licences – the draft policy contains guidance for managing the risks to groundwater sources, connected water sources, groundwater dependent ecosystems and the current uses of these sources and ecosystems; and
- A ban on the use of evaporation ponds relating to CSG production.[14]

In addition, NSW established the Environmental Protection Agency (EPA) as a separate statutory authority on 29 February 2012, to strengthen the role of this authority as an important tool in focussing the EPA's work and resource allocation in this area.[15]

Is a stable and certain framework in eastern Australia establishing a social licence to operate?

The use of the adaptive environmental management approach to the regulation of CSG extraction in Queensland provides flexibility in the regulatory framework, enabling the law to adapt to environmental challenges and demands as and when they arise. While this flexibility is a positive aspect of the Queensland regulatory regime, it has also highlighted the inability of the existing Queensland framework to create a legal framework categorised by stability and certainty. The use of adaptive management provides little assurance to stakeholders, especially landholders.

> "There is clear evidence that the recovery of UGR resources in Australia does not enjoy a social licence to operate. The lack of confidence in the extraction of UGR in eastern Australia is illustrated in the many grassroots movements to prevent CSG in Queensland and NSW."

Similarly, in NSW the introduction of bans, a moratorium on fracking, and new CSG land use policies also indicates a lack of community confidence in UGR activities. This NSW community attitude has been captured in a recent NSW Legislative Council Standing Committee Report on Coal Seam Gas[16] which addresses community concerns about CSG activities. Although the committee recognises that, "gas plays an important role in meeting energy needs in NSW, and demand is projected to triple in the next 20 years", it also recognises strident community concerns relating to fracking, use and damage of water resources, use of agricultural land for CSG purposes, land access and land use conflict.

There is clear evidence that the recovery of UGR resources in Australia does not enjoy a social licence to operate. The lack of confidence in the extraction of UGR in eastern Australia is illustrated in the many grassroots movements to prevent CSG in Queensland and NSW. Such groups have included the Lock the Gate Alliance in various communities, NSW Farmers Federation, Six Degrees, Caroona Coal Action Group, various NSW Councils and the Greens Party. Such intense and extensive opposition to the extraction of UGR in eastern Australia is unprecedented in Australia, severely hampering the perception of a social licence to extract UGR in eastern Australia at present.

Is a stable and certain framework in Western Australia establishing a social licence to operate?

The UGR activities in eastern Australia, social media, and films such as *Gasland* have made a huge and lasting impact on attitudes toward the development of UGR in Western Australia. The report Regulation of Shale, Coal Seam and Tight Gas Activities in Western Australia[17] was commissioned by the WA Government, who recognised the groundswell of community concern and agitation concerning the possibility of the development of UGR in the west, and the impact of such activities. As recognised in the report, regulatory robustness is needed in order to provide community assurance. To date, the regulatory changes that are required to provide community assurances have not been implemented, although there are regulations in draft stage. In the interim, the WA Department of Mines and Petroleum has approved several small exploration wells in the North Perth Basin. Such approvals have caused much community concern and consternation, leading to community protests and growth in protest groups and activities.

> "To date, the regulatory changes that are required to provide community assurances have not been implemented, although there are regulations in draft stage."

Unless and until a strong regulatory framework is in place, community consternation will remain. At present, the UGR sector does not have a licence to operate in the west. Much community consternation arises from lack of knowledge about where the industry is going, and how much activity will be undertaken. This is reasonable. However, there are certainties in the development of UGR in WA. It is likely that the development of the resources is going to be slow – much slower than the breakneck pace that is occurring in Queensland, and to a lesser extent NSW. The reason for this is fourfold:

1. The difficulty in getting access to drilling rigs to undertake these activities. There is an enormous shortage of drilling capacity for UGR in the west. This will place significant limitations on the pace of development of UGR;
2. The huge conventional gas developments currently underway in WA. The volume of gas resources and money invested in WA is staggering. These projects are advancing, and the ease and cost of accessing conventional gas over UGR means that the development of UGR is secondary;

3. The remoteness of the resources, and lack of competition between mining and petroleum tenures. One of the greatest drivers of the development of UGR in Queensland is the competing CSG tenures granted under the petroleum statutes, and coal mining tenures granted under mining statutes. Such legal issues are not present in WA; and
4. The development of LNG processing and shipping facilities. In Queensland the development of these facilities is being driven by several players and consortiums, including the Curtis LNG project (QGC), Gladstone LNG (Santos), Australia-Pacific LNG (Origin and Conoco-Phillips) and Arrow LNG. Such market competition for development of LNG does not exist in WA. Instead, a joint partnership of Woodside, Chevron, BHP and Shell are working together with the WA Government to develop the Browse LNG Hub at James Price Point.

These differentiating factors between eastern and Western Australia are important. Regulators and industry in WA need to identify and communicate to the community these differences. In doing so, not only will they be able to provide community assurance, but are much more likely to develop community relations that will establish the vital social licence needed to operate.

Strengthening the social licence to operate: A national approach to UGR

The Commonwealth Government through the Standing Council on Energy and Resources (SCER) has undertaken to improve community certainty and confidence by undertaking an important role in the development of UGR, particularly CSG. In November 2011 the Commonwealth established a new Independent Expert Scientific Committee. The Committee has three roles:

1. Provide advice to governments on CSG projects;
2. Oversee bio-regional assessments in areas of CSG activities; and
3. Oversee research on potential water-related impacts of CSG development.

This committee has been embraced by most state governments through the National Partnership Agreement on Coal Seam Gas and Large Coal Projects (NPA).[18] This Partnership is designed to provide community assurance that CSG industry developments are being undertaken in a responsible and sustainable manner. In addition, there are legislative changes earmarked that will ensure that the Commonwealth plays an approval role in CSG projects that consume large quantities of water through the *Environmental Protection and Biodiversity Conservation Act (Cth)*.

Future issues in the regulation of UGR in Australia

The establishment of the NPA by the Commonwealth, and the participation by all states except WA, is likely to provide some community assurance regarding the development of UGR in Australia. However, there are still significant issues for governments to address and overcome.

In NSW, the Legislative Council report Coal Seam Gas[19] has identified many areas of concern regarding the development of CSG. In order for the development of UGR to progress in that state, policy development and legitimate legislative reform to address the environmental effects of fracking, water resources use and management, and the protection of strategic farmland, is required.

Similar policy development and legislative reform is required in Queensland. Such policy development and legislative reform in eastern Australia needs to be coherent, consultative, and coordinated between the two jurisdictions. The role of the NPA may be significant, although it is too early to determine whether the states will welcome the Commonwealth Government in a coordination role.

At a national level, the use and management of the Great Artesian Basin and the Murray-Darling Basin is significant in the development of UGR in eastern Australia. In November 2011 the Senate Rural Affairs and Transport References Committee released the report Management of the Murray-Darling Basin Interim Report: The Impact of Mining Coal Seam Gas in the Management of the Murray-Darling Basin. This report addressed significant policy and regulatory issues associated with the development of UGR in Australia. It also considered the effects of UGR development on water resources use, and the threat of contamination to underground water resources.

In order for the development of UGR to occur in Australia, there is a need for major policy formulation and legislative reform in a number of important areas at both state and federal level. Such areas include competing land use between UGR and agricultural activities, water resources use, underground aquifer contamination, land access and socio-cultural changes in communities associated with the influx of UGR activities.

Endnotes

1 NSW Department of Primary Industries, *Coal Seam Methane in NSW* (2011) http://www.dpi.nsw.gov.au/minerals/geological/overview/regional/sedimentary-basins/methanensw .

2 Ingrid Campbell, *An Overview of Tight Gas Resources in Australia* (2009), http://www.pesa.com.au/publications/pesa_news/june_july_09/images/pn100_95-100.pdf, 95–6.

3 WA Department of Mines and Petroleum, *Shale, Tight and Coal Seam Gas* (2011) http://www.dmp.wa.gov.au/12872.aspx#12884

4 The only powers which the Commonwealth could regulate the extraction of UGR is under s51 (i) of the constitution (Interstate and overseas trade and commerce), or 51 (XX) of the constitution (Corporations Power).

5 For example the preamble (section a) of the Constitution of Queensland, 2001; section 5 of *Constitution Act 1902* (NSW); and s 2 (1) of the *Constitution Act 1889* (WA) (to make laws for the peace, order, and good Government).

6 This definition for petroleum comes from s 5 of the *Petroleum and Geothermal Petroleum Resources Act 1967* (WA).

7 Queensland's petroleum – exploration and development potential – May 2012. http://mines.industry.qld.gov.au/mining/petroleum-exploration-development-potential.htm

8 Department of Environment and Heritage Protection (Qld), *Adaptive Management* (2012) http://www.ehp.qld.gov.au/management/coal-seam-gas/adaptive-management.html

9 Nicola Swayne, 'Regulating Coal Seam Gas in Queensland: Lessons in Adaptive Environmental Management Approach?' (2012) 29 *Environment and Planning Journal* 163, 163. http://eprints.qut.edu.au/49293/2/49293.pdf

10 Queensland Government, "Adaptive Environmental Management Regime for the Coal Seam Gas Industry" (Department of Environment and Natural Resources, 2011) http://www.ehp.qld.gov.au/factsheets/pdf/environment/en7.pdf at 1.

11 Queensland Government, "Adaptive Environmental Management Regime for the Coal Seam Gas Industry" (Department of Environment and Natural Resources, 2011) http://www.ehp.qld.gov.au/factsheets/pdf/environment/en7.pdf at 1.

12 Queensland Government, "Adaptive Environmental Management Regime for the Coal Seam Gas Industry" (Department of Environment and Natural Resources, 2011) http://www.ehp.qld.gov.au/factsheets/pdf/environment/en7.pdf at 1.

13 Department of Employment, Economic Development and Innovation (Qld), *Land Access code: November 2010* (2010) http://mines.industry.qld.gov.au/assets/land-tenure-pdf/land_access_code_nov2010.pdf , at 3.

14 Department of Environment and Heritage (NSW), *Coal Seam Gas in NSW* (2012) http://www.environment.nsw.gov.au/licensing/coalseamgas.htm .

15 Department of Environment and Heritage (NSW), *Environment Protection Authority* (2012) http://www.environment.nsw.gov.au/epa/index.htm

16 NSW Legislative Council General Purpose Standing Committee No. 5, Coal Seam Gas (2012) http://www.parliament.nsw.gov.au/Prod/parlment/committee.nsf/0/318a94f2301a0b2fca2579f1001419e5/$FILE/Report%2035%20-%20Coal%20seam%20gas.pdf

17 Report written by Author of this paper. See http://www.dmp.wa.gov.au/documents/000041.jason.medd(1).pdf

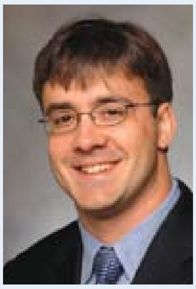
18 Queensland, NSW, South Australia, Victoria and the Northern Territory have all signed up to the National Partnership agreement on Coal Seam Gas and Large Coal Projects. See http://www.federalfinancialrelations.gov.au/content/national_partnership_agreements/environment/csg_and_lcmd/NP.pdf .

19 NSW Legislative Council General Purpose Standing Committee No. 5, *Coal Seam Gas* (2012).

5. International implications of expanded shale gas production

Dr Kenneth Barry Medlock III

This chapter provides an international perspective, examining the development of unconventional energy in the US and potential lessons Australia can learn from those developments.



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Introduction

The application of innovative new techniques involving the use of horizontal drilling with hydraulic fracturing, allowing the recovery of natural gas from shale formations in North America over the past decade, have been nothing short of game-changing for the natural gas market. The Barnett shale in northeast Texas was the first play where this occurred, and production from shale in that play has grown to over five billion cubic feet per day (bcfd), which is up from virtually nothing just 10 years ago. Furthermore, the techniques that proved so successful in the Barnett shale have been successfully applied to other shale formations around North America – including the Marcellus shale, Haynesville shale, Fayetteville shale, Eagle Ford shale, and more (see Figure 1). This has effectively unlocked a vast hydrocarbon resource. Success has been so dramatic that shale gas production in the United States, which was less than 1.5 per cent of domestic production in 2000, is expected to reach over 50 per cent of total US natural gas production by the 2030s.

Rising shale gas supplies have significantly reduced projected requirements in the US for imported liquefied natural gas (LNG). This has had previously unforeseen ripple effects in markets around the world, affecting both domestic and international market structure as well as geopolitics. Shale gas developments in the North American gas market have, by displacement, increased the availability of LNG to other markets, particularly those LNG supplies that were originally targeted for the US market. This has played a key role in the ongoing re-negotiation of long term oil indexed contracts in Europe, where an increase in the number of supply options has put downward pressure on price and reduced traditional suppliers' market power. Russia, for example, has allowed its sales in Europe to be increasingly indexed to spot natural gas markets, or regional market hubs, rather than oil prices, which is a clear signal of a major paradigm shift.

FIGURE 1
SHALE BASINS IN NORTH AMERICA

Source: US Energy Information Administration

Displacement effects have also been felt in Asia. Specifically, since expected US demands for LNG did not materialise, supplies were available for shipment to Japanese buyers in the wake of the disaster at Fukushima. Without North American shale developments, Asian LNG prices would have likely risen even higher under more intense competition for global supplies.

In addition, the success in North America related to shale gas has encouraged upstream developers to investigate opportunities in Europe and Asia. If those regions see success that is even remotely similar to that in North America, the impacts would be direct, rather than indirect, and have even more significant long term ramifications for regional gas markets. Certainly, viable shale resources have been identified in other regions around the world, and shale gas exploration is actively being pursued in Poland, the UK, Ukraine, China, India, Australia, Argentina, and elsewhere.

The scale of the global shale gas potential, if commercial success is realised, will alter geopolitical relationships. However, it is important to note that sustained, rapid development of shale gas is not a certainty. In fact, there are several factors that must align to ensure success. These include, but are not limited to:

- A stable regulatory environment to minimise investment uncertainties;
- Market structures that encourage exploration and development; and
- Protection of intellectual property rights so that productivity improving technologies and techniques can be applied widely.

In addition, it is vital that public concerns be allayed, meaning it is imperative that environmentally benign approaches to development must be demonstrated. All of these issues must be addressed before the full global benefit of shale can be realised.

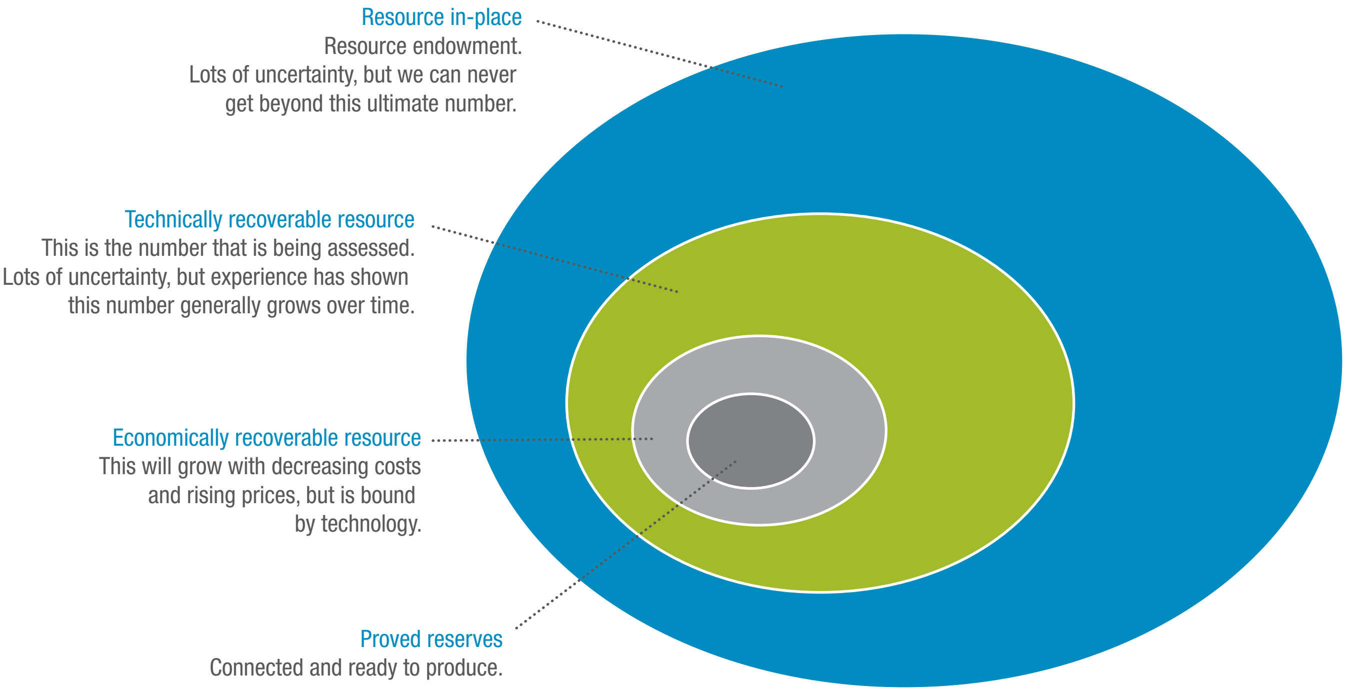
The shale gas resource

The state of knowledge regarding the amount of shale gas that is economically recoverable has changed rapidly over the last 10 years. As recently as 2003, the National Petroleum Council estimated about 38 trillion cubic feet (tcf) of technically recoverable resources spread across multiple basins in North America.[1] By 2008, Navigant Consulting estimated a mean of 280 tcf of technically recoverable resources from reviewable geologic literature, but a survey of producers indicated up to 840 tcf.[2] In 2009, the latter estimate drew increasing support from the Potential Gas Committee, which put its mean estimate at just over 680 tcf.[3] More recent still, in 2011 Advanced Resources International (ARI) reported an estimate of about 1930 tcf of technically recoverable resource for North America, with over 860 tcf in US gas shales alone.[4]

The pattern of "more resource with time" is unmistakable with each subsequent assessment. Moreover, the ever-increasing assessments are largely coincidental with more drilling activity and technological advances, as well as an indication of the "learning-by-doing" that is still occurring as the industry moves into this new production frontier. Today, little disagreement about the scale of the technically recoverable resource remains. However, there is still considerable disagreement regarding cost. As a result the economically recoverable resource remains a subject of debate.

Geologists have long known about the existence of shale formations, but technical and commercial access to those resources is new. Several years prior to the emergence of shale in North America, Rogner[5] estimated over 16,000 tcf of shale gas resources "in-place" globally, with just under 4000 tcf of that total estimated to be in North America. It should be noted here that large resource in-place estimates do not guarantee large-scale production is forthcoming. Technical innovations are required to render resources technically recoverable and cost reductions are critical to making the resource economically recoverable. Figure 2 helps to delineate these definitions, illustrating economically recoverable resources as a subset of technically recoverable resources, which are a subset of resources in-place. Note that proved reserves, also delineated for reference, are actually a subset of what is economically recoverable, which highlights the problems inherent with statements linking proved reserves with resource life. We must be aware of the entirety of the resource in-place. At the time of Rogner's work, less than 10 per cent of the resource in-place was deemed to be technically recoverable, meaning shale was not identified as having much commercial potential. But, technological breakthroughs since have effectively increased the size of the technically and economically recoverable subsets of resource in-place, and therefore have substantially changed the picture.

FIGURE 2
THE RESOURCE BASE AND RECOVERABILITY



In fact, developments over the last decade led the International Energy Agency (IEA) to recently estimate that about 40 per cent of Rogner's estimated resource in-place will ultimately be technically recoverable. Moreover, a recent assessment of technically recoverable shale resource done by ARI for the Energy Information Administration (EIA) identifies a global in-place shale resource of over 25,300 tcf, of which over 6600 tcf is assessed as technically recoverable. Importantly, the ARI report points out that the estimate does not include shale resources in the countries of the former Soviet Union (FSU) or the Middle East, so the full global total is likely to be much higher. In any case, it is certainly true that the knowledge base regarding this resource has expanded substantially in the last decade.

Analysis done at the James A Baker III Institute for Public Policy at Rice University indicates a global estimate of economically recoverable shale resource of about 4025 tcf at prices below $10/mcf. Assuming a 12 per cent return on investment, the long-run breakeven price needed for an average type well in each of the shale plays identified around the world ranges from the low $3 to $10. To be clear, there is a distribution that characterises possible well performance, meaning some wells will be better than average and some will be worse. Moreover, the performance of shale wells around the world can be expected to vary widely. But, if developers are able to identify so-called "sweet spots" in shale plays, then prices, at least for a period of time, can be at the lower end of this range.[6]

Currently, the cost of drilling and completing shale gas wells is generally much higher outside of North America. For example, a 10,500 ft well (TVD) with a 4000 ft lateral in the Haynesville shale in the US will typically cost around $8 million. If drilled today, the same well in Poland will cost in the $14–16 million range, and in

Australia, the cost would be even higher. However, much of the increased cost is due to transitory factors, such as horizontal rig availability, fracking crews and equipment, qualified personnel, etc. As such, it should be noted that first entry in many regions may be considerably more expensive than in North America, but if activity ramps up, costs should fall as these short run constraints are relieved due ultimately to the mobility of capital, labor and technology.

Once activity does increase, the experience in the US in particular, has revealed that operators benefit from "learning-by-doing". As an example, the experience in the Barnett shale is a good barometer for the "learning-by-doing" that can occur as shale related activity ramps up. In the Barnett to date, over 12,000 horizontal wells have been drilled, most of which have been completed since 2005. In the last three years, large improvements in productivity have been realised, as rig counts are down to about one-third of their levels in September 2008 but production is actually higher. Much of this owes to operators finding the so-called "sweet spots" and improvements in turn rates for rigs. However, ongoing innovations will challenge our understanding of both cost and recoverability as drilling operations are being down-spaced from 80 acres to 40 acres, effectively increasing the quantity of hydrocarbons that can be extracted from a given acreage. In sum, as operators drill and complete shale wells, they learn about the resource and apply those lessons to reduce costs and raise well-productivity. In the upstream in general, this is actually a common theme as producers enter new exploration and development frontiers.

Importantly, ongoing cost reductions and growth in the economically recoverable resource base makes the supply of natural gas more elastic. This has implications for the future of global and regional natural gas market development and the evolution of pricing paradigms that have persisted to date.

Implications for natural gas prices

Brito and Hartley[7] show that growth in liquidity limits the ability of any single supplier to price above marginal cost, or to put it another way, greater liquidity limits the ability to price discriminate. To be sure, oil indexation of natural gas price is a form of price discrimination. Accordingly, it can be argued that for a producer to sell natural gas at an oil-indexed price:

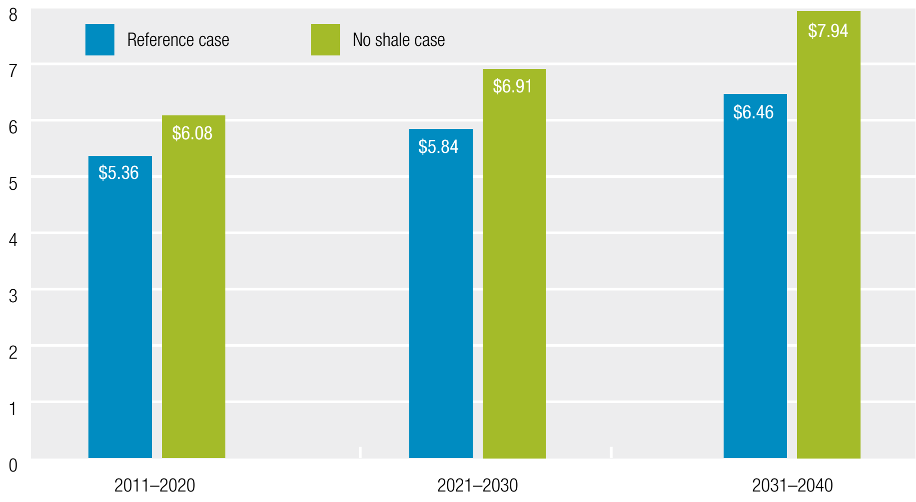
- It must be able to distinguish consumers and prevent resale; and
- It must face consumers with different demand elasticities.

Historically, both conditions have been met in Europe and Asia. However, an increased ability to trade between market participants, which would occur as supply becomes more elastic, will lead to a violation of the first condition.

As the abundance of commercially viable natural gas supplies rises due to the dramatic growth in shale gas production, supply will become more elastic and liquidity will be enhanced. This will pressure prices in the direction of marginal

FIGURE 3

HENRY HUB PRICE IN TWO CASES, 2010–2040 (DECADAL AVERAGES)



Source: Medlock III, K.B., A.M. Jaffe, P. Hartley, Shale Gas and US National Security, available online at http://www.bakerinstitute.org/programs/energy-forum/publications/energy-studies/shale-gas-and-u.s.-national-security, (2011).

cost, which should, in turn, result in resistance to the continuation of the historical paradigm of oil indexation. The ability to price discriminate appears to already be diminishing in Europe. In the past couple of years, particularly with the emergence of continental gas market hubs, an increasing proportion of contracted sales have been indexed to hub prices.[8] If shale resources are proven to be commercially viable in Europe and Asia, this will likely accelerate, leading to much more intense competition. As a result, the traditional pricing paradigm of oil indexation is likely to face considerable pressure. In fact, this result should not be that surprising; natural gas is one of the only internationally traded commodities that is still priced explicitly in terms of another commodity.

In North America, the direct effect on price is already evident, with the price hovering in the mid-$2/mcf range for the balance of 2012. Longer term, the effect of shale gas developments on price has been analysed. Medlock et al compared two simulated futures – one in which shale did not exist (no shale case) and one in which it is found in relative abundance (reference case) – to show that the emergence of shale has effectively rendered the US domestic supply curve to be much flatter (more elastic).[9] This, in turn, yields projected prices that are considerably lower (see Figure 3).

As seen in Figure 3, the price of natural gas is $1.50 lower by the 2030s, and it is sourced domestically, when shale developments occur unfettered. The availability of relatively low cost, ample domestic natural gas supplies could also give the US greater flexibility to forge policies to diversify its transportation sector away from overwhelming reliance on oil-based fuels. For example, since the US uses barely any oil to generate electricity, ample natural gas for electricity generation means a shift to electrified vehicles would lessen dependence on imported oil at a lower cost than might otherwise have been possible.

The importance of market structure

Market structure is also very important when considering the growth opportunities for shale. It is the most underappreciated factor that positively benefited growth in shale gas production in the US. To understand this, one only needs to realise that it was the small, independent producers who drove the entrepreneurial efforts that led to the large increases in shale gas production – not the large integrated majors. Arguably, the upstream success story of shale gas would not be occurring had the independent producers not taken the first steps into this new frontier. Moreover, they could not have done so without the market structure that exists in the US. As one example, in the US natural gas market, ownership of transportation capacity rights is unbundled from pipeline ownership. Unbundling of capacity rights from facility ownership makes it possible for any producer to access markets through a competitive bid. As another example, mineral rights in the US are in many places negotiated directly with the landowner. This can accelerate the development process by removing layers of bureaucracy and facilitating rent-sharing between private individuals and the exploration companies.

Without these very relevant features related to market structure, many of the small producers that first ventured into shale might not have been willing to do so, specifically because access to markets could have been limited. By contrast, in most other markets globally, pipeline capacity is not unbundled from facility ownership, meaning large incumbent monopolies can effectively present barriers to entry through control of the transportation infrastructure. In addition, mineral rights are held exclusively by governments rather than individuals, which can exclude the landowner from earning rents related to activities on his/her land, and make them generally less amenable to development.

More generally, the US has a well-developed, competitive regulatory framework governing natural gas infrastructure development, transportation services, marketing, and mineral rights. This has promoted the rapid development of shale resources, and it may not be fully or quickly replicable where government involvement in resource development and transportation is more prevalent. In fact, the regulatory structure governing the North American gas market is a major reason that US energy security has benefitted from having an active sector of small, independent energy companies. Without this sector, US shale gas production would likely have taken many more years to grow to its current levels. Of course this would have meant the LNG regasification terminals that were constructed in the last several years would be more greatly utilised, and it would also have yielded more market and geopolitical power to a few foreign natural gas suppliers.

Geopolitical impacts

Prior to the mid-2000s and the innovations that led to the recent growth in shale gas production, huge production declines were expected in the US, Canada, and the North Sea. This, in turn, meant an increasing reliance on foreign-sourced supplies for much of the industrialised world. In addition, prior to the revelations about shale, Russia and Iran accounted for more than half of the world's known gas resources, which put these countries in a unique position to leverage the apparent pending increase in global reliance on their resources.

In a recent study sponsored by the US Department of Energy, the Baker Institute at Rice University explored the geopolitical impacts of expanded shale gas development.[10] According to that study, three countries in particular have been negatively affected by shale gas – Russia, Iran, and Venezuela. For Russia, they showed that, had shale not emerged, Russian market share in non-FSU Europe remains relatively steady through time at just over 20 per cent. However, with shale developments possible, Russia's market share of non-FSU Europe falls to below 14 per cent by the 2030s. This is a dramatic difference, and it substantially changes the tenor of the conversation in Europe regarding geopolitical matters between Russia and its European consumers.

In addition, if shale gas output is not inhibited, we see much greater global reliance on LNG exports from Iran and Venezuela in the long term. This occurs precisely because the abundance of conventional gas supplies in these countries makes them prime for supplying growing global gas demands.

Since natural gas is expected to become a pivotal fuel in meeting growing energy demands and environmental objectives, the emergence of these two countries as crucial suppliers runs counter to US interests against the existing backdrop of US-Iranian and US-Venezuelan relations. Shale gas not only has spatial impacts on the global gas market, but also temporal impacts, as seen by the fact that the emergence of shale gas greatly reduces the chance of any individual or group of producers gaining substantial market share.

Industrialised economies already face challenges from the high costs of importing foreign oil. Large trade deficits driven by oil imports and the threat of oil supply disruptions driven by unrest in producing regions remain a risk factor to overall macroeconomic stability. Against that backdrop, the idea of further increasing exposure to international events through an increase in imports of LNG is not a desirable outcome. Therefore, rising production of natural gas, rather than rising imports, improves the energy security outlook for all importing nations.

For all countries to realise this benefit, it will be essential to promote a stable investment climate with regulatory certainty and well-defined rules regarding environmental impacts. This is the only way to ensure that shale gas can positively contribute to greater diversification of global energy supplies.

Endnotes

1 National Petroleum Council, *Balancing Natural Gas Policy – Fueling the Demands of a Growing Economy*, (2003).

2 Navigant Consulting, *North American Natural Gas Supply Assessment*, (2008).

3 The Potential Gas Committee, *Potential Gas Committee Biennial Assessment*, (2009).

4 Advanced Resource International, *World Gas Shale Resources: An Assessment of 14 Regions outside the United States*, a report prepared for the United States Energy Information Administration, available online at http://www.eia.gov/analysis/studies/worldshalegas/, (2011).

5 H. Rogner, "An Assessment of World Hydrocarbon Resources," *Annual Review of Energy and the Environment*, 22 (1997), 217–262.

6 Details regarding the projected long run development costs and economically recoverable resources are available upon request.

7 Dagobert Brito and Peter Hartley, "Expectations and the Evolving World Gas Market," *Energy Journal* 28, no. 1 (2007), 1–24.

8 A note on market centers, or hubs, is warranted here in order to highlight the possibilities for the emergence of hubs in the region more generally. Two important services offered by market centers include (1) interconnections with other pipelines and (2) physical coverage of short-term receipt/delivery balancing. These basic services are often referred to as "hub services" along with other provisions that have also emerged at market centers over time, primarily to help expedite the gas transportation process. In general, a natural gas market hub is a point at which customers are able to physically trade natural gas between two or more pipeline systems, thus providing arbitrage capability between otherwise distinct supplies. Thus, hubs serve the functions of transparency and price discovery, which enables deal structures to be developed using the hub price as an index. A market center allows interaction between numerous participants enabling the mitigation of risk via diversification of suppliers and markets.

9 Medlock III, K.B., A.M. Jaffe, P. Hartley, *Shale Gas and US National Security*, available online at http://www.bakerinstitute.org/programs/energy-forum/publications/energy-studies/shale-gas-and-u.s.-national-security, (2011).

10 Ibid.

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