WGCPARIS2015
WORLD GAS CONFERENCE
"GROWING TOGETHER TOWARDS A FRIENDLY PLANET"

26th World Gas Conference | 1-5 June 2015 | Paris, France

Challenges in Developing Unconventional Gas

An Australian case study

Dr Graeme Bethune
Chief Executive Officer
EnergyQuest
Australia

Table of Contents

Tables

Figures

Background[1]

With substantial coal bed methane (CBM) resources, Australia is the largest producer of unconventional gas outside North America and CBM production is set to grow strongly with the completion of the three CBM-based LNG developments under construction in the Australian state of Queensland. One project, BG's Group QCLNG (BG, CNOOC, Tokyo Gas), which was sanctioned in October 2010, has already commenced production. The other two projects, GLNG (Santos, Petronas, KOGAS and Total), which was sanctioned in January 2011, and APLNG (Origin Energy, ConocoPhillips and Sinopec), which was sanctioned in July 2011, are also due to commence production in 2015.

Given the challenges involved this is a remarkable achievement, not only for the Australian gas industry but indeed for the industry globally because industry professionals from and in many countries have contributed to this success.

Aim

Development of Queensland CBM has entailed many challenges:

- Understanding the CBM resource
- Regulating the development
- Winning the support of affected communities
- Impacts on the domestic gas market
- Project costs

This paper considers these challenges. Some of the challenges experienced in Queensland may also apply in other countries, others will not. The paper also contrasts experience in Queensland with subsequent lack of development in the state of New South Wales and the lessons that this suggests.

The history of Australian CBM is a large subject, worthy of several books, and it is impossible to do it justice in a short conference paper. Accordingly this paper can only scratch the surface.

---

[1] This paper has benefitted greatly from the insights of industry colleagues who have been directly involved in the development of CBM LNG in Queensland. The errors are my own.

Methods

Analysis of company, government and community statements and discussions with key participants, statistical analysis.

Results

Understanding the CBM resource

LNG buyers and producers took on a significant challenge in committing to three LNG projects based on CBM, something that had never been done previously.

While there was extensive knowledge of the properties of Queensland coals gained from coal mining, there was limited production history. Total Queensland CBM production up to 2010 was less than 900 PJ yet the projects plan to produce 1,500 PJ per annum in aggregate over 20 years.

Conventional LNG projects are underwritten by Proved (1P) reserves. However, the LNG buyers and producers committed to the three Queensland projects with varying degrees of Proved and Probable (2P) reserves cover. This was done on the basis of assumptions about the resource base and how much of the resource would ultimately convert to 1P reserves and production. Unlike conventional LNG projects, CBM appraisal (and exploration) drilling continue after project commitment.

Table 1 Queensland CBM reserves and resources (PJ)

	1P	2P	3P	2C
End 2010				
APLNG	1,527	11,218	14,558	4,329
QCLNG	2,120	8,480	9,804	9,275
GLNG	1,432	5,009	7,680	3,732
Total	5,079	24,707	32,042	17,336
End 2014				
APLNG	4,566	14,085	17,518	2,752
QCLNG	6,705	9,294	9,768	6,132
GLNG	2,245	5,603	5,603	1,202
Total	13,516	28,982	32,889	10,086

Source: EnergyQuest

Table 1 shows reserves and resources for the projects at the end of 2010 (around the time of sanction) and 2014. It also includes Proved, Probable and Possible reserves (3P) and Contingent Resources (2C). In aggregate the projects require 1,500 PJ pa of gas to meet their contracts, totalling 30,000 PJ over the life of the contracts. APLNG has been able to grow its 1P and 2P reserves significantly over the last four years. QCLNG has grown its 1P reserves but less so its 2P reserves. GLNG has had to contract third-party gas. Development of CBM reserves is an incremental process over the life of the project and it does not make economic sense to have all the necessary reserves base proved up on day one. However, some early reserves forecasts have proved optimistic.

Regulating the development

Regulation of the development has been another challenge.

The main role of governments in the development of Queensland CBM LNG has been in regulating land-use and environmental impacts. Otherwise, compared with other countries, state and federal governments have taken a free market approach, as they do to resource sector projects generally. Australia does not have export controls and governments have not tried to get involved in project planning.

On the other hand there has not been any government assistance by way of tax breaks or infrastructure assistance. Companies have to meet infrastructure costs and often going beyond what would normally be defined as project infrastructure (e.g. hospital funding).

In fact, there have been taxation increases. The Rudd Labor government proposed a so-called resource super profits tax (RSPT) and the Gillard Labor government introduced a carbon tax. The RSPT, suddenly proposed without consultation on the eve of major projects making investment decisions, was quickly abandoned in the face of mining industry opposition. However it has left CBM development subject to the federal Petroleum Resource Rent Tax in addition to state royalties. The carbon tax had a range of exemptions for export industries and has subsequently been abolished by the current federal government but its introduction created uncertainty, particularly for foreign investors.

The impact of environmental and land-use regulation was severely under-estimated by the companies.

Queensland has had an onshore conventional oil and gas industry for over 50 years but nothing on the scale of CBM development for LNG, with each project requiring 1,000-2,000 wells to first LNG plus a 500 km gas pipeline to the LNG plant.

Australia has a strict environmental regulation regime. Major projects require environmental approval from both the state and federal governments (creating duplication), based on

Environmental Impact Statements, which are wide-ranging, cover environmental, social and economic impacts, and typically run to thousands of pages.

The GLNG EIS was almost 13,500 pages. This application was approved but subject to 300 conditions. These are not the only conditions. The projects are each subject to around 1,500 regulatory requirements in total.

The regulation of the CBM projects was much stricter than that of the smaller domestic CBM projects. For example water from CBM wells could previously be evaporated in storage ponds. However the LNG projects have generally been required to treat their produced water by much more expensive reverse osmosis.

Complying with the overwhelming number of environmental regulations is regularly cited as a major challenge and driver of increased costs.

The Queensland Competition Authority(2014) has summed up the situation:

The regulatory framework for the CBM industry in Queensland was developed quickly to respond to the rapid growth of the industry. Concerns about the environmental and community impacts of the new industry were often addressed by introducing new regulations applying solely to CBM activities. In many cases, these CBM regulations duplicate, or overlap with, regulations applying to the resources sector. The combination of specific CBM regulation alongside general regulations for the resources sector can be confusing for government, industry and the community. It risks increasing compliance costs and, unless there are risks unique to the CBM industry, may be unnecessary for achieving policy goals.

The QCA recommended a range of regulatory reforms that would reduce costs to government (A$3.0-$3.6m pa) and industry (A$55.7-$56.3m pa) without affecting the degree of environmental protection.

These comments have focussed on the challenges of regulation for companies. However, developing a regulatory regime over a fast-growing industry and maintaining broad public support was also a substantial challenge for Queensland Government elected representatives and public servants. Regulating unconventional gas development and maintaining public support is a challenge for governments globally. Queensland has succeeded where many have failed.

Working with land holders

Working in populated areas is also a challenge. Most oil and gas activity in Australia is carried out offshore or in relatively unpopulated outback locations. Although the Queensland CBM fields are not densely populated, there are farms and towns. Land-use varies, with grazing in some areas and more intensive cropping in others. In developing their CBM

projects the companies were proposing to overlay the established land-use pattern with thousands of gas wells plus associated gas plants and water processing facilities. Companies and their contractors that were used to working offshore or in remote areas would be working in populated farming areas with myriad potential community and environmental issues.

Furthermore, the companies were proposing to move quickly to meet their own deadlines, exacerbating pace of change required of local communities.

The fiscal and regulatory regime does not provide incentives for landholders to support CBM development. Under Australian law the government owns mineral resources and royalties are paid to government, as in Canada. Exploration companies have the right to access private property but are reluctant to enforce this by legal means. Landowners do have the right to compensation for any alienation of their property.

Generally the companies did not get off to a good start, failing to capture the hearts of land owners and communities. CBM development was treated as an engineering issue rather than an emotional one for local residents. In some cases too there was a legacy of mistrust from earlier dealings with small CBM companies.

In particular, the areas of CBM development had just been through a long drought and the companies were planning to withdraw and potentially dispose of millions of litres of precious water, a scarce and emotional resource for farmers.

One partial solution for the companies was to buy critical parcels of land needed for infrastructure while continuing to farm them. This led to the appearance of job titles like General Manager Livestock in oil and gas companies.

Over time the companies have had to improve the way they negotiate with landowners. Oil and gas companies are used to contracting with other major companies but not with small landholders, by whom they were seen as secretive and heavy-handed.

Compensation for land owners has also been improved and is provided not only for initial disturbance but also on an ongoing per well basis. This is a valuable asset for landowners. Some companies also employ landowners part-time.

Companies now employ significant numbers of landholder relations personnel.

The Queensland Government also established a Gas Fields Commission, an independent statutory body formed to specifically manage and improve coexistence among rural landholders, regional communities and the onshore gas industry. This has been very successful.

In general landholder relations in Queensland are now satisfactory. In Queensland 4,944 land access agreements had been signed to the end of September 2014, with only one formal access dispute.

However reaching this stage has required a substantial effort and cost, which were under-estimated at the time projects were sanctioned.

In working in settled areas, the companies are also not only dealing with individual landowners but with whole communities. Between 1 January 2011 and the end of September 2014 companies in Queensland held 2,406 community engagement events and paid A$146m in community contributions.

Project Costs

Costs have been a huge challenge. Rather than economies of scale CBM development has proved to have diseconomies of scale.

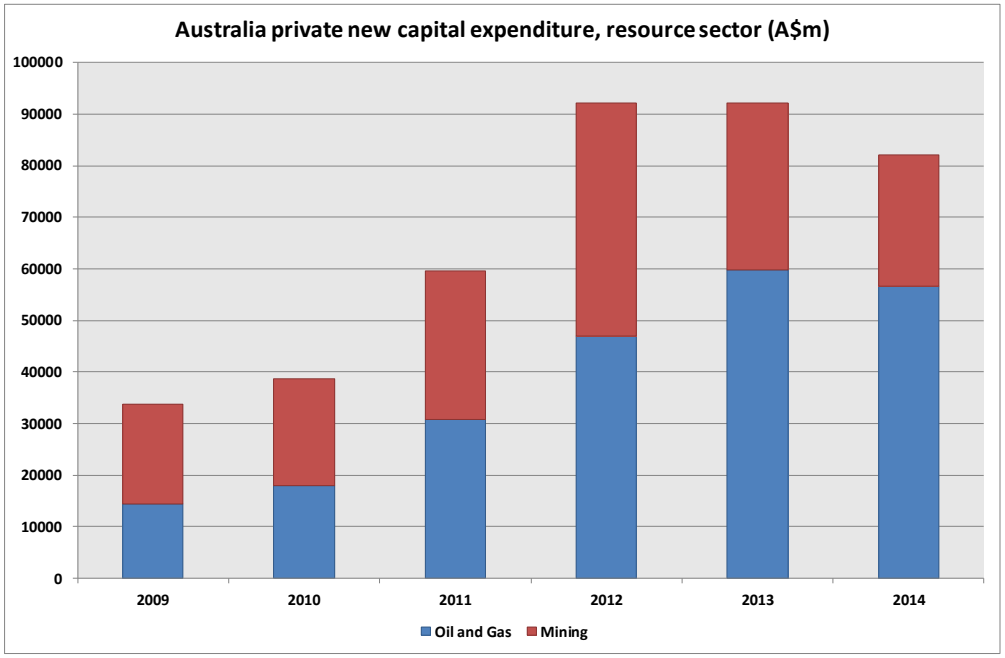
Development of small scale domestic CBM projects is relatively cheap. However this has not been the case for developing mega-projects. The costs of the three projects have all increased to varying degrees since project sanction. QCLNG was originally going to cost US$15 billion but is now budgeted at US$20.4 billion. The original GLNG cost was US$16 billion but is now US$18.5 billion. APLNG's initial costing was more accurate at A$23 billion but this has ultimately also increased, to A$24.7 billion. These are the costs to first LNG. Beyond that ongoing development is expected to cost A$1-2 billion pa in the first five years after initial production and then around A$0.5 billion pa thereafter.

There were also significant costs prior to sanction for foreign companies. BG paid US$3.9 billion in total for its acquisition of QGC and Pure Energy (now effectively written off). ConocoPhillips paid A$8.3 billion for its interest in APLNG.

The cost increases reflect a number of factors. Costs in the oil and gas industry globally increased through the 2000's as oil prices increased. This applied particularly to the cost of building LNG plants, which increased from US$300 per annual tonne of capacity in 2000 to US$1,200 in 2013 (Songhurst, 2014).

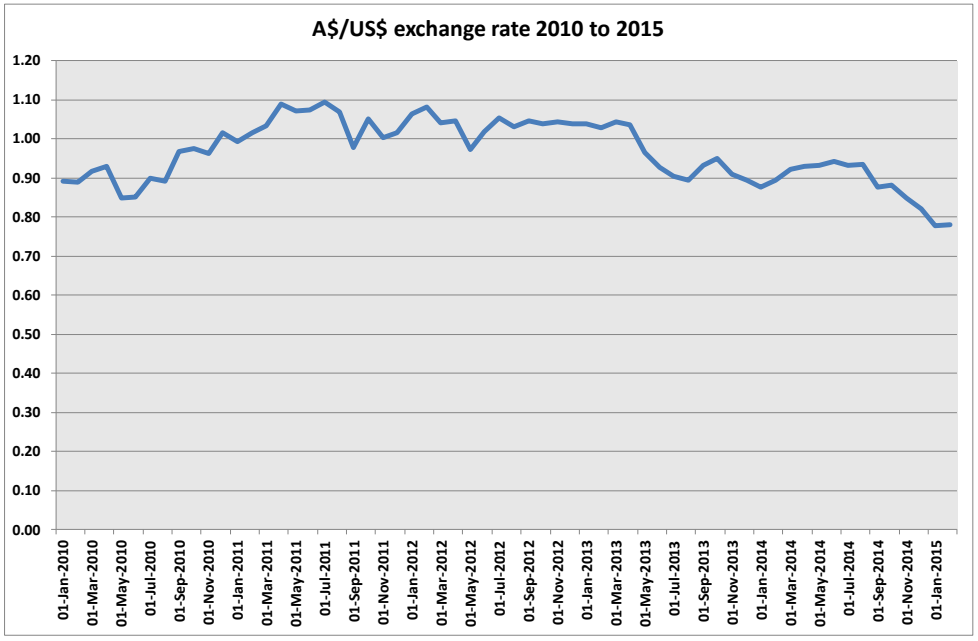
The CBM LNG projects were not the only resource projects being developed in Australia. There were also five west coast LNG projects plus mining projects. In both 2012 and 2013 total resource sector investment totalled over A$90 billion (Figure 1). At the end of 2010 the unemployment rate in Australia was only 5.1% and only slightly higher in Queensland at 5.6% (now 6.7%).

Figure 1 Australia private new capital expenditure, resource sector (A$m)



Source: Australian Bureau of Statistics

Figure 2 A$/US$ exchange rate 2010-15



Source: Reserve Bank of Australia

Multiple projects across the country were bidding for labour in a fully-employed economy. Many of the jobs in Queensland were fly-in-fly-out and to attract workers it was necessary to offer substantial penalty rates for working more than an eight hour day or weekend work. This is in addition to the costs of accommodating and feeding workers. Contractors might have to pay the equivalent of A$160,000 pa for a trades assistant. In these circumstances it is hardly surprising that workers and trade unions (and also professionals working in companies) were keen to take advantage of the scarcity of labour.

Cost inflation was exacerbated by the rise in the A$ exchange rate (Figure 2). The A$ rose from US$0.90 at the start of 2010 to US$1.10 in 2011. Projects were typically budgeted in US$ but might have 50% or more of their expenditure in A$. A trades assistant who might have cost US$144,000 in US$ terms in 2010 would have cost US$176,000 in 2011.

The rise in the A$ partly reflected the resources boom but also the fall in the US$ following the global financial crisis.

As noted above, companies under-estimated the cost of regulatory compliance. They also under-estimated other costs. The number of wells required was underestimated as was the labour force. Initial estimates of peak employment were typically 4,000 to 6,000 per project but as of 2013 QCLNG was employing nearly 9,000.

Due to the uncertainties of development, aspects of the projects were over-engineered. For example, the capacity of water handling infrastructure have proved to be larger than necessary. Three major gas transmission pipelines have been built, each capable of servicing three LNG trains. The companies are all confident that they can reduce unit costs of upstream development based on the learnings from the first stage of development.

One frequent question is why there was virtually no coordination or cooperation between the three projects (voluntary or government-imposed) to reduce costs. This applies particularly to the development on Curtis Island where three LNG plants have been built next to each other.

It is generally agreed that separate development resulted in duplication and over expenditure. The Qatari model where facilities for processing and exporting gas from a number of upstream producers were co-located, would have been better suited to the Queensland situation. There should only have been a single LNG plant on Curtis Island that processed gas from each of the three upstream companies. It would have resulted in a lower overall cost structure and possible shorter execution time frame (less competition for labour, more appropriately sized plant, operations and maintenance synergies, only having to undertake a single EIS for the plant as opposed to three individual ones etc.).

However, there were practical challenges in getting agreement. The companies were initially competing to sign up buyers and had different timetables. Not all three companies were ready at the same time. Further challenges of cooperating were resolving questions like who would operate the LNG Plant and also transfer pricing.

Ultimately the Queensland Government and the three projects could not even agree to build a bridge from the mainland across Gladstone Harbour to Curtis Island, a distance of about 6 km. The result was three individual marine terminals on both the mainland and Curtis Island. Building infrastructure, sufficiently in advance of sanction decisions would have allowed lower costs and lower environmental impacts.

In reality it is difficult enough to get alignment within a joint venture developing a major project, let alone between joint ventures. People who have moved on from the Queensland projects to proposed LNG projects in Canada and Mozambique have spoken about how they are determined to avoid the mistakes of Curtis Island. However there is little sign of this occurring.

It is also possible that the projects might not have been developed at all if they had been delayed by trying to achieve agreement on a more complicated model. The subsequent growth of the anti-fossil fuel movement and the potential of US LNG exports could have completely derailed the Queensland projects.

Impacts on domestic gas markets

So far this paper has focussed on challenges for companies developing the CBM LNG projects. One other important challenge has been the challenge for domestic gas buyers of becoming part of the international gas market. Suddenly demand for east coast gas is tripling and it has been difficult for domestic gas buyers to compete with LNG buyers. Gas prices are expected to double or triple and gas buyers have had trouble rolling over contracts. This is a difficult situation for aluminium, fertiliser and other energy-intensive industries. Australia is generally a high cost country but manufacturing has historically had the advantage of low energy costs. This is changing, with higher gas and electricity prices. And higher energy prices are only one of multiple challenges, including a high exchange rate, high wages, a small domestic market and competition from Asia. In 2000 Australia had eight oil refineries. It now has four. In 2000 Australia had three motor vehicle manufacturers but by 2017 it will have none.

The economic impact of developing east coast LNG has been extensively modelled and the findings are generally positive when judged in terms of GDP and Gross National Income.

The manufacturing sector and one of the trade unions have argued for a domestic gas reservation policy (as applies in Western Australia). The gas industry has countered that gas

development costs have increased and prices would have risen even without LNG development. With higher costs, Queensland's gas resources could only be developed if sold at premium Asian prices.

Neither the federal nor Queensland governments have been prepared to provide the protection sought by gas buyers.

Getting to first LNG

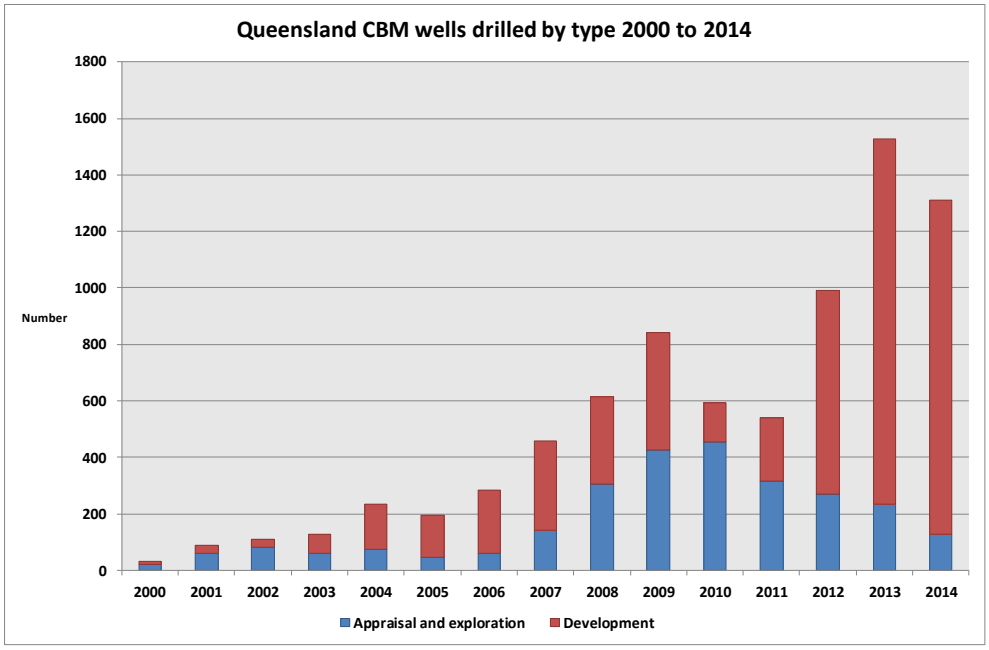
Notwithstanding the many challenges, the CBM CSG projects have been progressing quickly.

Figure 3 shows the growth in drilling, which reached a peak in 2013 with over 1,500 wells drilled. With the three LNG projects under construction, the focus is now on development drilling

Reserves and resources have grown rapidly since 2007. Over the last three years the total resource base has flattened out, with the main focus now being on conversion of 2C resources and 3P reserves to 2P (Figure 4).

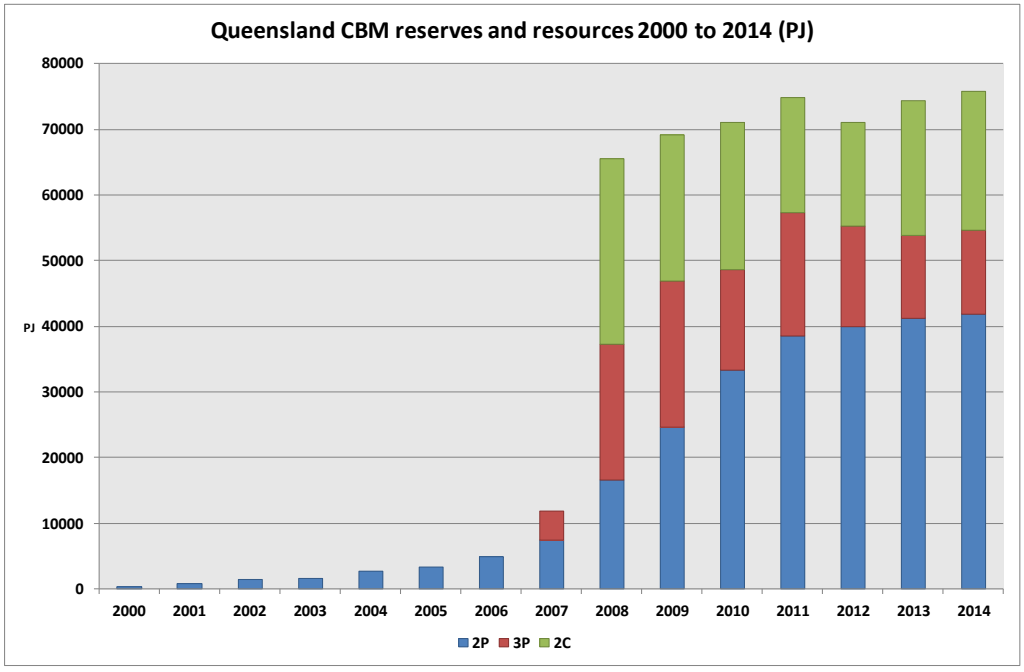
Queensland CBM production has been increasing rapidly, reaching over 300 PJ in 2014 (Figure 5). CBM production is expected to reach 1,500 PJ by 2020.

Figure 3 Queensland CBM wells drilled by type 2000 to 2014 (Number)



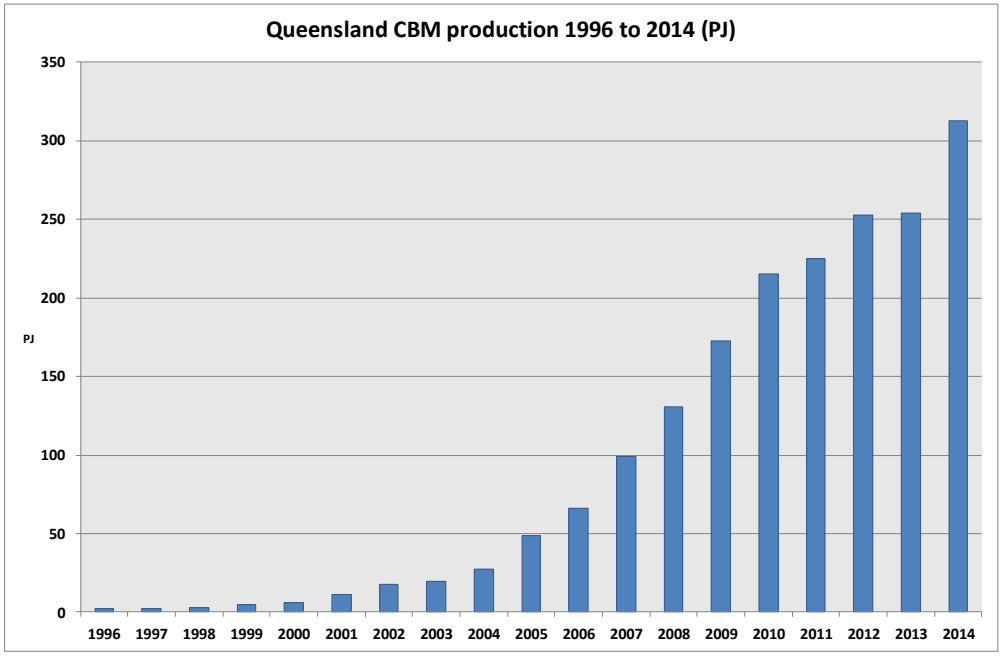
Source: EnergyQuest, Qld DNRM

Figure 4 Queensland CBM reserves and resources 2000 to 2014 (PJ)



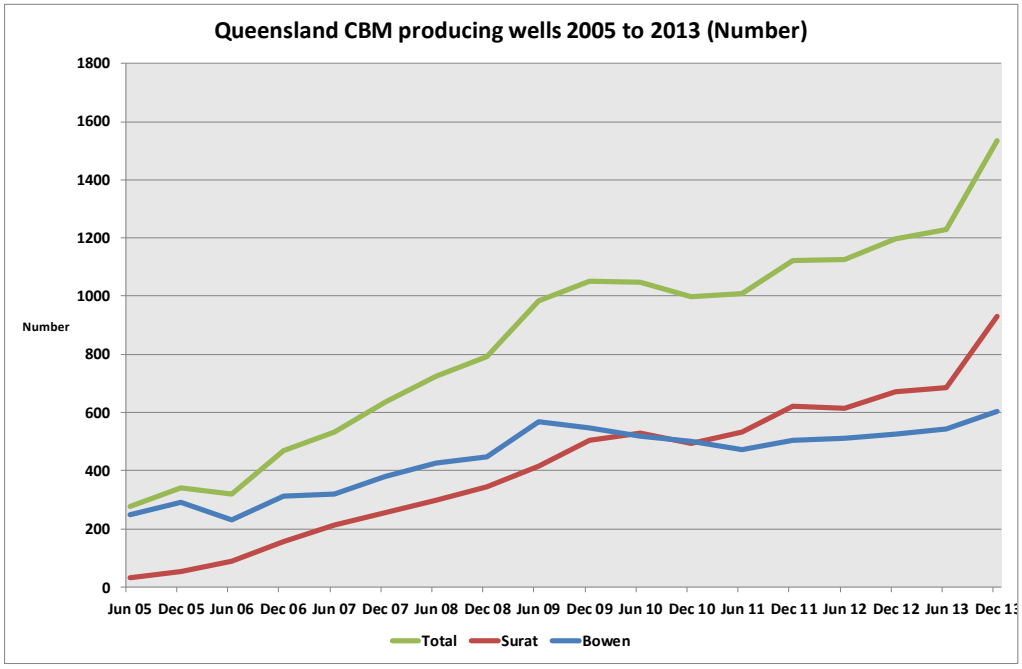
Source: EnergyQuest

Figure 5 Queensland CBM production 1996 to 2014 (PJ)



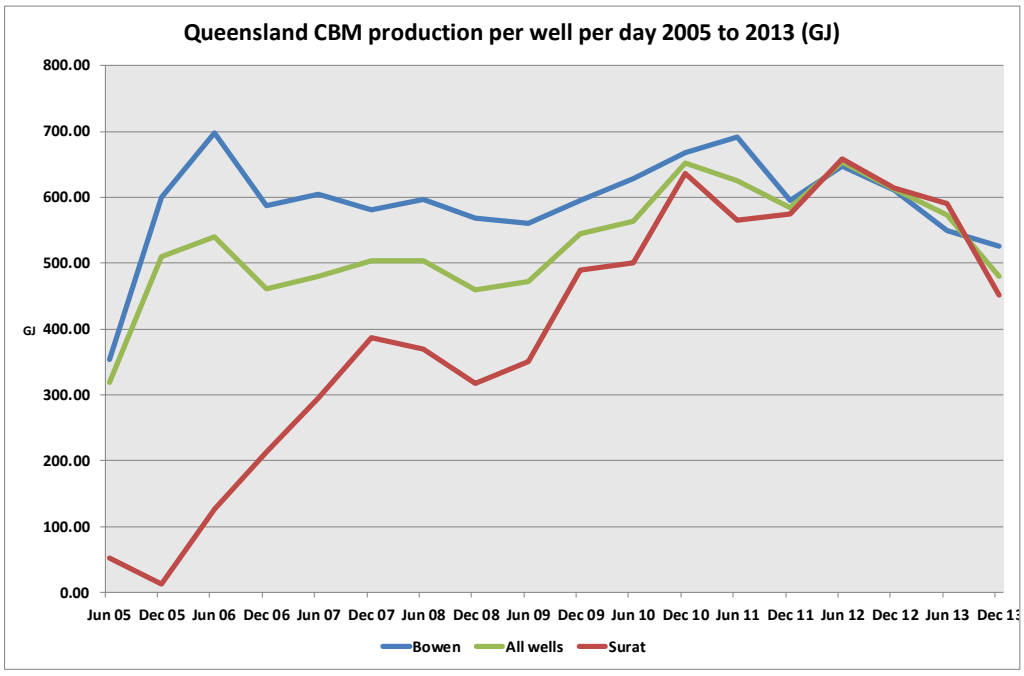
Source: EnergyQuest

Figure 6 Queensland CBM producing wells 2005 to 2013



Source: EnergyQuest, Qld DNRM

Figure 7 Queensland CBM production per well per day 2005 to 2013



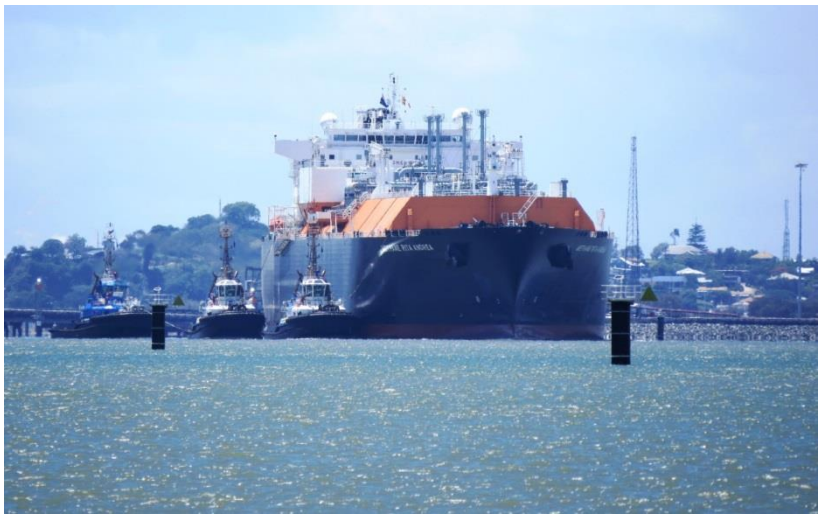
Source: EnergyQuest, Qld DNRM

As at the end of 2013 there were almost 1,600 producing wells, with the Surat Basin having overtaken the Bowen Basin (Figure 6). Average production per well has fallen slightly (Figure 7). This is for two reasons. Some wells have been turned down until LNG production commences (mainly in the Bowen Basin). In the Surat Basin many new wells are being brought on line, at low production rates initially but ramping up.

First LNG 2015

Notwithstanding the challenges and cost increases the Queensland projects are all successfully reaching completion. On 5 January 2015 the BG LNG carrier the Methane Rita Andrea left Gladstone Harbour with the first cargo of LNG from QCLNG (Figure 8). This is the first cargo of LNG from CBM in the world and the first cargo from the Australian east coast. As of mid-March there have been eight cargoes with a total of 530,000 tonnes of LNG.

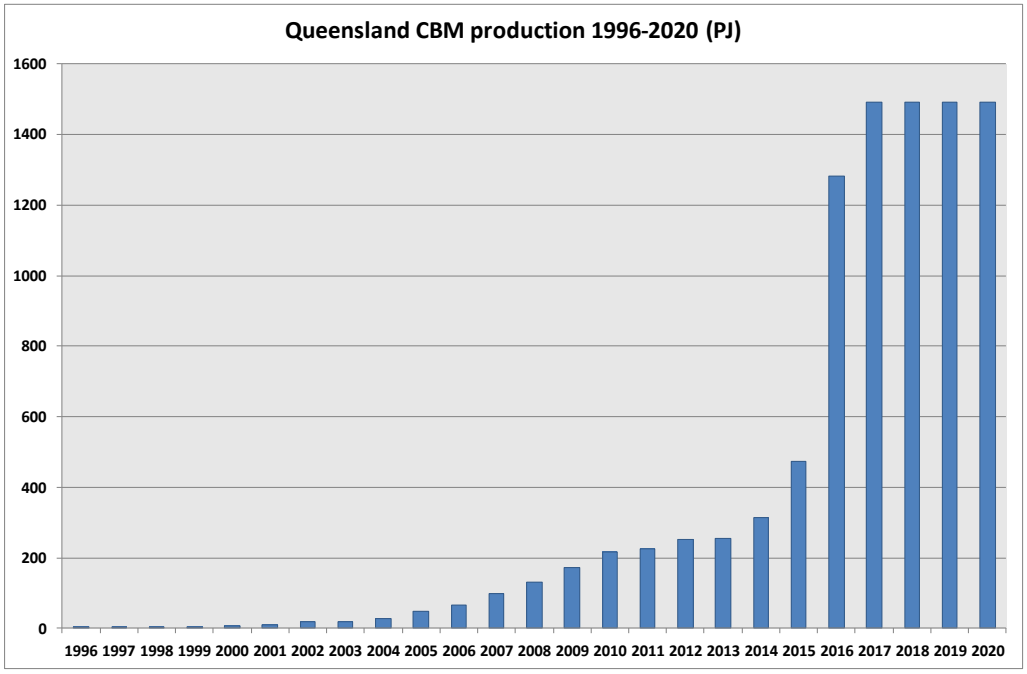
Figure 8 Methane Rita Andrea Gladstone Harbour January 2015



Source: BG

The challenge now is to ramp production up nearly five-fold to fill the six LNG trains and meet the contracts (Figure 9).

Figure 9 Queensland CBM production 1996-2020 (PJ)



Source: EnergyQuest

New South Wales

A detailed review of development (or lack thereof) in NSW is beyond the scope of this paper. However development of CBM in NSW is at a standstill, due to widespread community opposition and resulting restrictive government policies.

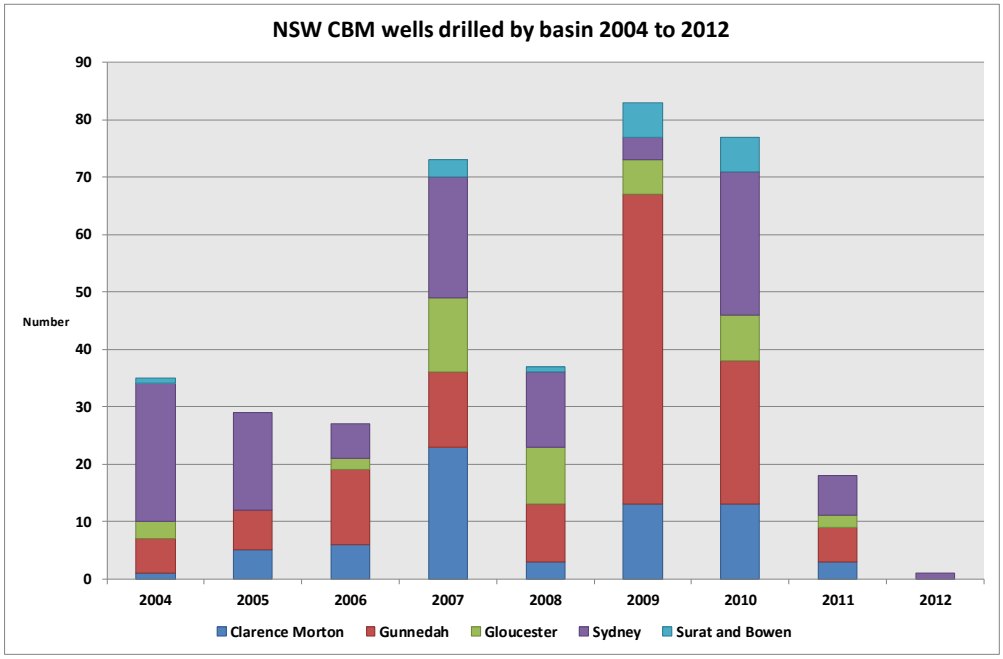
There was a significant level of drilling in NSW in 2007, 2009 and 2010 but there have only been a handful of wells drilled since (Figure 10).

The quality of the NSW CBM resource is not as high as in Queensland but the state has significant CBM reserves and resources, appealing enough for larger companies to take-over juniors.

However, after growing to nearly 3,000 PJ NSW resource base has more than halved, reflecting primarily restrictions on development plus also some resource reassessment (Figure 11).

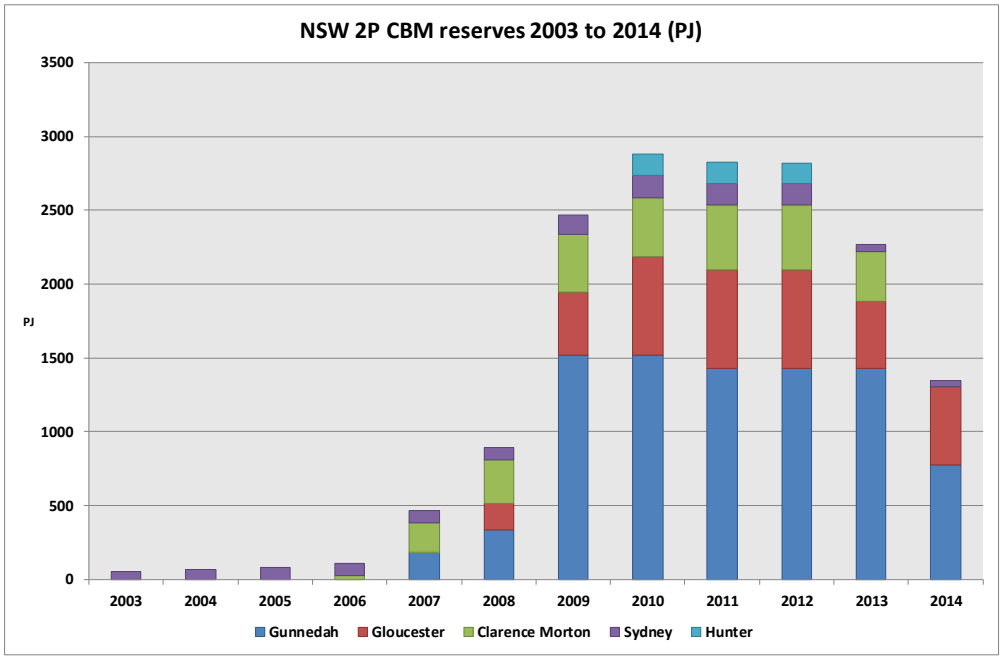
Figure 12 shows NSW production compared with Queensland.

Figure 10 NSW CBM wells drilled by basin 2004 to 2012



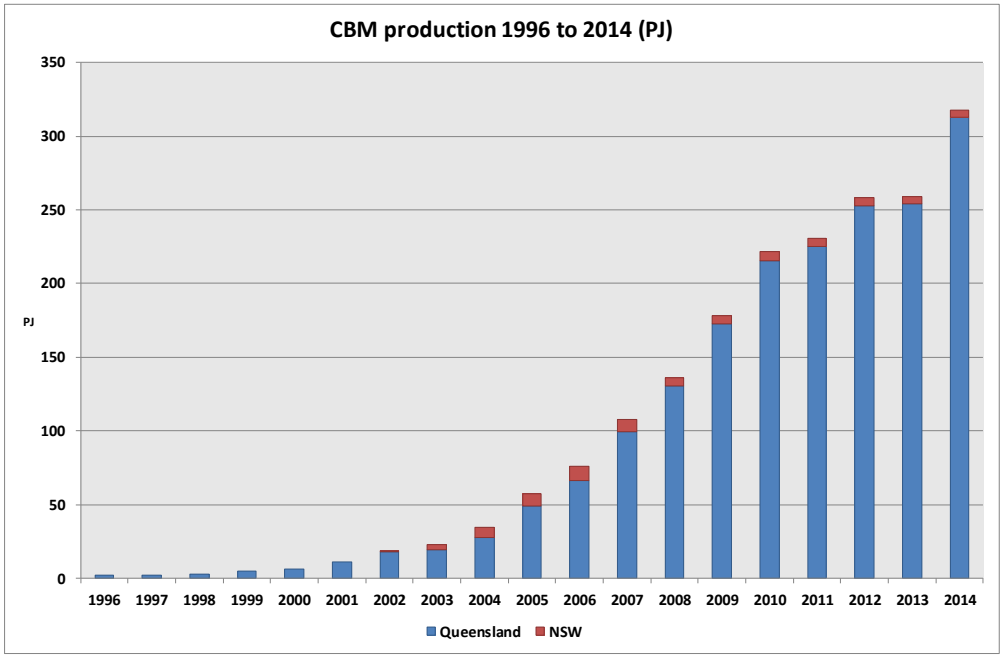
Source: EnergyQuest, NSW Dept of Industry

Figure 11 NSW 2P coal seam gas reserves 2003 to 2014



Source: EnergyQuest

Figure 12 CBM production 1996 to 2014 (PJ)



Source: EnergyQuest

There are a many reasons for the opposition to development in NSW. The industry got off to a bad start with landowners when it first started in the early 2000's. Land-uses are different in some key areas, with vineyards, hobby farms and horse studs and prime agricultural land. Some communities are against development of any kind.

The industry failed to get landholders on-side, particularly farmers, early enough and they were overtaken by anti-gas environmental groups, drawing inspiration from the global anti-gas movement as typified by the 2010 film Gasland.

Unlike the situation in Queensland, CBM development has also lacked decisive government support.

In 2014 the government commissioned an independent report from the state's Chief Scientist on CBM activities in NSW. It concluded that the technical challenges and risks posed by the CBM industry can be managed, with appropriate safeguards. The government accepted the Review's recommendations and released a new gas plan in late 2014 (the third in three years), which includes buying back exploration licences that have already been granted. It remains to be seen whether this new plan leads to any significant development.

Conclusions

With decisive governments, the Queensland CBM industry has proved itself able to successfully surmount major challenges in unconventional gas development. With the benefit of hindsight the Queensland experience provides a number of insights into how development might have been improved but ultimately the projects are being successfully completed. The NSW experience however demonstrates the importance of government leadership. In Queensland the government focussed on how development should occur, not whether it would occur. In NSW the government focus has been on whether or not development should occur, without ever reaching a definitive position favouring development. Without political commitment, development is very difficult.

References

Queensland Competition Authority. (2014). *Coal Seam Gas Review.*

Songhurst, B. (2014). *LNG Plant Cost Escalation. OIES Paper NG83.* Oxford Institute of Energy Studies.