Coal seam gas booms in eastern Australia

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Introduction

A decade ago a significant shortfall in gas supply was forecast in eastern Australia, herein defined as including Queensland, New South Wales, Victoria, Tasmania and South Australia. The rationale for this forecast was that producing conventional gas fields in the Cooper Basin of northeast South Australia and southwest Queensland, which supplied Adelaide, Brisbane and Sydney, had reached maturity, were in decline and would be unable to meet predicted demand. It was anticipated that the shortfall would be met by gas piped from existing fields in Bass Strait and by new production from gas fields discovered in the highlands of Papua New Guinea (PNG), delivered via a pipeline across Torres Strait. In the intervening period, gas for the Sydney market was delivered from Bass Strait. However, the advent of a new coal seam gas (CSG) industry in Queensland eliminated the predicted shortfall and obviated the need for supplies imported from PNG (Baker and Slater 2008). The main eastern Australian sedimentary basins targeted for CSG are shown in Figure 1, together with existing and planned gas transmission pipelines. At the end of 2008, certified 2P (Proven and Probable) reserves of CSG comprised 28 253 pentajoules (PJ) representing 60.2% of the known natural gas reserves in eastern Australia (Baker and Slater in press; Figures 2 and 3). This is a spectacular increase given that estimates of 2P reserves of CSG in the region were less than 5 PJ in 1996 (Figure 4). By December 2008, CSG production had risen from approximately 1 PJ per annum to 167 PJ a year (RLMS 2009). CSG now provides the major source of gas for the Queensland markets, increasing quantities are being piped to South Australia, with supplies to the Newcastle and Sydney market planned. Most importantly for the burgeoning CSG industry, significant exports as liquefied natural gas (LNG) are envisaged from the Central Queensland port of Gladstone. In this paper the history of the CSG industry in the region is reviewed, exploration and production methodology outlined, together with current production and reserves and future envisaged development.

History of the Australian coal seam gas industry

CSG, also known as mine gas, coal bed methane and coal mine methane, is methane that is adsorbed on to coal. It is simply natural gas produced from a non-conventional reservoir. Reduction of pressure causes methane to be released and gassy mines have been the scourge of coal miners since coal mining began. Initial attempts to utilise CSG were small in scale and focused on pre-mining drainage, with the methane produced used to power surface plants. In the USA energy shortages, substantial tax concessions and the proximity to gas distribution pipeline networks fostered the commencement of commercial production in 1982. By 1994 CSG production had become a major industry with production growing exponentially and reaching an annual production of 1800 PJ by 2004 (Davies and Day 2006). In Australia, notwithstanding differences in geology, drilling and completion techniques, pipeline infrastructure, market size and market maturity, the pattern of CSG industry development has been remarkably similar. This is particularly the case when the first five pioneering years of commercial production in the USA and Queensland is compared (Davies and Day 2006).

In Australia, the Bowen and Sydney Basins were the initial targets for CSG exploration, beginning with Houston Oil and Minerals Australia Limited's unsuccessful exploration drilling in the Bowen Basin in 1976. During the 1980s and early 1990s considerable effort and expense was incurred by major companies such as Conoco Australia Pty Ltd, MIM Holdings Ltd and Mitsubishi Gas Chemicals (Australia) Pty Ltd operating in the Bowen Basin; by Enron Corporation in the Galilee Basin; and by Amoco Exploration in the Sydney Basin. Limited exploration of the Clarence-Moreton Basin was also undertaken by Conoco and Seamgas Pty Ltd (a BHP Australia Coal Pty Ltd subsidiary). BHP also endeavoured to produce CSG commercially in both the Bowen and Sydney Basins, though their driver was primarily mine gas drainage to improve mine safety. None of their activities met with success, with several factors, including a poor appreciation of the local and regional geology, effect of stress regimes on coal permeability, inappropriate well completion methods, as well as cost contributing to the failure. This early unsuccessful phase is well documented by Riley (2004).

The first commercial production in Australia was achieved by BHP in February 1996 from within the Moura Mine Leases covering the Late Permian Baralaba Coal Measures of the eastern part of the Bowen Basin. Production averaged 4 terajoules (TJ) per day and was piped to Gladstone. This project is now operated by Anglo Coal (Moura) Ltd. Commercial production in the Sydney Basin began in April 2001, when Sydney Gas Ltd, which had been exploring Permian coals of that Basin since 1998, supplied CSG to the Sydney market.

During the 1990s, Oil Company of Australia (OCA) (now a subsidiary of Origin Energy Ltd) acquired Conoco's interests in the Moura-Dawson Valley area of the eastern Bowen Basin. The Baralaba Coal Measures in this area contain an aggregate of 30 m seams of coal with gas contents of 9–25 m^3/tonne on a dry ash free basis at depths of 300 m to 1000 m. However, permeability is adversely impacted by high compressive stress and mineralisation in cleats and fractures. Conoco's experience had demonstrated that concepts applicable under these conditions in the Black Warrior Basin in the USA were not valid here. OCA's focus on understanding the local geological setting and stress regime together with improvements in drilling and well completion and better cost control resulted in modest success with current estimated production of 5.5 PJ per year (Baker and Slater in press). Factors that reduce and/or destroy permeability in the Moura-Dawson Valley region continue to inhibit CSG production in the Gunnedah and Sydney Basins in New South Wales. The Moura-Dawson Valley operations are now owned by Anglo Coal (Moura) Ltd in joint venture with Mitsui Moura Investments Pty Ltd, with Molopo Australia Ltd holding a 50% interest in some areas.

Western areas of the Bowen Basin have proven to be more favourable for commercial CSG production. In 1989 at Fairview, Tri-Star Petroleum Pty Ltd identified the potential of the

Fig. 1. *Eastern Australian sedimentary basins showing gas transmission pipelines (after Baker and Slater 2008, fig. 1).*

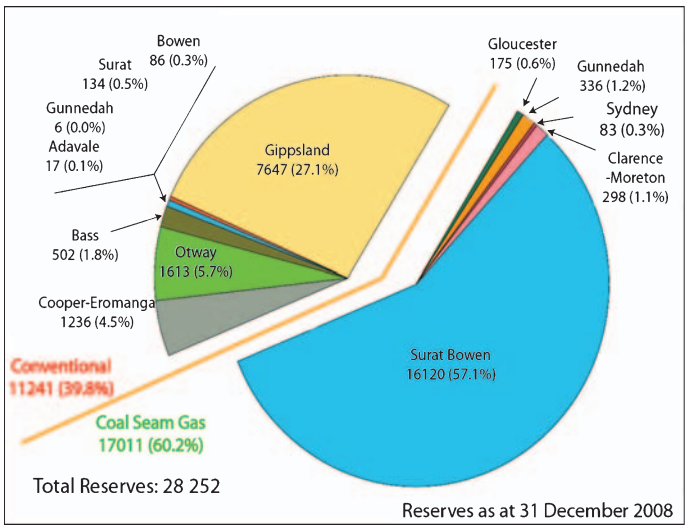

Fig. 2. *Eastern Australian gas reserves by sedimentary basin (source RLMS 2009).*

Comet Ridge which is characterised by low structural stress. At Fairview, the Bandanna Formation (a correlative of the Baralaba Coal Measures) has 5 m to 11 m of coal with high gas content (10–15 m^3 per tonne) at depths ranging from 500 m to 800 m and permeabilities exceeding 50 millidarcies. Production of the first sales gas occurred in 1996 when an estimated 1 PJ was produced that year. Fairview CSG Field has large reserves and is now jointly owned by Origin Energy Ltd (23.93%), Santos Ltd (36.07%) and PETRONAS (Petroliam Nasional Berhad) of Malaysia. The field was producing at an annualised rate of just over 26 PJ in 2008. Spring Gully Gas Field is a similarly large field that occupies the southern portion of the

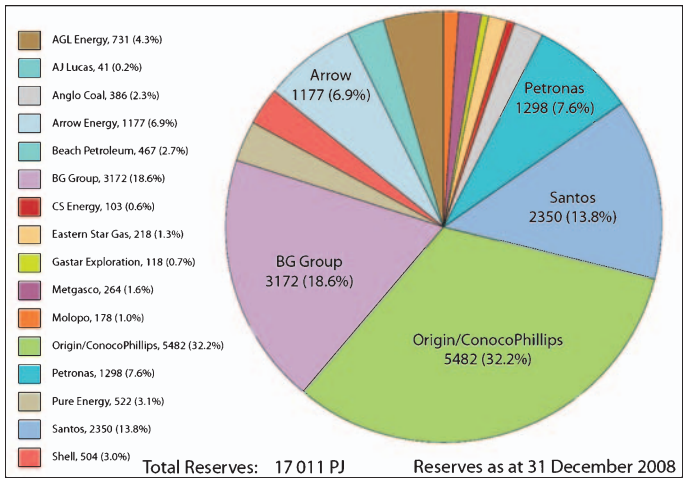

Fig. 3. *Eastern Australian coal seam gas reserves by company (source RLMS 2009).*

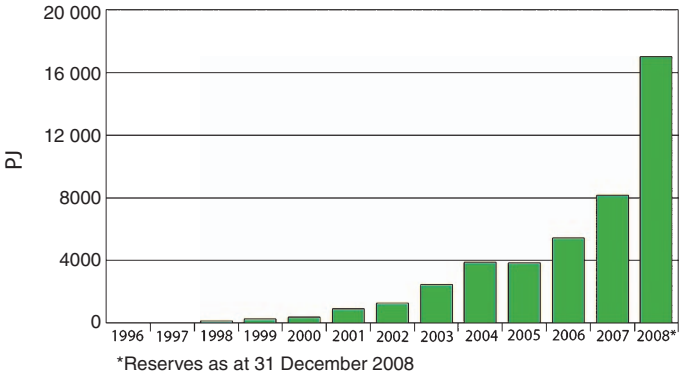

Fig. 4. *Coal seam gas reserves at 31 December 2008 (source RLMS 2009).*

Comet Ridge Anticline and shares the geological setting of Fairview. Origin is the operator and production from the field began in June 2005. To the east, coals of the Baralaba Coal Measures of Burunga Anticline are highly fractured and display good permeability. The Burunga Anticline hosts two large fields. Scotia in the north is owned by Santos and began production in May 2002. Peat CSG Field, to the south of Scotia, is operated by Origin and commenced delivering CSG to markets in February 2001.

In the northern Bowen Basin, the Late Permian Rangal Coal Measures (a correlative of the Baralaba Coal Measures and the Bandanna Formation) and the older Moranbah Coal Measures, German Creek Formation, Collinsville Coal Measures and more recently, the Fort Cooper Coal Measures have been explored for CSG. The main target has been the Moranbah Coal Measures which have 2 to 4 m seams with a net aggregate average thickness of 15 m of coal and good gas content at shallow depths around 300 m, although permeability is low to moderate. Initial exploration undertaken by North Queensland Energy Pty Ltd at Broadmeadow in the 1980s was unsuccessful, mainly due to low permeability. Like the eastern part of the Bowen Basin further south, the northern region is characterised by high stress and compressional faulting. Success was achieved at Moranbah by a joint venture comprising BHP Coal Pty Ltd and CH_4 Ltd, which adopted an innovative combination of in-seam horizontal and vertical drilling. Production began in 2005 with delivery

to customers in Townsville via a 373 km pipeline built by the Queensland Government owned corporation Enertrade. The Moranbah project is now owned by AGL Energy Ltd and Arrow Energy Ltd, each with a 50% interest and the pipeline by the Victorian Funds Management Corporation.

The focus of the early CSG exploration in Eastern Australia was on the higher rank thermal and coking Permian coals of the Bowen and Sydney Basins which exhibited good gas contents. In this, companies were following the USA experience and insufficient attention was given to factors that impacted permeability, local geology, drilling methods and costs. However, by 2000 the local industry had addressed earlier shortcomings in their exploration strategy and methodology and significant CSG production was firmly established in the Bowen Basin. Attention then turned to the Middle Jurassic Walloon Coal Measures of the Surat Basin. Demonstrated success in CSG development in the Bowen Basin was partially responsible, but the major reason was the success of CSG production from low rank coals of the Powder River Basin in the USA, with the projected shortfall in supplies of gas for eastern Australia also a factor contributing to the initiation of CSG exploration in the Surat Basin. The first CSG well in the Surat Basin was drilled in 1995 (Day *et al.* 2006), but further exploration did not occur until 2000 when Origin Energy Ltd and two new public companies, Arrow Energy NL and Queensland Gas Company Ltd (QGC) took up permits. Success was achieved rapidly. CSG productive coals were found to have adequate gas contents ranging from 5 to 10 m^3 per tonne, at shallow depths (150 m to 600 m) and occurred in multiple seams aggregating up to 20 m in thickness (Day *et al.* 2006). Arrow Energy's Kogan North Field achieved the first commercial CSG production in January 2006, followed soon after by QGC's Berwyndale South Field, which delivered its first sales gas in May 2006 (Baker and Slater 2008). Exploration of the Surat Basin outlined a fairway favourable for CSG production from the Walloon Coal Measures. The fairway was defined by depth and gas content and extended from northwest of Roma in the west to south of Dalby (Day *et al.* 2006). Numerous CSG fields have been discovered within this fairway by Arrow Energy Ltd, Origin Energy Ltd, Santos Ltd, Bow Energy Ltd, and the companies recently acquired by the BG Group plc through its wholly owned subsidiary BG International (AUS) Pty Ltd (QGC Ltd, Sunshine Gas Ltd and Pure Energy Resources Ltd).

In the USA, the CSG industry in its formative years was reliant on substantial tax concessions. A similar, though more modest, assistance to the local CSG industry flowed from a Queensland Government greenhouse gas reduction strategy, which mandated that 13% of electricity sold in the State be generated by gas rather than coal (Queensland Government 2000). The policy led to new opportunities for gas sales in the dominantly coal-fired electricity generation sector. In southeast Queensland, CS Energy, a government owned generating corporation, entered into long-term contracts to buy CSG and assisted in funding the development of some CSG fields in the Surat Basin. In North Queensland, Enertrade, built the 393 km pipeline that enabled the Moranbah Project to deliver gas as a substitute fuel for diesel in power stations in Townsville. Without the stimulus provided by the Queensland Government policy, the projected shortfall in gas supply in eastern Australia would have been insufficient to give birth to a new industry. Other factors also contributed to the acceptance of CSG and its remarkably rapid growth in Queensland. These include the large size of the coal resources of the Bowen and Surat Basins, the optimum depth and gas content of the coal seams, and their proximity to existing natural gas pipelines. In addition to these attributes, the State's strong economic growth with its attendant energy demands resulted in the construction of a number of gas fueled peak-load power stations which were able to benefit from the curtailment of electricity generation by large coal-fired power stations reliant on water cooling, resulting from the prolonged drought in eastern Australia (Baker and Slater in press).

Exploration methodology

Draper and Boreham (2006) have documented the six geological controls that determine the suitability of Queensland Bowen and Surat Basin coals for CSG production. The key factors are:

- depositional environment,
- tectonic and structural setting,
- rank and gas generation,
- gas content,
- permeability, and
- hydrogeology.

These parameters vary reflecting the coals varied geological histories. Permian coal seams in the Bowen Basin are higher in rank, more laterally continuous and have greater gas contents than Jurassic coals of the Surat and Clarence-Moreton Basins. In the former, rank varies from vitrinite reflectance of 0.55% to above 1.1% Rv and from 0.35% to 0.6% Rv in the latter. CSG productive coals have high vitrinite contents usually exceeding 60% and are well cleated.

Exploration for CSG involves a combination of the methodologies of coal and petroleum exploration and in the Surat Basin, ground water production. As in all successful exploration, diligent preparation of a data base compiled from previous investigations is an essential prerequisite. Open-file results of previous exploration now available online are the starting point. Regional geological and geophysical studies, especially closely spaced airborne magnetic data, provide a good guide to structural and inferred stress regimes and faulting. Existing seismic survey data from petroleum exploration is invaluable, but specially commissioned seismic surveys for CSG are not a first option, because of cost in relation to the low prices received for gas. Compilation of a data base of relevant information from previous coal, petroleum and groundwater drilling is an important prerequisite.

Exploration drilling is the preferred initial stage because of the shallow depths of the targets involved. Anticlinal features or plunging noses are favourable sites for initial drilling as these are most likely areas of tensional stress, fracturing and attendant enhanced permeability. Seismic and magnetic data may prove useful in identifying pressure shadows associated with faulting. Drilling procedures are those adopted in coal exploration and indeed, the same slim-hole rigs are frequently used. If necessary, chip holes are drilled first to establish the presence, approximate thickness and extent of target coals, with core holes spaced as required to obtain coal cores for determination of coal properties, as is the case in coal exploration. To minimise formation damage, drilling of coal bearing sequences with air or water is preferred. Coals intersected are frequently drill stem tested to determine water production potential and estimate

permeability. Flow injection tests may also be made to gauge permeability. A simple suite of wireline logs is run, including gamma ray and electric logs, although a wider range of logs such as acoustic scanning logs, which indicate fractures and stress, may be utilised. Selected coals intersected during coring are placed in sealed canisters on retrieval and their gas content and desorption rates recorded.

Once coal thickness, areal extent and gas content are ascertained, a volumetric calculation of estimated gas resource in place is possible. CSG pilot projects with 3 to 30 wells are necessary to evaluate the most prospective locations. These allow establishment of the feasibility of production, well spacing, appropriate well completion procedures, what measures may be needed to stimulate gas production and to obtain data for independent reserve certification. Vertical wells provide the cheapest option. Pilot and production wells are spaced 0.5 km to 1 km apart, are cased to just above the coal bearing production zone, and the well bore usually enlarged by under-reaming, before perforated or slotted production casing and down-hole pumping equipment are installed. Fracture stimulation or cavitation may be undertaken in areas of low permeability. An innovative combination of horizontal in-seam wells intersecting a vertical well was developed in the Moranbah Project (Matthew and Hogarth 2003) and is likely to have wider application elsewhere in regions with gassy but tight coals as in the Gunnedah, Sydney and Clarence-Moreton Basins.

CSG has more than 95% methane and requires little processing other than removal of minor inert gases (mainly carbon dioxide) and water. Isotopic studies show that CSG can have biogenic, thermogenic or metamorphic sources (Draper and Boreham 2006). In some cases, as in the Sydney Basin, CSG contains contributions from all three sources (Pinetown *et al.* 2008). Metamorphic methane is generated during coal formation. Biogenic gas is formed by methanogenic bacteria and occurs at depths down to 1 km. In the Surat Basin biogenic processes have enriched the gas content of coals in the Jurassic Walloon Coal Measures. Thermogenic gas is derived from volcanic activity and is prevalent in parts of the Sydney Basin.

Methane adsorbed onto coal requires a reduction in pressure to allow gas to flow. Gas production is achieved by pumping

Fig. 5. *Aerial view of Tipton West CSG Field showing dam for by-product water and compressors (Arrow Energy photo).*

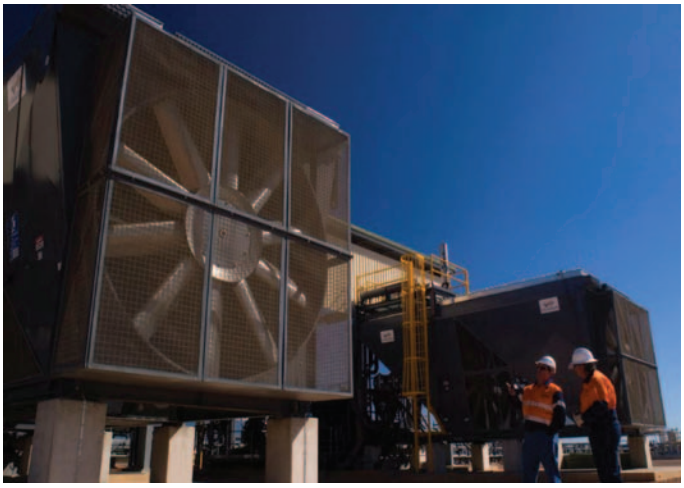

Fig. 6. *Compressors at Tipton West CSG Field (Arrow Energy photo).*

Fig. 7. *Well head at Tipton West CSG Field in sorghum field.*

water contained in the coal seams, although free gas in cleats and fractures is not uncommon. Some CSG fields produce little water while the Permian Scotia Field has no water production. In the Surat Basin, the coals act as aquifers and water production is substantial. CSG pilot wells need to achieve a certain level of gas production to be considered commercial and to enable reserve certification. By-product water must be contained in purpose built dams (Figure 5) as its salt content is too high for discharge into streams. Disposal of by-product water has become a significant issue (Baker and Slater in press). CSG is produced at low pressures and large compressors (see Figure 6) are needed to bring the gas to pressures needed for pipeline transmission. All gas and water production gathering lines are buried and the well heads have a minor 'footprint' (Figure 7). Untreated by-product water is brackish and has been used in coal-washery plants and some cattle feedlots and a range of aquaculture studies have been conducted (Day *et al.* 2006). Potable water can be produced by reverse osmosis and may be used for irrigation and to supplement town water supplies. In Queensland, by-product water production, storage and disposal is tightly regulated by the Environmental Protection Authority (Queensland Government 2008). Water production reaches a peak and declines as gas production increases, so the water resource has a finite life

estimated to be 10–20 years. Additional production wells must be drilled to maintain gas production throughout the life of the field and this will prolong water production.

Current activities

Queensland is the centre of current CSG activities as existing fields expand and new projects are brought into production. At the end of 2008 the State was providing over 95% of the CSG output in eastern Australia (Baker and Slater in press). The major producing fields in the Bowen Basin are Moranbah, Fairview, Spring Gully, Peat, Scotia and the Dawson Valley near Moura. In the Surat Basin, Berwyndale South, Argyle-Kenya, Kogan North, Daandine and Tipton West are in production, while the Camden area is the producer in the Sydney Basin.

Moranbah CSG Project is a 50/50 joint venture between Arrow Energy Ltd and AGL Energy Ltd and is operated by Arrow Energy. Gas production began in February 2005 and currently stands at approximately 16.8 PJ per year from the Moranbah Coal Measures. Gas is piped to Townsville where it is used in power generation and by nickel and copper refineries. AGL also uses CSG in a small power station at Moranbah. Local gas consumption will rise when the Incitec Pivot ammonium nitrate plant is built there. Arrow Energy is actively exploring Permian coal measures in this northern region of the Bowen Basin in addition to those of the Moranbah Coal Measures. Present 2P reserves of 947 PJ of the Moranbah Project will increase significantly as a result. Arrow's future reserves will largely be dedicated to their Gladstone LNG project. A pipeline 450 km in length is planned to carry gas from Moranbah to Gladstone.

In the Dawson Valley where production from the Baralaba Coal Measures first began in 1996, the Anglo Coal/Mitsui Moura Investments/Molopo operations supply gas to the ammonia/ammonium nitrate plant of Queensland Nitrates Pty Ltd and to markets in Gladstone. Present 2P reserves are reported to be 386 PJ.

On the Comet Ridge, the Fairview CSG Field now operated by Santos Ltd on behalf of Origin Energy Ltd and PETRONAS began production in 1996. The Field now produces from the Bandanna Formation at an annual rate of almost 27 PJ (Baker and Slater in press). Fairview is linked to the Wallumbilla to Gladstone pipeline and separately to Wallumbilla. CSG production to date is mainly used in electricity generation. Production will increase substantially as new processing capacity is installed. Reserves are large but have not been reported separately by the operator. Fairview is likely to be a key CSG supplier to the proposed Santos-PETRONAS LNG plant in Gladstone. By-product water from these two fields is treated by reverse osmosis.

Further south on the Comet Ridge, the Spring Gully CSG Field, which is operated by Origin Energy, began production in 2005 and by 2008 production had reached 39 PJ per year. The field is undergoing expansion and production will increase substantially in future. CSG from Spring Gully is piped to Wallumbilla where the gas can be shipped eastwards to Brisbane or Gladstone or via southwest Queensland to Mount Isa and South Australia. A gas-fired power station is also planned at Spring Gully. As at Fairview, reserves are large but have not been reported separately. Conoco-Phillips has acquired a 50% interest in this and other Origin Energy CSG projects and an LNG export project in Gladstone is planned.

Origin Energy also has the Peat CSG Field on the Burunga Anticline which commenced production in 2001 from the Baralaba Coal Measures. Wells at Peat and Scotia CSG Field on the northern part of the Anticline produce little or no water. Current production is at the rate of 5.5 PJ per year and 2P reserves are estimated to be 38 PJ (RLMS 2009). A lateral line links Peat and the Scotia CSG Field to Wallumbilla to Brisbane pipeline. Gas-fired power stations provide the main market for their production.

CSG has been produced from the Middle Jurassic Coal Measures of the Surat Basin since 2006. The most productive fields are associated with the Undulla Nose where Origin Energy and the BG Group (which bought QGC) have interests. QGC's Berwyndale South Field, with daily production at the rate of 70 TJ per day is the most productive in the Surat Basin. This field supplies gas to the Swanbank Power Station near Brisbane and the Braemar Power Station near Dalby. At 30 June 2007 2P reserves stood at 385 PJ; they have since been upgraded but not reported separately. The Argyle-Kenya CSG Field discovered and developed by QGC, is now jointly owned by Origin Energy and the BG Group. As with Berwyndale South, upgraded 2P reserves have not been reported separately, but were 831 PJ (RLMS 2009). Gas from this field is contracted to supply the Incitec Pivot ammonia plant in Brisbane. Other QGC fields, Bellevue, Lauren and Codie near Berwyndale South are in the development stage. Additional exploration and appraisal work will be undertaken in connection with BG's planned LNG export facility in Gladstone.

Arrow Energy has three CSG fields in production – Kogan North, Daandine and Tipton West – with all production dedicated to electricity production. Kogan North is a 50/50 joint venture with the government owned corporation CS Energy, while the Shell Group has a 30% interest in all of Arrow's projects through the Shell–Arrow alliance. At 31 December 2008, Daandine, Kogan North and Tipton West have 2P reserves of 148 PJ, 84 PJ and 565 PJ respectively (RLMS 2009). Arrow has several additional projects in development, including Dundee, Stratheden, Longswamp and Meenawarra.

Elsewhere within the 'Walloon Fairway', more development will occur as projects are undertaken by Santos (Coxen Creek), Origin (Talinga) and the BG Group through their takeovers of Sunshine Gas Ltd (Lacerta and Polaris) and Pure Energy Resources Ltd (Cameron).

Other sedimentary basins in Queensland have attracted CSG exploration. They include the Permian-Triassic Galilee Basin, the Mesozoic Eromanga, Ipswich, Clarence-Moreton, Maryborough, Styx and the coastal Tertiary Coastal Basins. None have achieved commercial success to date.

In New South Wales, the Gloucester, Gunnedah, Sydney and Clarence-Moreton Basins are being actively explored for CSG. Commercial production has only been achieved in the Sydney Basin although there are projects with certified reserves in the remaining basins. In Victoria, results of CSG exploration have been disappointing, while in Tasmania, coals with promising permeability have so far had gas contents deemed insufficient for pilot production. In South Australia, coals of the Arckaringa Basin are being investigated for their underground coal gasification potential.

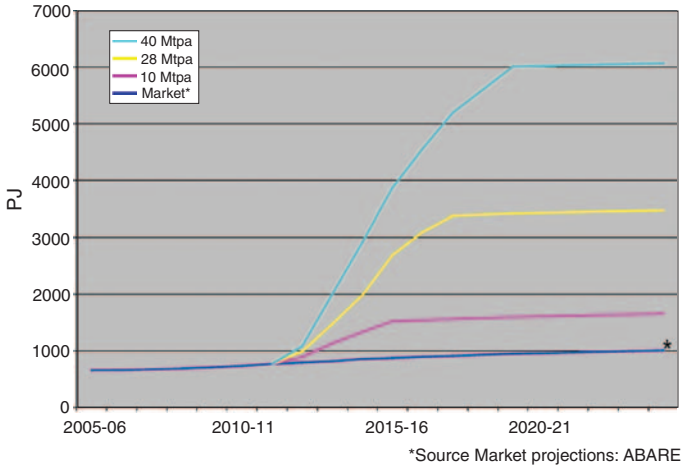

Fig. 8 *Forecast CSG growth projections to service a LNG industry (source RLMS 2009).*

Production and reserves

CSG production in eastern Australia began 13 years ago and has increased rapidly since 2000, with production doubling in 2008 (Figure 8). The eastern Australian market for gas at the end of 2008 is estimated to be 670 PJ per year (RLMS 2009) with CSG accounting for about 25% of gas sold in this market. In eastern Queensland, production is estimated at 164 PJ per year, with an additional 27 PJ piped to the Mount Isa region from the southwest of the State (RLMS 2009). Estimated daily CSG production from all Queensland fields during 2008 is 443 TJ, with 15 TJ per day produced by the Camden Project southwest of Sydney (RLMS 2009).

Figure 2 shows the size and distribution of independently audited proven (1P) and probable reserves (2P). These totaled 28 251 PJ at 31 December 2008, with CSG comprising 17 011 PJ or 60.2% of that total (RLMS 2009). Currently reported reserves of individual CSG fields have been presented previously. Five groups, Origin/Conoco Phillips, Santos/Petronas, Arrow/Shell and the BG Group held over 80% of the certified 2P reserves (Figure 3) at the end of 2008. Since that date further industry consolidation has seen Pure Energy Resources Ltd acquired by the BG Group and Beach Petroleum Ltd's interests bought by Arrow Energy. RLMS (2009) estimates that 2P reserves will exceed 25 000 PJ by the end of 2010 as 3P (proven, probable and possible) now estimated at 40 490 PJ, are converted to 2P. Four groups, Origin/Conoco Phillips, Santos/Petronas, Arrow/LNG/Shell and the BG Group through their wholly owned subsidiary QGC LNG Pty Ltd have proposals to produce LNG for export via the Central Queensland port of Gladstone. All of these may not proceed in their current form for a variety of reasons. Already LNG projects proposed by Sunshine Gas and Sojiitz and the Impel LNG are uncertain. However, drilling and development activities undertaken in connection with LNG projects will substantially increase CSG reserves.

Future developments

The pace of CSG development is accelerating and in the next year new Queensland production is anticipated from the Bellevue, Coxen Creek, Lacerta, Stratheden and Talinga CSG fields in the Surat Basin. In New South Wales, the Casino project in the Clarence-Moreton Basin and the Narrabri project in the Gunnedah Basin could be in production. New pipelines are planned to link Wallumbilla with Newcastle and Casino to Brisbane, thereby opening greater opportunities for CSG development in New South Wales.

Recognition of the size of the CSG resources in Queensland has attracted the attention of major international oil and gas industry companies such as Conoco Phillips, PETRONAS and Shell as well as the BG Group. Prior to that local companies were examining the feasibility of LNG production with a view to obtaining prices for gas that were more aligned to the prevailing world oil price. The price of gas used for electric generation is low by world standards as CSG in eastern Australia is in competition with coal as a fuel source and only gained market entry as a result of the introduction of greenhouse gas reduction initiatives in Queensland.

Proposals for export of LNG have gained momentum with the entry of the major companies mentioned above. CSG has not been utilised on such a scale and significant challenges lie ahead. Approximately 65 PJ of raw CSG has to be produced to provide 1 million tones of LNG for export (Baker and Slater in press). The smallest proposal, that of the Arrow led group, envisages an LNG plant at Gladstone producing 1.5 million (MM) tonnes per year. Origin-Phillips, Santos-PETRONAS and the BG Group all plan separate, larger, notional 3.5 million tonne per year processing trains in Gladstone. Baker and Slater (in press) estimate that LNG production of 40 MM tonnes per year would require the drilling of about 20 000 wells per year over a 20 year period. Not all LNG projects will proceed as planned for commercial and logistic reasons. Also governmental approval and environmental requirements will have to be addressed. Notwithstanding these issues, the CSG industry stands to grow enormously in the coming few years.

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The author has been an active participant in the development of the CSG industry. He became a Director of Arrow Energy NL in 1998 soon after the formation of that company and saw it move from fledgling explorer to significant player in the industry. In 2006 he resigned from Arrow and became Chairman of Pure Energy Resources Ltd until this company's success led to its acquisition by the BG group in March 2009.

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