September 2008

Queensland coal seam gas

Introduction

Coal seam gas (CSG) has developed rapidly in Queensland over the last decade, emerging as a flexible, clean and competitive source of energy in an expanding economy seeking lower emission fuels. It has become a key component of eastern Australia's energy supply, growing steadily at around 3.8% p.a., and at 5.3% p.a. in Queensland. Increasing demand for power generation from gas will support further growth in CSG. Coal seam gas is the current major focus for gas exploration in eastern Queensland.

Most of Australia's coal seam gas is in Queensland and New South Wales; much of it adjacent to existing major gas pipelines. This helps make coal seam gas attractive to power station operators, large industrial users and gas retailers.

CSG is just another source of natural gas that can be used like the gas from conventional gas wells to power water heaters, stoves and space heaters in both domestic and business settings. CSG can be used as a direct source of power for industry and as a fuel for electricity generation.

- Electricity generation from coal seam gas produces 50 per cent lower greenhouse gas emissions than conventional coal-fired electricity.
- Once coal seam gas is in a gas pipeline it is indistinguishable from conventional natural gas.
- Queensland's proved and probable (2P) coal seam gas reserves as at 31 December 2007 were 7,050 petajoules (PJ). *One PJ is the heat energy content of about 43,000 tonnes of black coal or 29 million litres of petrol.*
- In 2006, coal seam gas overtook conventional gas as the major source of gas for the Queensland market.
- Under the State's *ClimateSmart 2050* policy, Queensland's 13% Gas Scheme will increase to 18% by 2020. This will lead to increased gas-fired power generation and development of coal seam gas projects.
- It is likely that Queensland could be using as much as 320 PJ per annum (pa) of gas by the middle of the next decade and exporting a further 200 PJ pa of gas interstate.
- Proposed liquefied natural gas (LNG) exports have the potential to add in excess of 500 PJ a year to Queensland's production by 2015.

Gas Markets

The Queensland Government's 13% Gas Scheme, introduced under the Cleaner Energy Strategy 2000, has provided increased impetus for the Queensland gas market and coal seam gas industry.

It required Queensland electricity retailers and large electricity users to source at least 13 per cent of their electricity from gas-fired generators by 2005.

The 13% Gas Scheme was designed to diversify the state's energy mix towards a greater use of gas. It will encourage the development of new gas sources and infrastructure in Queensland, boost regional economic development and reduce greenhouse gas emissions from Queensland's electricity sector.

The scheme – the only one of its kind in Australia – has driven a $1 billion investment in the development of Queensland's CSG industry, creating at least 600 jobs.

Queensland's CSG industry will build this investment by an estimated $160 million a year to meet committed demand.

Typical coal seam gas production well. *Photo courtesy of Arrow Energy Limited*

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It has delivered increased royalty revenue to the state and seeded two significant listed companies, with an estimated combined market capitalisation exceeding $3.7 billion.

The 13% Gas Scheme has also created the economic and policy incentive for $1.2 billion in gas-fired power station investment – growing Queensland's gas-fired generation portfolio from 900 megawatts (MW) to more than 2000 MW since 2000.

Recognising its success, the Queensland Government will raise the scheme's target to 15 per cent by 2010 as part of its *ClimateSmart 2050* Strategy, to stimulate additional lower-emission generation for Queensland.

With greenhouse gas emissions 50 per cent lower than conventional coal-fired electricity production, gas-fired generation has reduced greenhouse gas emissions by 4.3 million tonnes (compared with conventional coal-fired power stations), the same impact as planting 17 million trees.

Electricity Generation

Accredited gas-fired power stations earn tradeable gas electricity certificates (GECs) for each megawatt hour (MWh) of electricity produced.

Electricity retailers and large consumers purchase and surrender GECs equivalent to 13 per cent of the electricity they have sold or used each year to the Regulator (the Department of Mines and Energy).

The value of GECs produced provides an incentive for developers of gas-fired generation. Since 2005, the GEC price has averaged $16. When added to the value of the electricity the GEC represents, this creates an opportunity for gas-fired generators to compete with coal-fired electricity sources.

Since trading began, Queensland's gas-fired generators have shared in approximately $158 million worth of Gas Electricity Certificate (GEC) sales – making low-emission gas-fired generation a more economically viable option for energy industry participants.

Formation of gas resource

Coal seam gas is formed as organic material is transformed into coal by biogenic and thermogenic processes.

Once generated, methane is held in the coal by the overlying rocks acting as a seal and hydrostatic (water) pressure. Because of numerous residual pore spaces from the original organic structures and natural fractures called cleats, coal has a large internal surface area. Coal is therefore capable of potentially holding larger volumes of gas than conventional gas reservoirs.

The amount of gas present is dependent on a number of interrelated features including depth, duration of burial, chemistry of the original plant material, effectiveness of the seal provided by the surrounding rock, seam thickness and its extent.

History

CSG is predominantly methane (chemical formula CH_4) with lesser amounts of carbon dioxide and other trace gases. It is also known as coal bed methane. Coal seam gas is the current major focus for gas exploration in eastern Queensland.

The association between methane and coal seams has long been known from coal mining activities where it is also known as 'firedamp' due to its highly combustive nature. Methane fires and explosions in underground coal mines are still a major concern for miners.

Coal miners have traditionally extracted methane from coal seams for safety reasons. This gas is also referred to as coal mine methane. Modern miners seek to minimise the amount of methane being vented as it is identified as a significant greenhouse gas. More recently, the petroleum industry has developed the techniques to enable the commercial extraction of coal seam gas.

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Queensland coal seam gas operations

Specific exploration for coal seam gas in Queensland did not begin until the mid 1970s.

The first petroleum lease for the production of coal seam gas was granted over the Fairview Field, east of Injune, within the Bowen Basin in 1995. This was followed by the Dawson River field south of Moura, also in the Bowen Basin, in 1996.

The first commercial production commenced in 1996 from the Dawson River field south of Moura when gas flowed into the Wallumbilla–Gladstone pipeline. In the same year gas was also marketed from the Moura coal mine.

Production testing of Surat Basin gas started around 2004 and commercial coal seam gas production commenced in early 2006 from the Kogan North field to supply the Swanbank E gas-fired power station.

Properties and uses

Coal seam gas is predominantly composed of the simple hydrocarbon methane (CH_4), a single carbon atom linked with four hydrogen atoms. Methane is a colourless and odourless gas at standard temperature and pressure. Methane is not toxic but is extremely flammable and may form an explosive mixture with air. Odorants are often added to the gas when it is used commercially to help enable the early detection of leaks.

Methane is also the major constituent of gas produced from conventional petroleum wells.

The burning of methane in the presence of oxygen produces heat, carbon dioxide and water.

$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ + heat

Because of methane's relative abundance and clean burning nature, it is an attractive fuel.

As a gas, methane is relatively bulky, making it more difficult to transport economically than liquid or solid fuels. Gas in Queensland is generally transported via pipelines.

There is an increasing trend towards the use of methane in the generation of electricity. Methane is also used in the production of fertiliser and can be used as a source of gas for liquefied natural gas (LNG).

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Exploration and production

The decline in conventional gas production accompanied by growing gas demand for electricity generation and industrial development are driving exploration to find additional sources of gas.

Although proximity to existing infrastructure had been important in early coal seam gas exploration, the growing maturity of the industry has seen explorers work in increasingly remote locations.

Queensland has excellent prospects for coal seam gas discoveries because of favourable geology with extensive coal measures that provide numerous exploration targets.

The Bowen Basin's Permian-aged coal measures were the initial exploration target for the coal seam gas industry.

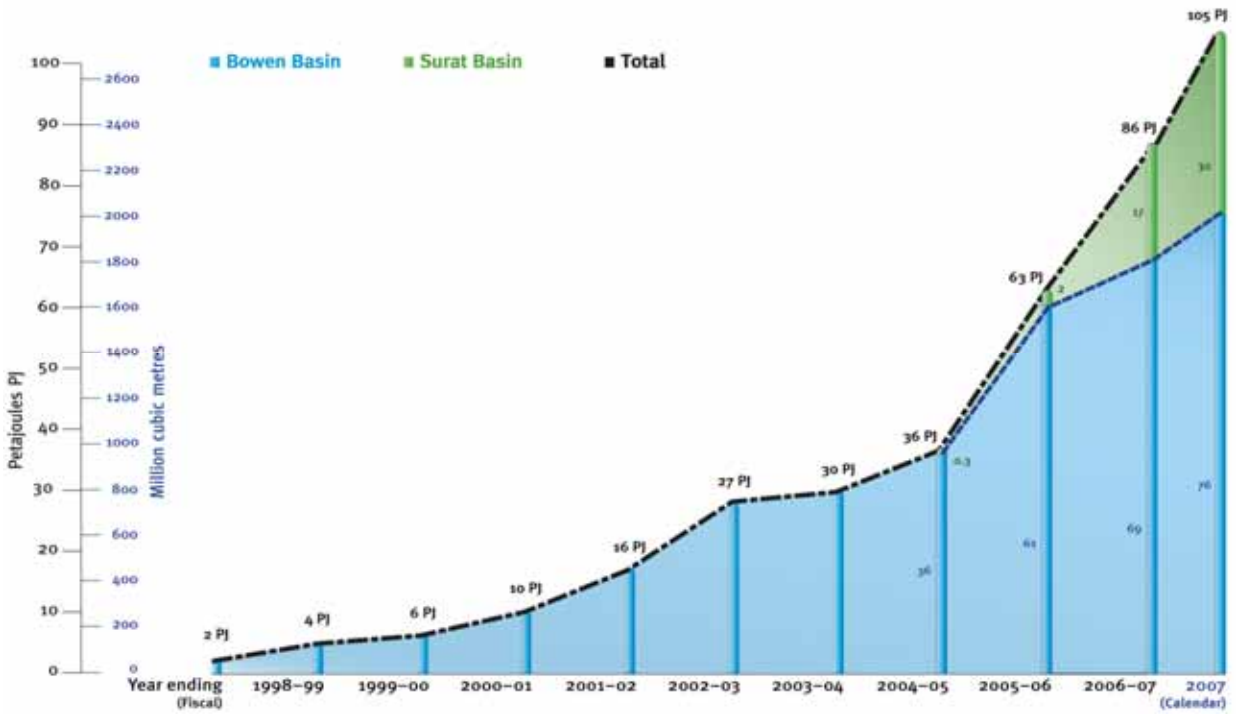
Successful exploration and development has resulted in a large portion of the commercial coal seam gas production in Queensland being sourced from these coal measures at Moranbah, Moura, Fairview, Spring Gully, Peat and Scotia coal seam gas areas.

The Surat Basin in south-east Queensland is currently the focus of a major exploration effort.

Although these coals were not buried as deeply as those in the Bowen Basin and thus have lower gas contents, the proximity to infrastructure and markets, and lower drilling costs, has made these deposits attractive.

Production of coal seam gas can generally be summarised by the following stages:

- Drilling wells into a coal seam
- Pumping out water from the seam to reduce hydrostatic pressure
- Extraction of the methane, released by the reduction of hydrostatic pressure, to the surface.



Queensland coal seam gas production

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The significant volumes of water extracted must be handled in an environmentally sound manner. The quality of the water produced can vary from suitable for drinking (potable) to saline.

Evaporation, re-injection into other aquifers, flowage into natural drainage or local use has been applied to water disposal, depending on local circumstances and appropriate environmental authorities.

When water is removed from a coal seam the hydrostatic pressure holding methane in pore spaces and cleats is reduced, allowing the gas to escape.

When a well is first drilled into a coal seam, gas does not usually flow to the surface until the well is dewatered, although some wells will flow free gas much like a conventional gas well.

As the amount of water produced declines, gas production generally increases.

A typical production curve for a coal seam gas well is shown in the diagram below.

To assist the flow of gas through the coal to the producing well, the coal may be mechanically fractured (referred to as 'fracturing' or 'fraccing').

Production from a well must be continuous. If production is halted, water will re-enter the seam and dewatering must begin again.

At the surface, gas from several wells is collected and the gas and water are separated. Processed gas is then passed to a compressor station and injected into to a pipeline for delivery to users.

Compression of the gas enables greater quantities to be transmitted by the pipeline.

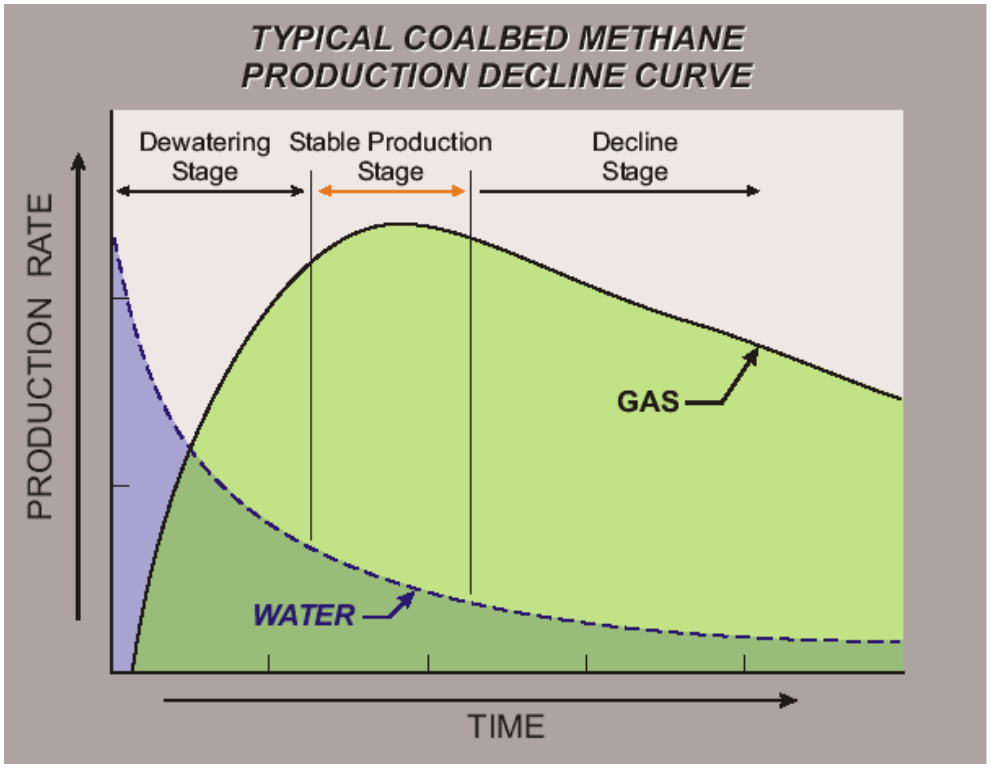


Diagram courtesy of CH4 Pty Ltd (Arrow Energy Limited)

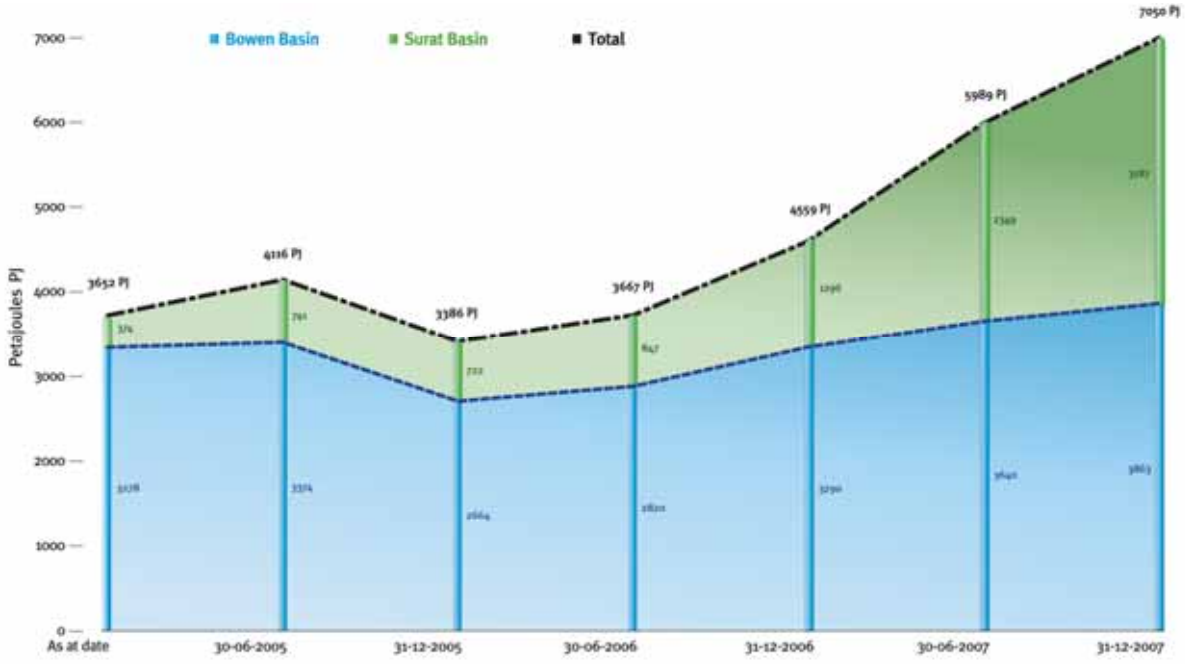
Queensland coal seam gas

Reserves

Certified proved and probable (2P) reserves of coal seam gas have been increasing as exploration for Queensland coal seam gas resources continue.

In recent times, certified coal seam gas reserves in the Surat Basin have increased significantly as exploration programs have been completed.

Bowen Basin reserves also continue to increase as additional exploration and development drilling programs have been completed.



Queensland coal seam gas proved and probable (2P) reserves to December 2007

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