Department of **Employment, Economic Development and Innovation**
Geological Survey of Queensland

Queensland's coal seam gas overview

February 2012

Industry update

Queensland's coal seam gas (CSG) industry has grown rapidly over the past 15 years — the annual number of wells drilled increasing from 10 in the early 1990s to almost 600 in 2010–11.

The CSG industry has defied the recent global economic downturn with both exploration and development activity remaining strong. It continues to be at the forefront of Queensland's petroleum industry.

The Queensland Government is supporting the growth of the petroleum industry by making available geoscientific information and company exploration data, and coordinating approvals for major petroleum projects.

In the past five years there has been a growing interest in using Queensland's CSG resources to produce liquefied natural gas (LNG) for export, taking advantage of increasing global demand for gas. Three export LNG projects based on Queensland coal seam gas resources are under construction on Curtis Island near Gladstone with first cargoes expected in late 2014.

A further five proposals to develop export LNG projects are under consideration. If all current projects and proposals are developed to full capacity, this would represent a potential LNG export market for the state of more than 50 million tonnes per annum. Current infrastructure consists of more than 4000 kilometres of gas transmission pipelines. Additional pipelines to markets interstate and for supply of gas to the Gladstone LNG plants are planned or under construction.

Many Queensland basins are highly prospective for CSG and production in the Bowen (Permian coal measures) and Surat (Jurassic Walloon Coal Measures) basins represents more than 79% of the total gas produced in the state (Figure 1). As at 30 June 2011, proved and probable (2P) reserves reached 33 001 petajoules (PJ) (Figure 2, Table 1). In 2010–11, production increased to 234 PJ from 212 PJ in 2009–10 (Figure 3). Production from these sources is expected to supply an increasing proportion of the Queensland and other eastern Australian markets.

Bowen Basin

The Permian to Triassic Bowen Basin is the birthplace of the CSG industry in Queensland. The first commercial production commenced from the Dawson River CSG area near Moura in 1996 and later from the Fairview CSG area near Injune in 1998. Currently, commercial production occurs in the central and southern parts of the basin near Moranbah, Injune, Moura and Wandoan. The Permian coal measures are the main targets.

Quick facts *(as at 30 June 2011)*

Coal seam gas production	
1998–99	4 PJ
2005–06	63 PJ
2010–11	234 PJ
2P reserves	
Coal seam gas	33 001 PJ

A locality map and contact details for Queensland's coal seam gas resources are on pages 2–4
For more information go to **www.mines.industry.qld.gov.au**

CSG produced at Moranbah is sourced from the Goonyella Middle (GM) and P seams of the Moranbah Coal Measures. The coal at Moranbah has a rank greater than 1.1% Rv with vitrinite contents of the order of 60%. Future production is likely from the Goonyella Middle Lower (GML) seam while the overlying Fort Cooper and Rangal Coal Measures have potential.

Coal permeability in the Moranbah area is relatively low with production enhanced by in-seam drilling. Development has concentrated on seams at around the 300 metre level to avoid the loss of permeability that generally comes with increasing depth. As the Moranbah area is located in a hinge zone, with its associated faulting, areas of increased permeability are expected.

At Moura, CSG is produced from the Permian Baralaba Coal Measures. Coal ranks around the Moura area, along strike, have a range from 0.7% Rv at Theodore to around 2.1% Rv at Baralaba and about 1% Rv in the Moura area. Exploration and development is concentrated on seams around 300 m in depth. Permeabilities are less than 10 mD in the Moura area. To cope with these low permeabilities, in-seam drilling has been undertaken to enhance production.

East of Wandoan at Scotia and Peat, gas is sourced from the Baralaba Coal Measures. Coal rank around Peat and Scotia is of the order 0.55 to 0.7% Rv with about 60% vitrinite content. The Peat and Scotia fields are located on the Burunga Anticline and contain structurally trapped free gas. Gas is produced from around 700 to 800 m depth where permeability is enhanced by the anticlinal structure. Below 900 m, the seams are considered sub-economic, where permeability is lower.

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Table 1: Queensland coal seam gas — statistics for financial year 2010–11 *(Source: Statutory Tenure Reports 30 June 2011)*

Project name	2P Reserves (PJ)	Gas (PJ)	Water (ML)	Status	Basin	Location – stratigraphic unit	Tenure
Arrow Energy Limited							**www.arrowenergy.com.au**
Bowenville	989	•	•	ud	Surat	Dalby area – (Walloon Coal Measures)	ATP 683
Burunga Lane	281.6	•	•	ud	Surat	Wandoan area – (Walloon Coal Measures)	ATP 810
Carborough	114.5	•	•	ud	Bowen	Morandah area – (Moranbah Coal Measures)	PL 223
Castledean	215.3	•	•	ud	Surat	Miles area – (Walloon Coal Measures)	ATP 810
DAANDINE	349.6	12.87	1003.20	op	Surat	Dalby area – (Walloon Coal Measures)	PL 230
Dalby South	263.3	•	•	ud	Surat	Dalby area – (Walloon Coal Measures)	ATP 683
Dundee	101	•	•	ud	Surat	Chinchilla area – (Walloon Coal Measures)	ATP 676; PLA 185
Hopelands	96.8	•	•	ud	Surat	Chinchilla area – (Walloon Coal Measures)	ATP 676; PLA 185
Kedron	201.8	•	•	ud	Surat	Miles area – (Walloon Coal Measures)	ATP 810
Kogan East	88.8	•	•	ud	Surat	Dalby area – (Walloon Coal Measures)	ATP 676
KOGAN NORTH	185.8	4.05	626.54	op	Surat	Dalby area – (Walloon Coal Measures)	PL 194
Long Swamp	519.5	•	•	ud	Surat	Dalby area – (Walloon Coal Measures)	ATP 683; PLA 260
Meenawarra	288.8	•	•	ud	Surat	Dalby area – (Walloon Coal Measures)	ATP 683; PLA 258
Millmerran	176.6	•	•	ud	Surat	Millmerran area – (Walloon Coal Measures)	ATP 683
MORANBAH GAS PROJECT	2020.6	12.14	223.21	op	Bowen	Moranbah area – (Moranbah Coal Measures)	PL 191, 196, 222, 224; ATP 1103
Plainview	652.2	•	•	ud	Surat	Dalby area – (Walloon Coal Measures)	ATP 683; PLA 238
Punchbowl/Baking Board	145	•	•	ud	Surat	Dalby area – (Walloon Coal Measures)	ATP 676
Stratheden	286.8	•	14.11	ud	Surat	Dalby area – (Walloon Coal Measures)	PL 252
TIPTON WEST	626.6	9.93	1460.77	op	Surat	Dalby area – (Walloon Coal Measures)	PL 198
Bow Energy Ltd							**www.bowenergy.com.au**
Blackwater	61.2	•	•	ud	Bowen	Blackwater area – (Rangal Coal Measures)	ATP 1025
Don Juan	57.2	•	•	ud	Surat	Roma area – (Walloon Coal Measures)	ATP 771
Vermont	36.1			ud	Bowen	Dysart area – (Moranbah Coal Measures)	ATP 1031
Molopo Energy Limited							**www.molopo.com.au**
Harcourt	141.5	•	•	ud	Bowen	Moura area – (Baralaba Coal Measures)	ATP 564
Lilyvale	64.8	•	•	ud	Bowen	Moura area – (Baralaba Coal Measures)	ATP 564
Mungi	228.2	•	•	ud	Bowen	Moura area – Baralaba Coal Measures)	PL 94
Timmy	130.1	•	•	ud	Bowen	Moura area – Baralaba Coal Measures)	ATP 564
Origin Energy							**www.originenergy.com.au**
Combabula	3173.7	•	•	ud	Surat	Wandoan area – (Walloon Coal Measures)	ATP 606
Condabri	1523.6	•	•	ud	Surat	Miles area – (Walloon Coal Measures)	ATP 702
Dalwogen	201.1	•	•	ud	Surat	Miles area – (Walloon Coal Measures)	PL 216
Gilbert Gully	314	•	•	ud	Surat	Dalby area – (Walloon Coal Measures)	ATP 663
Kainama	166.9	•	•	ud	Surat	Dalby area – (Walloon Coal Measures)	ATP 692
Kainama North	200.6	•	•	ud	Surat	Dalby area – (Walloon Coal Measures)	ATP 692
Membrance	18.2	•	•	ud	Bowen	Injune area – (Bandanna Formation)	PL 219
Orana	312.8	•	•	ud	Surat	Chinchilla area – (Walloon Coal Measures)	PL 215
Orana North	442.2	•	•	ud	Surat	Chinchilla area – (Walloon Coal Measures)	ATP 692
PEAT	133.4	3.43	11.25	op	Bowen	Wandoan area – (Baralaba Coal Measures)	PL 101
Ramyard	641.6	•	•	ud	Surat	Wandoan area – (Walloon Coal Measures)	ATP 847
SPRING GULLY	1616.4	49	1891.04	op	Bowen	Injune area – (Bandanna Formation)	PLs 195, 200, 203, 204; ATP 592
Spring Gully	17.3	•	•	ud	Surat	Wandoan area – (Walloon Coal Measures)	ATP 592
TALINGA	567	30.07	2398.68	op	Surat	Chinchilla area – (Walloon Coal Measures)	PL 226

Table 1: Queensland coal seam gas — statistics for financial year 2010–11

continued

Project name	2P Reserves (PJ)	Gas (PJ)	Water (ML)	Status	Basin	Location – stratigraphic unit	Tenure
Woleebee	217.9	•	•	ud	Surat	Wandoan area – (Walloon Coal Measures)	PL 209, ATP 692
Queensland Gas Company Limited (a BG Group business)							**www.qgc.com.au**
Aberdeen, Ridgewood	170.4	•	•	ud	Surat	Dalby area – (Walloon Coal Measures)	ATP 621
ARGYLE	120.2	4.68	532.15	op	Surat	Chinchilla area – (Walloon Coal Measures)	PL 179
ARGYLE EAST	57.3	1.39	277.14	op	Surat	Chinchilla area – (Walloon Coal Measures)	PL 229
BELLEVUE	216.9	2.88	369.23	op	Surat	Chinchilla area – (Walloon Coal Measures)	PL 247
BERWYNDALE	313.8	0.15	33.96	op	Surat	Chinchilla area – (Walloon Coal Measures)	PL 211
Berwyndale and Berwyndale Deep	115.3	•	•	ud	Surat	Chinchilla area – (Walloon Coal Measures)	ATP 632
BERWYNDALE SOUTH	330	33.5	1290.86	op	Surat	Chinchilla area – (Walloon Coal Measures)	PL 201
Cameron	1533.2	•	•	ud	Surat	Wandoan area – (Walloon Coal Measures)	ATP 852
CODIE/LAUREN	549.1	7.46	452.42	op	Surat	Chinchilla area – (Walloon Coal Measures)	PL 180
KENYA	448.4	5.46	799.52	op	Surat	Chinchilla area – (Walloon Coal Measures)	PL 228
Kenya East/Jammat/Jen/Sean	2264.6	•	•	ud	Surat	Chinchilla area – (Walloon Coal Measures)	ATP 648
Lacerta	103.6	•	•	ud	Surat	Roma area – (Walloon Coal Measures)	ATP 767, 795
Matilda John	343.7	•	•	ud	Surat	Chinchilla area – (Walloon Coal Measures)	ATP 620
Owen/McNulty/Avon Downs	617.8	•	•	ud	Surat	Chinchilla area – (Walloon Coal Measures)	ATP 676
Polaris	604.1	•	•	ud	Surat	Wandoan area – (Walloon Coal Measures)	ATP 768
Woleebee Ck/Ross/Cam/Kathleen	1043.4	•	•	ud	Surat	Chinchilla area – (Walloon Coal Measures)	ATP 651
Santos Ltd							**www.santos.com.au**
Arcadia	549.9	•	•	ud	Bowen	Injune area – (Walloon Coal Measures)	PL 233-4, ATP 653
ATP 631	1055	•	•	ud	Surat	Miles area – (Walloon Coal Measures)	ATP 631
Roma OA	1480	0.13	256.62	op	Surat	Roma area – (Walloon Coal Measures)	PLs 3–8, 13, 93, ATP 336
FAIRVIEW	2901	44.08	3690.57	op	Bowen	Injune area – (Bandanna Formation)	PLs 90–92, 99, 100
SCOTIA	244.6	10.32	•	op	Bowen	Wandoan area – (Baralaba Coal Measures)	PL 176
Westside Corporation Ltd							**www.westsidecorporation.com**
DAWSON VALLEY Includes Moura, Mungi, Dawson River, Nipan	130.1	•	•	op	Bowen	Moura area – (Baralaba Coal Measures)	PL 94, ATP 564
DAWSON RIVER	n/a	0.27	64.36	op	Bowen	Moura area – (Baralaba Coal Measures)	PL 94
MOURA	n/a	0.54	7.02	op	Bowen	Moura area – Baralaba Coal Measures)	PL 94
MUNGI	n/a	0.66	6.88	op	Bowen	Moura area – (Baralaba Coal Measures)	PL 94
NIPAN	n/a	0.56	27.45	op	Bowen	Moura area – (Baralaba Coal Measures)	PL 94

op – operating field **ud** – under development **ATP** – Authority to Prospect **PLA** – Petroleum Lease Application **PL** – Petroleum Lease

Production from Fairview and Spring Gully is sourced from the Permian Bandanna Formation. Three coal seams of the Bandana Formation have been targeted at depths ranging from 500 to 880 m. The coal rank of the CSG-producing Bandanna Formation at Fairview and Spring Gully is about 0.9% Rv with up to 70% vitrinite content.

Permeability at the Fairview and Spring Gully fields (Comet Ridge fairway) is enhanced by their location within a large anticlinal structure. Tensional areas at the axes of anticlines and synclines are obvious targets for enhanced permeability. Permeabilities are generally in excess of 50 mD. Production from this basin has provided the majority of CSG supplied to the Queensland market to date. Certified proved and probable CSG reserves are increasing steadily.

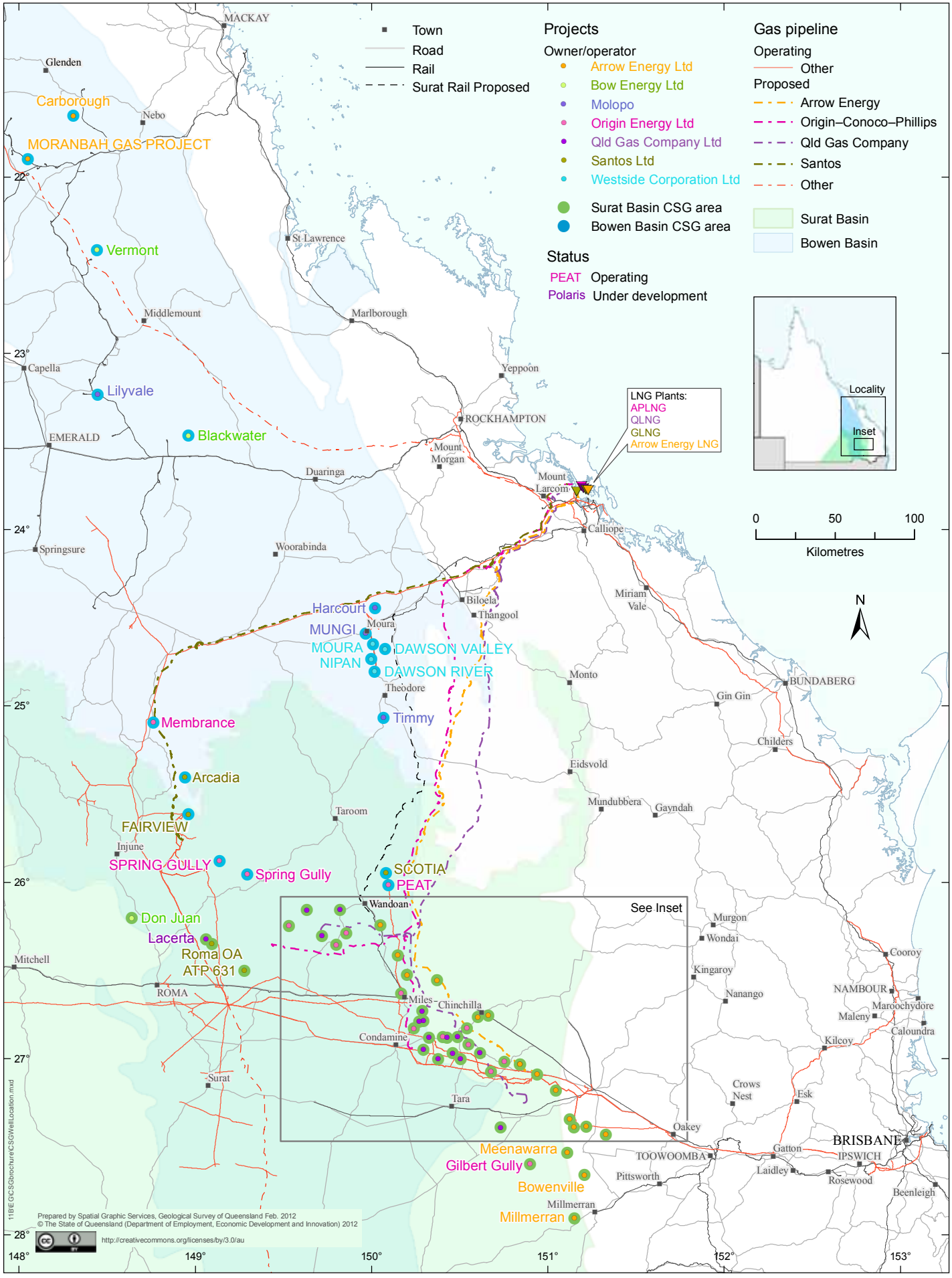
Surat Basin

Over the past few years, the Jurassic to Cretaceous Surat Basin in southern Queensland has grown in importance as a source of CSG. The Surat Basin became the focus for emerging CSG companies from 2000 onwards when it was realised that an analogy existed with the lower-ranked coals in the Powder River Basin in the United States of America, which were producing commercial quantities of gas.

The success of the QGC Argyle 1 well in 2000 demonstrated that the Surat Basin could become a significant CSG producer.

Commercial production of CSG from the Jurassic Walloon Coal Measures of the Surat Basin began in January 2006 from the Kogan North CSG area west of Dalby. This was followed in May 2006 by

Figure 1: Queensland coal seam gas — ownership and locality map



Updated January 2012
Prepared by Geological Survey of Queensland

Inset **Figure 1: Queensland coal seam gas — ownership and locality map**

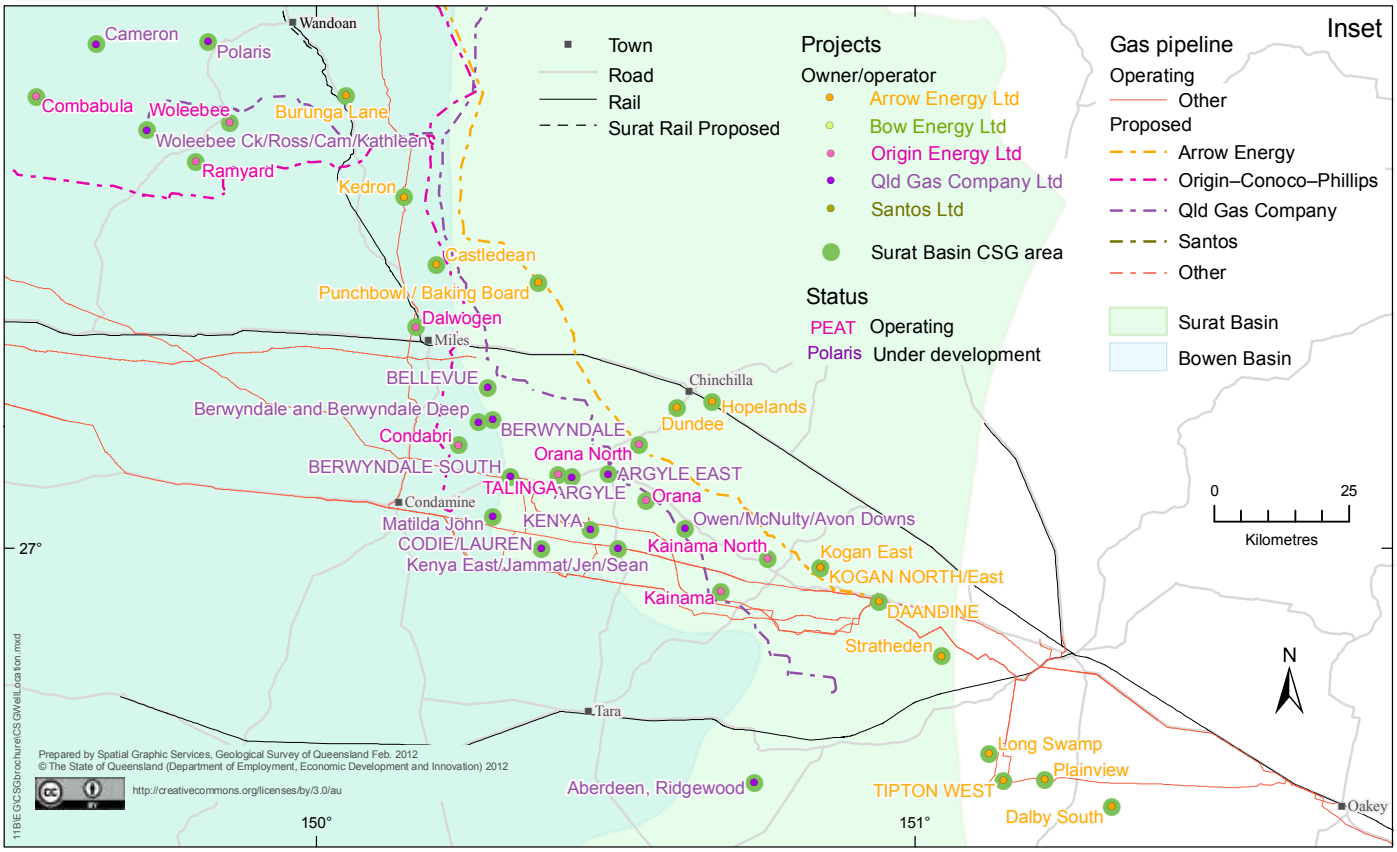


Figure 2: Queensland coal seam gas — 2P reserves ***(proved and probable)***

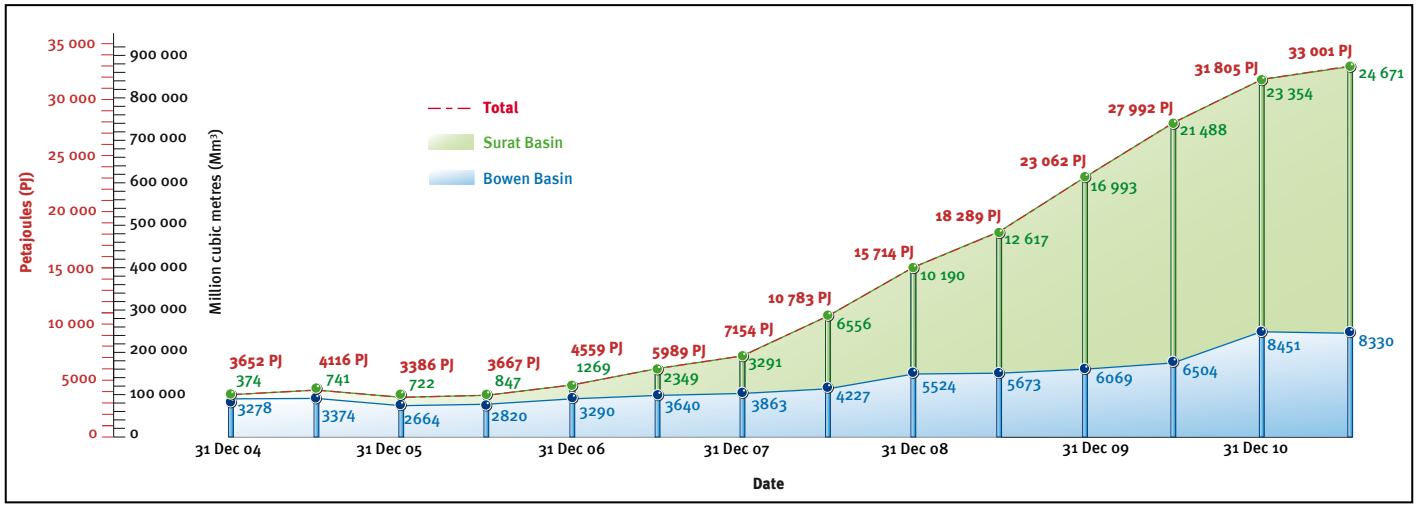
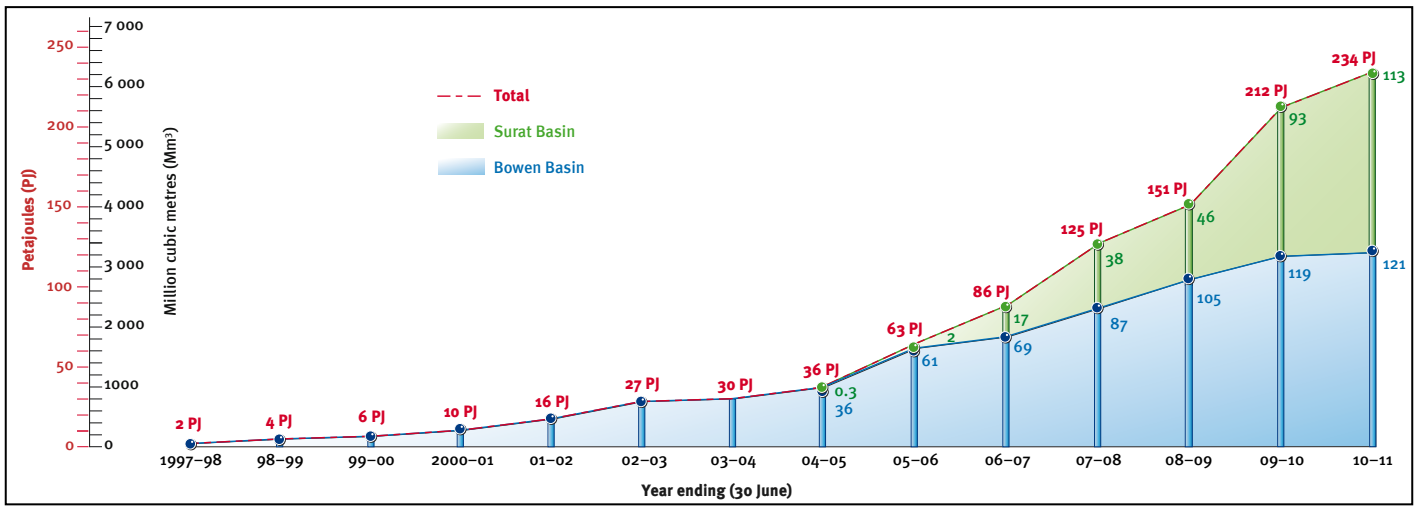


Figure 3: Queensland coal seam gas — production period 1997–2011



production from the Berwyndale South CSG area, south-west of Chinchilla. CSG is also currently produced from several areas from Dalby to Chinchilla.

Surat Basin CSG gas was first used to supply the Swanbank E gas-fired power station.

CSG produced commercially from the Walloon Coal Measures is typically obtained from seams 300 to 600 m deep. The term Walloon Coal Measures (Walloon Subgroup) is used for the combined thicknesses of the Taroom Coal Measures (lower), Tangalooma Sandstone and the Juandah Coal Measures (upper).

Coals in the Surat Basin were not as deeply buried as those in the Bowen Basin and therefore are less thermally mature, with generally lower gas contents. Vitrinite reflectance values for coals in the Walloon Coal Measures in Queensland range from 0.35% to 0.6%. The seams are generally not as thick or laterally continuous as seams in the Bowen Basin. This is compensated for by having higher permeability. Despite this, CSG has been commercialised using a range of well-completion techniques. Production and reserves continue to grow accordingly.

Certified proved and probable reserves in the Surat Basin have increased significantly in recent years. By 30 June 2008 certified CSG reserves in the Surat Basin had surpassed those in the Bowen Basin.

Galilee Basin

The Late Carboniferous to Triassic Galilee Basin may have potential as a major CSG region because it contains coal measures of a similar age to those targeted in the Bowen Basin.

Drilling for CSG began in 1992 in the Rodney Creek area, north-east of Longreach, targeting the Betts Creek Beds. Due to several factors, results from a pilot program were not conclusive. Results from the Rodney Creek 8 well were more encouraging with around 25 m gross of gassy coal intersected. Measured permeabilities ranged from 1 to 150 mD (average 30 mD) over the full coal thickness tested. The vitrinite reflectance values were in the range from 0.63 to 0.71 Rv max.

Other CSG exploration in the basin has been undertaken, with limited success. Wells have been drilled to test the Early Permian Aramac Coal Measures and Late Permian Betts Creek beds and Bandanna Formation. These coal sequences are currently the subject of a new round of exploration activity and results are pending.

Clarence–Moreton Basin

The Clarence–Moreton Basin in south-east Queensland is a Late Triassic to Jurassic basin with the Walloon Coal Measures being explored for CSG. This exploration has resulted in the delineation of reserves in the western part of the basin where it joins the Surat Basin. As the boundary between the two basins is difficult to define, the CSG reserves in the Walloon Coal Measures in the Clarence-Moreton Basin are included with those for the Surat Basin.

Other basins

Cooper Basin. Although the Cooper Basin contains widespread Permian coal measures, their depth has meant that they have not been explored for CSG. Only one well has been drilled in the Queensland portion of the basin.

Eromanga Basin. The Cretaceous Winton Formation in the Eromanga Basin has been explored for CSG but results were not encouraging. However, this basin is attracting renewed exploration interest in targeted areas.

Ipswich Basin. The Triassic Ipswich Basin in south-east Queensland is a target for CSG exploration, with limited work undertaken. Arrow Energy discovered CSG at their Swanbank-2 well, located to the south-east of the Swanbank Power Station. The well was drilled to a depth of 545 m and encountered a total of 28 m of coal below 400 m within the Tivoli Formation. Coals reportedly exhibited high gas contents. The basin's CSG potential remains relatively unknown.

Laura Basin. The Jurassic to Cretaceous Laura Basin contains Jurassic coal seams with potential for commercial CSG accumulations. However, land access for exploration in this area is limited owing to widespread national parks.

Maryborough Basin. The Maryborough Basin contains the Jurassic Tiaro Coal Measures and Cretaceous Burrum Coal Measures. Limited assessment of the CSG potential of Burrum Coal Measures in the northern portion of the Burrum Syncline has been undertaken. Two coreholes have been drilled to a total depth of about 600 m; however, no results are available.

Nagoorin Graben. The Tertiary Nagoorin Graben, south of Gladstone, is known to contain significant carbonaceous and low-rank coal deposits. Following the drilling of the ARM Boyne River 1 exploration well in 2004 and the reported good permeability and gas content, an application for a petroleum lease was made over the discovery. The Boyne River-2 well was drilled to a total depth of 780 m and intersected 95 m net of coal. A 50 m thick seam was intersected at 550 m depth and flow tested. It produced 2200 barrels of water per day and flowed gas at 1700 m^3 per day.

Styx Basin. The Styx Basin contains coal measures of Cretaceous age with coal seams up to a metre thick. The coals are thermally mature for petroleum generation and are being explored for CSG. ARM Styx River-1 was the first well drilled in the Styx Basin. It was drilled to a total depth of 660 m and intersected 14 m net of coal in the Styx Coal Measures. Initial gas desorption measurements were reported as very encouraging and a 2 m gas flare was produced during flow testing.

Other Tertiary basins. Other Tertiary basins to be explored for CSG include Duaringa, Herbert Creek, Hillsborough and Yaamba basins.

For further information contact:
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Note: Data sourced from Statutory Tenure Reports as at 30 June 2011 Department of Employment, Economic Development and Innovation.

CC12-PET018