Australian Government
Geoscience Australia

Coal Seam, Shale and Tight Gas in Australia: Resources Assessment and Operation Overview 2016

Upstream Petroleum Resources Working Group Report to COAG Energy Council

November 2016

Contents

Introduction

This report updates the 2015 report produced for the COAG Energy Council.

The significant changes from the 2015 report are:

- Decrease in New South Wales' 2C resources from 10 656 PJ to 2 254 PJ.
- Decrease in South Australia's 2C resources from 8 034 PJ to 6 881 PJ.
- Production of CSG in Queensland has more than doubled, from 347 PJ to 683 PJ.

Key points

- Current booked coal seam gas reserves show a potential supply shortfall against current LNG contract requirements.
- The potential shortfall arises with regard to the full volume of contractual gas supply requirements, comprising ramp, plateau, tail and system use, together with existing domestic gas supply commitments. Tail gas volumes (being the portion of gas remaining unproduced at end of contract life) are likely to comprise a large portion of current reserve figures.
- There are however significant 2C resource volumes which could be converted to reserves in future. Arrow Energy has an additional 11.4 Tcf (12 084 PJ) of currently uncommitted gas. In addition, there are 19.1 Tcf (12 296 PJ) of 2C CSG resources identified from the three LNG projects.
- While current drilling rates meet estimated requirements, there is risk of shortfall in the rate of gas supply due to reduced well productivity. However the data required to estimate the magnitude of this risk is not currently available to Geoscience Australia, since production reporting is reported on a tenure rather than well basis.

  The contracted gas volumes and projected drilling rates set a critical period from late 2015 through early 2019 where the required production rate per well will be at an average of between 400 000 and 500 000 cubic feet per day per well (if only gas resources allocated to the projects are considered). It is not clear to Geoscience Australia that production will be able to be sustained at this level for that duration and we do not currently have access to the data required to assess the risk. However, the analysis of historical CSG production rates in Queensland (Table 2.5) seems to provide evidence for a positive outcome.
- By the end of 2015, all three LNG projects in Queensland have successfully started production (all six trains are now in production). This significantly increased CSG production from 347 PJ in 2014 to 683 PJ in 2015.
- Contingent resource estimates from shale and tight gas have reduced.

Unconventional Gas Reserves/Resources

The following table is the sum of the reserves and resources presented in the sections on each jurisdiction. This summation is not strictly arithmetically correct for reasons discussed below but does give an indication of the overall resource potential.

TOTAL PETROLEUM INITIALLY-IN-PLACE (PIIP)	DISCOVERED PIIP	COMMERCIAL	**PRODUCTION: 687 PJ in 2015**		
			RESERVES 1P: 35 PJ	**RESERVES** **2P: 43 638PJ**	RESERVES 3P: 41 PJ
		SUB-COMMERCIAL	CONTINGENT RESOURCES 1C: 3 762 PJ	**CONTINGENT RESOURCES** **2C: 40 159 PJ**	CONTINGENT RESOURCES 3C: 32 865 PJ
			UNRECOVERABLE		
	UNDISCOVERED PIIP		PROSPECTIVE RESOURCES Low Estimate: 93 487 PJ	**PROSPECTIVE RESOURCES** **Best Estimate: 652 678 PJ**	PROSPECTIVE RESOURCES High Estimate: 767 807 PJ
			UNRECOVERABLE		

NOTE: Not all jurisdictions or companies' reports have reported volumes for each category (i.e. 1P, 3P, 1C, 3C, Low Estimate and High Estimate). So totals will not be indicative of the distribution of resources across each category.

Table 1.1: Summary of Australia's unconventional resources

Scope and assumptions

This report covers the potential for tight oil and gas, shale oil and gas and coal seam gas sourced from publicly available data published by operating companies, State authorities and other reporting bodies.

Resource data is not available for many prospective basins and formations, so the following estimates of unconventional resources are likely to understate the potential. To become reserves, however, these resources will need a commercially viable gas price, suitable infrastructure and a market. It is probable that the majority of the resources, if proven to exist, will not be produced for decades.

Unconventional resource potential from other resources such as oil shale, coal gasification or methane hydrates has not been considered.

Definitions

Useful summaries of the types and setting of unconventional resources can be found in Chapter 1 of the ACOLA Report 6 *Securing Australia's Future – Engineering energy: unconventional gas production* (see link in References) and in the *Roadmap for Unconventional Gas Projects in*

South Australia (see link in References) which also includes a brief description of the SPE PRMS resource reporting system in Chapter 1.

The following definitions have been adopted in listing the prospective formations in each jurisdiction:

Inactive – The formation may contain a resource but there is no current activity
Preliminary exploration – The formation is being actively explored
Under assessment – The formation is being tested for its ability to produce commercially
Producing – The formation is currently producing

SPE PRMS

The Society of Petroleum Engineers has published the Petroleum Resources Management System (SPE PRMS) to standardise the reporting of petroleum reserves and resource volumes. The reporting matrix lists reserves and resources by commercial uncertainty in the vertical direction and technical uncertainty in the horizontal direction.

It should be noted that only petroleum that is developed or is part of a current development project can be booked as reserves and petroleum that has been demonstrated to exist through exploration and testing can be booked as a contingent resource; the remainder should be booked as a prospective resource. There is a possibility that a contingent resource or a prospective resource may never become recoverable due to cost or the limitations of technology. A prospective resource may not exist at all as the assumptions used to predict its existence may be found to be invalid.

<table>
<tr><td rowspan="6">TOTAL PETROLEUM INITIALLY-IN-PLACE (PIIP)</td><td rowspan="4">DISCOVERED PIIP</td><td rowspan="2">COMMERCIAL</td><td colspan="3">PRODUCTION</td></tr>
<tr><td>RESERVES
1P</td><td>RESERVES
2P</td><td>RESERVES
3P</td></tr>
<tr><td rowspan="2">SUB-COMMERCIAL</td><td>CONTINGENT RESOURCES
1C</td><td>CONTINGENT RESOURCES
2C</td><td>CONTINGENT RESOURCES
3C</td></tr>
<tr><td colspan="3">UNRECOVERABLE</td></tr>
<tr><td rowspan="2">UNDISCOVERED PIIP</td><td colspan="2">PROSPECTIVE RESOURCES
Low Estimate</td><td>PROSPECTIVE RESOURCES
Best Estimate</td><td>PROSPECTIVE RESOURCES
High Estimate</td></tr>
<tr><td colspan="3">UNRECOVERABLE</td></tr>
</table>

Table 1.2: PRMS matrix

Resource estimates range from estimates of the number of methane molecules in all the rocks in a basin, through estimates of the volume that could be produced without consideration of technical factors and economics to the amount likely to be produced given current technology and commercial considerations. It is important to consider the nature of these different types of estimates when looking at resources in the PRMS matrix.

A description of the definitions used in the system is on the SPE website (see link in References). A non-technical guideline and the full guideline, including sections on estimation of different types of unconventional resource are also available (see links in References).

Resource potential by jurisdiction

The body of the report presents data on unconventional resources in each onshore jurisdiction.

The **unconventional resource potential** section includes listings of the basins and formations that are currently thought to be prospective, including the type(s) of resource thought to be present and the current exploration and development status of the formation.

The **reserves/resources** section is a compilation of the reserves and resources, which are listed according to Geoscience Australia's best estimate of where they should be placed in the SPE PRMS matrix. The totals are a summation of each of the categories of reserve or resource but it should be noted that in many instances only data in the 2P Reserves, 2C Contingent Resources and Best Estimate Prospective Resources categories have been provided.

The **unconventional resource drilling activity** section tabulates drilling activity.

The **commentary** section includes Geoscience Australia's and States/NT's observations on the status of unconventional resources in the jurisdiction and any caveats that should be applied in interpreting the data.

References

ACOLA Report 6 Securing Australia's Future – Engineering energy: unconventional gas Production
http://www.acola.org.au/PDF/SAF06FINAL/Final%20Report%20Engineering%20Energy%20June%202013.pdf

DMITRE South Australia
http://www.petroleum.dmitre.sa.gov.au/__data/assets/pdf_file/0008/179621/Roadmap_Unconventional_Gas_Projects_SA_12-12-12_web.pdf

EIA/ARI World Shale Gas and Shale Oil Resource Assessment
http://www.eia.gov/analysis/studies/worldshalegas/

SPE Guidelines for Application of the Petroleum Resources Management System
http://www.spe.org/industry/docs/PRMS_Guidelines_Nov2011.pdf

SPE Petroleum Resources Management System
http://www.spe.org/industry/docs/Petroleum_Resources_Management_System_2007.pdf

SPE Petroleum Resources Management System Guide for Non-Technical Users
http://www.spe.org/industry/docs/PRMS_guide_non_tech.pdf

Queensland

Unconventional resource potential:

Basin/Formation	Tight gas	Shale gas	CSG	*Status*
Laura Basin				
Dalrymple Sandstone	✓	✓	✓	*Inactive*
Maryborough Basin				
Maryborough Formation	✓	✓		*Inactive*
Tiaro Coal Measures		✓	✓	*Inactive*
Burrum Coal Measures			✓	*Preliminary exploration*
Clarence-Moreton Basin				
Walloon Coal Measures			✓	*Under assessment*
Surat Basin				
Walloon Coal Measures			✓	*Producing*
Bowen Basin				
Black Alley Shale		✓		*Preliminary exploration*
Tinowon Formation	✓			*Under assessment*
Moranbah Coal Measures			✓	*Producing*
Baralaba Coal Measures			✓	*Producing*
Fort Cooper Coal Measures			✓	*Under assessment*
Rangal Coal Measures			✓	*Under assessment*
Bandanna Formation	✓		✓	*CSG producing; Tight gas under assessment*
Eromanga Basin				
Winton Formation			✓	*Inactive*
Toolebuc Formation		✓*		*Preliminary exploration*
Birkhead Formation		✓		*Inactive*
Westbourne Formation		✓		*Inactive*
Poolowanna Formation		✓		*Inactive*
Cooper Basin				
Toolachee Formation	✓	✓		*Under assessment*
Roseneath Shale		✓		*Under assessment*
Epsilon Formation	✓			*Under assessment*
Murteree Shale		✓		*Under assessment*
Patchawarra Formation	✓	✓	✓	*Under assessment*
Galilee Basin				
Betts Creek Beds		✓	✓	*Preliminary exploration*
Aramac Coal Measures		✓	✓	*Preliminary exploration*
Bandanna Formation			✓	*Preliminary exploration*
Lake Galilee Sandstone	✓			*Preliminary exploration*
Adavale Basin				
Log Creek Formation	✓	✓		*Inactive*
Lissoy Sandstone	✓	✓		*Inactive*
Cooladdi Dolomite	✓	✓		*Inactive*
Georgina Basin				
Arrinthrunga Formation	✓	✓		*Preliminary exploration*
Inca Shale	✓	✓		*Preliminary exploration*
Thorntonia Limestone	✓	✓		*Preliminary exploration*
Beetle Creek Formation		✓		*Preliminary exploration*
Georgina Limestone	✓	✓		*Preliminary exploration*
Mount Isa Superbasin				
Lawn Hill Shale		✓		*Preliminary exploration*
Termite Range Formation		✓		*Inactive*

Riversleigh Siltstone		✓		*Preliminary exploration*
Styx Basin				
Styx Coal Measures			✓	*Inactive*
Ipswich Basin				
Tivoli Formation			✓	*Inactive*

**Unconventional oil and gas potential*

Table 2.1: Queensland unconventional resource potential

Reserves/Resources:

<table>
<tr><td rowspan="4">TOTAL PETROLEUM INITIALLY-IN-PLACE (PIIP)</td><td rowspan="3">DISCOVERED PIIP</td><td rowspan="2">COMMERCIAL</td><td colspan="3">PRODUCTION: 683 PJ in 2015*</td></tr>
<tr><td>RESERVES
1P</td><td>RESERVES
2P: 43 597 PJ*</td><td>RESERVES
3P</td></tr>
<tr><td rowspan="2">SUB-COMMERCIAL</td><td>CONTINGENT RESOURCES
1C: 1 103 PJ</td><td>CONTINGENT RESOURCES
2C: 26 709 PJ**</td><td>CONTINGENT RESOURCES
3C: 18 554 PJ</td></tr>
<tr><td colspan="3">UNRECOVERABLE</td></tr>
<tr><td rowspan="2">UNDISCOVERED PIIP</td><td colspan="2">PROSPECTIVE RESOURCES
Low Estimate: 12 608 PJ</td><td>PROSPECTIVE RESOURCES
Best Estimate: 185 793 PJ***</td><td>PROSPECTIVE RESOURCES
High Estimate: 84 843 PJ</td></tr>
<tr><td colspan="3">UNRECOVERABLE</td></tr>
</table>

*Source: *Queensland production and reserves statistics as at 31 December 2015, **Sourced from Santos, Origin and QSG reports, see the reference list***ACOLA Report 6 Securing Australia's Future – Engineering energy: unconventional gas production (Bowen and Clarence-Moreton shale gas), EIA/ARI World Shale Gas and Shale Oil Resource Assessment (Maryborough shale gas), Independent Expert's Reports for Armour Energy Limited (Mount Isa Superbasin) and for Drillsearch for ATP 940*

Table 2.2: Queensland unconventional resources

Coal seam gas reserves have increased markedly from 2007 as drilling accelerated to prove up reserves for the LNG projects as shown in Figure 2.1 (1 Tcf is approximately equal to 1000 PJ). However, sustained drilling in the last four years has not seen significant changes in reserves, except for the QCLNG project, which booked about 3 Tcf additional gas reserves in 2013. This is consistent with the LNG operators' drilling program, focusing on development activities (Figure 2.3).

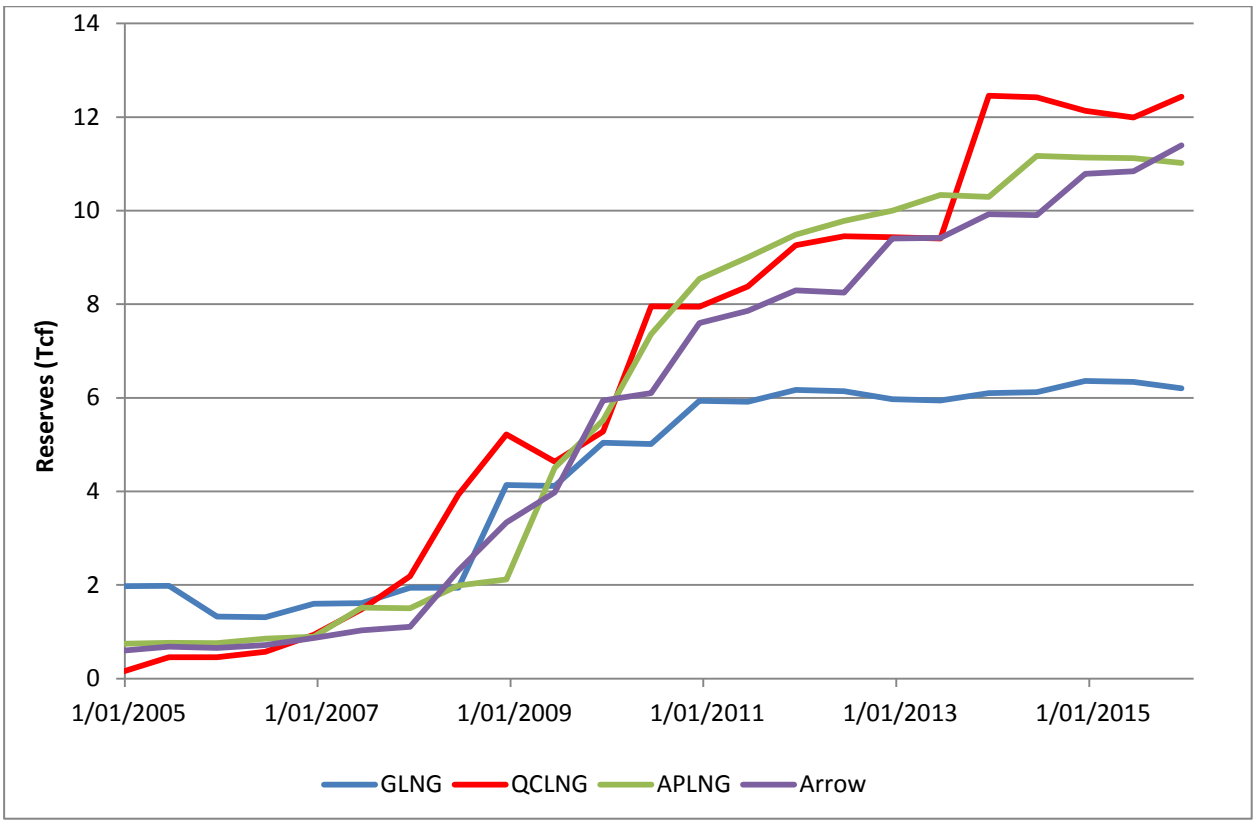

Figure 2.1: Queensland reserves growth in coal seam gas for major projects

Production/Forecasts:

The total annual gas production for the State was about 725 PJ in 2015 (43 PJ of conventional gas and 683 PJ of coal seam gas, the equivalent of about 12 MT LNG). The significantly increase of gas production in 2015 is due to the large increase in CSG production for all three LNG projects (Figure 2.2).

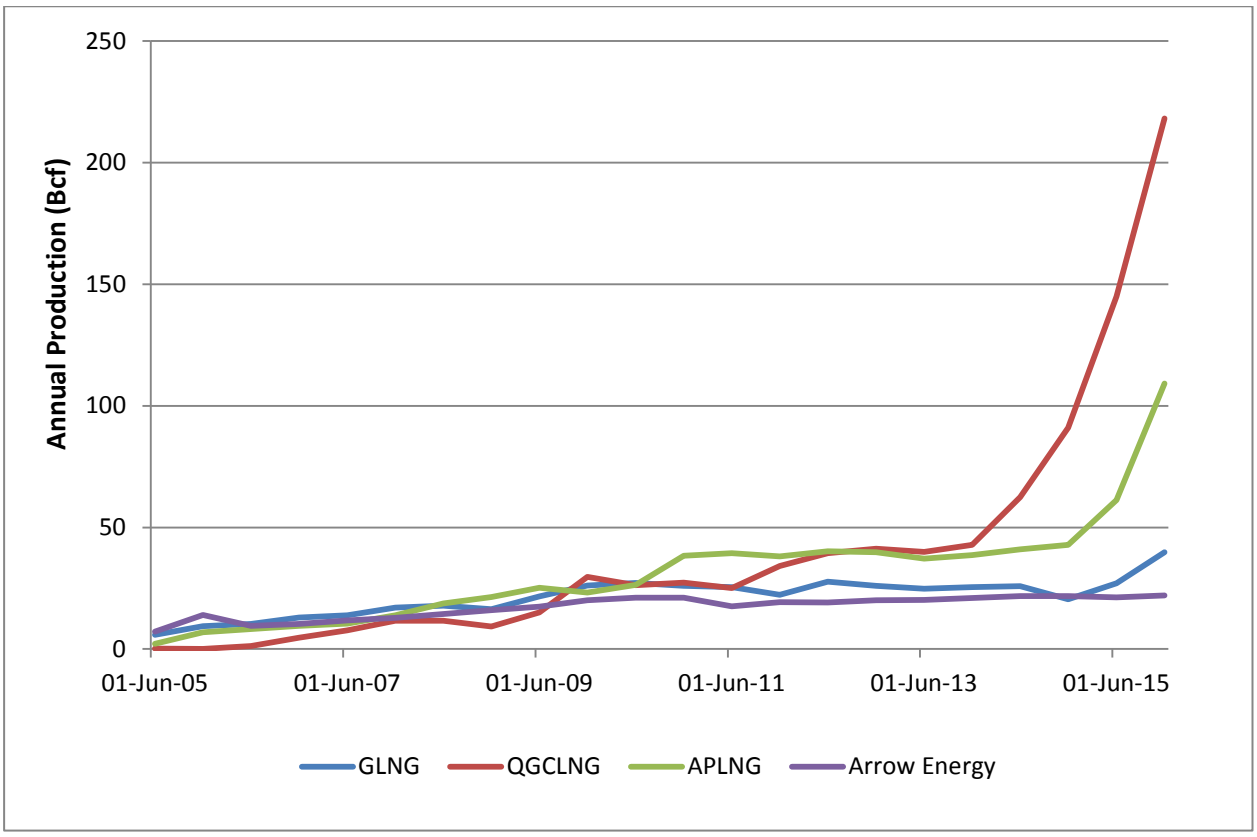

Figure 2.2 Annual CSG productions of major operations in Queensland (Source: Queensland Department of Natural Resources and Mines, July 2016).

From the start-up of the first LNG train in December 2014 (QGCLNG Train 1), Queensland now has all six LNG trains in production. The operators of the LNG projects have reported that in general gas ramp ups have happened more quickly than expected and the plants are around or exceeding nameplate capacity.

QGCLNG project is to complete a two-train plant with 8.5 million tonnes per year (mtpa) capacity. Commercial operations for the QGCLNG project started from Train 1 in May 2015. In July 2015 BG Group started up and loaded its first LNG from Train 2. It is expected to reach plateau production of 8 mtpa during 2016, with around 120 shipments of LNG per year (QGC, 2015). APLNG in 2015-16 FY produced 418 PJ of gas. A total of 32 cargoes have been shipped as at the end of June 2016 (Origin Reserve Report, 2016). Since GLNG's first cargo left Curtis Island on 16 October 2015, a total of 43 cargoes have been shipped by the end of June 2016 (Santos Quarterly Report, June 2016). The successful start-up of production from the three LNG projects significantly increased CSG production from 343 PJ in 2014 to 687 PJ in 2015.

By comparison, the forecast gas demand to supply the CSG LNG projects will be about 25 mtpa or almost 1 400 PJ/a, for a total of 18.5 Tcf (19 400 PJ) of gas over the current contracts. This is shown by contract in Figure 2.2, compiled from published LNG export volumes.

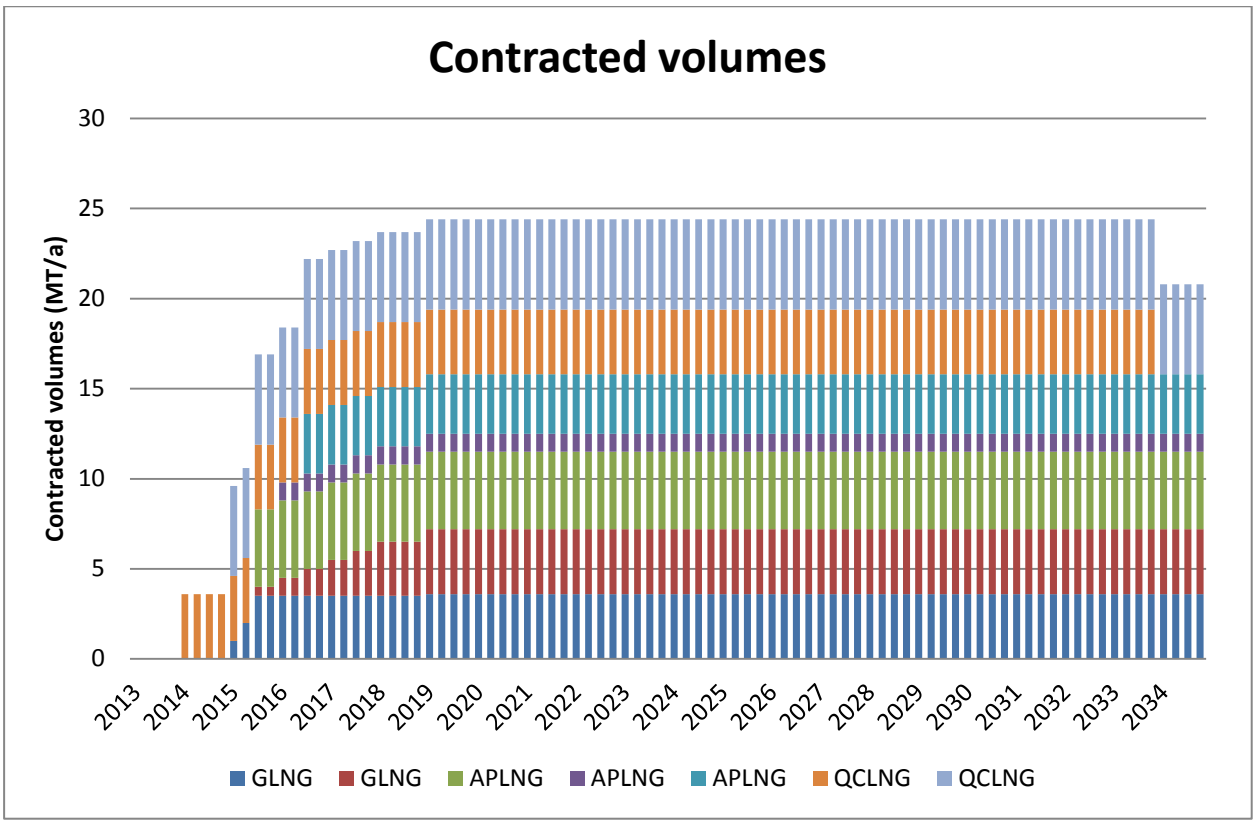

Figure 2.3: Contracted volumes by year for Queensland coal seam gas for LNG projects

Unconventional resource drilling activity:

Drilling activity has been high, in preparation for LNG exports. The number of wells drilled per year and the cumulative total of coal seam gas wells are shown in the graph below (Figure 2.4). Over the last four years, the drilling activity has focused on development wells. As a result, the number of exploration and appraisal wells has significantly reduced, while development wells have substantially increased.

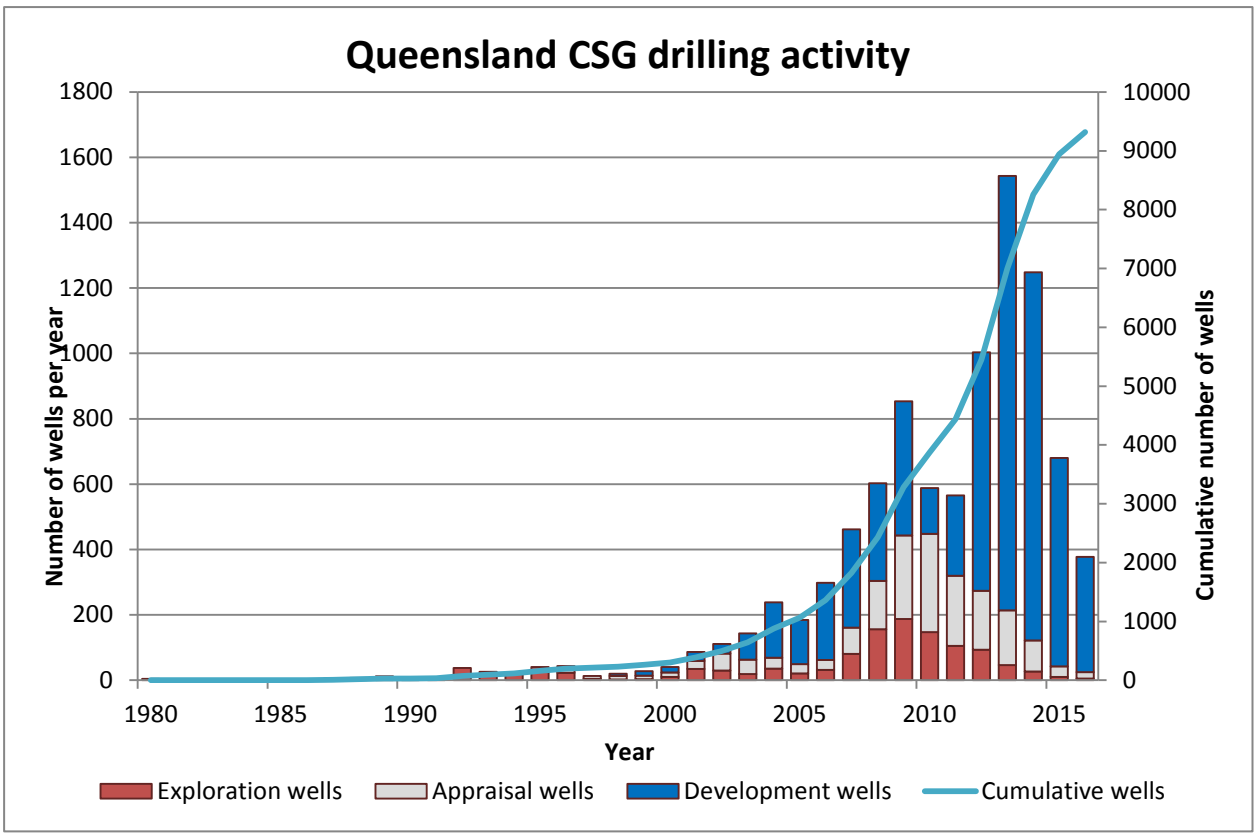

Figure 2.4: Well drilling rates and cumulative coal seam gas wells drilled (Queensland Department of Natural Resources and Mines, July 2016)

In order to sustain the high rate of production required for the LNG projects, an equally high rate of drilling will be required. The graph below (Figure 2.5) shows the projected drilling for the LNG projects, based on published data. This by far exceeds all other petroleum related activity in the State.

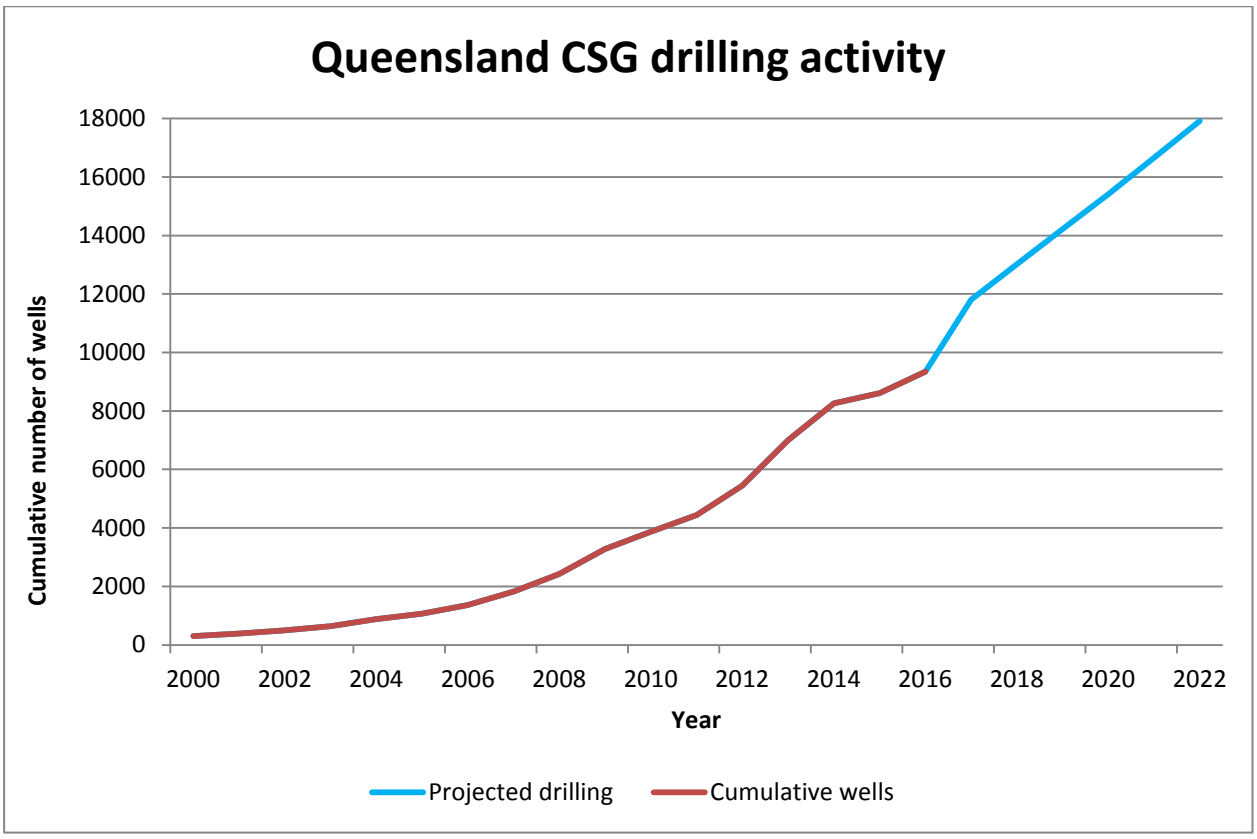

Figure 2.5: Historic and proposed cumulative coal seam gas wells (Queensland Department of Natural Resources and Mines, July 2016; Geoscience Australia compilations)

Commentary:
Gas reserves booked by the three LNG projects along with contracted LNG volumes are tabulated below. It is suggested that current reserves are not sufficient to cover the full volume of current domestic and LNG export contracts. The reported figures do not provide a breakdown of the proportional allocation to contractual ramp, plateau, tail and system use requirements. On assumption that tail gas volumes are likely to comprise a large proportion of reported 2P volumes, a potential supply shortfall exists.

It is noted that major operating companies retain significant 2C resource volumes, hence there is likelihood of their ability to convert 2C resources to 2P reserves at a time in the future that optimises investment in the conversion process.

Project	CSG Resources and Contracts (Tcf)			
	2P	2C	2P + 2C	Contracts[5]
APLNG[1]	12.8	2.9	15.6	8.6
GLNG[2]	5.2	1.3	6.5	7.0
QCLNG[3]	11.6	15	26.6	10.6
Sum for LNG projects	**29.6**	**19.1**	48.7	**26.2**
Arrow[4]	11.4	0	11.4	
Total	**41.0**	**19.1**	**60.1**	

Project	CSG Resources and Contracts (PJ)			
	2P	2C	2P + 2C	Contracts[5]
APLNG[1]	13,529	3,026	16,555	9,116
GLNG[2]	5,546	1,328	6,874	7,420
QCLNG[3]	12,296	15,900	28,196	11,236
Sum for LNG projects	**31,371**	**20,254**	**51,625**	**27,772**
Arrow[4]	12,082	0	12,082	
Total	**43,453**	**20,254**	**63,707**	

1: 2P value, see https://www.originenergy.com.au/content/dam/origin/about/investors-media/presentations/160729%20Annual%20Reserves%20Report%202016.pdf
2: 2P + 2C value. See https://www.santos.com/media/3206/160219_reserves_statement.pdf
3: 2P resource estimates from http://www.bg-group.com/files/pdf/qgc/2481_qgc-bg_ausprofile.webfinal.pdf
4: 2P value from Queensland Department of Natural Resources and Mines. https://www.business.qld.gov.au/invest/investing-queenslands-industries/mining/resources-potential/petroleum-gas-resources/petroleum-gas-statistics
5: Contract information from https://www.rlms.com.au/wp-content/uploads/2013/07/150804_JULY_Report.pdf

Table 2.3: Coal seam gas resources and LNG contracted volumes

APLNG and QCLNG appear best placed to utilise their native gas volumes (i.e. sourced from within their tenure holdings) to fulfil contractual requirements. Conversely, current reserve and resource figures for the GLNG project show a potential native gas shortfall. Santos's response to this position describes a range of solutions as stated in the 2015 Report (p14):

- GLNG has an integrated gas supply portfolio of indigenous gas, Santos portfolio gas, third party supply and gas storage
- GLNG proved reserves grew by 22% and proved and probable reserves by 4% in 2014, primarily due to positive re-assessments in the Fairview, Roma and Scotia fields
- GLNG has secured up to 2,228 PJ of Santos portfolio and third party gas supply agreements
- GLNG also has 1,202 PJ of 2C resources

Source (http://www.santos.com/library/070515_Macquarie%20Australia_Conference_Presentation.pdf).

In addition, Santos had announced that the GLNG project participants have executed an agreement with AGL for the purchase of 254 petajoules of gas for supply to the GLNG project (Santos December 2015). In total, GLNG has executed Santos portfolio and third party gas

supply agreements for an aggregate of between 2 100 PJ and 2 500 PJ over a period of up to 20 years (Santos 2016).

The CSG LNG projects have also published projected drilling programs and these can be combined with the contracted LNG volumes to estimate a required average production rate per well. These are tabulated for the three projects in Table 2.4 in millions of cubic feet per well per day.

QUARTER		GLNG	APLNG	QCLNG	TOTAL
2015	1Q	0.115		0.565	0.284
2015	2Q	0.217		0.536	0.298
2015	3Q	0.412	0.390	0.510	0.453
2015	4Q	0.393	0.371	0.486	0.433
2016	1Q	0.421	0.433	0.465	0.451
2016	2Q	0.403	0.411	0.445	0.433
2016	3Q	0.429	0.634	0.427	0.501
2016	4Q	0.411	0.605	0.410	0.483
2017	1Q	0.435	0.578	0.395	0.476
2017	2Q	0.418	0.553	0.380	0.461
2017	3Q	0.440	0.531	0.367	0.456
2017	4Q	0.425	0.510	0.355	0.442
2018	1Q	0.444	0.491	0.343	0.438
2018	2Q	0.430	0.473	0.332	0.426
2018	3Q	0.416	0.457	0.322	0.415
2018	4Q	0.404	0.441	0.312	0.404
2019	1Q	0.434	0.427	0.303	0.405
2019	2Q	0.421	0.414	0.295	0.395
2019	3Q	0.410	0.401	0.287	0.386
2019	4Q	0.398	0.389	0.279	0.378
2020	1Q	0.388	0.378	0.272	0.370
2020	2Q	0.378	0.367	0.265	0.362
2020	3Q	0.368	0.357	0.258	0.355
2020	4Q	0.359	0.348	0.252	0.348
2021	1Q	0.351	0.338	0.246	0.341
2021	2Q	0.342	0.328	0.241	0.334
2021	3Q	0.335	0.319	0.235	0.328
2021	4Q	0.327	0.311	0.230	0.322
2022	1Q	0.320	0.302	0.225	0.316
2022	2Q	0.313	0.295	0.220	0.311
2022	3Q	0.306	0.288	0.216	0.306
2022	4Q	0.300	0.281	0.211	0.301

Table 2.4: CSG production rates needed to fulfil LNG contracted volumes (mmscf/well per day)

The table shows that for the period 3Q 2015 to 1Q 2019, the production rate will need to be maintained at between 0.4 and 0.5 million cubic feet per day per well across all three projects. Within each project the required peak rate can be even higher.

While the projected drilling rate appears to be sustainable, based on drilling rates to date, the estimation of required wells is only valid for a given productivity per well; that is, if the peak production per well is less than anticipated or the production rate per well declines more rapidly to a lower production “tail” with time, more wells will be required to meet the

contracted volumes. The actual well productivity is only known after dewatering has been completed and it is unlikely that this has occurred for the majority of coal seam gas wells for the LNG projects. Limited data on well rates available in the public domain suggests “peak 7-day average gas rate” of 0.65 million cubic feet per day per well with a median rate of 0.55 million cubic feet per day per well in the Berwyndale South Walloon Coal Measures accumulation. The longer term sustained production rate is not known.

Origin presented that for wells that have been online for more than six months, the observed maximum average well production rates were 2.1 TJ/d per well (equivalent to 2 mmscf/d per well) for the Talinga project and 1.1 TJ/d (about 1 mmscf/d per well) for the Spring Gully project, higher than its expectation of 1.2 TJ/d per well on average of its Phase 1 drilling operation (see link below). These production rates appear to meet the required rates for the contracted demand (Table 2.4). For the GLNG project, Santos stated that the performance of Fairview wells continues to exceed expectations with average optimum gas capacity of 2.2 TJ/day per well. Roma wells are on line and are dewatering, supporting individual well capacity of 0.5 TJ/day; Roma 02- 04-01 well are producing over 1 TJ/day. All this information is still limited to the average peak production rates per well.

Half year end	Santos	Origin	QGC	Average	Total production wells
Jun-05	0.537	0.167	0.189	0.297	135
Dec-05	0.565	0.449	0.017	0.344	181
Jun-06	0.641	0.508	0.250	0.466	206
Dec-06	0.775	0.505	0.683	0.654	231
Jun-07	0.760	0.601	0.709	0.690	257
Dec-07	0.758	0.529	0.775	0.687	347
Jun-08	0.743	0.645	0.825	0.738	371
Dec-08	0.673	0.728	0.464	0.622	401
Jun-09	0.557	0.767	0.571	0.632	541
Dec-09	0.899	0.618	0.903	0.806	541
Jun-10	0.925	0.619	0.742	0.762	592
Dec-10	0.856	0.888	0.847	0.864	575
Jun-11	0.852	0.874	0.733	0.819	603
Dec-11	0.780	0.830	0.659	0.756	686
Jun-12	1.053	0.891	0.750	0.898	684
Dec-12	0.845	0.869	0.694	0.802	739
Jun-13	0.863	0.737	0.663	0.754	771
Dec-13	0.880	0.608	0.401	0.630	1083
Jun-14	0.714	0.428	0.259	0.467	2064
Dec-14	0.507	0.241	0.262	0.337	3074
Jun-15	0.277	0.267	0.381	0.308	3911
Dec-15	0.350	0.435	0.512	0.432	4299
Average	**0.719**	**0.600**	**0.558**	**0.626**	

Table 2.5: Historical rates of CSG daily production of the wells from the three LNG operators (mmscf/well per day) and the corresponding number of production wells (Data source: Queensland Department of Natural Resources and Mines, July 2016). The relatively low production rates of wells for all three projects in 2014 and 2015 may be related to the de-watering process of recent wells.

Longer term (10 years) sustained production rates can be obtained from the historical CSG production data and numbers of producing wells available online from the Queensland Department of Natural Resources and Mines (Table 2.5). The production rates from CSG projects operated by Origin, QGC and Santos in general exceed 0.5 mmscf/day per well, with the average rates of 0.600 mmscf/day, 0.558 mmscf/day and 0.719 mmscf/day, respectively. From these long term production rates, it seems that the CSG production rates would be adequate for fulfilling the committed contracts (Table 2.4).

References:

Armour Energy
http://www.armourenergy.com.au/investors/investment-research (7-August-2013)

Beach Energy for ATP 588
http://www.beachenergy.com.au/IRM/Company/ShowPage.aspx/PDFs/3985-10000000/NTNGContingentResources

Independent Expert's Report for Armour Energy Limited
http://www.empireenergy.com/pdf/McArthur%20Basin%20Armour%20Co%20Ltd%20Ind.%20Geo's%20Report.pdf

Origin APLNG Operational Review and Asset Visit (May 2014)
https://www.originenergy.com.au/content/dam/origin/about/investors-media/docs/june-2015-quarterly-production-report-consolidated-31072015.pdf

Origin Annual Reserve Report (July 2016)
https://www.originenergy.com.au/content/dam/origin/about/investors-media/presentations/160729%20Annual%20Reserves%20Report%202016.pdf

BG Group's LNG business:
http://www.bg-group.com/files/pdf/qgc/2481_qgc-bg_ausprofile.webfinal.pdf

Queensland production and reserves statistics December 2015
https://www.business.qld.gov.au/invest/investing-queenslands-industries/mining/resources-potential/petroleum-gas-resources/petroleum-gas-statistics

Resource and Land Management Services, Eastern Australia Upstream Gas Report July 2015
https://www.rlms.com.au/wp-content/uploads/2013/07/150804_JULY_Report.pdf

Santos purchased gas for GLNG
https://www.santos.com/media-centre/announcements/glng-signs-gas-purchase-agreement-with-agl/

Santos 2015 Reserves Statement
https://www.santos.com/media/3206/160219_reserves_statement.pdf

Santos GLNG contracted resources and well production rates
http://www.santos.com/library/2014_09_15_%20CLSA%20presentation.pdf (pages 113-14)

New South Wales

Unconventional resource potential:

Basin/Formation	Tight gas	Shale gas	CSG	*Status*
Clarence-Moreton Basin				
Walloon Coal Measures			✓	*Preliminary exploration*
Ipswich Coal Measures			✓	*Inactive*
Nymboida Coal Measures			✓	*Inactive*
Surat Basin				
Walloon Coal Measures			✓	*Preliminary exploration*
Gunnedah Basin				
Black Jack Formation			✓	*Preliminary exploration*
Maules Creek Formation			✓	*Preliminary exploration*
Sydney Basin				
Narrabeen Group	✓			*Inactive*
Bulgo Sandstone	✓			*Inactive*
Colo Vale Sandstone	✓			*Inactive*
Illawarra Coal Measures	✓		✓	*Producing*
Wittingham Coal Measures			✓	*Preliminary exploration*
Newcastle Coal Measures			✓	*Preliminary exploration*
Tomago Coal Measures			✓	*Preliminary exploration*
Greta Coal Measures			✓	*Preliminary exploration*
Shoalhaven Group	✓			*Inactive*
Clyde Coal Measures			✓	*Inactive*
Gloucester Basin				
Gloucester Coal Measures			✓	*Preliminary exploration*
Ashford Basin				
Ashford Coal Measures			✓	*Preliminary exploration*

Table 3.1 NSW Unconventional Resource Potential

Reserves/Resources:

TOTAL PETROLEUM INITIALLY-IN-PLACE (PIIP)	DISCOVERED PIIP	COMMERCIAL	**PRODUCTION: 4.7 PJ in 2015**		
			RESERVES 1P: 35 PJ	**RESERVES** **2P: 41 PJ**	RESERVES 3P: 41 PJ
		SUB-COMMERCIAL	CONTINGENT RESOURCES 1C: 0 PJ	**CONTINGENT RESOURCES** **2C: 2 254 PJ**	CONTINGENT RESOURCES 3C: 0 PJ
			UNRECOVERABLE		
	UNDISCOVERED PIIP		PROSPECTIVE RESOURCES Low Estimate	PROSPECTIVE RESOURCES Best Estimate	PROSPECTIVE RESOURCES High Estimate
			UNRECOVERABLE		

Table 3.2 NSW Reserves/Resources, August 2015, compiled from public sources.

Production/Forecasts:
The only unconventional gas production in NSW is from AGL's Camden Gas Project, which produces about 5% of the State's gas supply, averaging approximately 4.7PJ per annum.

AGL has announced that they will be withdrawing early from their Camden Gas Project in 2023, twelve years earlier than previously proposed. This follows a strategic decision from AGL that exploration and production of natural gas assets will no longer be a core business for the company due to the volatility of commodity prices and long development lead times.

AGL has also announced they will be withdrawing from the Gloucester Gas Project (PEL285). The Gloucester Gas project was proposed to produce up to 30 PJ per annum for 30 years. The relinquishment of PEL285 has no yet taken place.

An application has been submitted to the NSW Department of Planning for Santos's Narrabri Gas Project. The Narrabri Gas project proposes to produce up to 73 PJ per annum for 25 years. The Secretary's Requirements for the project (SSD 14_6456) were issued 25 July, 2014. For now it is uncertain as to when this project will finalise the approval process and begin producing. Meanwhile, Santos has reclassified the reserves in the Gunnedah Basin as contingent resources at the current low oil price environment (Santos 2016).

Unconventional resource drilling activity:

The unconventional drilling activity in the State is currently low. No petroleum wells have been drilled in 2016 in NSW to date.

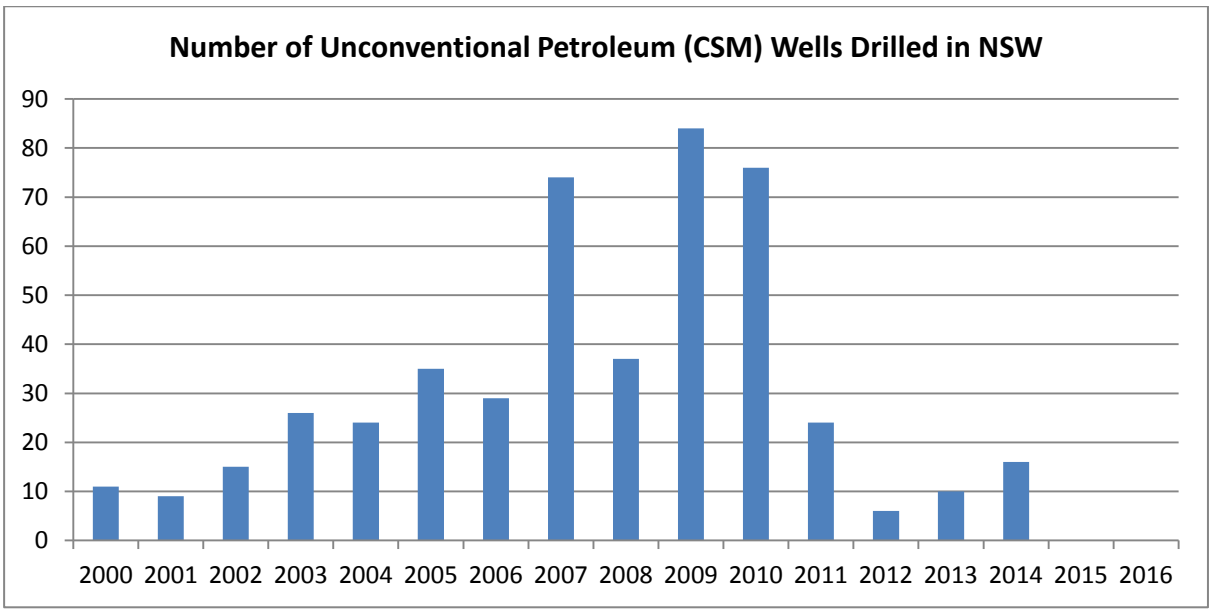

Figure 1: Chart of Unconventional Petroleum Wells from 2000 to 2015 (NSW Division of Resources and Energy, August 2015)

Commentary:

Other Resources:

In addition to the coal seam gas resources identified to date, conventional and tight gas resources may also be present, either in sandstones associated with the coal seams or independent of them. A number of gas accumulations have been discovered in the Sydney Basin but these typically produce gas at a rapid declining rate from vertical wells, indicating tight reservoirs or limited reservoir extent. Current drilling technology may make further investigation of these discoveries viable.

References:

AGL, 2016, Review of gas assets and exit of gas exploration and production https://www.agl.com.au/-/media/AGL/About-AGL/Documents/Media-Center/ASX-and-Media-Releases/2016/1521917.pdf?la=en

Metgasco, 2015, Metgasco 2014 Annual Report, http://www.metgasco.com.au/asx-announcements/2014-annual-report

NSW Parliamentary Research Service, 2014, A tightening gas market: supply, demand and price outlook for NSW. Briefing Paper No 4/2014 by Andrew Haylen. http://www.parliament.nsw.gov.au/prod/parlment/publications.nsf/key/AtighteninggasmarketsupplydemandandpriceoutlookforNSW

Santos, 2016, Reserves Statement Report to ASX, https://www.santos.com/media/3206/160219_reserves_statement.pdf

Victoria

Unconventional resource potential:

Basin/Formation	Tight gas	Shale gas	CSG	*Status*
Gippsland Basin				
Latrobe Group			✓	*Inactive*
Strzelecki Group	✓			*Inactive*
Otway Basin				
Eumeralla Formation	✓			*Inactive*

Table 4.1: Victorian unconventional resource potential

Reserves/Resources:

TOTAL PETROLEUM INITIALLY-IN-PLACE (PIIP)	DISCOVERED PIIP	COMMERCIAL	PRODUCTION		
			RESERVES 1P	RESERVES 2P	RESERVES 3P
		SUB-COMMERCIAL	CONTINGENT RESOURCES 1C	**CONTINGENT RESOURCES 2C: 4 060 PJ**	CONTINGENT RESOURCES 3C
			UNRECOVERABLE		
	UNDISCOVERED PIIP		PROSPECTIVE RESOURCES Low Estimate	**PROSPECTIVE RESOURCES Best Estimate: 9 875 PJ**	PROSPECTIVE RESOURCES High Estimate
			UNRECOVERABLE		

Source: See Goldie Divko 2015a & b
The Wombat, Trifon and Gangell fields are reported to host an additional estimated 1.7TCF of tight gas.
Table 4.2: Victorian unconventional resources

Production/Forecasts:

Nil

Unconventional resource drilling activity:

Nil

Commentary:

On 30 August 2016, the Victorian Government announced a permanent ban on the exploration and development of all onshore unconventional gas in Victoria, and an extension of the current moratorium on the exploration and development of conventional onshore gas until 30 June 2020. This was in response to a Parliamentary Inquiry into onshore unconventional gas

exploration and production, which tabled its final report on 8 December 2015. A moratorium has been in place since 2012. Further information is available at http://onshoregas.vic.gov.au/. On 22 November 2016 the Victorian Government introduced the Resources Legislation Amendment (Fracking Ban) Bill 2016 which aims to:

- ban the exploration for and mining of coal seam gas;
- ban hydraulic fracturing; and
- extend the moratorium on onshore conventional gas exploration and development to 30 June 2020.

References:

Goldie Divko, L. M., 2015a. A review of gas prospectivity: Gippsland region. Department of Economic Development, Jobs, Transport and Resources. Melbourne, Victoria.

Goldie Divko, L. M., 2015b. A review of gas prospectivity: Otway region. Department of Economic Development, Jobs, Transport and Resources, Melbourne, Victoria.

Tasmania

Unconventional resource potential:

Basin/Formation	Tight gas	Shale gas	CSG	*Status*
Tasmania Basin				
Woody Island Formation	✓*+	✓*+		*Inactive*

**Unconventional oil and gas potential + nature of resources yet to be determined*

Table 5.1: Tasmanian unconventional resource potential

Reserves/Resources:

None.

Production/Forecasts:

None.

Unconventional resource drilling activity:

None.

Commentary:

While there is prospectivity for both conventional and unconventional resources in Tasmania, there have been no discoveries and limited exploration undertaken to date.

References:

The Tasmania Basin – Gondwanan Petroleum system
http://www.mrt.tas.gov.au/mrtdoc/tasxplor/download/02_4832/Tasmaniax.pdf

South Australia

Unconventional resource potential:

Basin/Formation	Tight gas	Shale gas	CSG	*Status*
Eromanga Basin				
Winton Formation			✓	*Inactive***
Cooper Basin				
Toolachee Formation	✓	✓		*Under assessment****
Roseneath Shale		✓		*Under assessment****
Epsilon Formation	✓			*Under assessment****
Murteree Shale		✓		*Under assessment****
Patchawarra Formation	✓	✓	✓	*Under assessment****
Warburton Basin				
Pando Formation	✓			*Inactive*
Dullingari Group	✓	✓		*Inactive*
Kalladeina Formation	✓			*Inactive*
Mooracoochie Volvcanics	✓*			*Inactive*
Pedirka Basin				
Purni Formation			✓	*Inactive*
Simpson Basin				
Peera Peera Formation			✓	*Inactive*
Officer Basin				
Observatory Hill Formation	✓*		✓	*Inactive*
Ouldburra Formation	✓			*Inactive*
Narana Formation	✓			*Inactive*
Dee Dee Mudstone	✓			*Inactive*
Arckaringa Basin				
Mount Toondina Formation			✓	*Preliminary exploration*
Stuart Range Formation		✓*		*Preliminary exploration*
Otway Basin				
Pretty Hill Formation	✓			*Inactive*
Sawpit Shale		✓		*Preliminary exploration*
Casterton Formation		✓*		*Preliminary exploration*

**Unconventional oil and gas potential*
***Preliminary exploration showed coal thickness and gas content currently below commercial thresholds*
****Minor production*

Table 6.1: South Australian unconventional resource potential

The nature of these resource plays is fully described in Chapters 2 and 4 of the *Roadmap for Unconventional Gas Projects in South Australia*. Core Energy (2016) also provide a summary of gas play types and potential.

Reserves/Resources:

TOTAL PETROLEUM INITIALLY-IN-PLACE (PIIP)	DISCOVERED PIIP	COMMERCIAL	PRODUCTION		
			RESERVES 1P	RESERVES 2P	RESERVES 3P
		SUB-COMMERCIAL	CONTINGENT RESOURCES 1C: 2 482 PJ*	**CONTINGENT RESOURCES 2C: 6 881 PJ***	CONTINGENT RESOURCES 3C: 13 930 PJ*
			UNRECOVERABLE		
	UNDISCOVERED PIIP		PROSPECTIVE RESOURCES Low Estimate: 72 253 PJ**	**PROSPECTIVE RESOURCES Best Estimate: 181 799 PJ****	PROSPECTIVE RESOURCES High Estimate: 331 909**
			UNRECOVERABLE		

*Source: *Roadmap for Unconventional Gas Projects, pages 89-111, Santos, Beach Energy, Senex and Strike Reports, (see reference links in page 25)*
*** As for * plus Drillsearch report*

Resource play	BCG	REM	Permian Coal	Patchawarra SR	Deep CSG
OIP (BBO)	-	-	39.94	23.59	-
Sales GIP (TCF)	150.54	33.58	113.77	53.15	TBD

Note: BBL = billion barrels of oil. TCF = trillion cubic feet. Results are un-risked (deterministic).

Table 6.2: South Australian unconventional resources SA Cooper Basin Resource play estimates, deterministic in place, unrisked from DSD as published in Core Energy (2016). These estimates were enabled by basin modelling outputs generated by Lisa Hall as part of the Cooper Basin Petroleum Prospectivity Review (Geoscience Australia) in 2015-16.

Production/Forecasts:

Minor production from recent shale gas exploration wells.

The challenges associated with accelerating shale gas production are described at pages 158 and 159 of the Roadmap for Unconventional Gas Projects in South Australia (see link below).

Beach Energy, Drillsearch and Senex are also actively exploring the Roseneath-Epsilon-Murteree (REM) and Patchawarra resources while Beach Energy and Strike Energy are assessing coal seam gas potential in the southern Cooper Basin.

Recently, Beach reduced contingent resources associated with its operated unconventional gas acreage (PRLs 33 to 49 and ATP 855) to nil, following its completion of the Nappamerri Trough Natural Gas (NTNG) stage 1 exploration program. Analysis of the program results demonstrated

that the high costs of the project and the low gas price environment means the NTNG project is unlikely to be developed commercially in the medium term (Beach 2016).

Unconventional resource drilling activity:

Low since the fall in the price of oil in late 2014.

Explorers have accelerated appraisal of Cooper Basin unconventional plays since the first exploration well to test these plays was drilled in 2010 (Table 6.2). Following on from 19 vertical wells to test unconventional gas plays in 2012 and 2014, 4 wells were drilled during 2015 (Table 6.2). Due to the downturn in drilling in the basin in the last 18 months there has been little unconventional (or even conventional) activity on the South Australia side of the boarder.

Year	No. of Wells Drilled
2010	2
2011	2
2012	13
2013	13
2014	6
2015	4

Source: Department of State Development, South Australia (http://www.petroleum.statedevelopment.sa.gov.au/prospectivity/basin_and_province_information/unconventional_gas/cooper_basin_unconventional_wells)

Table 6.3. Number of wells targeting natural gas in unconventional reservoirs, South Australia.

Commentary:

Exploration drilling activity in the Cooper Basin has slowed markedly as a result of the global downturn in the industry because of the significant drop in the oil price. As a result, the main players in the Cooper have significantly reduced their operational expenditures. This significantly impacts the drilling activity levels.

Over 800 fracture stimulations have been undertaken in the South Australian part of the Cooper Basin since production commenced in 1969. Some of these stimulations were in low permeability (tight) sandstones in the REM and Patchawarra Formation sequence that contain the shale gas and coal seam gas resources. Better than expected well performance suggests that these wells have been producing from the unconventional reservoirs adjacent to the tight sands.

Refer to table 6.2 for estimates of in-place resource volumes in unconventional reservoirs in the Cooper Basin across South Australia and Queensland. Potential exists in other bsisn – but less data is available to underpin estimates

With regard to the timing of production, although three unconventional wells (Moomba 191, 193H and 194) have been producing for over two years, no reserves for unconventional petroleum have been reported in South Australia. It is unlikely that substantial volumes of gas from this resource will be available to the gas market in the short term.

Beach reduced contingent resources associated with its operated unconventional gas acreage in the Cooper Basin to nil, indicating the NTNG project is unlikely to be developed commercially in the medium term due to the high costs of the project and the low gas price environment means.

References:

Beach Energy 2016 Reserves and Contingent Resources Statement
http://www.beachenergy.com.au/irm/PDF/6210/ReservesandContingentResourcesasar30June2016

Core Energy, 2016. Cooper-Eromanga Basin Outlook 2035. Core Energy Group report commissioned by DSD-ERD.

Roadmap for Unconventional Gas Projects in South Australia
http://www.pir.sa.gov.au/petroleum/prospectivity/basin_and_province_information/unconventional_gas/unconventional_gas_interest_group/roadmap_for_unconventional_gas_projects_in_sa

Santos Cooper Basin and GLNG Investor Presentation
https://www.santos.com/media/1854/2015_cooper_and_glng_investor_visit.pdf
Senex Energy
http://www.strikeenergy.com.au/wp-content/uploads/2016/04/20160331-March-Quarterly-2016.pdf

Schenk, C.J, Tennyson, M.E., Mercier, T.J., Klett, T .R., Finn, T.M., Phuong, A. Le., Brownfield, M.E., Gaswirth, S. B., Marra, K.R., Hawkins, S.J., Leathers-Miller, H.M., & Pitman, J.K. 2016. The assessment of Continuous Oil and Gas Resources of the Cooper Basin, Australia, 2016. USGS Fact Sheet 2016-3050

Strike Energy
http://www.strikeenergy.com.au/wp-content/uploads/2015/07/20151028_September-Quarterly-2015.pdf
http://www.strikeenergy.com.au/wp-content/uploads/2016/04/20160331-March-Quarterly-2016.pdf

Western Australia

Unconventional resource potential:

Basin/Formation	Tight gas	Shale gas	Shale Oil	*Status*
Northern Perth Basin				
Yarragadee Formation	✓			*Under assessment*
Kockatea Shale		✓	✓	*Under assessment*
Dongara/Wagina Sandstone	✓		✓	*Producing*
Carynginia Formation		✓	✓	*Preliminary exploration*
Irwin River Coal Measures	✓	✓	✓	*Preliminary exploration*
High Cliff Sandstone	✓		✓	*Under assessment*
Southern Perth Basin				
Sue Coal Measures	✓			*Inactive*
Carnarvon Basin				
Wooramel Group		✓		*Inactive*
Byro Group		✓		*Inactive*
Canning Basin				
Laurel Formation	✓	✓		*Under assessment*
Goldwyer Formation		✓	✓	*Preliminary exploration*
Bonaparte Basin				
Milligans Formation	✓			*Inactive*
Bonaparte Formation	✓			*Inactive*

**Unconventional oil and gas potential*

Table 7.1: Western Australian unconventional resource potential

Reserves/Resources:

TOTAL PETROLEUM INITIALLY-IN-PLACE (PIIP)	DISCOVERED PIIP	COMMERCIAL	PRODUCTION: 0* PJ in 2015		
			RESERVES 1P	**RESERVES 2P**	RESERVES 3P
		SUB-COMMERCIAL	CONTINGENT RESOURCES 1C: 177 PJ	**CONTINGENT RESOURCES 2C: 254 PJ**	CONTINGENT RESOURCES 3C: 382 PJ
			UNRECOVERABLE		
	UNDISCOVERED PIIP		PROSPECTIVE RESOURCES Low Estimate	**PROSPECTIVE RESOURCES Best Estimate**	PROSPECTIVE RESOURCES High Estimate
			UNRECOVERABLE		

** The production data for individual fields is commercial-in-confidence and is not shown here.*

Table 7.2: Western Australian unconventional resources as compiled by WA Department of Mines and Petroleum, and Geoscience Australia from company annual reporting

Prospective resources are not collected in Western Australia by the Department of Mines and Petroleum. The contingent resources shown in the table above are optimistic, as the

classification between conventional and shale and tight gas reservoirs or formations cannot always clearly be made.

Production/Forecasts:

Production data in Western Australia is confidential for two years, as per the *Resource Management and Administration Regulations (2015)* to the *Petroleum and Geothermal Energy Resources Act (1967).* Currently the only unconventional play producing is the Corybas tight gas field. The 2015 production data is not shown in this report.

Unconventional resource drilling activity:

Moderate.

Since 2005 towards end 2015, 24 exploration wells have been drilled to search for shale and tight gas resources in Western Australia. Eight of these involved hydraulic fracturing to test the capacity of the reservoir to generate commercial gas flows

Commentary:

Western Australia is considered to hold significant shale and tight gas resources in the Kimberley, East Pilbara and Midwest regions. Department of Mines and Petroleum, Western Australia, has shown that the state potentially contains an estimated 39 140 Gm^3 (1 381 Tcf) gas initially in place (GIIP) resources of shale and tight gas. Of this, approximately 29 900 Gm^3 (1 054 Tcf) are in the Canning Basin (Kimberley and East Pilbara regions); 6 540 Gm^3 (232 Tcf) are in the north Perth Basin (Midwest region); and 2 700 Gm^3 (95 Tcf) are in the Northern Carnarvon Basin (onshore).

The Canning Basin is recognised as having great potential. Prospective formations have great areal extent although the extent of unconventional resources within them is currently unknown. Resource estimates assessing the whole of a formation across the basin should, therefore, be suitably discounted for this uncertainty. Due to the remoteness of the basin, transport and infrastructure will also be a significant issue in any unconventional resource development.

The Northern Perth Basin, however, is better placed near markets, infrastructure and pipelines and is more likely to see unconventional gas reach market first. It also holds the only tight gas fields currently progressed to the contingent stage of exploration.

If exploration in Western Australia proves successful, significant commercial production is anticipated to be at least five to ten years away.

References

Department of Mines and Petroleum, Petroleum Division, Petroleum in Western Australia, September 2015.

Northern Territory

Unconventional resource potential:

Basin/Formation	Tight gas	Shale gas	CSG	*Status*
Onshore Bonaparte Basin				
Milligans Formation	✓	✓		*Inactive*
"Bonaparte Formation"	✓	✓		*Preliminary exploration*
Georgina Basin				
Arthur Creek Formation	✓	✓		*Preliminary exploration*
Thorntonia Limestone		✓		*Preliminary exploration*
Chabalowe Formation		✓		*Inactive*
McArthur Basin/Beetaloo Sub-basin				
Kyalla Formation		✓		*Preliminary exploration*
Velkerri Formation	✓	✓		*Under assessment*
Barney Creek Formation		✓		*Preliminary exploration*
Coxco Dolostone	✓			*Preliminary exploration*
Bessie Creek Sandstone	✓			*Preliminary exploration*
Moroak Sandstone	✓			*Preliminary exploration*
Tawallah Group				
Wollagorang Shale		✓		*Preliminary exploration*
McDermott Formation		✓		*Preliminary exploration*
Mount Isa Superbasin				
Lawn Hill Shale		✓		*Inactive*
Riversleigh Siltstone		✓		*Inactive*
Amadeus Basin				
Pacoota Sandstone	✓	✓		*Producing*
Horn Valley Siltstone		✓		*Producing*
Stairway Sandstone	✓	✓		*Producing*
Eromanga Basin				
Toolebuc Formation		✓		*Inactive*
Oodnadatta Formation		✓		*Inactive*
Pedirka Basin				
Peera Peera Formation			✓	*Inactive*
Purni Formation		✓	✓	*Preliminary exploration*
Ngalia Basin				
Mount Eclipse Sandstone	✓			*Inactive*
Wiso Basin				
Montejinni Limestone		✓		*Inactive*

Table 8.1: Northern Territory unconventional resource potential

Reserves/Resources:

TOTAL PETROLEUM INITIALLY-IN-PLACE (PIIP)	DISCOVERED PIIP	COMMERCIAL	PRODUCTION		
			RESERVES 1P	RESERVES 2P	RESERVES 3P
		SUB-COMMERCIAL	CONTINGENT RESOURCES 1C	CONTINGENT RESOURCES 2C	CONTINGENT RESOURCES 3C
			UNRECOVERABLE		
	UNDISCOVERED PIIP		PROSPECTIVE RESOURCES Low Estimate: 8 626 PJ	**PROSPECTIVE RESOURCES Best Estimate: 275 211 PJ**	PROSPECTIVE RESOURCES High Estimate: 351 054 PJ
			UNRECOVERABLE		

Source: Munson (2014), http://www.armourenergy.com.au/assets/1475615.pdf, http://www.empireenergygroup.net/announcements/resignation-of-joint-company-secretary
NT DPIR 2016, EnergyNT 2015

Table 8.2: Northern Territory unconventional resources

Production/Forecasts:

None

Unconventional resource drilling activity:

The number of wells drilled for unconventional resource exploration since 2011 are shown in Table 8.3 and Figure 8.1

Year	No. of Wells Drilled
2011	2
2012	5
2013	10
2014	12
2015	6
2016	4

Table 8.3: Number of unconventional wells drilled since 2011

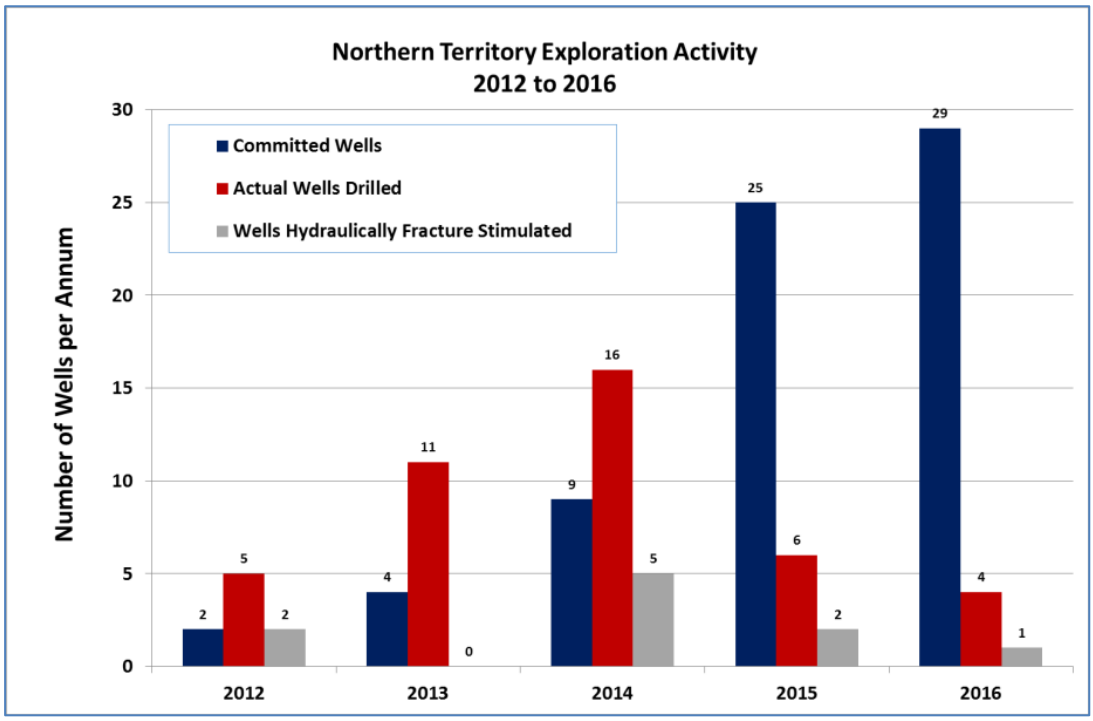

Figure 8.1: Number of wells drilled targeting unconventional petroleum resources in Northern Territory since 2012

Commentary:

Figure 8.1 illustrates the level of activity vs the volume of work commitments and hydraulic fracturing activity in the last 5 years.

The most advanced unconventional play in the Northern Territory relates to shale gas in Beetaloo Sub-basin of the McArthur Basin. Exploration and geological investigations of the Velkerri Formation in the Beetaloo Sub-basin increasingly suggest that the formation has very large potential resources of shale gas and liquids in-place.

NT exploration and production activity, however, dropped in 2016 due to the ongoing low global oil price and a proposed moratorium by the now elected Labor party on unconventional resource hydraulic fracture stimulation practices. The moratorium has been implemented and will remain in force until the outcomes of a scientific inquiry into hydraulic fracturing in the Northern Territory have been considered by the government. At the conclusion of this process the government will either ban hydraulic fracturing of unconventional reservoirs in the Northern Territory or allow it to proceed in highly controlled areas under strict regulatory oversight.

References:

NT DPIR 2016, EnergyNT 2015

Munson TJ, 2014. Petroleum geology and potential of the onshore Northern Territory, 2014. Northern Territory Geological Survey, Report 22

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http://www.armourenergy.com.au/assets/1475615.pdf

Empire Energy (2016)
http://www.empireenergygroup.net/announcements/resignation-of-joint-company-secretary