NGP Economics
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NGP Economics
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Office of the Independent Planning Commission NSW
Level 3, 201 Elizabeth Street
SYDNEY NSW 2000

21st August 2020

Narrabri Gas Project, Commission Public Hearing
Material Last-Minute Change in Proponent's Claims and Material

It was with dismay that I learnt on 11th August 2020 that Santos had made a number of new submissions to the Independent Planning Commission on the last day for submissions, just before the closing time for project stakeholders to provide material.

These late submissions contain materially different positions and claims for a range of NGP factors.

I have perused the new material and the significant changes in Santos' claims and assertions, gas price impact and project cost assumptions, and environmental issues, amongst other new material, require in my view a comprehensive independent evaluation and further public opportunity for comment.

A review of the documents lodged by Santos on 10th August reveals that they contain major changes in project assumptions and justifications, and a number of impossible-to-validate statements and figures, vague assurances and inconsistencies with prior proponent submissions, all of which indicate that the entire Assessment Process has been based on a now superseded set of project assumptions and information. The new and, and in some cases, markedly different justifications for the project present a clear and pressing need for the Assessment process to be reconsidered.

Attached is a detailed consideration and response to a number of statements contained in the Proponent's and its Advisors' 10th August submissions. The short time to respond did not allow for a consideration of many issues.

The price claims are dealt with in the attached material. There is nothing in the new Santos material which supports the claim of possible downward pressure on gas prices, in the absence of two import terminals, and no analysis of impacts on contracted gas prices.

With regards to the contentious issue of Greenhouse gas emissions (vented carbon dioxide and fugitive emissions), there is a clear need for hard limits on Greenhouse Gas emissions to address uncertainties in NGP emission limits for the Project, which are currently not set out or detailed in the "SPECIFIC ENVIRONMENTAL CONDITIONS" of the draft Development Consent.

It should not be left to the DPIE and Santos to agree GHG emissions limits at some future time in an "Air Quality and Greenhouse Gas Management Plan for the development [to the satisfaction of the Planning Secretary]".

There is no mechanism for effective external control in developing such a plan with relevant external technical and environmental input and widely differing views on carbon dioxide content and timing of production of this carbon dioxide.

These GHG emission limits should be set now, and limit the emissions to the Santos' claimed factors: 5% of produced CO2 (250,000 tonnes CO2 vented p.a.) and 0.0058% for fugitive methane (2,000 tonnes CO2e p.a. fugitive methane).

In addition to including these "hard" conditions in any Consent, they will need to be monitored by an independent agency or organisation which is not restricted in what and when it takes the required samples to ensure compliance.

The restrictions to date placed on researchers in accessing CSG production facilities to take measurements of fugitive emissions do not convey that the industry has nothing to hide - in fact, it conveys the opposite message.

The proposed solution to constrain CO2 production will provide the required strong commercial incentive for Santos to only produce low CO2 gas. It is not considered feasible for the DPIE to direct Santos where and how to produce, in order to meet limits which are not yet defined.

A fixed limit, in this case of 250,000 tonnes CO2 p.a. extracted and vented, will ensure that the NGP gas production does result in lower emissions for electricity from NGP gas than coal.

Similarly, a fixed limit of 2,000 tonnes CO2e p.a. of fugitive emissions, with penalties and requirement form immediate rectification in the case of breach, would simply bind Santos to the emission factors it proposes.

I remain at the Commission's disposal to further discuss any technical or other issues that may relate to the above, and in providing input on any necessary frameworks for monitoring and compliance to the recommended "hard" limits on emissions to be included in "SPECIFIC ENVIRONMENTAL CONDITIONS" of any Consent.

Sincerely

Dr Andrew Grogan, PhD, BE (Hons)

Observations and summary of some key issues from Final Proponent Submissions

Gas Price 'Pressure'

- It is very hard to construct a valid reason why any east coast gas producer (such as Santos) would willingly develop and produce excess volumes of gas at a high marginal cost in order to reduce its overall revenue by also lowering the price of gas.
  - The continued insistence by Santos on the cost-of-supply number (itself highly arguable) distracts from the fundamental fact that gas prices are set by the market, not the cost of supply.
  - Santos' revelation that it achieved A$12/GJ for LNG imports while the STTM was sub A$6/GJ explains why contract prices during this period at $9-10/GJ were much closer to LNG prices than the STTM price.
  - There continues to be a lack of explanation or admission by supporters of the NGP that the price of gas in the east coast market is set by the alternative market for that gas which is LNG; although IPART and ACCC documents and the 14th August 2020 ACIL Allen report provided by Santos all confirm this
- An examination of the ACIL Allen report reveals that in order for the NGP gas to have any impact on STTM prices (and this is late in the 2020 decade in the ACIL Allen modelling), that gas supply from two import terminals also needs to be invoked
  - The absence of any gas supply profiles in the ACIL Allen report renders it of extremely limited value in assessing what is fundamentally a market volume/price relationship
  - The ACIL Allen report specifically does not address any impacts on contracted gas prices, and so has limited relevance to any consideration of the NGP on gas contract prices

Greenhouse Gas Emissions (CO2)

- CO2 production
  - There is no incompatibility between the high calculated in -situ CO2 and reported low initial CO2 production. There is simply an unknown timing issue for when the CO2 will be produced.
  - The CSG wells at Narrabri have a high in-situ CO2 content; the data from the desorption tests on thousands of samples is unambiguous. What is unknown is how and when this CO2 would be produced over the life of a well. The currently reported 5% CO2 composition (from 29 wells out of 116 in PEL 238) will increase over the life of the field.
  - An "average" content of 10% over the project life will result in the CO2 content being considerably higher late in life if the initial production is 5% CO2. This late life high CO2 should be constrained by Project conditions.
  - This expected increase in CO2 is forecast by Connell et al (2015) and observed in the San Juan basin, where the late-life high CO2 causes significant production problems.
- Santos is highly confident that current CO2 is 5% of produced gas, which would be equivalent to vented CO2 (to meet sales gas specifications) of 250,000 tonnes CO2 p.a. A key issue is therefore the necessity to constrain the Project Conditions to this limit and to independently measure and enforce the limit. This removes any argument and accepts Santos claim of 5% CO2, and binds them to it over the life of the project.

Proposed Solution on defining and enforcing CO2 limits

The cleanest and simplest way to address uncertainties in the producing CO2 content over the life of the NGP is to include in the Recommended Conditions a firm annual extracted and vented CO2 limit of 250,000 tonnes CO2 p.a., corresponding to 5% of produced gas composition (Some suggested drafting for this is provided at the end of this document)

Greenhouse Gas Emissions (Fugitive Methane)

- The fact remains, regardless the many Standards and Factors referred to by Santos, that the EIS value of .002 million tonnes per year of CO2e fugitive emissions in the EIS (see Table 5.3 in Appendix R of the EIS) corresponds to an emission factor of 0.0058%
- This factor is based on a CSIRO report that was unreasonably constrained in its sampling; and in any case relevant only for wellheads. The limitations of the specific CSIRO report are set out in the attached material.
- The USA EPA uses a total fugitive emission factor for the oil and gas industry factor (wells, pipelines, compressors, water pumps and all field facilities) from 2014 of 1.4%
- Santos is highly confident or insistent that annual fugitive emissions will be only 2,000 tonnes CO2e. A key issue is therefore the necessity to constrain the Project Conditions to this limit and to independently measure and enforce the limit.

Proposed Solution to constrain fugitive emissions and hold Santos to account for the emission factor of 0.0058%

- The cleanest and simplest way to therefore address uncertainties in the fugitive emissions over the life of the NGP is to include in the Recommended Conditions a firm annual fugitive emissions limit of 2,000 tonnes CO2 p.a.
- To ensure transparency and compliance, this measurement of fugitive emissions should be conducted by competent, independent and external environmental agencies and consultants, with unfettered access to well pads, pumps, gathering lines, field facilities on an inspection basis which allows for random sampling by the agency, and at all locations around the NGP.

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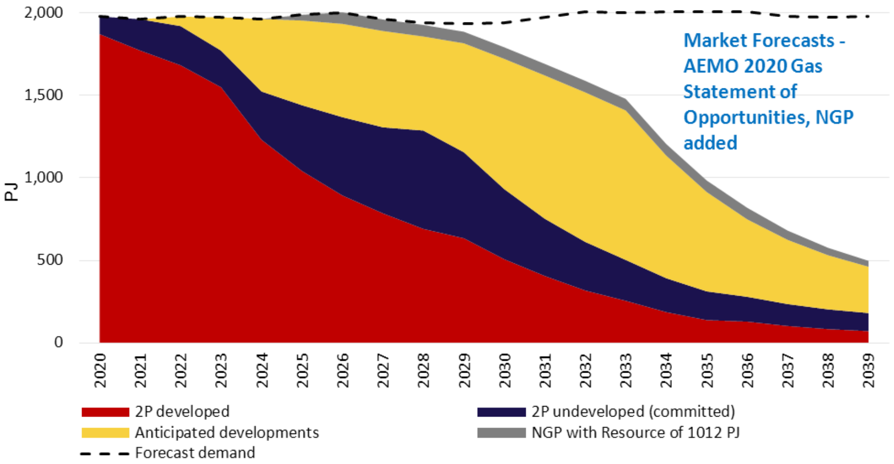
Santos Statement	Observation / Response	Background / Evidence
“Simply, the Narrabri Gas Project will offer large volumes of gas to the domestic market on long-term contracts. “	It is incorrect to claim that the NGP will offer ‘large volumes of gas’ (see plot on right with AEMO data). The DPIE acknowledged that the NGP gas volumes are small and will not impact prices. In any case, regardless of volumes, long term contract pricing is driven by the LNG netback in Queensland plus a healthy premium exacted by gas producers - NGP gas will not affect this. The linkage of east coast gas prices to the LNG import parity price has been described and acknowledged by IPART (NSW), the ACCC and ACIL Allen. Long term gas contracts for NSW without this “producer premium” can, however, can be sourced from an import terminal (as assumed by ACIL Allen in its report provided by Santos on 10th August 2020) at the same or a lower price than NGP gas would be sold for, when customers accept the linkage of east coast gas prices to LNG prices. It is of note that the ACIL Allen report did not address gas contract prices, only impacts on the STTM, which are not relevant to assessing any gas price benefits for the NGP project(ACIL Allen Report) *“The model results are based on the behaviour of the market as a pure spot market. However, the results give an indication of the forces that would drive prices in long term contracts over time”* The qualified and indeterminate phase *“an indication of forces*” can be decoded as: more gas volume than the NGP can provide may have an impact in terms of reducing east coast (NSW) long term gas contract prices. However, why gas sellers would prefer to sell at low gas prices (compared to LNG netback) when they can sell at a high price has never been explained. It is not a logical conclusion and in fact the opposite is observed in the market.	David Kitto, DPIE, Day 7 of Hearings - *“In terms of the pricing, I think we went into that in quite a bit of detail in the hearings. We’re not saying it will reduce prices. I think what we’re saying is, you know ,in all the gas that’s produced on the east coast, you know, it’s not big enough to change prices on its own” (Underline added : the ACIL Allen report need to add two import terminals to NGP to achieve any modelled price impact)*  The NSW (a part of the eastern state market) gas price is set by LNG imports: - *“Over the 12 month period to April 2019, the averages of producer price offers in Queensland were broadly in line with expected 2020 LNG netback prices”* (ACCC, Feb 2020 Gas Inquiry) - *“When we have lower gas prices around the world, and the Australian market linked to world gas markets, it is vital that Australian gas users get the benefit.”* (Rod Sims, ACCC, 17th August 2020) - *“There is a link between LNG prices and domestic prices” ACIL Allen, August 2020, Proponent’s NGP Submission*

NGP Economics

Santos Statement	Observation / Response	Background / Evidence
"ACIL Allen has updated its assumptions on the Narrabri Gas Project to reflect current economic conditions."	It is of note that the ACIL Allen report specifically did not address gas contract prices, only impacts on the STTM, which are not really relevant to assessing any gas price benefits for the NGP project(ACIL Allen Report) Long term gas contracts for NSW without the ACCC "producer premium" (see ACCC observations on the right) can, however, be sourced from an import terminal (as assumed by ACIL Allen in its report provided by Santos on 10th August 2020) at the same or a lower price than NGP gas would be sold for. This will occur when C&I customers realise that east-coast gas prices have forever been linked to the international LNG price (oil price) due to the existence of partially filled LNG trains in Queensland setting the floor price for contracted gas. This acceptance is slow in coming, but inevitable.	Rod Sims, ACCC, 17th August 2020 *"Queensland LNG producers sold 18 LNG spot cargoes into international markets in late 2019 and early 2020, equivalent to more than 10 per cent of annual domestic east coast demand," he said.* *"This gas was sold at prices substantially below domestic gas price offers, showing the importance of our continuing work to understand the drivers behind the price levels we are seeing across the domestic market.* *"I am yet to hear a compelling reason from LNG producers as to why domestic users are paying substantially higher prices than buyers in international markets.* *"When we have lower gas prices around the world, and the Australian market linked to world gas markets, it is vital that Australian gas users get the benefit."* https://www.pipeliner.com.au/2020/08/17/accc-concerned-about-gas-prices/

NGP Economics

Santos Statement	Observation / Response	Background / Evidence
"This will support Australian industries like manufacturing to drive the economic recovery out of the COVID-19 pandemic."	The assessment of which industries can best generate post COVID-19 employment requires a quantitative comparison with alternatives. While there has been energetic assertion in the Australian media about "low cost gas driving some sort of post COVID-19 boom", no market analysis or evidence has ever been provided by any individual or agency to support this claim. Renewable energy and many other alternatives are much higher employment generators on a sustainable basis than short-term resource project construction booms. Any industry may create jobs, but large numbers of sustainable, long term jobs for NSW personnel will not be the outcome from the NGP. The use of several billion dollars of capital for renewables, with a low cost LNG import terminal, would generate more jobs post COVID-19. Notwithstanding that the there are other options for large contracted volumes of gas for the NSW market, the ACIL Allen report clearly assumes that two LNG import terminals are fundamental to reducing prices; the small amount of gas from the NGP can be easily supplied by slightly increasing the throughput of the ACIL-Allen-assumed two import terminals; and import terminals offer a long term supply option.	CEC Report , June 2020 • The largest study of current and projected employment in the renewable energy industry in Australia has found that the sector employs over 25,000 people and could employ as many as 44,000 by 2025 with the majority of those jobs in regional Australia, according to the "Clean Energy At Work" report. https://www.forbes.com/sites/energyinnovation/2019/04/22/renewable-energy-job-boom-creating-economic-opportunity-as-coal-industry-slumps/#6304a8763665 • Renewable energy jobs are booming across America, creating stable and high-wage employment for blue-collar workers in some of the country's most fossil fuel-heavy states, just as the coal industry is poised for another downturn. • Economics are driving both sides of this equation: Building new renewable energy is cheaper than running existing coal plants and prices get cheaper every year. By 2025, almost every existing coal plant in the United States will cost more to operate than building replacement wind and solar within 35 miles of each plant. • Multiple states and utilities are setting 100% clean energy goals, creating new demand for workers to build solar panels and wind turbines. Planning for the inevitable coal-to-clean economic transition can create new economic opportunities in every corner of the country – and some forward-thinking policymakers are already heeding this lesson. • The renewable energy industry has become a major U.S. employer. E2's recent Clean Jobs America report found nearly 3.3 million Americans working in clean energy – outnumbering fossil fuel workers by 3-to-1. Nearly 335,000 people work in the solar industry and more than 111,000 work in the wind industry, compared to 211,000 working in coal mining or other fossil fuel extraction. Clean energy employment grew 3.6% in 2018, adding 110,000 net new jobs (4.2% of all jobs added nationally in 2018), and employers expect 6% job growth in 2019.

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Santos Statement	Observation / Response	Background / Evidence
It should be noted that most LNG, including Santos' projects is sold under long term contract, to underpin the many tens of billions of dollars of investments in LNG supply. That's why, in the first half of this year, despite the oil price war between Saudi Arabia and Russia, and despite the demand side shock caused by a mild northern winter and the coronavirus pandemic, Santos has realised relatively strong LNG prices, averaging US$8.57/mmbtu, which is around A$12 per gigajoule, much higher than spot LNG prices and also higher than average realised domestic gas [STTM] prices of around A$5.40 per gigajoule.	It is ironically appropriate that Santos has now confirmed the high prices it receives for LNG; as this simply sets the floor price for the market for Eastern States contract gas and for Santos gas. The STTM price is not the issue, it is a small segment of the 2,000 PJ p.a. market and of little relevance to businesses that need long term volumetric certainty - and this statement by Santos simply says that customers wishing to contract for gas in this period would need to have paid A$12/GJ or close to it; this was observed by the ACCC which noted contract prices of around A$10/GJ. Given the premium to east coast STTM prices that are obtained by gas producers fulfilling LNG contracts, it is hard to see a sound commercial reason why Santos (which is short gas for its LNG facilities) would sell NGP gas at a lower price on long term contracts than it could realise for LNG. This should be borne in mind when assessing claims about gas prices.	

NGP Economics

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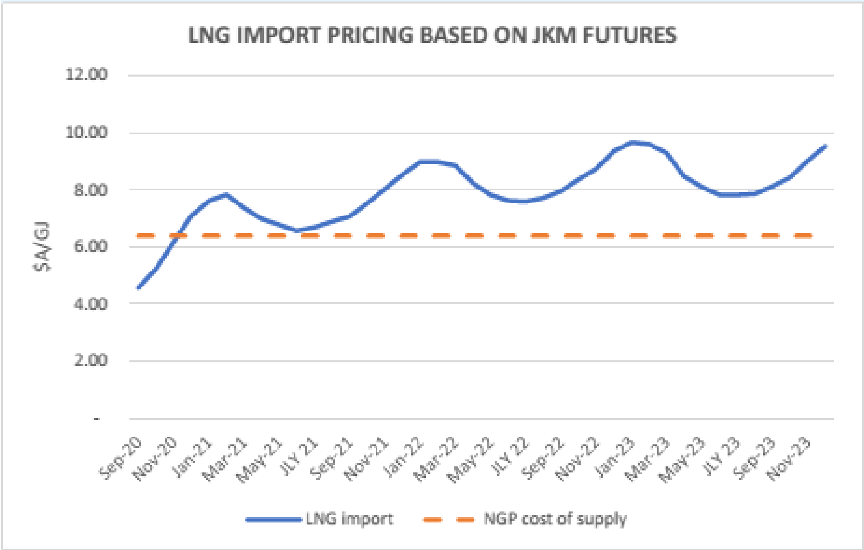
It should be noted that most LNG, including Santos' projects is sold under long term contract, to underpin the many tens of billions of dollars of investments in LNG supply. That's why, in the first half of this year, despite the oil price war between Saudi Arabia and Russia, and despite the demand side shock caused by a mild northern winter and the coronavirus pandemic, Santos has realised relatively strong LNG prices, averaging US$8.57/mmbtu, which is around A$12 per gigajoule, much higher than spot LNG prices and also higher than average realised domestic gas [STTM] prices of around A$5.40 per gigajoule.	Comment: the comparison of Santos contract LNG prices with STTM prices of A$5.40 / GJ is simply not relevant, as it bears no relevance to the observed price for firm contracted gas in the NSW. The price of long term contract gas, which is what consumers require, was approximately $9.00-$10.00/GJ during this period (ACCC Gas Inquiry, Feb 2020) This is close to the Santos' alternative LNG market for its gas of A$12/GJ, which is what would be expected in a market where the LNG export facilities set the price for large volumes of gas and this effect is felt in the 1-3 year domestic contract pricing. This contact price of $9.00-$10/GJ should also have been shown by Santos on the plot (shown on the right) that was inserted in Santos' submission with LNG import pricing, as it represents the price for consumers who require contractual volume certainty. It can be seen the long term contract price of A$9-$10/GJ would make LNG imports quite viable. <u>NB - This would appear to be the reason that ACIL Allen assumes two import terminals in their Base Case and Base Case+NGP Case.</u> **There is a tendency for Santos and its advisors to stress the NGP "cost of supply" in submission material. However, this bears no relation to the "price of supply" - which is determined by the market and is the number that matters to gas consumers.** The relevant market price for NGP gas should have been inserted on the comparison plot on the right - this would, based on ACCC 2019-2020 data, be approximately A$9-10/GJ	 Note: Cost of shipping and gasification assumed to be AU$1.20 per GJ, AUD/USD 0.70, MMBTU/GJ 1.055 SOURCE: PLATTS JKM MARKER PRICE FOR LNG AS AT 22 JULY 2020 The addition of a A$9/GJ long term contract price value to the above graph would provide the necessary information to assess (a) what the NGP gas will be sold for (b) why an import terminal with a much larger annual volume is a viable alternative to NGP. The emissions associated with LNG import from a low CO2 in-gas source (e.g. Papua New Guinea) would result in considerably lower emissions for NSW (and globally) than the production and use of NGP gas.

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Santos Statement	Observation / Response	Background / Evidence
"The economics of the Narrabri Gas Project stack up - Santos would not have already invested $1.5 billion in the Narrabri Gas Project if they didn't. Narrabri is an economically robust investment opportunity for Santos and one that will deliver numerous economic benefits for the community."	Santos has a documented and public history of making poor investment decisions in CSG, overestimating reserves or available gas volumes, and underestimating costs. It is of note that Santos has already written off the value of its expensive acquisition of Eastern Star Gas and Gastar interests in the NGP. There may be some value to Santos in using expensive NGP gas to free up 70 PJ p.a. of other lower cost Santos gas (e.g. from Moomba) for its underutilised GLNG facilities, of which informed commentators observe that Santos never had sufficient gas. While such writedowns theoretically do not impact future economics - they can be a useful indicator of a Company's decision making and ability to forecast CSG resources and costs. Santos' commitment to a project is not a reliable indicator of a project being beneficial for the NSW economy or Santos shareholders - It is just an indication of Santos' commitment to a project, in the same way that Santos was committed to GLNG, with a subsequent A$7 billion in writedowns.	https://www.michaelwest.com.au/santos-blows-7-billion-in-five-years-and-no-relief-for-gas-customers/ "As Santos reports its profits this week, there is one number you are unlikely to hear from chief Kevin Gallagher: $7 billion. That's $7 billion in gas losses over five years. Santos reports its annual results tomorrow. There is one figure they will not be highlighting - the nearly $7 billion they have written off their investments in the Coal Seam Gas (CSG) and Liquefied Natural Gas (LNG) facilities at Gladstone in the last 5 years. In every result since 2014, the company has had to take write-offs on this unsuccessful venture. The write-offs have become so regular that to term them "extraordinary" or "abnormal" would be a misnomer." https://www.theaustralian.com.au/business/mining-energy/how-santoss-leap-of-faith-became-gas-supply-strife/news-story/24fb1882347ac293f131f74b1255600b https://www.theaustralian.com.au/business/mining-energy/santos-chief-defends-csg-foray-in-nsw-despite-808m-impairment/news-story/4aecf44f82b871072afa17b6859d9570 "… This was revealed in August 2012, after the GLNG budget rose by $US2.5bn to $US18.5bn because, Santos said, of extra drilling and compression requirements …."

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Santos Statement	Observation / Response	Background / Evidence
"The tightness in supply in the New South Wales gas market, where around 95 per cent of gas currently has to be imported from other states, has meant this has been difficult in recent years." *Page 3*	It is not the fact that NSW imports 95% of its gas that caused market tightness - NSW has imported nearly all of its gas for decades; and prior to GLNG, there was no market tightness. It is totally misleading to conflate gas imports into NSW (which functions as part of the whole eastern-state market) with NSW market tightness. The tightness in the Eastern States market is principally due to the fact that Santos built two LNG trains for which it did not have adequate gas, and is reported as knowingly contracting large volumes of gas from the domestic market to try to fill its LNG plants. To invoke a major supply tightness problem that Santos caused as the justification for a project which won't solve the problem of high contract gas prices (STTM prices are not relevant for the bulk of consumers) indicates a highly contestable and arguable commitment to social or economic benefits for NSW. **The solution to supply tightness is an import terminal and/or for Santos to shut in one of its LNG trains. This has been costed by Credit Suisse in 2017, and is not an onerous cost and would cost substantially less than NGP gas development**. The economic benefits of this approach need to be separately modelled and fully discussed to allow an objective comparison of project benefits to be conducted.	https://www.theaustralian.com.au/business/mining-energy/how-santoss-leap-of-faith-became-gas-supply-strife/news-story/24fb1882347ac293f131f74b1255600b https://www.theaustralian.com.au/business/mining-energy/santos-chief-defends-csg-foray-in-nsw-despite-808m-impairment/news-story/4aecf44f82b871072afa17b6859d9570 *"…. In order to do it (approve the second train) we need to have absolute confidence ourselves that we've got all the molecules in order to fill that second train."* *But in the months ahead, things changed. In January, 2011, the Peter Coates-chaired Santos board approved a $US16 billion plan to go ahead with two LNG trains from the beginning….as a result of the decision and a series of other factors, GLNG last quarter had to buy more than half the gas it exported from other parties. … In hindsight, assumptions that gave Santos confidence it could find the gas to support two LNG trains, and which were gradually revealed to investors as the project progressed, look more like leaps of faith …. When GLNG was approved as a two-train project, Mr Knox assuredly answered questions about gas reserves.* *"We have plenty of gas," he told investors. "We have the ¬reserves we require, which is why we've not been participating in acquisitions in Queensland of late - we have the reserves, we're very confident of that."* *But even then, and unbeknown to investors, Santos was planning more domestic gas purchases, from a domestic market where it had wrongly expected prices to stay low. This was revealed in August 2012, after the GLNG budget rose by $US2.5bn to $US18.5bn because, Santos said, of extra drilling and compression requirements.* https://research-doc.credit-suisse.com/docView?language=ENG&format=PDF&sourceid=csplusresearchcp&document_id=1071888041&serialid=eEJviFWlCRzuHdkLE27aurRlpz4UiGfPB0ewbZzvGQI%3d Credit Suisse, 1 March 2017 "Eventually something will have to crack" makes the case for the closure of a GLNG train to overall benefit for the east coast market and GLNG participants

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<tr><th>Santos Statement</th><th>Observation / Response</th><th>Background / Evidence</th></tr>
<tr>
<td>Fuel switching to natural gas for electricity generation can deliver an improvement in emissions intensity of the electricity grid. As set out on page 20 of Appendix R of the NGP EIS, in the United States of America, fuel switching to natural gas enabled by the shale gas boom has resulted in an emissions reduction of 200 Mt CO2-e per year. Similarly, in the United Kingdom, coal-fired power generation has been phased out over the last two decades, with gas now accounting for almost 40 per cent of total power generation. This has led to a reduction in CO 2 emissions of 38 per cent compared to 1990 levels. This gas-led reduction in emissions has allowed the United Kingdom to have one of the fastest declines in domestic emissions of the past 30 years.</td>
<td>
<p>Many of these statements about the carbon (GHG) benefits of gas are highly general/generic and are of limited relevance to Narrabri CSG and the Eastern States.</p>
<p>In the east-coast electricity market, the use of battery storage and pumped-hydro (much lower cost than gas, and with minimal emissions) offers cheaper and lower GHG solutions for the support of renewable energy and for overall lower wholesale electricity prices.</p>
<p>Any generic statements on gas assisting in reducing emissions rely on an underlying assumption that the produced natural gas has minimal GHG emissions (CO2 and fugitive methane) associated with it.</p>
<p>This is simply not the case for gas in the Eastern States of NSW, either NGP gas or other sources (see plot on right)</p>
<p>Generic statements by the IEA on emissions intensity are also based on the underlying assumption of minimal GHG associated with gas production; they are not relevant to NGP gas, in the same way they are not relevant to high emission LNG producers in Australia.</p>
<p>Each gas source must be assessed for its life cycle emissions before and including generation.</p>
<p>It can be seen from the plot on the right that holding the NGP gas production to a 5% producing CO2 limit can approach a 50% emission factor to coal.</p>
<p>For 10% or 15% CO2, the project emissions result in an emissions intensity that approaches coal.</p>
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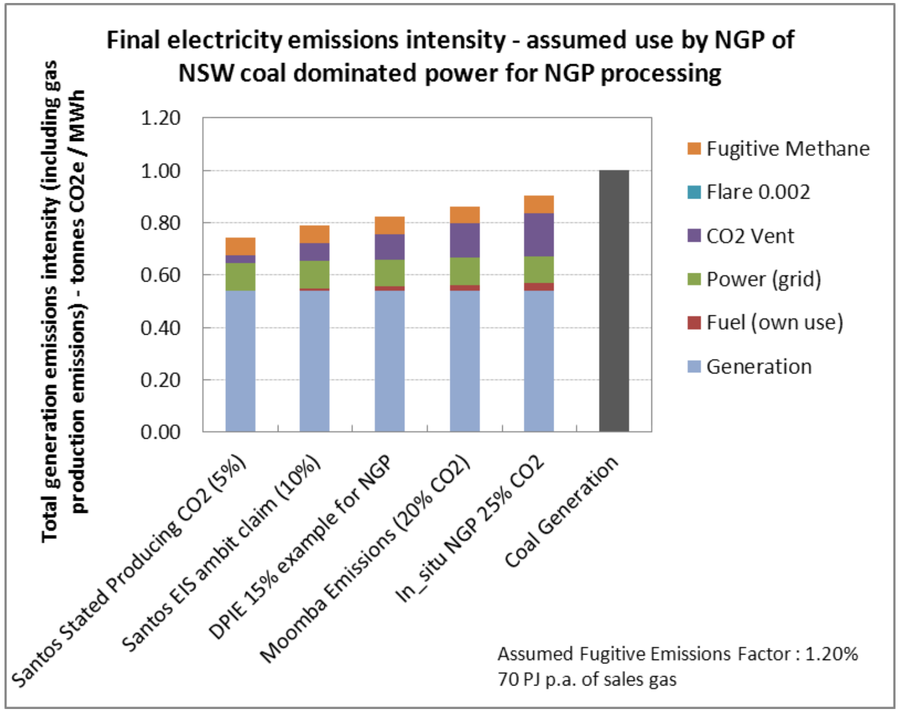

<p>Source of data
NGP - Appendix R of EIS, Chapter 24 of EIS
Moomba - (CSIRO, Huddlestone-Holmes et al) 3 July 2015</p>
<p>Emissions Intensity with use of NSW coal dominated grid power [tonnes CO2e/MWh]</p>
<p>Assumed Fugitive Emissions Factor : 1.20%</p>
<table>
<tr><th></th><th>Santos Stated Producing CO2 (5%)</th><th>Santos EIS ambit claim (10%)</th><th>DPIE 15% example for NGP</th><th>Moomba Emissions (20% CO2)</th><th>In_situ NGP 25% CO2</th></tr>
<tr><td>Fuel (own use)</td><td>0.003</td><td>0.011</td><td>0.017</td><td>0.024</td><td>0.031</td></tr>
<tr><td>Power (grid)</td><td>0.103</td><td>0.103</td><td>0.103</td><td>0.103</td><td>0.103</td></tr>
<tr><td>CO2 Vent</td><td>0.033</td><td>0.071</td><td>0.098</td><td>0.131</td><td>0.163</td></tr>
<tr><td>Flare</td><td>0.000</td><td>0.001</td><td>0.001</td><td>0.001</td><td>0.002</td></tr>
<tr><td>Fugitive Methane</td><td>0.066</td><td>0.066</td><td>0.066</td><td>0.066</td><td>0.066</td></tr>
<tr><td>Generation</td><td>0.539</td><td>0.539</td><td>0.539</td><td>0.539</td><td>0.539</td></tr>
<tr><td>Total</td><td>0.743</td><td>0.790</td><td>0.823</td><td>0.864</td><td>0.904</td></tr>
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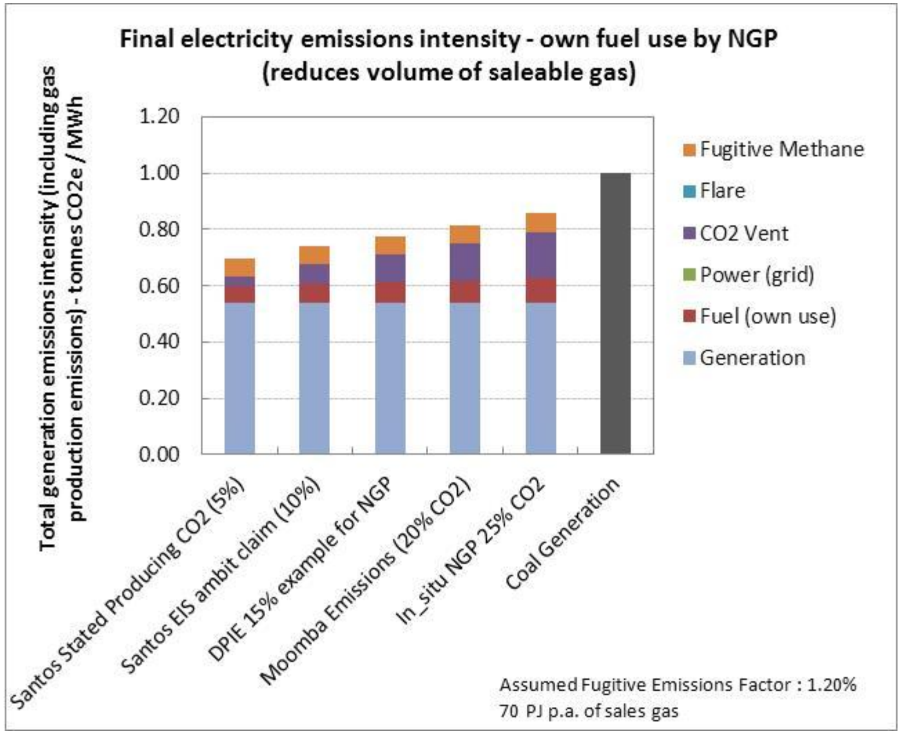


Source of data
NGP - Appendix R of EIS, Chapter 24 of EIS
Moomba - (CSIRO, Huddlestone-Holmes et al) 3 July 2015

Emissions Intensity with own use of gas for fuel (less saleable gas) [tonnes CO2e/MWh]
Assumed Fugitive Emissions Factor : 1.20%
<table>
<tr><th></th><th>Santos Stated Producing CO2 (5%)</th><th>Santos EIS ambit claim (10%)</th><th>DPIE 15% example for NGP</th><th>Moomba Emissions (20% CO2)</th><th>In_situ NGP 25% CO2</th></tr>
<tr><td>Fuel (own use)</td><td>0.059</td><td>0.067</td><td>0.073</td><td>0.080</td><td>0.087</td></tr>
<tr><td>Power (grid)</td><td>0.000</td><td>0.000</td><td>0.000</td><td>0.000</td><td>0.000</td></tr>
<tr><td>CO2 Vent</td><td>0.033</td><td>0.071</td><td>0.098</td><td>0.131</td><td>0.163</td></tr>
<tr><td>Flare</td><td>0.000</td><td>0.001</td><td>0.001</td><td>0.001</td><td>0.002</td></tr>
<tr><td>Fugitive Methane</td><td>0.066</td><td>0.066</td><td>0.066</td><td>0.066</td><td>0.066</td></tr>
<tr><td>Generation</td><td>0.539</td><td>0.539</td><td>0.539</td><td>0.539</td><td>0.539</td></tr>
<tr><td>Total</td><td>0.696</td><td>0.743</td><td>0.776</td><td>0.816</td><td>0.856</td></tr>
</table>
</td></tr>
</table>

NGP Economics

<table>
<tr><th>Santos Statement</th><th>Observation / Response</th><th>Background / Evidence</th></tr>
<tr>
<td>“Compared to coal and some existing sources of natural gas in the east coast gas market, Narrabri gas has a very low CO2 content, so would be displacing higher-emissions energy sources.”</td>
<td>

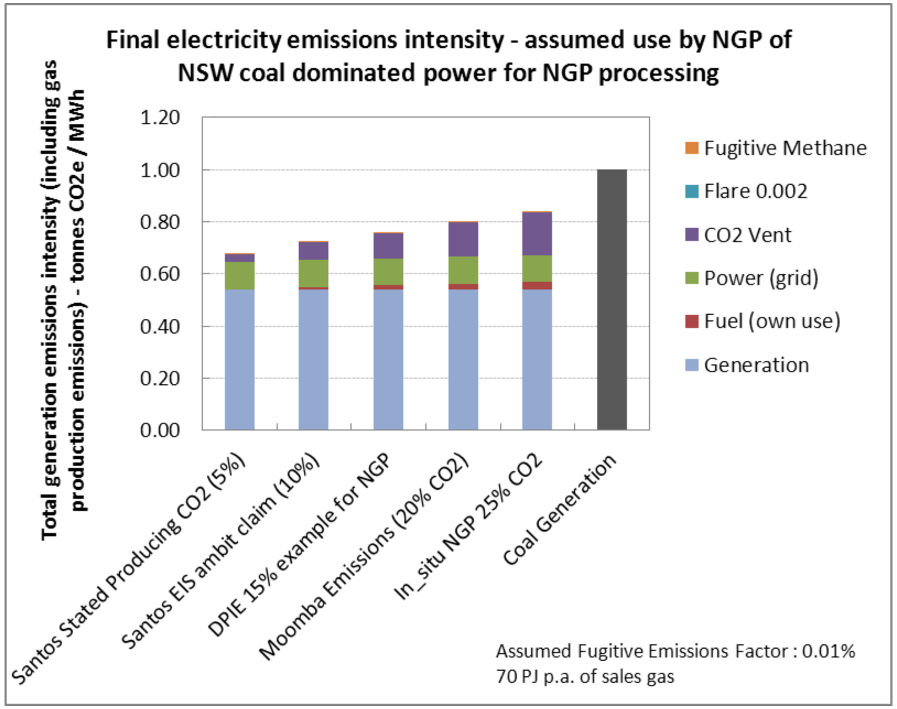
The statement that Narrabri gas has a very low CO2 content compared to “some existing sources of natural gas” is misleading. 25% CO2 is low compared to natural gas produced from the Caroline-1 well in Eastern Australia, which has 90% CO2. <u>Without the specifics of these sources, the comparison lacks meaning or relevance</u>. The Nangwarry-1 well drilled in the Otway Basin in 2020 also has 90% CO2. The igneous source of elevated CO2 in natural has in eastern Australia is well documented, and relevant to the NGP area with underlying magmatics and igneous intrusions.

The statement that Narrabri gas has a very low CO2 content compared to coal is also confusing. Many coals have a very low carbon dioxide content; some have a high CO2 content. However, even coal with low in-situ carbon-dioxide is a large greenhouse gas emitter when used for electricity generation. Coal such as that mined from the Hoskissons at Narrabri has a high CO2 content and also releases gas with 90% CO2 into the atmosphere, considerably increasing the total emissions intensity of coal used for power generation from that seam. What is important is the ultimate emissions intensity of power generated from any given fuel or energy source. Santos appears confused on this fundamental emissions issue.

Coal emissions intensity for electricity generation = life cycle GHG emissions from mining and from combustion of coal (1 tonne CO2e per MWh in Australia for black coal)

Gas emissions intensity = life cycle GHG emissions from production (0.2-0.4 tonnes CO2e/MWh) for NGP gas and combustion of gas (0.5 tonnes CO2e/MWh for pure natural gas with no energy used to produce and transport it to the generation site) (total 0.7-0.9* tonnes CO2e/MWh) [*at 15% average CO2]

</td>
<td>



Emissions Intensity with use of NSW coal dominated grid power [tonnes CO2e/MWh]

Assumed Fugitive Emissions Factor : 0.01%

<table>
<tr><th></th><th>Santos Stated Producing CO2 (5%)</th><th>Santos EIS ambit claim (10%)</th><th>DPIE 15% example for NGP</th><th>Moomba Emissions (20% CO2)</th><th>In_situ NGP 25% CO2</th></tr>
<tr><td>Fuel (own use)</td><td>0.003</td><td>0.011</td><td>0.017</td><td>0.024</td><td>0.031</td></tr>
<tr><td>Power (grid)</td><td>0.103</td><td>0.103</td><td>0.103</td><td>0.103</td><td>0.103</td></tr>
<tr><td>CO2 Vent</td><td>0.033</td><td>0.071</td><td>0.098</td><td>0.131</td><td>0.163</td></tr>
<tr><td>Flare</td><td>0.000</td><td>0.001</td><td>0.001</td><td>0.001</td><td>0.002</td></tr>
<tr><td>Fugitive Methane</td><td>0.000</td><td>0.000</td><td>0.000</td><td>0.000</td><td>0.000</td></tr>
<tr><td>Generation</td><td>0.539</td><td>0.539</td><td>0.539</td><td>0.539</td><td>0.539</td></tr>
<tr><td>Total</td><td>0.678</td><td>0.724</td><td>0.758</td><td>0.798</td><td>0.838</td></tr>
</table>

</td>
</tr>
</table>

Santos Statement

"Compared to coal and some existing sources of natural gas in the east coast gas market, Narrabri gas has a very low CO2 content, so would be displacing higher-emissions energy sources."

Observation / Response

The EIS basis provided by Santos results in total electricity generation emissions intensity ranging from:

- A minimum of 0.63 tonnes CO2e/MWh for 5% CO2 produced gas and minimal (Santos factor) fugitive emissions and own fuel use
- A minimum of 0.70 tonnes CO2e/MWh for 5% CO2 produced gas and minimal (Santos factor) emissions and use of NSW 'coal heavy' power to remove CO2

to

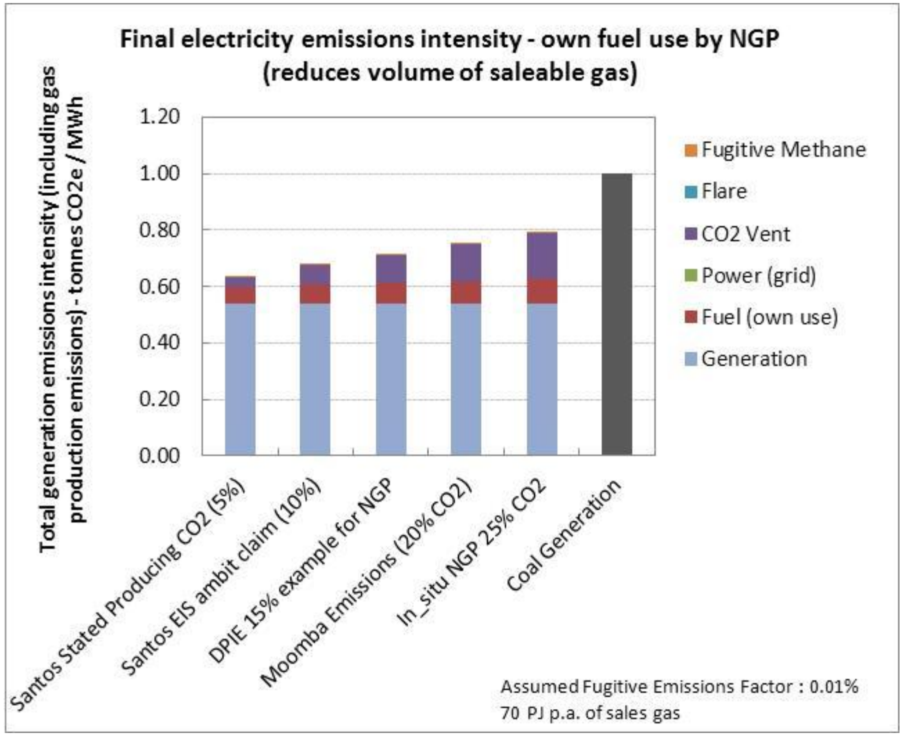
- A maximum of 0.79 tonnes CO2e/MWh for 25% CO2 produced gas and minimal (Santos factor) emissions and own fuel use and using USA EPA fugitive emission factors
- A maximum of 0.82 tonnes CO2e/MWh for 15% CO2 produced gas and USA EPA fugitive emissions factor and NSW grid fuel use

None of the above emission intensity factors are the "50% of coal" that Santos claims for gas.

The closest that can be achieved to the "50% of coal number" is a 0.63 tonnes CO2e / MWh with gas production containing 5% CO2.

It is recommended that this limit be applied to the project. It is equivalent to an annual vented CO2 volume of 250,000 tonnes CO2.

Background / Evidence



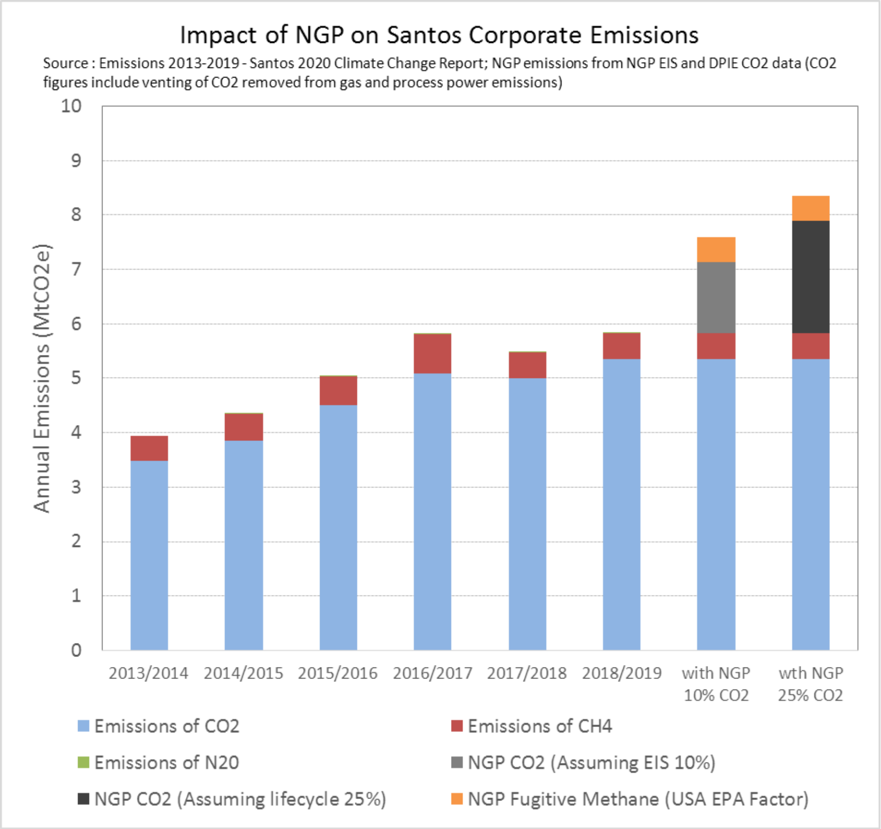
Assumed Fugitive Emissions Factor : 0.01%
70 PJ p.a. of sales gas

Emissions Intensity with own use of gas for fuel (less saleable gas) [tonnes CO2e/MWh]

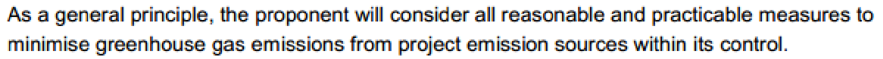
Assumed Fugitive Emissions Factor : 0.01%

	Santos Stated Producing CO2 (5%)	Santos EIS ambit claim (10%)	DPIE 15% example for NGP	Moomba Emissions (20% CO2)	In_situ NGP 25% CO2
Fuel (own use)	0.059	0.067	0.073	0.080	0.087
Power (grid)	0.000	0.000	0.000	0.000	0.000
CO2 Vent	0.033	0.071	0.098	0.131	0.163
Flare	0.000	0.001	0.001	0.001	0.002
Fugitive Methane	0.000	0.000	0.000	0.000	0.000
Generation	0.539	0.539	0.539	0.539	0.539
Total	0.631	0.677	0.711	0.751	0.791

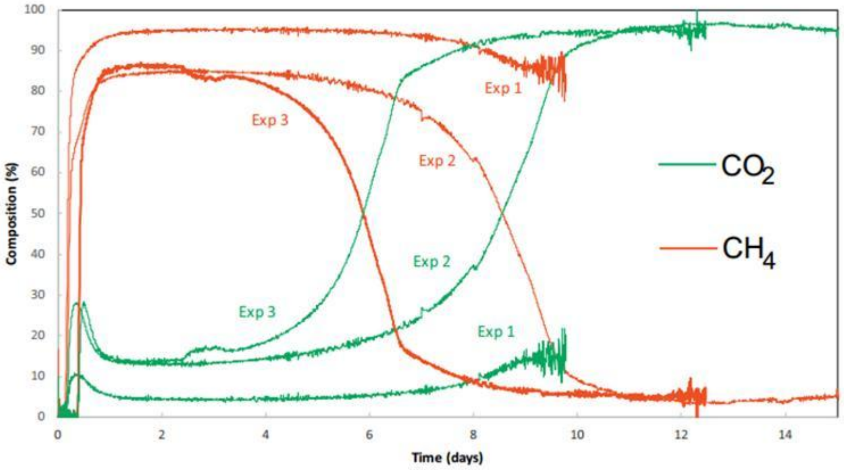
NGP Economics

Santos Statement	Observation / Response	Background / Evidence
"Santos supports limiting global temperature rise to less than 2°C in line with the Paris Agreement." *"The [NGP] emissions should be considered in terms of the net environmental benefit of the natural gas generated by the Project.* *In the transition to a lower-carbon economy, natural gas offers a unique opportunity for Australia by providing a lower-carbon alternative to existing fossil fuel energy sources."* *"Santos has a long-term aspiration of achieving net-zero emissions by 2050"*	These statements should simply be considered along with Santos' own data for its emissions shown on the right. There is a substantial gap between the statements and Santos' own data. It appears from Santos own emissions data that its other gas production already has high CO2 emissions; and this will be materially increased by the NGP. NGP gas, using Santos' own EIS figures, is demonstrably not a low carbon alternative.	 Impact of NGP on Santos Corporate Emissions Source : Emissions 2013-2019 - Santos 2020 Climate Change Report; NGP emissions from NGP EIS and DPIE CO2 data (CO2 figures include venting of CO2 removed from gas and process power emissions) Data above is taken from Santos Climate Change Report and NGP EIS Chapter 24 and Appendix R (assuming grid supplied electricity is correctly accounted for as being incremental from the NGP), except for the last bar where NGP emissions have been calculated. The USA EPA fugitive methane emission factor is used. It is important to look at the substance of Santos production and greenhouse emissions, historical and forecast, and discount generic statements on "low carbon" (see analyses and plots in rows above.

NGP Economics

Santos Statement	Observation / Response	Background / Evidence
"These mitigation measures are primarily designed to reduce the Projects Scope 1 and Scope 2 emissions , and would be secured by the GHG conditions of consent which the IPC is required to consider in accordance with clause 14 of the State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007."	*"Under Clause 14 of the Mining SEPP, a consent authority must consider an assessment of the greenhouse gas emissions (including any downstream emissions) of a project and consider whether conditions are required to ensure that greenhouse gas emissions are minimised to the greatest extent practicable.* *The Department has done this in its detailed assessment of the project. " DPIE* There is nothing obvious in the DPIE Assessment report that refers to minimising emissions to the greatest extent possible. There is a repetition of Santos' comparisons to Australia's excessively high emissions (on a per capita basis) of NGP emissions, stating that they are small in comparison. With this logic, any high GHG intensity project would be acceptable when compared to total country emissions. What is required is an objective assessment of overall emissions intensity, and comparison of this with alternative renewable electricity generation options. **There is a clear need for hard limits on Greenhouse Gas emissions to address uncertainties in NGP emission limits for the Project, which are currently not set in on the "SPECIFIC ENVIRONMENTAL CONDITIONS" of the draft Development Consent** **It should not be left to the DPIE and Santos to agree GHG emissions limits at some future time in a "Air Quality and Greenhouse Gas Management Plan for the development to the satisfaction of the Planning Secretary"**	The mitigation commitment in Chapter 6 of Appendix R simply says  As a general principle, the proponent will consider all reasonable and practicable measures to minimise greenhouse gas emissions from project emission sources within its control. "Consideration" of not producing high CO2 gas is not a commitment to not produce that gas. "Practicable" is not defined legally, and has no weight in this context. The mitigation measures on page 22 and 23 of Appendix R (note: two pages in a 34 page document) are generic, and specifically do not address the issue of CO2 to be extracted from the gas and vented straight into the atmosphere).

NGP Economics

Santos Statement	Observation / Response	Background / Evidence
CO2 *“The NGP EIS assessed a conservative average of 10 per cent CO2 content across the Project area over the 25-year assessment period.* *Santos has not misrepresented the CO2 content of the coal seams in the Project site. The data available from appraisal well gas continues to show that the composition of gas produced by the Project over 25 years would be no more than the average of 10 per cent CO2 assessed.* *Between 2014 and 2019, over 250 gas samples were taken from approximately 32 operating appraisal wells. The average CO2 content of the gas in these samples is less than 5 per cent.* *This sampling data, which is Commercial in Confidence due to commercial considerations linking gas content, composition to resource and asset value was provided to the EPA. While produced gas CO2 content is below 5 per cent in these areas, the average in-situ CO2 content is around 15 per cent and up to 24 per cent in some locations”*	*There is no confusion. There is simply a difference between the DPIE data results showing high in-situ CO2 over the whole of PEL 238 (25%) and the reported currently observed producing CO_2 levels of around 5% from certain wells currently producing in PEL 238.* *The reasons for this difference are: 1. possible sample bias; and/or 2. desorption physics* *1. As the wells have been producing gas for the Wilga Park power station, it may be reasonable to assume that the low CO2 wells are those which produced over the period 2014-2019, resulting in sampling bias fort low CO2 wells. It is also not clear whether the 5% figures are on an air-free basis, which would reduce the CO2 proportion otherwise. It appears unlikely (but is possible) that the lower CO2 regions of PEL 238 were sampled as only 29 wells out of 116 drilled wells in PEL 238 were sampled.* *2. It is also well understood that in coals with high CO2 (which are quite common, see literature examples on the right) that methane is produced first, with CO2 increasing to much higher levels later in a wells life. As the bottom hole pressure approaches atmospheric pressure, then all the CO2 and CH4 will be desorbed. This well-known phenomena has been observed in the San Juan Basin and analogous coals seams in NSW, and is a simple consequence of the physics of gas adsorption/desorption.*	*“High-CO2 coal seams occur in many sedimentary basins world-wide. The Permo-Triassic BGS basin system of eastern Australia contains coal seams and gas fields with elevated levels of CO2.[1] “* *“Coal seams where the gas has high CO2 content have been found around the world[2].”*  *The above plots shows typical gas desorption over time, with low CO2 rising to very high late in life for coal with high in-situ CO2 content gas (Connell et al[4]).*

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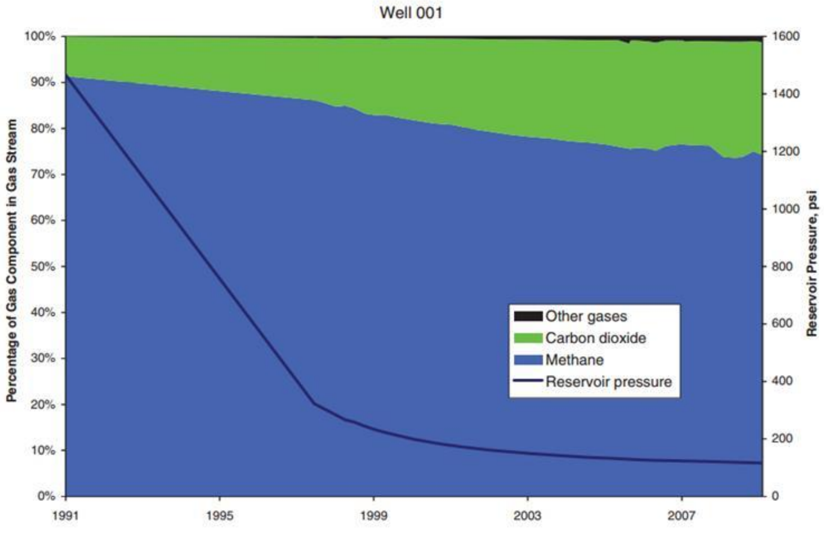
[1] Golding et al “Adsorption and mineral trapping dominate CO2 storage in coal systems”. International Conference on Greenhouse Gas Control Technologies (10th, GHGT, 2011) , Amsterdam, Netherlands , 19-23 September 2010

[2] “The Variation in Produced Gas Composition from Mixed Gas Coal Seam Reservoirs”, Luke D. Connell, Zhejun Pan, Michael Camilleri, CSIRO Energy, Melbourne, Victoria, Australia, International Journal of Coal Geology 201 (2019) 62-75

NGP Economics

Santos Statement	Observation / Response	Background / Evidence
CO2 *"The difference between in-situ and produced CO2 content regrettably led to some confusion in the submissions during the public hearing.* *Multi-isotherm science, the physics of relative gas sorption affinities, observation data gathered from field appraisal pilots CSG operating experience, shows that CO2 is produced at a much lower level than the proportion in-situ. Dr Andrew Grogan said that based on his analysis of data on the Geological Survey of New CO2 content of the gas would be at least 25-30 per cent."*	*There is no confusion. There is simply a difference between the DPIE data results showing high in-situ CO2 over the whole of PEL 238 (25%) and the reported currently observed producing CO_2 levels of around 5% from certain wells currently producing in PEL 238.* *The reasons for this difference are: 1. possible sample bias; and/or 2. desorption physics* *1. As the wells have been producing gas for the Wilga Park power station, it may be reasonable to assume that the low CO2 wells are those which produced over the period 2014-2019, resulting in sampling bias fort low CO2 wells. It is also not clear whether the 5% figures are on an air-free basis, which would reduce the CO2 proportion otherwise. It appears unlikely (but is possible) that the high CO2 regions were sampled as only 29 wells out of 110 drilled wells in PEL 238 were sampled.* *2. It is also well understood that in coals with high CO2 (which are quite common, see literature examples on the right) that methane is produced first, with CO2 increasing to much higher levels later in a wells life. If the bottom hole pressure approaches atmospheric pressure, then all the CO2 and CH4 will be desorbed. This well-known phenomena has been modelled by the CSIRO (see plot on right) and is a simple consequence of the physics of gas adsorption/desorption.*	*"High-CO2 coal seams occur in many sedimentary basins world-wide. The Permo-Triassic BGS basin system of eastern Australia contains coal seams and gas fields with elevated levels of CO2.[3] "* *"Coal seams where the gas has high CO2 content have been found around the world[4]."*  Fig. 5—Increase in CO_2% with time, Well 001. *The above plots shows typical gas desorption over time in the San Juan Basin, with low initial CO2 rising to higher levels late in life for coals (Okotie et al[5]).*

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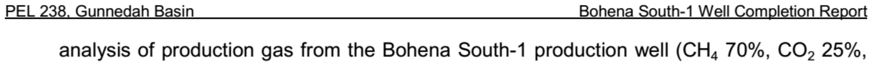
[3] Golding et al "Adsorption and mineral trapping dominate CO2 storage in coal systems". International Conference on Greenhouse Gas Control Technologies (10th, GHGT, 2011) , Amsterdam, Netherlands , 19-23 September 2010

[4] "The Variation in Produced Gas Composition from Mixed Gas Coal Seam Reservoirs", Luke D. Connell, Zhejun Pan, Michael Camilleri, CSIRO Energy, Melbourne, Victoria, Australia, International Journal of Coal Geology 201 (2019) 62-75

[5] Well-Production Challenges and Solutions in a Mature Very-Low-Pressure Coalbed-Methane Reservoir, Victoria U. Okotie, SPE. and Robert L. Moore, SPE. BP America, May 2011 SPE Production & Operations

NGP Economics

Santos Statement	Observation / Response	Background / Evidence
CO2 *"The table below shows the difference between the observed CO2 content of produced gas and that of in-situ gas which is reported on DIGS."*	The CSG wells at Narrabri have a high in-situ CO2 content; the data from the desorption tests on thousands of samples is unambiguous. **What is unknown is how and when this CO2 would be produced over the life of a well. The 5% CO2 composition (from 29 wells out of 116 in PEL 238) will increase over the life of the field.** There is no incompatibility between high calculated in -situ CO2 and reported low initial CO2 production. **There is simply an unknown timing issue, possibly complicated by sampling bias due to many of the high CO2 wells in the NGP area not being on production.** "Point in time" samples or reports of methane (CH4) concentration are not valid indicators of the expected lifetime production of methane or carbon dioxide. The CO2 can be produced in significant amounts at the beginning of well drainage; or at the end of seam depletion when the pressure falls low enough for the CO2 to desorb in large amounts from the coal.	*"Coal seams where the gas has high CO2 content have been found around the world with examples being in the southern Sydney Basin (Faiz et al., 2007), the Bowen Basin (Golding et al., 2013), and the San Juan Basin (Scott et al., 1994; Moore et al., 2011).* *A challenge with producing mixed CH4-CO2 reservoirs is that the gas composition changes during production, with the concentration of carbon dioxide increasing as the reservoir pressure is drawn down. This has been observed in the San Juan Basin, where in one example the CO2 concentration increased from 10% initially to 25% after 15 years of production (Okotie and Moore, 2010).*[6]*"* It is also important to note that there is at least one public domain data point for gas composition from a producing well in the NGP area. **The Bohena South 1 well flowed at 25% CO2 and 70% methane from the Maules Creek formation**, which reportedly had a methane content from desorption samples of 38% - 71% (20% - 60% CO2)  PEL 238, Gunnedah Basin Bohena South-1 Well Completion Report analysis of production gas from the Bohena South-1 production well (CH_4 70%, CO_2 25%, The Bohena 1 Well Completion report mistakenly states that the desorption results do not represent the in-situ composition. The desorption results DO represent the composition, it is just that methane is preferentially produced early in a CSG well's life; CO2 increases later

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[6] "The Variation in Produced Gas Composition from Mixed Gas Coal Seam Reservoirs", Luke D. Connell, Zhejun Pan, Michael Camilleri, CSIRO Energy, Melbourne, Victoria, Australia, International Journal of Coal Geology 201 (2019) 62-75

NGP Economics

Santos Statement	Observation / Response	Background / Evidence
CO2 *"Should the Project be approved, further appraisal is required in order to refine those areas that are most economic. Santos remains confident that over the 25-year Project the average CO2 content of the gas will not exceed the 10 per cent assessed."*	<u>An "average" content of 10% over the project life will result in the CO2 content being considerably higher late in life if the initial production is 5% CO2 (see plot from Connell et al above)</u> This expected increase in CO2 is forecast by Connell et al (op cit) and observed and reported in the San Juan basin by Okotie et al (op cit), where the late-life high CO2 causes significant production problems (see example on right). **<u>Proposed Solution to Constrain CO2 production and provide incentive for Santos to only produce low CO2 gas:</u>** **Santos is highly confident that current CO2 is 5% (molar fraction) of produced gas, which would be equivalent to vented CO2 to meet sales gas specifications of 250,000 tonnes CO2 p.a.** **The future CO2 fraction will increase, but at an unknown rate.** **The cleanest and simplest way to therefore address uncertainties in the producing CO2 content over the life of the NGP is to include in the Recommended Conditions a firm annual extracted and vented CO2 limit of 250,000 tonnes CO2 p.a.** **CO2 emissions from power and heat would be separate to the extracted CO2 vented emissions.**	San Juan Basin experience: *"The main source of corrosion in Fairway wells is CO2.* ***Because CO2 is desorbed at a slower rate from the coal than methane, the percentage of CO2 in the gas stream increases with time and declining reservoir pressure,*** *as shown for Well 001 in Fig. 5. At higher reservoir pressures, the amount of CO2 in the gas was relatively small and corrosion did not present a major threat.* ***Now that the CO2 content has increased to <u>as high as 30% in some wells,</u> corrosion caused by carbonic acid attack is quite severe****.* *An example of a well with a severe corrosion problem is Well 003. This well had seven pump replacements in the 10 years from 2000 through 2009. Corrosion, scale, and fines plugging were the major causes of pump failure. During this time, the concentration of <u>CO2 in the well's gas stream increased from 10% to 25%</u>.* *The mix of produced water, coal fines, and CO2 created a highly erosive/corrosive downhole environment, resulting in corroded tubing and collars, pitted rods, and frequent downhole pump failures. Gas production over this period was characteristically erratic, with many down days and extended periods of low production rates.[7]"*

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[7] Well-Production Challenges and Solutions in a Mature Very-Low-Pressure Coalbed-Methane Reservoir, Victoria U. Okotie, SPE. and Robert L. Moore, SPE. BP America, May 2011 SPE Production & Operations

Santos Statement

Fugitive emissions

"The NGP EIS Greenhouse Gas Assessment (Chapter 24 and Appendix R) was prepared in accordance with the following standards, guidelines and legislation:

The Greenhouse Gas Protocol, A Corporate Accounting and Reporting Standard, Revised Edition, developed by the World Resource Institute and the World Business Council for Sustainable Development (GHG Protocol);

The NGER Act and associated legislative instruments;

American Petroleum Institute, Compendium of greenhouse gas emissions methodologies for the oil and gas industry, August 2009 (API Compendium);

The Commonwealth Department of the Environment National Greenhouse Accounts (NGA) Factors, August 2016 (DoE 2016); and

The Commonwealth Department of the Environment and Energy National Inventory Report 2014 (Revised), August 2016 (DoEE 2016).

Observation / Response

The fact remains, regardless of this lengthy statement, that the EIS value of .002 million tonnes per year of CO2e fugitive emissions in the EIS (see Table on right) corresponds to an emission factor of 0.0058%, based on a CSIRO report that was unreasonably constrained in its sampling; and in any case relevant only for wellheads.

The USA EPA use a total fugitive emission factor for the oil and gas industry factor from 2014 of 1.4%

A consideration of the documented limitations of the CSIRO report which Santos and others use as justification leads to the following conclusion:

Proposed Solution to constrain fugitive emissions and hold Santos to account for the emission factor of 0.0058%

Santos is highly confident or insistent that annual fugitive emissions will be only 2,000 tonnes CO2e

The cleanest and simplest way to therefore address uncertainties in the fugitive emissions over the life of the NGP is to include in the Recommended Conditions a firm annual fugitive emissions limit of 2,000 tonnes CO2 p.a.

To ensure transparency and compliance, this measurement of fugitive emissions should be conducted by competent, independent and external environmental agencies, with unfettered access to well pads, pumps, gathering lines, field facilities on an inspection basis which allows for random sampling by the agency, and at all locations around the NGP

Background / Evidence

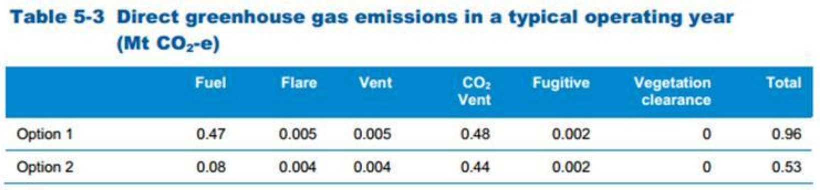
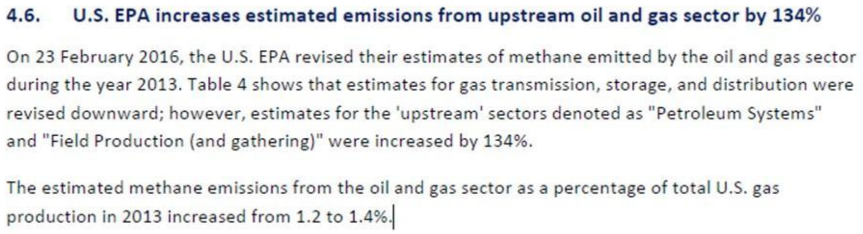


Table 5-3 Direct greenhouse gas emissions in a typical operating year (Mt CO_2-e)

	Fuel	Flare	Vent	CO_2 Vent	Fugitive	Vegetation clearance	Total
Option 1	0.47	0.005	0.005	0.48	0.002	0	0.96
Option 2	0.08	0.004	0.004	0.44	0.002	0	0.53



4.6. U.S. EPA increases estimated emissions from upstream oil and gas sector by 134%

On 23 February 2016, the U.S. EPA revised their estimates of methane emitted by the oil and gas sector during the year 2013. Table 4 shows that estimates for gas transmission, storage, and distribution were revised downward; however, estimates for the 'upstream' sectors denoted as "Petroleum Systems" and "Field Production (and gathering)" were increased by 134%.

The estimated methane emissions from the oil and gas sector as a percentage of total U.S. gas production in 2013 increased from 1.2 to 1.4%.

NGP Economics

Santos Statement	Observation / Response	Background / Evidence
Fugitive Emissions *“Conservative estimates were used so that emissions are overestimated rather than underestimated.”*	Santos is highly confident that annual fugitive emissions will be only 2,000 tonnes CO2e, so the cleanest and simplest way to therefore address uncertainties in the fugitive emissions over the life of the NGP is to include in the Recommended Conditions a firm annual fugitive emissions limit of 2,000 tonnes CO2e p.a. This will result in the NGP proponent having to stand by its claims on emission levels. **To ensure transparency and compliance, this measurement of fugitive emissions under fixed conditions should be conducted by competent, independent and external environmental agencies, with unfettered access to NGP well pads, pumps, gathering lines, field facilities on an inspection basis which allows for random sampling by the agency, and at all locations around the NGP**	

<table>
<tr><th>Santos Statement</th><th>Observation / Response</th><th>Background / Evidence</th></tr>
<tr><td>*Fugitive Emissions*

“CSIRO has undertaken a number of studies attempting to directly measure (quantify) fugitive emissions and their results show that the emissions reported under the Commonwealth NGER framework are acceptable.

As there is national emissions reporting legislation in place for all industries, it would be inconsistent to use any other emissions forecasting methodology to estimate emissions for the Project.”</td><td colspan="2">*“The CSIRO study (referenced by Santos) was confined to methane leakage at well pads. CSIRO noted that large methane emissions emanating from neighbouring water-gathering lines, water-pump shaft seals, and gas compression plants were not measured because they were outside the prescribed scope of their study. Such observations suggest that the factor of 0.058 tonnes of methane per kilotonne of methane produced may substantially underestimate ‘production’ emissions for the associated network of gathering lines, compressors and pumps along with wellheads.*

The NIR states that emissions are estimated using a single emission factor of 0.058 tonnes of methane per kilotonne of methane produced, i.e. 0.0058%. The NIR states that this value is validated by measurements made by a CSIRO study of coal seam gas fugitive emissions (Day et al., 2014):

“The methane emission factor for general leakage of 0.058 t CH4/kt production was validated by a measurement study undertaken by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) during 2013/14 (Day et al., 2014). The study collected field data measurements from 43 coal seam gas wells and found the median and mean emission leakage rates corresponded to emission factors of about 0.005 and 0.102 t CH4/ kt production, respectively. CSIRO concluded that the range of leakage rates measured were consistent with the existing emission factor of 0.058 t CH4/kt production.” (p. 125)

In fact, the CSIRO measurements were confined to methane leakage emissions detected on a [industry curated] sample of production well platforms. The work emphatically does not support the use of this single, very low emission factor for all fugitive emissions from the “gas wellhead through to the tie-in points on gas transmission systems”.

This is particularly significant because in the course of the study the researchers noted large methane emissions emanating from neighbouring water-gathering lines, water-pump shaft seals, and gas compression plants. For example, they point out that they were not able to take measurements at some wells because ‘high ambient CH 4 levels from major leaks or vents made locating minor leak points difficult’. They noted that in one case ‘CH 4 released from a vent on a water gathering line was drifting over the pad components so it was not possible to determine if there were other leaks against the high background’.

However, because these emissions were outside the scope of the CSIRO study, which was confined to production well platforms, they were not measured. Nevertheless, the CSIRO researchers do comment on the potential scale and significance of emissions from these other sources, stating that:

"We found a significant CH4 emission point from a water gathering line near Well B13. Methane was being released from two vents ... at a rate sufficient rate to be audible a considerable distance from the vents. ... Based on the prevailing wind speed, we estimate that the CH4 emission rate from the two vents was at least 130 [grams per minute].... This is a factor of three more than the highest emitting well examined during this study."

That admission alone is sufficient to confirm that the use of 0.058 tonnes of methane per kilotonne of methane produced is inappropriate, and is likely to be substantially underestimating production emissions[8].”</td></tr>
</table>

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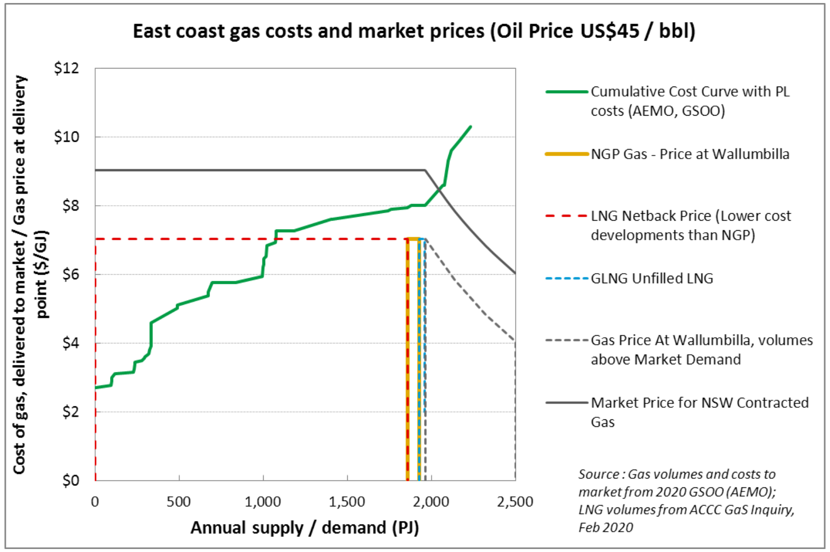
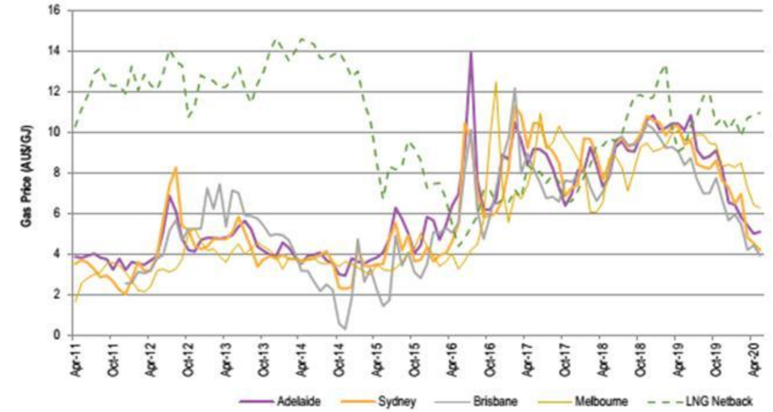
[8] “A review of current and future methane emissions from Australian unconventional oil and gas production”, Lafleur et al, October 2016

Santos Statement	Observation / Response	Background / Evidence
Fugitive Emissions *"Direct comparisons to international examples are inherently flawed due to differences in geology, regulation and development standard"*	By this logic, Santos should also remove any of its many and continual references to other international situations and its operations in the Surat and global and overseas locations where it claims gas is a clean fuel - clearly every development has its own characteristics. It appears that the use of international analogues is considered appropriate for Santos if done by Santos, but not appropriate for external observers. Carefully selected and detailed analogues with appropriate context are very useful guides. However, the fugitive emissions solution proposed (external verification of a hard limit of 2,000 tonnes CO2e of fugitive emissions) would simply remove any need for argument on appropriate emissions factors.	

Santos Statement	Observation / Response	Background / Evidence
Fugitive Emissions *"fugitive emissions estimating techniques adopted in the public submissions, including by Lock the Gate, Dr Grogan and Tim Forcey, are not appropriate reference points for the Australian Coal Seam Gas industry"*	This is a statement which is highly arguable, after a careful reading above of the limitations of the CSIRO work which underpins Santos insistence on the 0.0058% emission factor. The limitations of the CSIRO report underpinning the 0.0058% factor, and inherent uncertainties in top down modelling mean that there is little option but to use an international factor. The factors chosen are the factors recommended by the USA Environmental Protection Agency (1.2%-1.4%) As Santos is insistent that annual fugitive emissions will not exceed 2,000 tonnes CO2e, the cleanest and simplest way to therefore address uncertainties and lack of agreement for fugitive emissions over the life of the NGP is to include in the Recommended Conditions a firm and unalterable annual fugitive emissions limit of 2,000 tonnes CO2e p.a, to be independently assessed and verified by external environmental auditors. This will result in Santos having to stand by its claims. To ensure transparency and compliance, this measurement of fugitive emissions under fixed conditions will need to be conducted by competent, independent and external environmental agencies, with unfettered access to NGP well pads, pumps, gathering lines, field facilities on an inspection basis which allows for random sampling by the agency, and at all locations around the NGP. **Breaching of the limits should require material penalties and immediate rectification**.	

ACIL Allen Statement	Comments / Observations	Background / Evidence
"The proximity of the Narrabri project to major customers in Sydney means it can also compete with many undeveloped 2P projects on economics alone. According to marginal production cost estimates in the 2020 GSOO report by AEMO, the average undeveloped 2P marginal cost of production is $5.66/GJ. Cheaper sources of undeveloped 2P can still be extracted from the Bass Strait but the majority of this is likely to satisfy Victorian demand in the first instance. Some supply will then also be made available to NSW customers via the Eastern Gas Pipeline and NSW-Victoria Interconnector."	The average marginal cost is not relevant, and the proximity argument can also be made for an import terminal - more so, as an import terminal would be much closer to Sydney and there would be no extra capital required for a spur pipeline to the GNP which offers no other connection value to NSW. The marginal <u>price</u> and <u>cost</u> at 2,000 PJ p.a. are the relevant numbers to quote. This would be over $8.00 /GJ from the AEMO figures, developed by Core Energy (an independent consultancy) except for the NGP where AEMO in the 2020 GSOO gas used a Santos figure of $6.40 at the NGP site (higher delivered Sydney) - see plot on the right	 *Source : Gas volumes and costs to market from 2020 GSOO (AEMO); LNG volumes from ACCC GaS Inquiry, Feb 2020* Source: AEMO data to 2000 PJ p.a. **Adding an NGP volume of 70 PJ p.a. at a cost of somewhere between $7.90 and $8.90 delivered to Sydney does not change the fact that the cost of adding production in excess of annual demand of 2,000 PJ p.a. is over $8/GJ**

ACIL Allen Statement	Comments / Observations	Background / Evidence
"New South Wales has also been increasingly reliant on supply from Queensland CSG over the past few years" *"With transportation costs of around $2.50/GJ added on according to the latest tariffs posted by APA, the delivered cost will be north of $8/GJ."*	The partial reliance on Queensland CSG is the result of NSW's long-term and low-cost supply from the Cooper Basin being diverted by Santos into the GLNG facilities; it is not a relevant justification for the NGP, only a de-facto admission that LNG exports from Queensland are actually responsible for the increase in east coast gas prices. See the ACCC plot on the right, and ACIL Allen's statement in the 10th August 20920 submission material that "There is a link between LNG prices and domestic prices". It is important to note that the $2.50 transmission charge for gas into NSW form Queensland is avoided with an import terminal, and means an import terminal can offer long term supply volumes at competitive prices.	**FIGURE 3.1** PRICES IN THE DWGM AND THE SYDNEY, ADELAIDE AND BRISBANE STTMS.  SOURCE: AEMO There is a link between LNG prices and domestic prices, commonly with reference to a price called the LNG netback price. The ACCC defines an LNG netback price as a measure of an export parity price that a gas supplier could expect to receive for exporting its gas[3]. The link is shown in Figure 3.2. There has been a general correlation between spot prices in the eastern Australian gas market and LNG netback prices since around 2016 when Queensland LNG projects began exporting LNG.
"The Narrabri project will also be dedicated to the domestic market and will increase competition in supply of gas to that market."	It needs to be acknowledged that committing high cost NGP gas volumes to NSW (compared to Santos other low cost gas from the Cooper Basin) simply frees up 70 PJ of Santos' other gas production for Santos to use in its GLNG facilities. It is hard to see how high cost gas produced in NSW is better for NSW than low cost gas from the Cooper Basin.	It is very hard to construct a reason why any east coast gas producer would willingly produce excess volumes of gas at a higher marginal cost in order to reduce its revenue by intentionally lowering the price of gas.

NGP Economics

ACIL Allen Statement	Comments / Observations	Background / Evidence
"Spot prices are … not a good indication of prices in longer term gas sales contracts. *Future prices in GSAs are likely to be driven primarily by:* *- the marginal cost of undeveloped, contingent, and prospective resources after around 2026.* *- longer term LNG price movements which in turn will be influenced by movements in oil prices, global economic conditions, and global LNG production capacity* *- transmission pipeline capacity and the efficiency of the transmission system and capacity trading* *- the level of competition in the eastern Australian gas market."*	The reason why ACIL Allen suddenly invokes a case with two LNG import terminals to increase volumetric competition is not explained in the report. The volumetric contribution of NGP is never presented graphically in the ACIL Allen report (unsurprisingly, as it is minimal, see plot with AEMO volumes from GSSO earlier in this document). The mechanics of how NGP small gas volumes would reduce prices further with two LNG import terminals is not described. The modelling with two import terminals contradicts Santos assertion that an LNG import terminal is not viable (although as it avoids pipeline costs, it is quite viable). ACIL Allen models that LNG imports are needed to ensure completion and any price effect; Santos claims that imported LNG is not economic. It is not possible for both to be correct. The assertion that 70 PJ of Narrabri would place downwards pressure on supply also simply cannot be true unless all the existing LNG facilities in Queensland are full, otherwise there will not be any volumetric oversupply; it is telling that the report does not present any volumetric gas profiles for LNG supply and use, import volumes or NGP gas	There is no plot or data in the ACIL Allen report presenting the gas supply flows which underlie the stated conclusions. As a consequence, the report does not provide the necessary data for validation or examination. ACIL Allen Report Assumptions *"The assumptions on which the base case was constructed are set out below.* • *Oil price at US$60/barrel* *LNG export price at AU$10.90 per GJ* • ***Two LNG import terminals online - Crib Point (AGL) and Port Kembla (AIE)*** • *Pipeline capacities are unchanged from current nameplate capacities* • *Narrabri online by 2024 and maximum annual production capacity of 75 PJ per annum* • *Narrabri production cost - $6.40/GJ* • *Pipeline tariff - $1.50/GJ"*

ACIL Allen Statement	**Comments / Observations**	**Background / Evidence**
"The model results are based on the behaviour of the market as a pure spot market. However, the results give an indication of the forces that would drive prices in long term contracts over time. It is not so much that the modelled prices are lower but that the project has the ability to place downward pressure on prices because it adds another source of supply close to the Sydney market at a time when additional contingent gas supplies are needed to meet market demand in the eastern Australian gas market. This increased competition is important to maintaining downward pressure on prices."	This calls into question the use of the report to support any claims about impacts on long term contracted gas prices. It is the convergence of contract gas market prices to the LNG netback plus avoided penalty cost that sets the price of reliable gas. In place of an auditable forecast of the impact on domestic contract gas prices, ACIL Allen makes a qualitative assertion that the NGP "place downward pressure" on prices - this is just a restatement of the initial assertions, but with no contract gas price modelling and opaque volumetric assumptions for import, LNG use and NGP production. Unless modelling is conducted which (a) incorporates the price-setting effect of LNG trains (admitted to by ACIL Allen in the report) and (b) determines gas contract prices, the modelling of STTM prices has no validity for expected firm supply contract prices.	

ACIL Allen Statement	Comments / Observations	Background / Evidence
Gunnedah Cost of Supply $6.40 (represented as AEMO data)	Table 3.3 and Table A.1 refers to AEMO data from February 2020. However, in the 2020 GSOO, the cost of supply of $6.40 is noted by AEMO as “(4) Gunnedah value provided by Santos and represents Santos' p50 (mid-case) production cost at the gate (post processing).” It is therefore not the cost of gas delivered at Sydney, which should include the Pipeline tariff - $1.50/GJ - total of $7.90. The Core Energy cost estimate of $7.40 (gate price, $8.90 in Sydney) remains the only independent assessment of project costs; and Santos’ history of cost and volume forecasting problems does not provide credence that the $6.40 cost can be achieved. **However, as previously pointed out, the cost of gas is not the price at which it is sold - that price will continue to be set by the partially full LNG plants in Queensland, with contract gas prices in excess of the NGP cost of supply**	Note that Santos has historically overestimated well CSG production: https://uk.reuters.com/article/uk-santos/santos-lng-project-cost-blows-out-to-18-5-billion-idUKBRE85R02V20120628

DPIE Response to Independent Planning Commission Questions	**Comments / Observations**	**Background / Evidence**
"The Department has concluded that the project: - *…. would not generate significant greenhouse gas emissions either incrementally or in a cumulative sense"*	The project is likely to result in high emissions unless the proponent is held to hard emissions limits of 250,000 tonnes CO2e p.a. extracted and vented Co2, and 2,000 tonnes p.a. CO2e fugitive emissions, with external measurement and validation of these emissions without impediment	See emissions intensity plots provided above
"Under Clause 14 of the Mining SEPP, a consent authority must consider an assessment of the greenhouse gas emissions (including any downstream emissions) of a project and consider whether conditions are required to ensure that greenhouse gas emissions are minimised to the greatest extent practicable. *The Department has done this in its detailed assessment of the project."*	There are no appropriate or defined limits on Greenhouse gas emissions, or the mechanism to ensure these, set out in the Assessment Report.	
"The simple fact is no single project can affect the global climate on its own, and the direct and indirect greenhouse gas emissions of the Narrabri Gas Project would be very minor compared to annual global emissions."	This is not relevant and while a widely advanced argument by some commentators in the media and other quarters, simply does not acknowledge that the collective application of strict GHG limits on a large number of "small" projects has a material impact. All projects should be managed to reduce emissions; large or small.	

Opinion on Public Interest	Observation / Response	Background / Evidence
"To the extent that submissions about 'social licence' might be thought to raise considerations related to the "public interest" under section 4.15(1)(e) of the EP&A Act, in my opinion the only safe course is to abandon any gloss on that statutory provision and instead apply the words of the statute. In that regard, the consideration of the 'public interest' operates at a "high level of generality" and does not require the consent authority to have regard to any particular aspect of the public interest."	This position is not considered valid. There is ongoing and healthy debate on the definition of "public interest" and the need to continually find a way to balance "public interest" and "private interest", and in relevant cases, the Consent Authority should consider whatever number of relevant "particular aspects" of "the public interest" are raised. Santos asserts that its project would be in the public interest by making available gas in NSW (at some unknown contract price), thereby creating a way to send other Santos gas its LNG facilities. To request that this the specific "public interest" claim of extra gas be included, but at the same time hold that the Consent Authority not have regard to other "particular aspect[s] of the public interest" is a curious position, as it is logically inconsistent. It does follow logically that many particular aspects of the "public interest", in the absence and presence of a project proceeding, should be considered. Greenhouse gas emissions, impacts on nature and livelihood and other negative impacts must therefore all be part of the assessment process.	https://www.lindsaytaylorlawyers.com.au/in_focus/balancing-the-public-interest-against-private-interests/ The assessment of a development's merits requires consideration of the public interest under section 79C of the *Environmental Planning and Assessment Act 1979* (**EPA Act**). Weighing up the private good against the public good is part of that consideration.

List of PEL 238 wells

No	hole_name	drill_type	hole_status	year_drilled	MCF CO2 (%)	HS CO2 (%)
1	Bibblewindi 1	Partly Cored Drill Hole	Plugged & Aband	2000	7.6	No Data
2	Bibblewindi 10	Rotary drill hole	Shut-In Single	2006		
3	Bibblewindi 11C	Partly Cored Drill Hole	Plugged & Aband	2007	13.9	74.0
4	Bibblewindi 2	Rotary drill hole	Plugged & Aband.	2006		
5	Bibblewindi 3	Rotary drill hole	Shut-In Single	2006		
6	Bibblewindi 4	Rotary drill hole	Shut-In Single	2006		
7	Bibblewindi 5	Rotary drill hole	Shut-In Single	2006		
8	Bibblewindi 6	Rotary drill hole	Suspended	2006		
9	Bibblewindi 7	Rotary drill hole	Shut-In Single	2006		
10	Bibblewindi 8	Rotary drill hole	Shut-In Single	2006		
11	Bibblewindi 9	Rotary drill hole	Shut-In Single	2006		
12	Bibblewindi North 1C	Precollared Diamond Hole	Plugged & Aband.	2007	22.6	59.1
13	Bibblewindi West 1C	Precollared Diamond Hole	Plugged & Aband.	2007		75.0
14	Bibblewindi 12			2009	5.4	
15	Blue Hills 1	Partly Cored Drill Hole	Plugged & Aband.	2009		
16	Blue Hills 2	Diamond drill hole	Plugged & Aband.	2010		
17	Bohena 12C	Diamond drill hole	Plugged & Aband.	2007	15.3	52.6
18	Bohena 13C	Diamond drill hole	Plugged & Aband.	2007		
19	Bohena 2	Rotary drill hole	Plugged & Aband.	1998	6.3	15.6
20	Bohena 3	Rotary mud	Suspended	1998	6.7	
21	Bohena 3C	Diamond drill hole	Plugged & Aband.	1999	14.6	18.3
22	Bohena 4	Unknown drill type	Plugged & Aband.	1998	9.1	
23	Bohena 4L	Rotary drill hole	Plugged & Aband.	2004		
24	Bohena 5	Rotary drill hole	Plugged & Aband.	1998	24.7	
25	Bohena 6	Rotary drill hole	Plugged & Aband.	1998	2.6	13.7
26	Bohena 6H	Rotary drill hole	Plugged & Aband.	1998		
27	Bohena 7	Rotary drill hole	Shut-In Single	1998		
28	Bohena 9	Rotary drill hole	Shut-In Single	2004		
29	Bohena 14				93.2	64.4
30	Bohena South 1	Rotary drill hole	Suspended	2004	25.0	
31	Bohena South 1C	Diamond drill hole	Plugged & Aband.	2004		
32	Bohena South 2C	Diamond drill hole	Plugged & Aband.	2007		
33	Brigalow Park 1	Rotary drill hole	Suspended	2004		
34	Brigalow Park 2	Diamond drill hole	Plugged & Aband.	2010	1.4	0.7
35	Burrawarna 1	Diamond drill hole	Plugged & Aband.	2000	85.1	61.7
36	Coogal 2	Diamond drill hole	Plugged & Aband.	2009		
37	Coonarah 2			1995		0.0
38	Coonarah 3			2001	0.1	
39	Coonarah 5			2001	0.1	
40	Coonarah 9			2009	3.6	
41	Culgoora 1	Diamond drill hole	Plugged & Aband.	2010		
42	Culgoora 1A	Diamond drill hole	Plugged & Aband.	2010		

No	hole_name	drill_type	hole_status	year_drilled	MCF CO2 (%)	HS CO2 (%)
43	Culgoora 2	Diamond drill hole	Plugged & Aband.	2011		
44	Dewhurst 10	Rotary drill hole	Shut-In Single	2009		
45	Dewhurst 11	Partly Cored Drill Hole	Plugged & Aband.	2009	80.0	38.0
46	Dewhurst 13	Rotary drill hole	Shut-In Single	2009		
47	Dewhurst 14	Rotary drill hole	Shut-In Single	2009		
48	Dewhurst 15	Rotary drill hole	Shut-In Single	2009		
49	Dewhurst 16H	Rotary drill hole	Shut-In Single	2009		
50	Dewhurst 17H	Rotary drill hole	Shut-In Single	2009		
51	Dewhurst 17H Leg 1 ST1	Rotary drill hole	Shut-In Single	2009		
52	Dewhurst 18H	Rotary drill hole	Shut-In Single	2009		
53	Dewhurst 18H L1	Rotary drill hole	Shut-In Single	2009		
54	Dewhurst 18H L1 ST1	Rotary drill hole	Shut-In Single	2009		
55	Dewhurst 18H L1 ST2	Rotary drill hole	Shut-In Single	2009		
56	Dewhurst 18H L1 ST3	Rotary drill hole	Shut-In Single	2009		
57	Dewhurst 18H L1 ST4	Rotary drill hole	Shut-In Single	2009		
58	Dewhurst 19	Partly Cored Drill Hole	Plugged & Aband.	2011	95.0	25.0
59	Dewhurst 2	Partly Cored Drill Hole	Plugged & Aband.	2008		
60	Dewhurst 22	Diamond drill hole	Shut-In Single	2013	64.3	57.2
61	Dewhurst 23	Open Hole	Shut-In Single	2014		
62	Dewhurst 23 DW1	Open Hole	Shut-In Single	2014		
63	Dewhurst 23 DW1 ST1	Open Hole	Shut-In Single	2014		
64	Dewhurst 24	Open Hole	Shut-In Single	2013		
65	Dewhurst 25	Diamond drill hole	Shut-In Single	2014		
66	Dewhurst 25 DW1	Diamond drill hole	Shut-In Single	2014		
67	Dewhurst 25 DW1 ST1	Roller cone open hole	Shut-In Single	2014		
68	Dewhurst 26	Open Hole	Prodn. Gas	2014	20.8	No data
69	Dewhurst 27	Diamond drill hole	Prodn. Gas	2014		
70	Dewhurst 27 DW1	Diamond drill hole	Prodn. Gas	2014		
71	Dewhurst 27 DW2	Diamond drill hole	Prodn. Gas	2014		
72	Dewhurst 27 DW3	Diamond drill hole	Prodn. Gas	2014		
73	Dewhurst 28	Open Hole	Prodn. Gas	2014		
74	Dewhurst 29	Diamond drill hole	Prodn. Gas	2014		
75	Dewhurst 29 DW1	Diamond drill hole	Prodn. Gas	2014		
76	Dewhurst 29 DW2	Diamond drill hole	Prodn. Gas	2014		
77	Dewhurst 29 DW3	Diamond drill hole	Prodn. Gas	2014		
78	Dewhurst 3	Partly Cored Drill Hole	Plugged & Aband.	2008		
79	Dewhurst 4	Partly Cored Drill Hole	Plugged & Aband.	2008	17.5	41.1
80	Dewhurst 5	Partly Cored Drill Hole	Plugged & Aband.	2008	59.2	
81	Dewhurst 6	Rotary drill hole	Shut-In Single	2009		
82	Dewhurst 7	Partly Cored Drill Hole	Plugged & Aband.	2008	30.6	59.2
83	Dewhurst 8	Rotary drill hole	Plugged & Aband.	2009		
84	Dewhurst 8A	Diamond drill hole	Water Bore	2013	49.9	29.5
85	Dewhurst 9	Rotary drill hole	Shut-In Single	2009		
86	Edgeroi 1	Diamond drill hole	Plugged & Aband.	2008		

No	hole_name	drill_type	hole_status	year_drilled	MCF CO2 (%)	HS CO2 (%)
87	Edgeroi 2	Diamond drill hole	Plugged & Aband.	2010		
88	Jacks Creek 1	Diamond drill hole	Plugged & Aband.	2000	86.0	54.0
89	Rosevale 1	Diamond drill hole	Plugged & Aband.	2009		
90	Rosevale 1A	Diamond drill hole	Plugged & Aband.	2010	1.2	43.6
91	Strathmore 2	Partly Cored Drill Hole	Plugged & Aband.	2011		
92	Strathmore 2 ST1	Diamond drill hole	Plugged & Aband.	2011		
93	Tintsfield 1	Partly Cored Drill Hole	Plugged & Aband.	2009	9.1	1.8
94	Tintsfield 2H	Rotary drill hole	Prodn. Gas	2010		
95	Tintsfield 2H Lateral 1	Rotary drill hole	Prodn. Gas	2010		
96	Tintsfield 2H ST1	Rotary drill hole	Prodn. Gas	2010		
97	Tintsfield 2H ST2	Rotary drill hole	Prodn. Gas	2010		
98	Tintsfield 2H ST3	Rotary drill hole	Prodn. Gas	2010		
99	Tintsfield 2H ST4	Rotary drill hole	Prodn. Gas	2010		
100	Tintsfield 3H	Rotary drill hole	Prodn. Gas	2010		
101	Tintsfield 4H	Rotary drill hole	Prodn. Gas	2010		
102	Tintsfield 4H Lateral 1	Rotary drill hole	Prodn. Gas	2010		
103	Tintsfield 4H ST1	Rotary drill hole	Prodn. Gas	2010		
104	Tintsfield 4H ST2	Rotary drill hole	Prodn. Gas	2010		
105	Tintsfield 4H ST3	Rotary drill hole	Prodn. Gas	2010		
106	Tintsfield 5	Rotary drill hole	Prodn. Gas	2010		
107	Tintsfield 6	Rotary drill hole	Prodn. Gas	2010		
108	Tintsfield 7	Rotary drill hole	Prodn. Gas	2010		
109	Wilga Park 1	Diamond drill hole	Plugged & Aband.	1999	4.1	2.0
110	Wilga Park 2	Rotary drill hole	Plugged & Aband.	1998		
111	Wilga Park 3	Rotary drill hole	Suspended	1999	30.7	
112	Wilga Park 4	Rotary drill hole	Plugged & Aband.	1999		
113	Wilga Park 5	Rotary drill hole	Plugged & Aband.	1998		
114	Willala 1	Precollared Diamond Hole	Plugged & Aband.	2011	78.7	87.1
115	Yallambee 1	Precollared Diamond Hole	Plugged & Aband.	2009	96.3	87.4
116	Yallambee 2	Precollared Diamond Hole	Plugged & Aband.	2011	83.4	28.5

Possible suggested drafting for hard 5% CO2 emission venting limits:

Project Conditions are in "Narrabri Gas Project Recommended Conditions.pdf"

Suggested changes need to Conditions for carbon dioxide and fugitive methane control

Air Quality Operating Conditions
B22. The Applicant must:
(a) implement all reasonable and feasible measures to:
(i) minimise odour, fume and particulate matter (including PM10 and crustal and combustion PM2.5) emissions of the development;
(ii) minimise point source and fugitive emissions of methane, carbon dioxide and other pollutants from all project related infrastructure;
(iii) minimise any visible off-site air pollution generated by the development;
(iv) minimise the extent of potential dust generating surfaces exposed in the project area at any given point in time;
(v) ensure negligible contribution to baseline methane, carbon dioxide and other pollutant levels at any residence or other sensitive receiver location;
(vi) improve energy efficiency and reduce greenhouse gas emissions of the development; including:

Maximum CO2 venting of 250,000 tonnes p.a. (equivalent to a 5% molar CO2 average concentration in produced gas)

A maximum of 2,000 tonnes CO2e of fugitive methane emissions, with independent and unfettered measurement and documentation of fugitive emissions by independent certification experts
(vii) minimise the air quality impacts of the development during adverse meteorological conditions and extraordinary events (see Note c to Table 5 above);
(b) operate a detailed air quality management system that uses a combination of unattended and attended air quality monitoring to ensure compliance with the relevant conditions of this consent; and
(c) regularly assess meteorological and air quality monitoring data and modify operations in the project area to ensure compliance with the relevant conditions of this consent.

Air Quality and Greenhouse Gas Management Plan
B23. Prior to the commencement of Phase 2, the Applicant must prepare an Air Quality and Greenhouse Gas Management Plan for the development to the satisfaction of the Planning Secretary and which includes the following conditions:.

- Maximum CO2 venting of 250,000 tonnes p.a. (equivalent to a 5% molar CO2 average concentration in produced gas)
- A maximum of 2,000 tonnes CO2e of fugitive methane emissions, with independent and unfettered measurement and documentation of fugitive emissions

This plan must:
(a) be prepared by a suitably qualified and experienced person/s;
(b) be prepared in consultation with the EPA, NSW Health and the CCC;
(c) describe the measures to be implemented to ensure:
(i) compliance with the air quality criteria and operating conditions in this consent;
(ii) reasonable and feasible air quality and greenhouse gas mitigation measures are being employed;
(iii) leaks are promptly detected and repaired; and
(iv) the air quality impacts of the development are minimised during adverse meteorological conditions and extraordinary events; and
(d) describe the air quality management system, and leak detection and repair system, in detail;
(e) detail baseline levels of methane, carbon dioxide and other pollutants in the project area, at representative sensitive receiver locations, and adjacent the Leewood facility;
(f) include predicted air quality concentrations for all potential pollutants at representative sensitive receiver

locations, and adjacent the Leewood facility, based on additional air quality assessment and modelling; and
(g) include an air quality monitoring program that:
(i) evaluates and reports on:
- the effectiveness of the air quality management system;
- compliance against the air quality criteria in this consent;

- compliance with air quality impact assessment criteria in the *Approved Methods for Modelling and Assessment of Air Pollutants in New South Wales* (EPA, 2016), for other relevant pollutants (including air toxics);
- composition of the coal seam gas extracted by the development;
- changes to baseline methane, carbon dioxide and other pollutant levels in the project area;
- compliance against the air quality operating conditions;
- leakage and detection from project related infrastructure; and

(ii) defines what constitutes an air quality exceedance, incident or non-compliance, and includes a protocol for identifying and notifying the Department and relevant stakeholders of these events.
B24. The Applicant must implement the approved Air Quality and Greenhouse Gas Management Plan. Non - compliance will include:

- Breaching the maximum CO2 venting of 250,000 tonnes p.a. (equivalent to a 5% molar CO2 average concentration in produced gas)
- A maximum of 2,000 tonnes CO2e of fugitive methane emissions, with independent and unfettered measurement and documentation of fugitive emissions by independent certification experts

Requirements to limit GHG to ensure reduction in NSW emissions

Project Conditions are in “Narrabri Gas Project Recommended Conditions.pdf”

Suggested changes need to Conditions for carbon dioxide and fugitive methane control

Air Quality Operating Conditions
B22. The Applicant must:
(a) implement all reasonable and feasible measures to:
(i) minimise odour, fume and particulate matter (including PM10 and crustal and combustion PM2.5) emissions of the development;
(ii) minimise point source and fugitive emissions of methane, carbon dioxide and other pollutants from all project related infrastructure;
(iii) minimise any visible off-site air pollution generated by the development;
(iv) minimise the extent of potential dust generating surfaces exposed in the project area at any given point in time;
(v) ensure negligible contribution to baseline methane, carbon dioxide and other pollutant levels at any residence or other sensitive receiver location;
(vi) improve energy efficiency and reduce greenhouse gas emissions of the development; including:

- Maximum CO2 venting of 250,000 tonnes p.a. (equivalent to a 5% molar CO2 average concentration in produced gas)
- A maximum of 2,000 tonnes CO2e of fugitive methane emissions, with independent and unfettered measurement and documentation of fugitive emissions

(vii) minimise the air quality impacts of the development during adverse meteorological conditions and extraordinary events (see Note c to Table 5 above);
(b) operate a detailed air quality management system that uses a combination of unattended and attended air
quality monitoring to ensure compliance with the relevant conditions of this consent; and
(c) regularly assess meteorological and air quality monitoring data and modify operations in the project area to
ensure compliance with the relevant conditions of this consent.

Air Quality and Greenhouse Gas Management Plan
B23. Prior to the commencement of Phase 2, the Applicant must prepare an Air Quality and Greenhouse Gas Management Plan for the development to the satisfaction of the Planning Secretary and which includes the following conditions:

- Maximum CO2 venting of 250,000 tonnes p.a. (equivalent to a 5% molar CO2 average concentration in produced gas)
- A maximum of 2,000 tonnes CO2e of fugitive methane emissions, with independent and unfettered measurement and documentation of fugitive emissions

This plan must:
(a) be prepared by a suitably qualified and experienced person/s;
(b) be prepared in consultation with the EPA, NSW Health and the CCC;
(c) describe the measures to be implemented to ensure:
(i) compliance with the air quality criteria and operating conditions in this consent;
(ii) reasonable and feasible air quality and greenhouse gas mitigation measures are being employed;
(iii) leaks are promptly detected and repaired; and
(iv) the air quality impacts of the development are minimised during adverse meteorological conditions and extraordinary events; and
(d) describe the air quality management system, and leak detection and repair system, in detail;

Requirements to limit GHG to ensure reduction in NSW emissions

(e) detail baseline levels of methane, carbon dioxide and other pollutants in the project area, at representative sensitive receiver locations, and adjacent the Leewood facility;

(f) include predicted air quality concentrations for all potential pollutants at representative sensitive receiver locations, and adjacent the Leewood facility, based on additional air quality assessment and modelling; and

(g) include an air quality monitoring program that:

(i) evaluates and reports on:

- the effectiveness of the air quality management system;
- compliance against the air quality criteria in this consent;
- compliance with air quality impact assessment criteria in the *Approved Methods for Modelling and Assessment of Air Pollutants in New South Wales* (EPA, 2016), for other relevant pollutants (including air toxics);
- composition of the coal seam gas extracted by the development;
- changes to baseline methane, carbon dioxide and other pollutant levels in the project area;
- compliance against the air quality operating conditions;
- leakage and detection from project related infrastructure; and

(ii) defines what constitutes an air quality exceedance, incident or non-compliance, and includes a protocol for identifying and notifying the Department and relevant stakeholders of these events.

B24. The Applicant must implement the approved Air Quality and Greenhouse Gas Management Plan. Non - compliance will include:

- Breaching the maximum CO2 venting of 250,000 tonnes p.a. (equivalent to a 5% molar CO2 average concentration in produced gas)
- A maximum of 2,000 tonnes CO2e of fugitive methane emissions, with independent and unfettered measurement and documentation of fugitive emissions

https://www.theaustralian.com.au/business/mining-energy/how-santoss-leap-of-faith-became-gas-supply-strife/news-story/24fb1882347ac293f131f74b1255600b

“How Santos's leap of faith became gas supply strife”,

April 3, 2017

As Santos worked toward approving its company-transforming Gladstone LNG project at the start of this decade, managing director David Knox made the sensible statement that he would approve one LNG train, capable of exporting the equivalent of half the east coast’s gas demand, rather than two because the venture did not yet have enough gas for the second.

“You’ve got to be absolutely confident when you sanction trains that you’ve got the full gas supply to meet your contractual obligations that you’ve signed out with the buyers,” Mr Knox told investors in August 2010 when asked why the plan was to sanction just one train first up.

“In order to do it (approve the second train) we need to have absolute confidence ourselves that we’ve got all the molecules in order to fill that second train.”

But in the months ahead, things changed. In January, 2011, the Peter Coates-chaired Santos board approved a $US16 billion plan to go ahead with two LNG trains from the beginning….as a result of the decision and a series of other factors, GLNG last quarter had to buy more than half the gas it exported from other parties.

…In hindsight, assumptions that gave Santos confidence it could find the gas to support two LNG trains, and which were gradually revealed to investors as the project progressed, look more like leaps of faith.

…When GLNG was approved as a two-train project, Mr Knox assuredly answered questions about gas reserves.

“We have plenty of gas,” he told investors. “We have the reserves we require, which is why we’ve not been participating in acquisitions in Queensland of late - we have the reserves, we’re very confident of that.”

But even then, and unbeknown to investors, Santos was planning more domestic gas purchases, from a domestic market where it had wrongly expected prices to stay low. This was revealed in August 2012, after the GLNG budget rose by $US2.5bn to $US18.5bn because, Santos said, of extra drilling and compression requirements.

“At the time of FID (final investment decision), there was a reasonable expectation during the early years that gas would be available in the market at the right price,” Mr Knox said. “However, large volume, long-term east coast gas supply and prices have tightened over the last 18 months, making third-party gas a relatively less attractive gas supply. This is what led to our announcement (that capital spending would increase).” For commercial reasons, Santos had not revealed the volumes of third-party gas needed to feed the second train.

Presentation slides reveal that by then, even with the $US2.5bn of extra spending, third-party purchases had grown from 140 terajoules a day, at FID, to 240 terajoules a day, or 20 per cent of east coast domestic demand.

Santos figured the gas it was taking out of east coast markets would be filled by accelerated production from the Cooper Basin (fuelled by the GLNG supply contract revenue), gas from the Narrabri coal-seam gas project in NSW and helped by the production of shale gas.

Unfortunately, shale drilling did not return hoped-for results, an oil price slump in late 2014 heavily restricted more Cooper Basin drilling and a community backlash, along with regulatory hurdles, stymied Narrabri.

NGP Media

Even before oil prices slumped, Santos revealed its call on domestic gas would be greater than flagged. In a June 2014 presentation slides to an analysts tour of the GLNG facility were told that third party gas would provide between 410 to 570 terajoules of gas per day, or the equivalent of up to half of total east coast domestic demand, even though it was planning to drill 200 to 300 domestic wells a year.

As a result, GLNG, had drilled 769 coal-seam gas wells as of November last year (and presumably connected fewer). This is about a quarter less than the 1000 it had planned to drill by the end of 2015.

https://www.michaelwest.com.au/santos-blows-7-billion-in-five-years-and-no-relief-for-gas-customers/

"Santos blows $7 billion in five years and no relief for gas customers",
Bruce Robertson, Feb 19, 2020

As Santos reports its profits this week, there is one number you are unlikely to hear from chief Kevin Gallagher: $7 billion. That's $7 billion in gas losses over five years. **Bruce Robertson** reports on the government's penchant for backing a big loss industry, future gas liabilities and the Federal Government's gas deal with the states.

Santos reports its annual results tomorrow.

There is one figure they will not be highlighting - the nearly $7 billion they have written off their investments in the Coal Seam Gas (CSG) and Liquefied Natural Gas (LNG) facilities at Gladstone in the last 5 years.

In every result since 2014, the company has had to take write-offs on this unsuccessful venture. The write-offs have become so regular that to term them "extraordinary" or "abnormal" would be a misnomer.

Santos should see further asset write-offs in its 2019 result as the long-term outlook for oil, and therefore gas, prices weaken.

The CSG to LNG venture was embarked upon with the great hope of providing cheap gas to Asia and starting an export boom.

For Santos, it has resulted in under-utilised LNG facilities at Gladstone as the CSG fields have failed to produce gas at the rates forecast or at the prices expected.

Santos has two long-term contracts to fulfil out of its Gladstone LNG export plant (GLNG) - a joint venture totalling 7.6MT. Each contract is for 3.8MTPA over 20 years with Petronas and Kogas.

The contracts started in 2015 and 2016 respectively. Santos has not been able to fulfil these obligations as yet.

All up its investments in the CSG to LNG industry have been a financial failure.

According to the 2014 Santos annual report, GLNG has a capital cost of $21.3bn. As a capital-intensive business, the plant's economic capacity utilisation rates should be very high, typically above 90%, but Santos has been unable to achieve these levels.

In the first half of 2019, GLNG produced 2.6MT of gas, indicating that it is still not achieving an economic return. On announcing its half year result Santos said: "GLNG remains on track to meet the six million tonne annualised LNG sales run-rate (including LNG volumes redirected to the domestic market) by the end of 2019." Despite its volumes increasing, GLNG keeps underperforming.

The Government, as witnessed by the recent deal between the Federal and NSW governments, has been backing this losing industry to the hilt.

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It is interesting to note that politicians of all persuasions are often quoted as saying it is not their job to pick winners in industry policy. While this is certainly a truism, it is also not a politician's job to back industries that have a sustained record of wealth destruction.

The CSG to LNG industry in Australia has such a record.

The stated purpose of the deal between the NSW and Federal governments is to bring down the price of gas for consumers in NSW. Santos has committed to supplying the 70PJ from Narrabri to NSW. The 70 PJ of gas is equivalent to 60% of the NSW market.

While it may be true that Santos will supply gas from its Narrabri project to NSW consumers, it will not bring down the price of gas for four reasons:

1. Narrabri (Gunnedah) gas is nearly twice the cost of the most expensive developed gas field on the east coast of Australia. Producing high cost gas is no way to bring down the cost of gas.
2. Santos will be able to divert cheaper gas to exports while supplying Australian consumers with expensive Narrabri gas.
3. There is a cartel of producers on the east coast of Australia that controls the price of gas and ensures that Australians pay well above global parity prices.
4. Santos remains significantly short of gas at its export terminals. Santos needs approximately an additional 100PJ of gas to supply its terminals to ensure full production.

The ACCC released yet another report into the gas industry yesterday as part of its on going inquiry into the price fixing occurring in this industry.

Yet again, the regulator found Australian consumers are paying far more than they should be for gas.

While industry is paying $10.50/GJ for gas, the ACCC thinks Australian consumers should be paying less than $7/GJ for contract gas.

The price gouging is poised to continue as the ACCC and our governments are recommending that Australians should get the expensive Narrabri gas while the cheap gas is exported.

The Government, rather than fixing the problem with a full domestic gas reservation policy which would supply Australian consumers with gas from all existing fields at a set price, has vowed to extend the ACCC gas price enquiry.

Australian gas and electricity consumers can take comfort in the fact that they will continue to be fully informed as to just how badly they are being ripped off.

While our government is proffering non-solutions to the gas price problem, it is instructive to look offshore and see what other large oil and gas companies are doing.