

Santos' Proposed New Darwin Harbour Pipeline for Barossa Gas – Potentially Enabling a CCS Scheme – Remains Problematic

Commencement of Work on the Barossa Project Should Be Suspended

Executive Summary

This brief note is to update a report on Santos' Barossa to LNG project which was published by IEEFA in October 2021.¹

At that time, Santos was intending² to reduce the high emissions of its Barossa gas found some 300kms north of Darwin in the Northern Territory, Australia, by injecting captured carbon dioxide (CO₂) into its nearly depleted Bayu-Undan (B-U) gas field in the Timor Sea.

Since then, it has been hard to get a fix on exactly what Santos is intending to do with this project, parts of which are already under construction (the Floating Production Storage and Offloading (FPSO) vessel in South Korea).

Santos now has an application for approval³ for a new Darwin Harbour pipeline for its Barossa gas – potentially enabling a carbon capture and storage (CCS) scheme in an attempt to reduce the very high emissions from the development.

But uniquely, despite the new application, Santos' project would still actually produce more carbon dioxide emissions offshore and onshore than its production of liquefied natural gas (LNG) – even with CCS implemented successfully – making it one of the more expensive and dirtiest gas projects in the world.

Australia's project approvals system doesn't help, being based on the old colonial principle of 'divide and rule'. The independent regulator, the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) which is based in Perth, WA is tasked with approving the offshore parts of an oil and gas project, and in this case, the Northern Territory Environment Protection Authority (NT EPA) based in Darwin would approve the onshore and near-shore facilities.

Assessing the offshore and onshore LNG processing parts of the project separately

¹ IEEFA. [How To Save the Barossa Project from Itself - Carbon Capture and Storage Will Not Help as Barossa Gas Is High-CO₂ Gas](#). October 2021.

² Upstream. [Santos betting big on carbon capture in bid to drive down emissions](#). 18 August 2021.

³ NT EPA. [Darwin Pipeline Duplication Project](#). 18 January 2022.

gives an incomplete picture as to the true emissions intensity of the whole Barossa project. Australia needs a comprehensive account of what a project developer wants to construct and operate on its lands and sea, particularly when the developer is exploiting domestic resources.

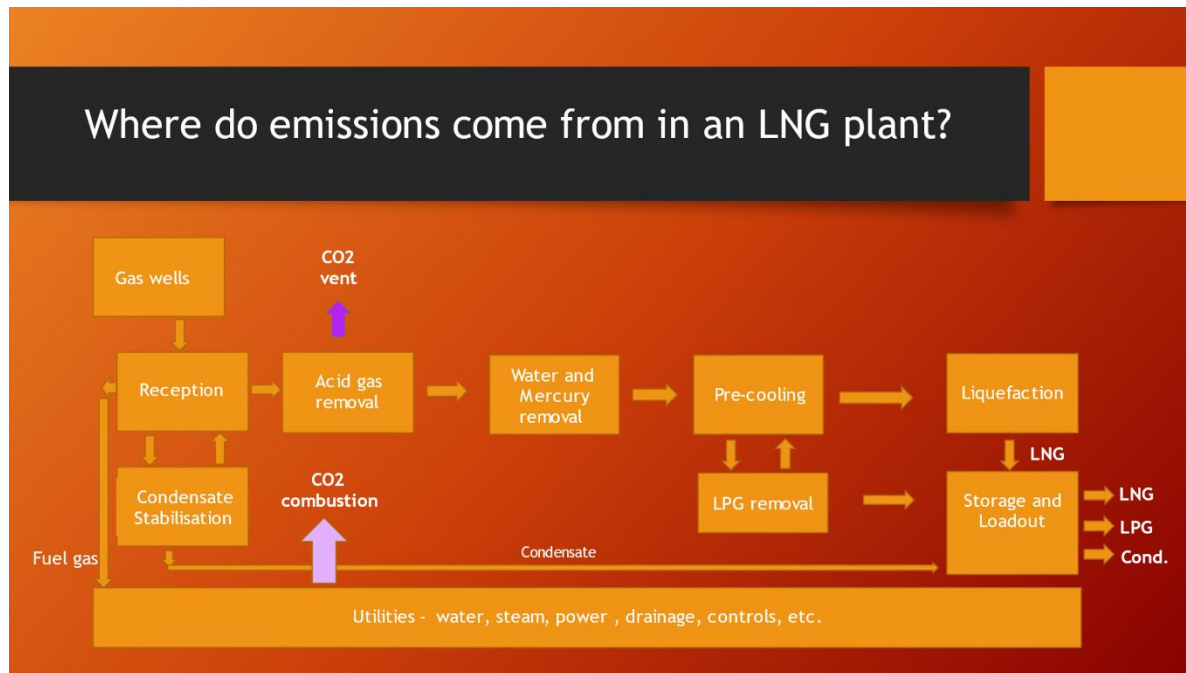
IEEFA suggests approval for commencement of work on the Barossa project should be suspended until a complete review of this apparently now fundamentally changed project is given approval.

Global LNG buyers also are increasingly interested in certification of the Green House Gas (CO₂e) emissions intensity of the cargoes they are going to receive – and the integrity of the certifying authority.⁴

Emissions from the Barossa Project

For background, it may be helpful to understand how the typical LNG process produces emissions, as well as LNG. Figure 1 shows the steps in processing or cleaning the methane before liquefying it to become LNG.

Figure 1: Typical LNG Plant Sources of Emissions



Source: Author's diagram.

The purple arrow indicates a nearly pure CO₂ stream separated from the methane (ie. 'captured') and vented prior to the methane liquefaction step, and the violet

⁴ Pavilion Energy. Pavilion Energy and Qatar Petroleum Sign Strategic LNG Supply Agreement for Singapore. 9 November 2020.

arrow indicates a dilute CO₂ stream within the combustion products exiting gas turbines driving compressors and electricity generators.

Four main sources of emissions were described in the Offshore Project Proposal (OPP) by the original Barossa development proponent and operator, ConocoPhillips. The OPP was the basis for approval of the project given by NOPSEMA in March 2018.

Table 1: Four Main Sources of Emission from the Barossa Offshore Development Project (OPP Case)

Million tonnes CO ₂ pa	Vent	Combustion	Total
Offshore (FPSO)	1.82	1.56	3.38
Onshore (Darwin LNG)	0.51e	1.54e	2.05
Total	2.33	3.1	5.43

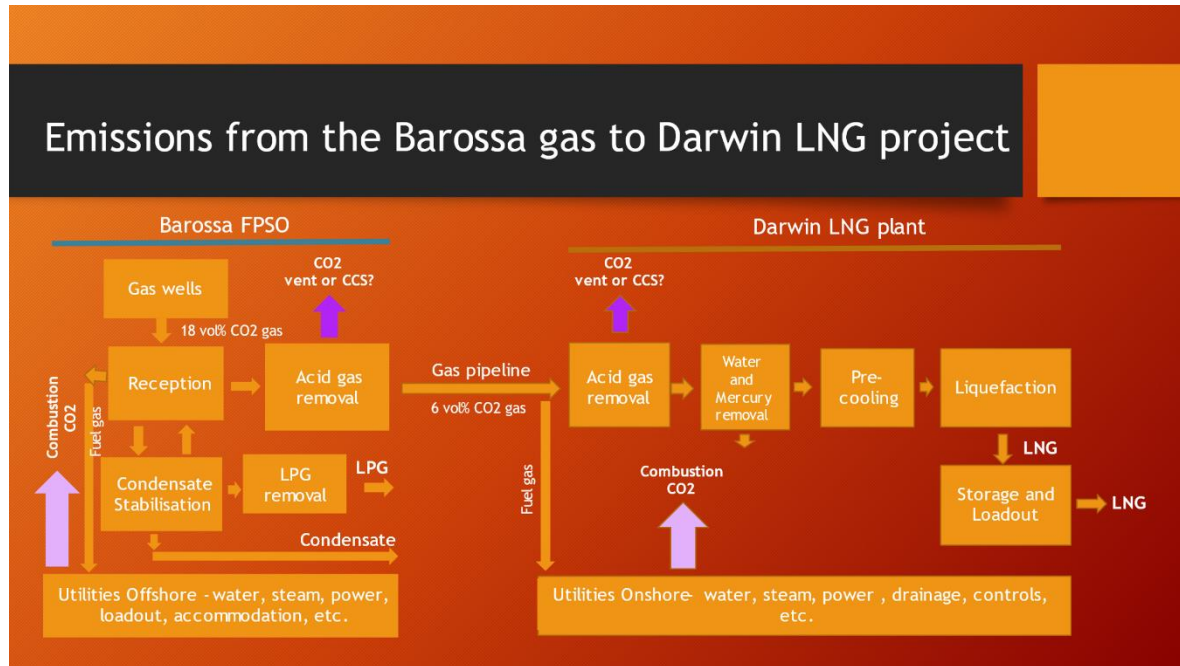
Source: OPP, e: estimated split of DLNG emissions between combustion and vent.

Emissions figures for the Barossa project were summarised in my October 2021 IEEFA paper for three development options.⁵

1. **Scenario 'A'** was for the original form of development as approved by NOPSEMA in 2018 (Table 1). The Barossa project is more complex than the typical LNG plant since it has two processing locations – the FPSO at the Barossa gas field and the Darwin LNG Plant (DLNG)- and the produced gas contains an unusually high concentration of CO₂ (18 volume%, or ~36 weight%). This processing scheme is shown in Figure 2.

⁵ IEEFA. [How To Save the Barossa Project from Itself - Carbon Capture and Storage Will Not Help as Barossa Gas Is High-CO₂ Gas](#). October 2021.

Figure 2: Scenario A - Barossa LNG Emission Sources per Approved Offshore Project Proposal (OPP)



Source: Author's diagram.

- Scenario 'B'** was based on an assumed scheme which included a CCS element to store the vent CO₂ (1.8Mt/y) from the processing aboard the FPSO vessel moored at the gas field. It was assumed that the CO₂ to be stored went directly to the B-U field via a direct, new 430km pipeline. Emissions from DLNG were assumed to be too small to warrant storage.
- Scenario 'C'** was provided to illustrate the impact of electrifying the operations using renewable power supplies and CCS for the offshore vent CO₂, as for Scenario 'B'. In this scenario, combustion emissions are eliminated by using renewable electricity and electric motor drives in place of gas turbines to power the process. IEEFA notes this approach could make a much more significant impact than Scenario 'B', by eliminating combustion emissions and possibly approaching a 90% reduction in emissions overall.

The results of considering these three scenarios last October are summarised in Table 2.⁶

⁶ IEEFA. How To Save the Barossa Project from Itself - Carbon Capture and Storage Will Not Help as Barossa Gas Is High-CO₂ Gas. October 2021.

Table 2: Scenario A, B and C for Reducing Emissions at Barossa

MtCO ₂ pa	Offshore at Barossa		Onshore at DLNG		Total Emissions	Emissions Intensity
	Scenario	Vent	Combustion	Vent		
A	1.8	1.6	0.5	1.5	5.4	1.47
B	0	1.9	0.5	1.5	3.9	1.06
C	0	0	0.5	0	0.5	0.14
				Australian LNG Average		0.7

Source: Author's calculations.

Santos' Latest Proposal

It was after that report was written that we learnt Santos was considering a new pipeline in Darwin Harbour, intended to carry Barossa gas all 300km to the DLNG, rather than utilising the last portion of the 500km pipeline from the B-U gas field to DLNG.

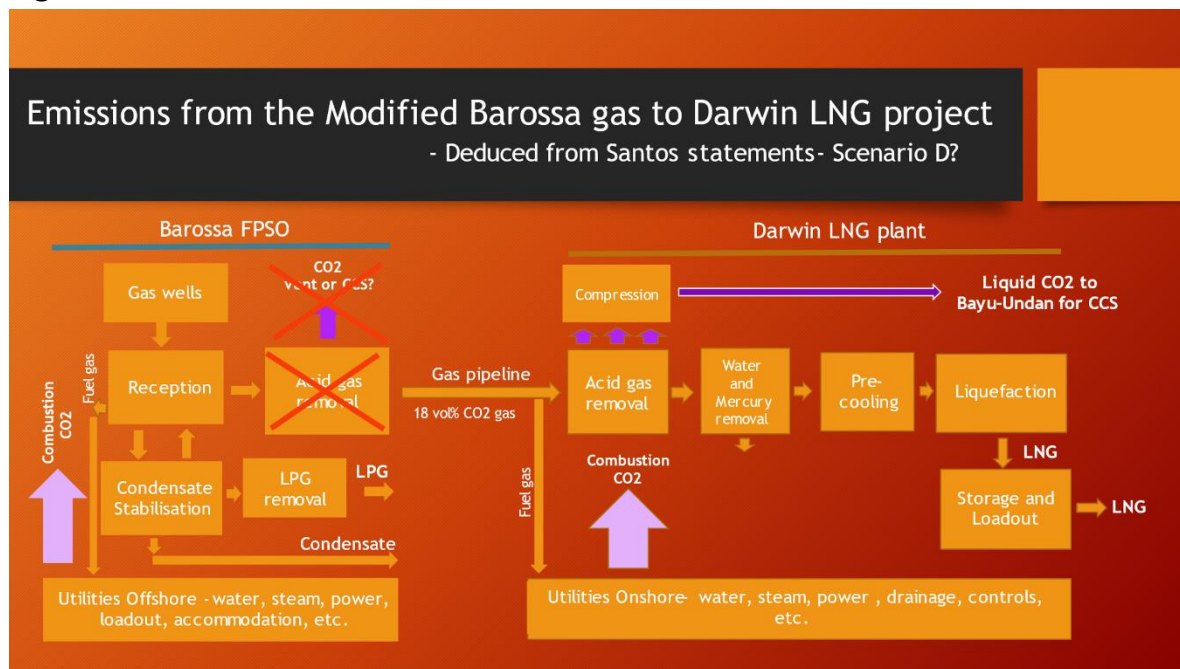
The Barossa development is intended to replace the gas supply from B-U as the reservoirs there are close to depleted, so the BU-DLNG pipeline would become redundant.

We also learnt that Santos intends to reverse the flow direction and re-use the BU-DLNG pipeline to carry CO₂ out to B-U for re-injection into the depleted gas reservoirs. This looks like an odd way to include CCS in the project as it would mean moving the produced CO₂ nearly twice as far (300+500km). (I had assumed 430km back in October 2021).

The proposed new section of line would pass through the port approaches and into the Harbour where the 8 metre tidal range scours channels and moves sand/mud banks. This would require trenching, ballasting or covering the pipeline with rock ballast to prevent it from being moved or damaged by the strong currents or ship anchors.

In light of Santos' latest application, there now should be a '**Scenario D: OPP + CCS via Darwin**' scenario to fit with our current understanding of Santos's intentions for the project. This scenario is shown in Figure 3.

Figure 3: Scenario D: OPP + CCS via Darwin



Source: Author's diagram.

In Scenario D (18vol%CO2 gas to Darwin), although more 'native CO2' (or 'reservoir gas CO2) is captured and stored (hopefully) at B-U, **there will be more combustion CO2 emissions** because more compression would be required on the Barossa FPSO to move gas with 18% CO2 to Darwin, rather than 6% as per the OPP (about 2 MtCO2/y of extra of gas flow). Additionally, there must be two more Acid Gas Removal Units (AGRU) – or CO2 separation units – and their vent emissions and power load at Darwin, which means more compression emissions at Darwin to move the separated CO2 out to B-U and then more compression at B-U. Additionally, the fuel gas used at Darwin would contain 18% CO2 (three times the original level) and so would emit more CO2 to produce each unit of an increased power load.

Although all of the vent CO2 (1.8 + 0.5 = 2.3 Mt/y) would be captured and stored at B-U in Scenario D, the increase in emissions from combustion (for processing and compression power) at three locations would probably add up to an amount similar to that of the vent CO2 sent to storage.

My judgement estimates of the extra combustion emissions for this scenario shown in the following table for this case are order of magnitude only.

Table 3: Scenario A, B, C and D for Reducing Emissions at Barossa

MtCO ₂ /y	Barossa FPSO		Darwin LNG and B-U		Total Emissions	Emissions Intensity tCO ₂ /tLNG
	Vent	Comb	Vent	Comb		
A: OPP basis	1.8	1.6	0.5	1.5	5.4	1.47
B: OPP+CCS	0	1.9	0.5	1.5	3.9	1.06
C: OPP+elec+ CCS	0	0	0.5	0	0.5	0.14
D: OPP+SCCS	0	1.9	0	3.5*	5.4	1.47

Source: Author's calculations.

- assumes 1/3 of Scenario A combustion emissions at Darwin is from powering the AGRU, and the balance is from powering the balance of the LNG process
- assumes Scenario D will require 2 new (each of same capacity as existing) AGRUs at DLNG, so add 1.0 to the 1.5 of Scenario A
- assumes Scenario D will require CO₂ compression/liquefaction into pipeline, adding 0.5
- assumes Scenario D will require CO₂ re-compression at B-U for re-injection, adding 0.5
- Scenario assumes some gas production at B-U to power the facility

Note that all combustion for power, etc at DLNG would use 18%CO₂ fuel gas instead of 6%, so flue gas from all gas turbines etc. would be richer in CO₂. Therefore, the above estimate may be conservative.

Conclusion

Adding CCS to the Barossa development in the way Santos appears to favour (Scenario D) would bring little or no reduction in emissions, while adding substantial cost, delays and risk.

Some gas discoveries are just not worth developing – especially now in light of the International Energy Agency's (IEA) recently released Net Zero to 2050 roadmap which clearly states there must be no new oil and gas projects globally from 2021 if the world is to have any chance of reducing increasing emissions, in addition to many world governments' net-zero commitments as displayed at COP26 in Glasgow. Barossa, with **twice** the reservoir gas CO₂ content of the equally highest currently developed Australian gas fields – Ichthys, Gorgon and Prelude – is one of those.

Santos and its partners in the Barossa development should take their losses as they are before they grow greater still.

If it is still to be considered for approval, this project should be required - by the relevant authorities - to build the CCS-enabling facilities no later than the gas production facilities and to prove their satisfactory operation before any export of LNG cargoes are permitted. A repeat of the Gorgon CCS debacle in Western Australia is just not acceptable.⁷

⁷ Gorgon exported LNG for three years before its CCS system started up and it has only been 50% as effective as required by its WA EPA approval. It built the CCS kit after everything else. See SMH. [Chevron's five years of Gorgon carbon storage failure could cost \\$230 million](#). 11 November 2021.

Approval for the commencement of work on the Barossa gas development and DLNG modifications should be suspended until a complete review of this apparently now fundamentally changed project is given approval.

Otherwise, Santos' suggestion of a solution using CCS which fails to address the fundamental fault with the Barossa gas development should be seen as greenwashing and a diversion while construction continues.

About IEEFA

The Institute for Energy Economics and Financial Analysis (IEEFA) examines issues related to energy markets, trends and policies. The Institute's mission is to accelerate the transition to a diverse, sustainable and profitable energy economy. www.ieefa.org

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