Submission to the EPA
Woodside Browse and North-west Shelf Proposals

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Sustainable Energy Now Inc.
PO Box 341
West Perth WA 6872

contact@sen.asn.au

http://www.sen.asn.au/

Author: Dr Rob Phillips
Contributors: Len Bunn, Humphrey Boogaerdt, Angus King, Ivan Quail, Alastair Leith

Sustainable Energy Now (SEN) is a technical, professional, evidence-based think tank advocating for a clean energy future for WA. We bring together independent specialists from the engineering, science, education, economics, and IT sectors who are passionate about volunteering their skills and knowledge to drive WA's transition to renewable energy.	Contact details: PO Box 341 West Perth, WA 6872 contact@sen.asn.au www.sen.asn.au

Introduction

SEN's expertise is in the renewable energy and greenhouse gas (GHG) emissions sector. This submission considers only the GHG emissions aspects of the three proposals to the EPA (and federal government):

- The proposed Browse to NWS project (ERD & Environmental Impact Statement)
- The North West Shelf project extension (ERD)

The Browse to NWS project is a key part of the Burrup Hub mega project. Emissions from this proposal must be considered cumulatively, alongside other gas developments proposed to be processed at the same Burrup Hub complex, in order to properly assess this proposal's environmental impact. CCWA research under preparation [1] shows that the Burrup Hub project, in its proposed form, will emit 139 million tonnes pa. of CO2-e (both new and existing projects). It will also have a lifecycle pollution total of 6,086 Mt CO2-e (6 giga tonnes).

SEN supports the Polluter-Pays principle of the EPA legislation, and expects that industry will be held responsible for dealing with its waste products. The cost of doing so should be a consideration in the pricing of the product.

SEN's considered view is that these proposals should be rejected completely because the volume of greenhouse gases emitted will contribute to global warming and compromise Australia's (and Western Australia's) ability to meet the legally-binding GHG emissions targets set under the Paris Climate agreement. The proposals will increase the emissions needing to be reduced by 2030 by 19%. There is no scope (globally or locally) to develop new natural gas projects, while attempting to reach the Paris COP21 warming targets.

SEN also argues that there are numerous flaws and misrepresentations in the Woodside proposals. In particular, they:

- do not clearly report estimated methane emissions, and what is reported is substantially lower than published leakage rates;
- under-estimate methane's Global Warming Potential (GWP) by using dated metrics;
- attempt to conceal the magnitude of the reservoir CO_2 emissions;
- use an unrealistic and discredited projection of global gas demand, which is at odds with other projections;
- make unrealistic claims about the emissions intensity of the Browse Basin gas;
- make no realistic attempt to avoid, minimise or offset emissions;
- attempt to claim that new GHG emissions from the sub-proposals are small on a global scale, instead of analysing them at a national and state level;
- attempt to minimise the impact by splitting up the proposed megaproject into independent sub-proposals, and cross-referring between them; and
- do not meaningfully address the WA State Climate policy, nor the EPA's soon-to-be-finalised GHG Guideline.

These shortcomings preclude the EPA from making a proper assessment on the impacts on air quality from processing emissions.

Emissions amounts are very large, but they are likely to be larger than claimed, because of underestimation of methane impacts.

Further, Woodside's claim that gas is half as emissions intensive as coal is incorrect. SEN's analysis, using credible sources and Woodside's own, very low methane emissions, is that Browse natural gas emissions intensity is 25% more efficient than coal, calculated using contemporary GWP values.

SEN urges the EPA to reject the current proposal because it poses an unacceptable level of risk to Western Australia's environment.

GHG Emissions Targets

The current concentration of CO_2 in the atmosphere is 410 ppm and the current global emissions trajectory will create warming of 3-4 degrees C .

In December 2015, nations around the world adopted the Paris COP21 climate treaty and agreed to reduce GHG emissions to keep global warming within 2.0°C with an aspiration for 1.5°C. Scientists considered that a maximum of 1.5°C to be the upper limit for a relatively 'safe' climate. The agreement entered in to force in November 2016 and has been signed by 197 countries and ratified by 187.

Australia has committed to a 5% reduction of GHG by 2020 and a 26-28% reduction of GHG on 2005 figures by 2030 (nationally Determined Contribution (NDC)). This target is widely considered to be inadequate (e.g. [2], [3]), and puts Australia on track for 3°C of warming by 2100.

Furthermore, Australia's emissions from fossil fuels and industry have been increasing over recent years, and are now 7% above 2005 levels [4].

Australia is clearly not on track to reduce GHG emissions to an extent that will keep global warming within Paris COP21 goals. Adding new emissions, as proposed here, will exacerbate the problem.

State targets

State governments are bound by the National Climate Resilience and Adaptation Strategy [5] to manage "risks and impacts to public assets (including natural assets) and infrastructure owned and managed by the State or Territory Government" [6].

Further, legal opinion [7, p. 29] is that the Paris targets adopted by Australia must be reflected in Western Australian legislation, and must become binding on the state.

Minister Johnston's [8] media release about the State Climate Policy *"supports the Federal Government's target of reducing emissions by 28 per cent by 2030"*, and sets an aspiration of net zero greenhouse gas emissions by 2050.

Western Australia's annual emissions targets, under these provisions, for 2030 and 2050 are significant. Recent figures [9, p. 7] show Western Australia contributed 16.7% of Australia's GHGs in 2017, for approximately 10% of the population. Annual emissions are displayed in Figure 1, which shows that non LNG emissions (blue) have increased slightly compared to 2005, and projected to remain constant, and not trend downward as required by the Paris commitments. More concerning, is that emissions from LNG projects (since 2005) have added 36% to WA's 2005 emissions baseline (burnt orange).

Fig. 2 also shows that emissions are projected to continue to grow due to further LNG developments proposed in Western Australia, such as those proposed here. The CCWA Runaway Train report [7, p. 35] predicted that emissions will add 17.2 MtCo2-e p.a. – a 25% increase on WA's 2005 emissions baseline (orange).

The bulk of this increase will come from this proposed 'mega project', including Browse, Scarborough, Pluto and NWS[1]. However, when the Scope 1 emissions from the megaproject are derived from the published Woodside ERMP documents submitted to the EPA, Fig.2 proves to be an underestimate. The actual Woodside documents for the megaproject show that the combined Scope 1 emissions amount to 23.7 MtCo2-e p.a.

[1] While these have been submitted as separate proposals, the EPA must assess these cumulatively, consistent with the proposed GHG Guideline.

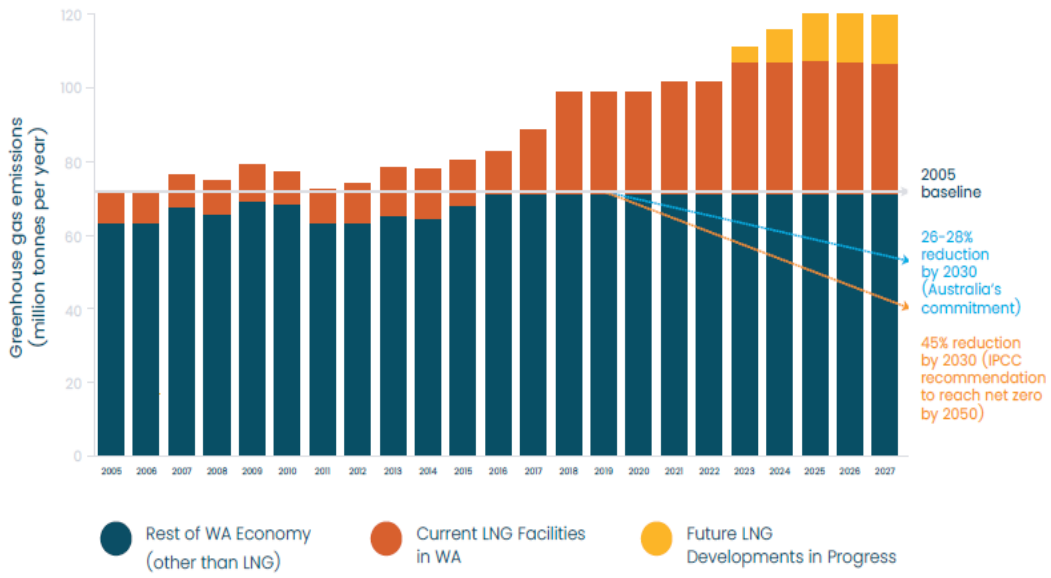

Figure 1. Trajectory of emissions in WA. From the "CCWA Runaway Train Report 2019" [7].

[1], meaning that, if these projects are approved, WA's emissions will be 48.1 Mtpa Co2-e above 2005 levels.

Not only will WA need to reduce its 2017 emissions by 36.9 MtCo2-e p.a. by 2030 to meet the 26% target, but it will need to reduce its emissions by an extra 23.7 MtCo2-e p.a. if these proposals are approved.

However, the inadequacy of federal policy settings in reaching the 1.5°C target is that the "state level greenhouse gas target for Western Australia … is a reduction of 49% by 2030 (from 2005 levels)" [10] – not 26-28%.

The mega project, or its individual components, will make it much more difficult for Australia to meet its NDC commitments.

Given the preceding arguments, the only way that such a mega project could be approved is if it avoids, minimises and/or offsets ALL of its emissions.

Global targets

The Browse Joint Venture (BJV) proposal acknowledges the impacts of climate change on the ecology:

> *"Global GHG emissions will continue to have an effect on trends in receptor condition and potential impacts to listed threatened and migratory species, threatened ecological communities" [11, p. 699] and*
>
> *"At the point where global temperature rise due to climate change reaches 2°C, increasing numbers of receptor groups suffer impacts which are high to very high, and likely to be irreversible (terrestrial ecosystems, warm- water corals, unique and threatened systems, and arctic regions)" [11, p. 695].*

However, the company goes on to justify its inaction on minimising GHG emissions through two arguments presented in numerous places throughout the proposals (SEN's emphasis):

> *As a **stand-alone project**, however, taking into account all planned emissions reduction and offsetting measures (Section 7.7), it is estimated that Scope 1 and 3 emissions from the proposed Browse to NWS Project could **contribute in the range of 0.06% to 0.15% global GHG emissions** depending on the NDC scenario considered (Table 7-13). [11, p. 699]*

These two arguments are spurious:

- Because GHGs are evenly distributed throughout the atmosphere, and relatively low in global terms, does not mean the company does not have any responsibility for emitting them.
- That each project 'stands alone', and should be assessed in isolation, without considering the combined impact of related projects on the environment.

Global impact

Woodside is scientifically correct when it argues that GHGs are evenly distributed throughout the atmosphere, but its ethics are questionable. Essentially, the company is arguing that its right to make a profit outweighs its corporate responsibility, and ignores its social license. Environment protection authorities around the world were established to respond to this world view.

If all people and corporations took this view, there would be no more human society as we know it.

In addition, the planetary carbon budget required to remain below 1.5°C or 2°C of warming is being compromised by every addition of GHGs to the planetary ecosystem. LNG extraction contributes a relatively large proportion of these additional emissions (see subsection below).

A responsible corporate citizen would assess its pollution in terms of Australia's Paris commitments, and Western Australia's contribution to these, as discussed in the previous section. Woodside's proposals do not meaningfully address the WA State Climate policy, nor the EPA's soon-to-be-finalised GHG Guideline.

In fact, Woodside uses the 'global impact' argument to explicitly *not* consider state and national impacts (SEN's emphasis):

> *"The impact associated with the Proposal's GHG emissions contribution needs to be considered in context of global emissions and the receptor relevant to GHG emissions is therefore the global atmosphere. **Therefore regional, state and national GHG contributions are not further assessed.**" [12, p. 115]*

However, elsewhere, they argue for a national and global response:

> *Owing to the global nature of GHG emissions, a national and global response is required in order to address the potential influence of climate change from changes to GHG emission concentrations." [12, p. 117]*

Woodside then argues that it will abide by the national NGER Safeguard Mechanism, which requires that 25% of the vented CO_2 from the Browse extraction facility be offset. When the SGM is reviewed this year, it will argue for this offsetting requirement to be written off or reduced.

Woodside also argues that Australia's NDC will be met by national policy settings, even with the megatons of additional GHG emissions associated with these proposals. As

argued above, it is very unlikely that Australia's NDC will contribute to limiting warming to 2°C; and that WA's carbon budget is also being compromised.

Woodside's proposals acknowledge their climate impact [11, p. 699] and [11, p. 695], but then seemingly do not intend to do very much about these impacts.

The proposals should not even be considered until the company takes its pollution impacts seriously.

Stand-alone projects

The proposition that each project 'stands alone', and should be assessed in isolation, is a convenient way to hide the bigger picture of the proposed pollution.

We have already identified that the two proposals being assessed here are part of a megaproject, which will emit 139 $MtCO_2$-e p.a. (both new and existing projects), for a lifecycle pollution total of 6,086 $MtCO_2$-e p.a. Woodside is clear about its strategy:

> *"Any direct impact associated with the direct emission of GHGs from the Proposal are negligible when assessed in isolation." [12, p. 116]*

A related 'global impact' argument applies here. Woodside can argue that its $50Bn project will contribute little to global emissions, it has other prospective projects in Senegal and Myanmar [13]. Other oil and gas companies are also ramping up production. For example, Exxon plans to invest in a "*$US35 billion-a-year capital investment plan that aims to build oil and gas projects from Guyana to Mozambique."* [14]. When the cumulative impact of multiple gas projects is assessed, the global climate impact is relatively large.

The EPA GHG Guideline is very clear that cumulative impacts on the environment of related projects need to be assessed together. SEN expects that this will occur in this case.

Global Warming Potential

Methane is a substantially more potent greenhouse gas than carbon dioxide, and is responsible for as much as a third of the anthropogenic global warming that has occurred to date [15, 16]. It is therefore important that an appropriate metric for the Global Warming Potential (GWP) be used.

Global Warming Potential is an *"index measuring the radiative forcing following an emission of a unit mass of a given substance, accumulated over a chosen time horizon, relative to that of the reference substance, carbon dioxide (CO_2). The GWP thus represents the combined effect of the differing times these substances remain in the atmosphere and their effectiveness in causing radiative forcing"* [17, page 124].

However, using different time horizons (periods of observation) for greenhouse gas impact changes the observable warming effect in comparison to other GHGs [18]. Methane has a high radiative forcing (RF), but its atmospheric life is around 10 years (half life ~7yrs), because chemical reactions in the atmosphere convert it to other gases, mostly CO_2, which has a much lower radiative forcing (RF) impact than methane.

Warming from methane decreases sharply after 10 years, as shown in Fig. 2, taken from [19]. If methane were a once-off pulse emission and humanity had decades to address climate change, then the concern would be low. Unfortunately, the atmospheric stock of methane has continued to grow since preindustrial times, much more rapidly than CO_2 in fact, and scientific opinion is that we have one decade left to rapidly reduce GHG emissions to half or less than current global emissions [2].

Two methods of Global Warming Potential are commonly used: whether methane should be compared with CO_2 in the atmosphere over 100 years (GWP_{100}) or 20 years (GWP_{20}).

The lower-impact GWP_{100} was used historically in government and quasi-government evaluations, before the rapid rate of change of climate was widely understood, but there has been a recent strong move to use of GWP_{20} to better reflect the timeframes available for realistic action.

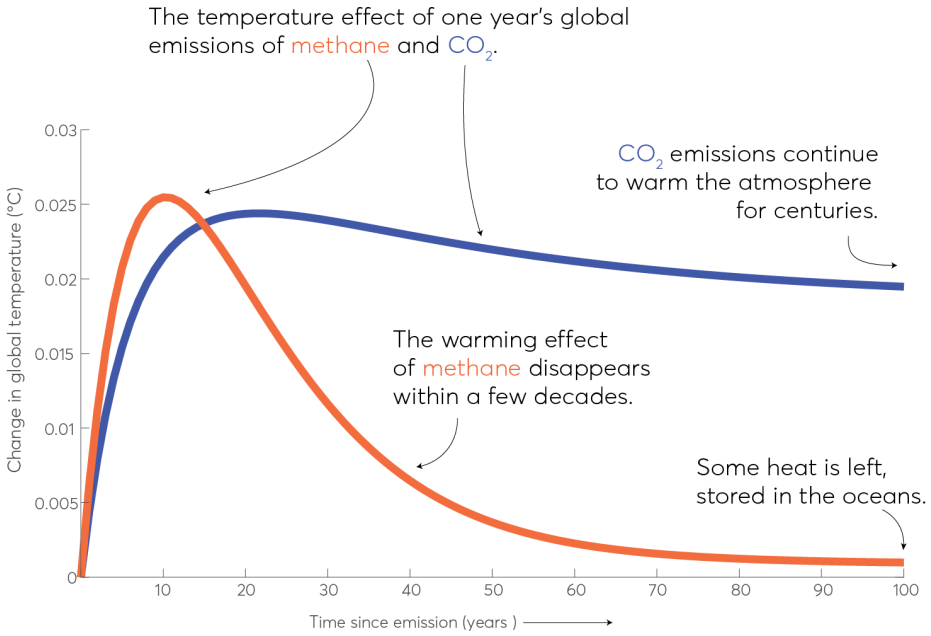

Figure 2. Methane and CO_2 decay curves in the atmosphere.

The IPCC has continually discussed various indices for comparing GHG warming effects, and while Global Warming Potential has been seen as a compromise between ease of application and accuracy, the IPCC has always listed estimates for both GWP_{100} and GWP_{20}, even though GWP_{100} has seen the greater adoption in UNFCCC negotiations and legislative frameworks around the world. This is largely due to the almost exclusive focus of world negotiations on CO_2 over other GHGs.

For example, the Kyoto Protocol is based on GWP_{100}. At the time it was signed, methane was indexed at 25 times the warming potential of carbon dioxide [20]. The current value for GWP_{100} (section 3.9.6 Page 251 of [21]) is 28. On the other hand, the latest IPCC figure for methane using GWP_{20} uses a factor of 84 for GWP_{20} (section 8.7.1.4 Table 8.7 of [22]).

In other words, use of GWP_{100} values substantially reduces the estimated global warming potential of methane compared to GWP_{20} values over the short (10-20 year) timeframes that are now being considered for effective climate change action.

Since a global spike in methane emissions in recent years after a temporary flattening, and the concurrent emergence of unconventional gas mining in recent years, more attention has been focused on methane and the inappropriateness of the reductions within the GWP_{100} index.

For example, in June 2019, the state of New York passed wide-ranging legislation that methane emissions both inside and outside state boundaries will be assessed using the GWP_{20} index [23].

In line with more recent understanding of climate change time frames, SEN advocates for the use of the GWP_{20} approach for methane reporting and accounting, because this is a more realistic measure of the effect of methane in these particularly critical near-term years of global warming. SEN suggests the EPA does the same.

However, in its proposals, Woodside has used a GWP_{100} metric of only 21 from 2007, 25% less than than a more contemporary metric for GWP_{100}; and ***fourfold*** less than the metric for GWP_{20}. The use of GWP_{20} is likely to significantly increase the CO_2 equivalent emissions from methane in the proposals, which Woodside has claimed in various places to be 'minimal', e.g. [11, p. 680].

In Appendix B, they state *"Woodside's methane emissions are approximately 4% of total operated emissions (CO_2-equivalent basis)"* [24, p. 246]. Using GWP_{20}, the methane emissions would account for 16% of 'total operated emissions'. We return to this in a later section.

Gas demand profiles

Demand for LNG is forecast to decrease worldwide, and scientific calls have been made for its use to be decreased. For example, in a recent IPCC report "Mitigation Pathways Compatible with 1.5°C in the Context of Sustainable Development" [25], Table 2.5, predicts that gas must decline by 15% by 2030 and 43% by 2050, relative to 2020, to have a chance of limiting global warming to 1.5°C above pre-industrial levels.

Climate Analytics [10] has reported a similar analysis:

> *"Global implementation of the Paris Agreement means that growth in the use of natural gas cannot continue. Scenarios vary, however a common denominator is that in the next decade natural gas demand would have to peak and begin to decline… fairly rapidly".*

Woodside, on the other hand, is predicting an increase in gas demand until 2040:

> *"The Proposal will supply gas into markets modelled under the SDS [International Energy Agency Sustainable Development Scenario] and the modelling demonstrates gas consumption in these markets grows by 130% between 2017 and 2040." [12, p. 117].*

A graphical representation is shown in Figure 3 (copied from [11, p. 690].

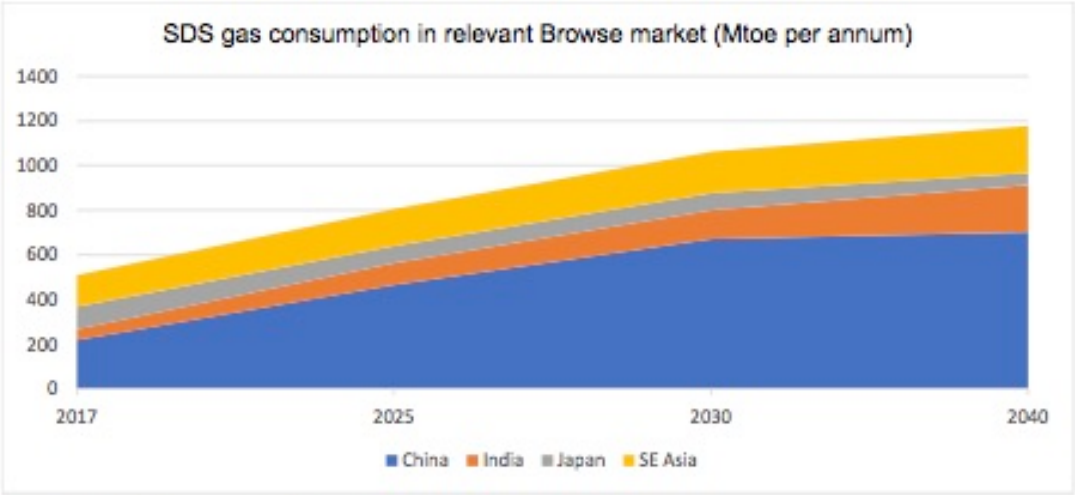

Figure 3-3 Forecast gas consumption in the IEA's SDS in relevant Browse markets (Mtoe)

Figure 3. International Energy Agency Sustainable Development Scenario for gas demand.

Alternative scenarios are presented by Climate Analytics [10, p. 18] in Figure 4. Figure 4 shows the projected demand for natural gas for electricity generation without CCS in the Asian region for 1.5°C compatible scenarios, which are assessed by the IPCC to be in line with the Paris Agreement long-term temperature goal. Fig. 4 compares 1.5°C compatible pathways (shaded) with the IEA B2DS (below 2°C scenario) from 2016. This latter scenario "is not fully Paris Agreement compatible … [It} peaks higher in 2030 but still drops quickly afterwards" [10, p. 17].

The trajectories in Figure 4 are markedly different from those in Woodside's proposals.

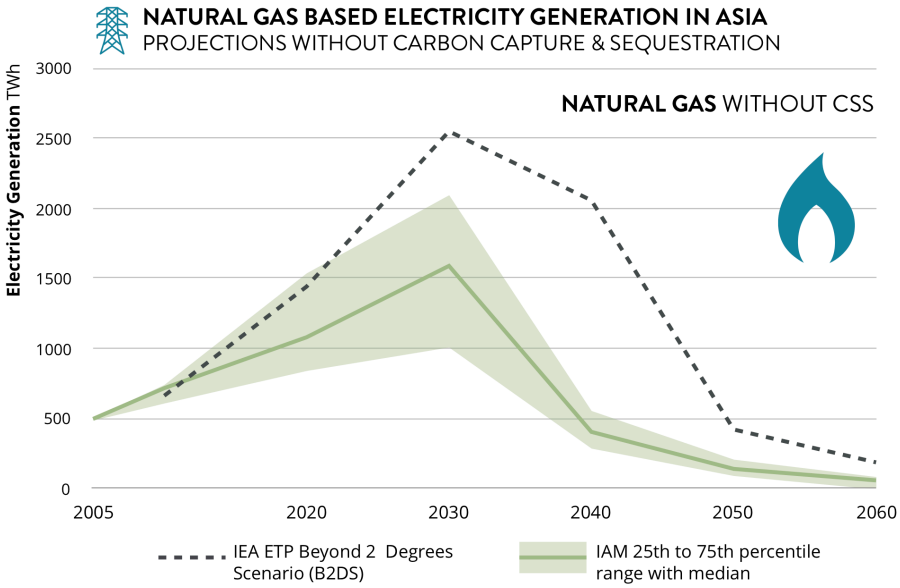

Figure 4: Electricity generation from natural gas without CCS. Shown are the median for PA-compatible Integrated Assessment Models (IAM), as well as the results from the IEA ETP B2DS used in the current study for some of the underlying pathways, both for the Asia region. Source:(Climate Analytics 2019c). The relative cost of CCS makes deployment of this technology unlikely in our assessment. The earlier IEA B2DS scenario shows a much higher natural gas demand than more recent fully Paris compatible scenarios.

Figure 4. Projected demand for natural gas for electricity generation in the Asian region for 1.5°C compatible scenarios.

Climate Analytics went on to critique the SDS scenario used by Woodside (SEN's emphasis):

> *"A more recent scenario published by the IEA, the Sustainable Development Scenario (SDS) is also far from Paris Agreement compatible and has an even higher level of natural gas use after 2030 than the B2DS scenario. The SDS scenario substantially exaggerates the amount of natural gas used in the power sector and is an outlier compared to model assessments of limiting warming to 1.5°C. The SDS natural gas use in the Asian region is still rising in 2040 unlike any other of the published 1.5° compatible scenarios.* ***The inconsistency between the IEA SDS scenario and the Paris agreement's 1.5°C temperature limit has been acknowledged by the IEA*** *in its recent 2019 World Energy Outlook. The agency has signalled it will do further the work on the subject" [10, p. 17].*

Thus, the gas demand scenario used by Woodside is problematic and contested. SEN wasn't able to access the IEA's full World Energy Outlook for 2019, but the abstract of the IEA's 2019 World Energy Outlook confirms that the SDS gas demand scenario used by Woodside is questionable.

> *"In the Sustainable Development Scenario, natural gas consumption increases over the next decade at an annual average rate of 0.9% before reaching a high point by the end of the 2020s. After this, accelerated deployment of renewables and energy efficiency measures, together with a pickup in production of biomethane and later of hydrogen, begins to reduce consumption." [26]*

If these alternative gas demand scenarios are more appropriate, and assuming the BJV venture commences in 2026, it will only be five years until peak demand is reached. This will impact on the ongoing economics of the proposal, and increase the risks of stranded assets [27], and austerity measures, as currently being implemented by Chevron [28].

This could result in associated environmental risks, arising from underfunded operational budgets and poor-to-no decommissioning. High levels of fugitive emissions become far more likely in these scenarios.

Given this information, the EPA should carefully review the gas demand target models as it assesses the proposals.

Proposed Woodside Emissions

Megaproject implications

In a recent publication [1], the Conservation Council of WA outlines its analysis of the cumulative emissions from the Burrup Hub megaproject, finding that it will emit 139 million tonnes CO_2-e pa., and will have a lifecycle pollution total of 6,086 $MtCO_2$-e.

The Browse to NWS project and the North West Shelf Project Extension are key parts of Woodside's Burrup Hub mega LNG processing facility.

We have argued earlier that emissions from this proposal must be considered cumulatively, alongside the other gas fields which will be processed at the same complex on the Burrup Hub, in order to properly assess the proposal's environmental impact.

This is important when assessing the impact on Australia's Paris commitments.

The rest of this sub-section only considers the emissions from the two proposals currently being assessed. The proposed emissions from the two proposals are summarised in Table 1. Column 4 scales the total emissions to estimate the total emissions by 2030, in order to compare these with Australia's Paris commitments.

Table 1. Summary of the emissions from the two proposals.

	Scope 1&2 pa Mtpa	Scope 1&2 total Mt	Scope 1&2 to 2030 Mt	Scope 3 pa Mtpa	Scope 3 total Mt
Browse Joint Venture (BJV)	4.8	200 *	24 §	32	995
NWS Karratha Gas Plant º	7.7	385 †	38.5 §	80.19	4009 †
Total	12.5	585	62.5	80.19	4009

* 31 years † 50 years § 5 years to 2030, assuming plant opens in 2025
° Unclear, but probably includes BJV Scope 3 emissions

The Browse to NWS Proposal [11] states:

> *"The emissions reduction task to achieve the 2030 target is currently 328 MT CO2-e. [11, p. 696]*

Table 1 shows that Scope 1 & 2 emissions will add 62.5 Mt to the 328Mt 2030 target. This increases the emissions needing to be reduced by 2030 by 19%.

Emissions Intensity

Page 680 of [11] claims *"The relative proportion of CO_2 emissions associated with reservoir and fuel combustion components are modified accordingly. For example:*

- *Gorgon LNG Development (operating): circa <1-14 mol%*
- *Proposed Browse to NWS Project: circa 7-12 mol%."* [11, p. 680]

On the other hand, p. 683 of [11] claims *"Range provided for expected (10.2%) and high (11.6%) reservoir CO2 composition (weighted average of reservoirs)."*

It is not clear why these figures are not consistent.

Woodside admits that *"Browse has a relatively high reservoir CO2 content"* [11. p. 697], but does not quantify this.

An attempt is made on page 697 to benchmark Emissions Intensity (EI) at Browse with other facilities, and reports an emissions intensity of 0.15t CO_2-e to 1t LNG. This compares favourably with the other sites, but a closer reading reveals that this is only for 'processing emissions'. The analysis explicitly *"does not include the reservoir CO2 emissions"* [11. p. 697].

Emissions Intensity at the NWS LNG plant is also not reported here. However, Appendix F of the NWS proposal [24, p. 474] by consultants Jacobs reports an average Emissions

Intensity at NWS of 0.41. This amounts to 0.56 t CO_2-e to 1t LNG, without accounting for reservoir emissions, which are not reported.

However, information in Appendix F [24] allows an estimate to be made of reservoir EI. The Barossa-Caldita field is estimated to have reservoir CO2 in the range of 16-20%. Fig. 5.1 of [24] shows that the EI from reservoir CO2 is 0.5. Scaling from an average 18% at Barossa-Caldite and 11% at Browse, results in an EI from reservoir CO2 of 0.3 t CO_2-e to 1t LNG, for a total emissions intensity of 0.86 t CO_2-e to 1t LNG.

Other work by the Conservation Council of WA claims that the Browse gas field has a very high emissions intensity – nearly double the Australian average.

> *"the emissions intensity of LNG produced from the Browse Basin will be almost 1 tonne of CO_2 for every tonne of LNG produced. This is significantly higher than any of the international LNG projects in Woodside's own comparisons." [1]*

Emissions intensity is discussed further in the following section.

Claimed Benefits of Gas over Coal

Woodside reports emissions intensity of electricity sourced from Browse gas as having a "lifecycle emissions intensity of 550 kgCO2-e/MWh." *[11, p. 689]*

They go on to to compare this with international benchmarks.

> *"This showed that the median emissions intensity of gas fuelled electricity was circa 450kgCO2-e/MWh and that the Browse emissions intensity fits within the interquartile range for global gas fired electricity of 400- 550kg CO2-e/MWh."*

Woodside has made claims throughout the proposals that switching from coal to gas will decrease greenhouse emissions:

> *"Numerous independent energy and climate bodies agree that natural gas has a significant role to play in achieving both a reduction in net global emissions and an increased access to a reliable modern energy supply that supports a progressive transition to renewable energy sources.*
>
> *"The IPPC's 2014 Synthesis Report said that "GHG emissions from energy supply can be reduced significantly" by switching to gas. According to the IPCC, electricity generated from gas has on average half the GHG emissions of electricity generated from coal (IPCC, 2014)." [11, p. 689]*

SEN investigated these claims. Woodside have not used 2014 data. They appear to have used 2011 IPCC [29, p. 19] estimates of the electricity emissions intensity of gas (450kgCO2-e/MWh) and coal (1,000kgCO2-e/MWh) [11, p. 689]. Science has moved on since 2011, and more recent, but still relatively old data from 2014 [30] is shown in Table2. A downward trend in coal emissions intensity can be seen, as older, more polluting, coal generators are retired or upgraded, and newer, more efficient coal generators are commissioned. This trend can be expected to continue and for the median to move closer to the lower boundary of 740 kg CO2-e/MWh.

Table 2 shows that the ratio of the electricity emissions intensity medians for gas and coal has changed from 45% to 60%. A comparison of the predicted Browse emissions intensity (550 kgCO2-e/MWh), and the minimum coal value (740 kg CO2-e/MWh), reveals that Browse gas is 74% more efficient than modern coal plants. Emissions intensities will be discussed further below in the context of fugitive emissions.

Table 2. Emissions of selected electricity supply technologies (gCO_2-e/kWh)[i]

Technology	Minimum	Median	Maximum
Coal – pre-critical	740	820	910
Gas – Combined Cycle	410	490	650

Woodside appears to have (deliberately?) used older IPCC data that significantly favours their argument re the CO_2-e savings from displacing coal. The EPA should expect that proponents provide realistic data in their proposals, and not 'cherry pick' the most favourable data. Woodside should be required to resubmit this argument with more up to date numbers that:

- Use contemporary IPCC data
- Include a review of trends in coal plant efficiency to project those efficiencies into the future, given that it is likely that the median will continue to trend downwards towards 740kg CO2-e/MWhr.

A misleading claim is made in both proposals about the amount of gas switching globally:

> *"The IEA has calculated that the coal-to-gas switching helped avert 95 mt of CO2 emissions in 2018" [11, p. 689, 12, p. 118]*

When the cumulative annual Scope 1, 2 & 3 emissions from the two proposals is 80Mtpa, a global figure of 95 Mtpa is relatively small, and raises the question of how much gas switching is actually occurring. This subsequently raises the question of whether Browse output will be used for coal replacement, or for additional GHG emissions.

There is little evidence that Australian gas is reducing emissions overseas:

> *"According to the IEA, most of the push for coal to gas switching in China is occurring … to replace coal-fired boilers in residential and industrial settings" [7].*

> *"Globally, most of the new natural gas being used isn't displacing coal, it's providing new energy." – Prof. Rob Jackson,Stanford University School of Earth, Energy & Environmental Sciences [Cited in 1]*

Methane Accounting

A particular weakness of the proposals, in terms of the EPA being able to properly assess them, is the lack of specific information about methane emissions. Claims are made in both proposals that *"Woodside's methane emissions are approximately 4% of total operated emissions (CO_2-equivalent basis)"* [12, p. 246]. This was the only place that SEN was able to locate that quantified methane emissions, albeit in carbon-equivalent units.

In other locations, fugitive emissions are claimed to be 'minimal' or 'small', e.g. [11, p. 680, 24, p. 242]. There is no quantification of this. This is a major oversight, given our previous discussion of Global Warming Potential, given that Woodside has used a GWP_{100} metric of 21 from 2007, and science now considers other metrics, which can have a large impact on GHG emissions.

4% of CO_2-e emissions is an unsubstantiated figure, and SEN cannot understand this without a tighter explanation of what they exactly mean by "total emissions". Woodside need to provide data to support that number.

That would include data for

- well site methane and other GHG extraction projections;
- methane ‘slippage' on the off-shore platform if membrane separation of CO_2 and methane occurs at that point;
- leaks of methane in transmissions and processing;
- fiscal meter projections at onshore point where the mixed gases or pure methane is received;
- consumption of parasitic load consumption of methane at the hub;
- final export projections of LNG;
- may or may not include methane leaks and during shipping handling and combustion in other countries
- possibly shipping emissions,

Woodside also need to demonstrate their commitment to the detection, reporting and independent verification that will mean they can abide by their own claim around methane leakage and venting emissions.

Such a low methane emissions figure is curious given Klemun and Trancik’s recent work on the impact of methane leakage on emissions intensity [31]. Relevant here, is Figure 5 from this work, that gives a historical summary of natural gas emissions over many years in the USA. Emissions percentages range from approx. 1.3% to over 3%. Woodside’s claim of 0.19% is certainly an outlier, and its veracity should be questioned by the EPA.

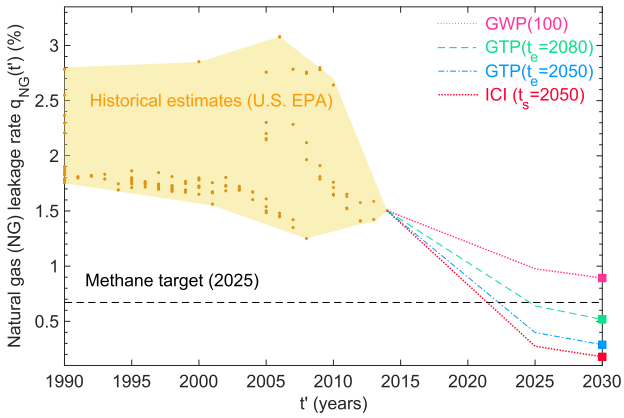

Figure 6. Historical estimates of natural gas (NG) leakage rates q_{NG} (circles) and leakage rates that meet the 2030 CO_2-equivalent target under scenario 1 (squares). Target leakage rates are lower than historical estimates, which are based on the EPA’s GHG inventories published since 1998 (e.g. [3]), and a 95% CH_4 content of natural gas. Most target leakage rates are also lower than estimated leakage rates under CH_4 regulations proposed in the US, which target a 40%–45% reduction from 2012 levels by 2025. Other estimates of current leakage rates are higher than those shown here [5], and have informed the high end (4.9%) of the range used in figures 1–5. Target leakage rates for all scenarios and parameters are given in supplementary table 3.

Figure 5. Historical methane leakage rates. Taken from [31].

In the following analysis, SEN assumes that the 4% CO2-e figure is accurate, and then applies the GWP_{20} metric to the emissions intensity discussed in the previous section. We established earlier that an appropriate GWP_{20} metric is 84, compared to the GWP_{100} metric of 21 used by Woodside. In such a scenario, the methane emissions will rise to 16% of total emissions. The calculations are shown in Table 3.

Table 3. Revised electricity emissions intensity of Browse gas under a different GWP scenario (kgCO2-e/MWh)

Stated electricity emissions intensity	550
4% methane component	22
16% methane component	88
Increase over 4% (12%)	66
Revised electricity emissions intensity	616

When comparing with the median coal emissions intensity from Table 2, Browse natural gas emissions intensity is 25% more efficient than coal.

When the lower end of the coal efficiency spectrum of 740kg CO2-e/MWh is considered, which is reasonable given the 30 year look ahead in which old plants will retire anyway, and either a new coal plant or gas plant will be built, and assuming no further methane abatement measures are developed, Browse natural gas emissions intensity is 17% more efficient than coal.

This calculation is made using the very low methane emissions cited by Woodside.

Firming

Woodside repeat the argument that gas can be used to support renewables in both proposals.

> *"By providing this firming capacity, gas-fired power allows high renewable penetration in the form of a reliable power source to help resolve intermittency issues (IEA, 2018)"[11, p. 689, 12, p. 117, 24, p. 248]*

SEN and independent energy analyst Ben Rose have conducted extensive modelling [32, 33] of how the SWIS can transition to renewable energy in a planned, orderly and secure series of steps.

- Modelling indicates that total methane usage for electricity generation will progressively drop to between 35% and 65% of current levels by the time Renewable Energy use has reached 90%-100%. Levels depend on several factors such as storage take up (battery and pumped hydro) and price points of the various technologies. Based on current trends, the 35% level is considered the more likely.
- Gas usage will drop significantly lower if alternative renewable fuels are introduced such as hydrogen or some renewable biomass for instance. The rapid advancement of hydrogen as an energy storage medium, makes this increasingly likely over the next decade.

These arguments apply equally well in other countries. It is questionable whether a reducing need for natural gas for power generation will require a large new gas development.

EPA and State Climate Policy Considerations

On SEN's reading of the lengthy documentation, the Woodside NWS proposal briefly refers to the 2019 State GHG Policy. Neither proposal refers to the EPA GHG Guideline which will be ratified shortly. This is a major oversight.

The EPA GHG Guideline requires proponents to address the hierarchy of avoidance, minimisation and offsets. This has only occurred as an afterthought.

The EPA GHG Guideline expects projects to be treated cumulatively, and not be treated in isolation. Woodside has attempted to minimise impact by splitting up the proposed megaproject into independent sub-proposals, and cross-referring between them. For example, in addition to others cited earlier:

> *"The Proposal is made by the NWSJV, which itself does not have additional operations. Its respective owners may do, but these are not part of the scope of this document." [24, p. 248]*

If the EPA GHG Guideline and the State GHG policy had been addressed, Woodside would have presented information about moving to contemporary *best practice*, rather than benchmarking against current practice.

For example, an appropriate response would have reported on planning to replace aging equipment at NWS with current best practice, as summarised in [10]. The NWS Executive Summary [12] mentions *"Replacing equipment, plant, and machinery as required that would not otherwise be replaced if not for the Proposal"*, but this is not subsequently referred to. Instead, Woodside is arguing that the NWS plant will continue to operate as it has, but with alternative feedstock. In other words, it will continue to pollute as it has. Given the aging nature of Trains 1-3, potential refurbishment offers an opportunity to replace gas generation with renewables, for example [10].

There was no mention of how they will meet the State 2050 net zero aspiration. Instead, Woodside *"proposes to contribute to the State GHG policy through its compliance with the Safeguard Mechanism..."* [12, p. 117]. See below.

The EPA GHG Guideline requires proponents to develop a GHG Management Plan. The NWS proposal includes a document with this name, but it does not address the criteria specified by the EPA. It does claim to address:

> *"identification of opportunities to reduce GHG emissions and energy intensity" [24, p. 244]*

The EPA Guideline requires this, but there is little evidence in the GHG MP or elsewhere that they are considering this. In reality, GHG Management Plan is a cost minimisation plan.

In terms of the Browse to NWS Project Woodside

> *"has proposed a GHG Abatement Plan to continuously review mechanisms to mitigate and manage GHG emissions and compliance with NGER/SGM baseline requirements through ACCUs to offset anticipated excess emissions over baseline". [11, p. 699]*

However, this plan has not been presented.

Offsets/ Mitigation

In terms of the mitigation hierarchy of avoidance, minimisation and offsets, Woodside has proposed to do almost nothing.

In terms of offsets, *"Woodside proposes to contribute to the State GHG policy through its compliance with the Safeguard Mechanism"* [12, p. 117]. That is basically the *only* minimising and offsetting activity it proposes (discussed further below). The EPA should require Woodside to do more than the minimum required under inadequate federal law.

The Browse to NWS Project GHG Abatement Plan has not yet been presented. This plan should be required before any approval, in line with the EPA GHG Guideline.

Woodside predicts that, for the Browse to NWS sub-project, under the current safeguard mechanism, it will be required to offset 1.2 Mtpa CO_2-e from venting reservoir CO_2 into the atmosphere. Woodside doesn't propose to offset the remaining 75% of emissions (3.6 Mtpa). To achieve the offsets, it proposes to purchase Australian Carbon Credit Units. SEN suggests that these should be used in WA, so the State benefits.

The proponent claims to be considering a *"carbon price (as per Woodside or Joint Venture approved economic assumptions) in development/production asset economics."* [24, p. 244]. However, in the documentation provided, they do not appear to be planning on spending the carbon price component that they have budgeted for.

T7.5 says they need 1.6Mtpa. of offsets. Elsewhere they plan for 330kt by 2030 at NWS. How will they achieve 1.6Mtpa. of offsets? They need to explain.

The NWS GHG Management Plan addresses what seem to be minor efforts at minimisation, but the focus seems to be on cost minimisation, rather than actually minimising emissions.

> *"mitigation measures will be put in place to ensure total direct emissions from the Proposal do not exceed 7.7 mtpa" [12, p. 115]*

> *"This GHG Management Plan identifies management and mitigation measures to ensure impacts from GHG emissions associated with the Proposal are not greater than predicted." [24, p. 240]*

The only other offsetting commitment Woodside has made is *"to avoid, reduce or offset 330,000 tpa of CO2e from the KGP by 2030."* [12, p. 119].

So, an amount of 33ktpa is being offset. This is 0.4% of the 7.7Mtpa they currently emit at NWS. It is difficult to believe that Woodside is taking gHG emissions seriously.

In another example of using the 'individual project' justification, Woodside claim (SEN's emphasis):"

> *"It is also anticipated that there will be emissions associated with the processing of Browse feed gas through third party infrastructure as described above in Section 7.4.1. It is **anticipated** that these emissions will be mitigated and managed by the NWSJV in accordance with regulatory requirements applicable to the proposed NWS Extension Project." [11, p. 700]*

However, the NWS proposal is not planning to mitigate ***any*** emissions.

In summary, Woodside's proposed offsets are minimal. If this proposal proceeds, the EPA needs to ensure that meaningful efforts are made to offset the substantial amount of emissions that will result from these proposals. They need to do more than the problematic Safeguard Mechanism (SGM).

Safeguard Mechanism

As stated above, the major mitigation proposed by Woodside is to offset 1.2 Mtpa CO_2-e (50 Mt lifetime CO_2-e) under the SGM (SEN's emphasis):

> *"Based on current SGM requirements, it is anticipated that reservoir CO_2 emissions will contribute to the proposed Browse to NWS Project exceeding any facility baseline by approximately 50 Mt CO_2-e over field life, which would need to be offset **in accordance with the rules of the SGM**" [11, p. 25].*

However, the SGM was amended in March 2019, and it will require all large emitters to re-apply for a new baseline before October 2020. It is likely that Woodside will apply to have the 'safeguard' renegotiated up, reducing its requirement to purchase offsets. .

The Safeguard Mechanism is clearly not working in terms of reducing emissions. In the absence of meaningful federal policy, the EPA GHG Guideline is an important mechanism to minimise global warming impacts in Western Australia.

Geosequestration

Woodside claims that geosequestration of Browse reservoir CO_2 is not feasible. However, it proposes to vent between 3.6 & 4.8 Mtpa into the atmosphere (depending on SGM negotiations) without offsetting this.

However, to stay within the 2030 carbon budget will require other measures, including geosequestration of all reservoir CO_2. Climate Analytics claim that this:

> *"would include extending carbon capture and storage for reservoir CO_2 losses to all LNG plant in Western Australia as well as replacing a significant fraction of natural gas used in LNG processing by renewable electricity. [10, p. 43]*

Natural gas proponents will need to solve this issue, or else not extract gas.

Miscellaneous

SEN notes that some gas fields can contain radioactive Radon gas, and this can have a detrimental effect on the environment. If present, is the EPA satisfied that Radon concentrations are at acceptable levels to the environment?

Conclusion

Corporate Responsibility

The Australian Securities and Investments Commission requires companies to factor climate change risks into their activities [34]. There is little evidence of this in these proposals, where climate risks have been ignored or underplayed.

The fossil fuel industry is aware of the need to act on climate change, or risk losing its social licence to operate:

> *"Woodside recognises that long-term meaningful relationships with communities are fundamental to maintaining a social licence to operate and works to build mutually beneficial relationships." [11, p. 3]*

Woodside also has a climate change policy, which focuses on reducing costs by reducing process emissions. This serves a purpose of *being seen to act* on climate change. However, the findings of this submission indicate that Woodside does not *intend to act* on climate change.

Findings

Despite earlier arguments, summarised in Table 1, that Scope 1 & 2 emissions will add 62.5 Mt to Australia's 328Mt 2030 NDC target, Woodside claims (SEN's emphasis) that:

> *"Australia's NDC is for an absolute economy-wide emissions reduction by 2030. Given the emission estimates and the likely NGER/SGM offset obligations, **it is not expected that the proposed Browse to NWS Project will prevent Australia meeting its NDC commitments.**" [11, p. 695]*

This statement is at odds with the evidence. If these projects proceed, without mitigation of emissions, then other sectors or states will need to take up this burden. This is inequitable.

Woodside concludes its Browse-NWS proposal with:

> *"Overall, in the context of Australia's international commitments and local legislation and policy, it is considered that given the proposed mitigation of emissions, safeguard mechanism obligations and the importance of gas as a clean and reliable source of energy in the current and future energy mix, GHG emissions from the proposed Browse to NWS Project are acceptable." [11, p. 698]*

In this submission, SEN has critiqued the claims embedded here:

- Emissions need to be considered locally, not globally
- Australia's emission budget by 2030 will increase by 19% because of the Browse and NWS components of this megaproject
- The safeguard mechanism provisions are inadequate
- Gas is only marginally 'cleaner' than 'clean coal'

GHG emissions from these proposals are ***not*** acceptable.

SEN has argued that there are numerous flaws and misrepresentations in the Woodside proposals. Some of these might be interpreted as misleading the market under Corporations Law, or expose the company to class action litigation – climate 'lawfare'. In particular, they:

- do not clearly report estimated methane emissions, and what is reported is substantially lower than published leakage rates;
- under-estimate methane's Global Warming Potential (GWP) by using dated metrics;
- attempt to conceal the magnitude of the reservoir CO_2 emissions;
- use an unrealistic and discredited projection of global gas demand, which is at odds with other projections;
- make unrealistic claims about the emissions intensity of the Browse Basin gas;
- make no realistic attempt to avoid, minimise or offset emissions;
- attempt to claim that new GHG emissions from the sub-proposals are small on a global scale, instead of analysing them at a national and state level;
- attempt to minimise the impact by splitting up the proposed megaproject into independent sub-proposals, and cross-referring between them; and
- do not meaningfully address the WA State Climate policy, nor the EPA's soon-to-be-finalised GHG Guideline.

These shortcomings preclude the EPA from making a proper assessment on the impacts on air quality from processing emissions.

Emissions amounts are very large, but they are likely to be larger than claimed, because of underestimation of methane impacts.

Further, Woodside's claim that gas is half as emissions intensive as coal is incorrect. SEN's analysis, using credible sources and Woodside's own, very low methane emissions, is that Browse natural gas emissions intensity is 25% more efficient than coal, calculated using contemporary GWP values.

SEN urges the EPA to reject the current proposal because it poses an unacceptable level of risk to Western Australia's environment.

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