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Submission to the Clean Energy Regulator: Enhancing Method 2 for Coal Mine Emissions Reporting

This report includes an analysis of the impact of Method 2 on coal mining emissions reporting, and the potential for the methodology to be improved.

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About Ember

Ember is an independent, not-for-profit energy think tank that aims to shift the world to clean electricity using data. It gathers, curates and analyses data on the global power sector and its impact on the climate, using cutting edge technologies and making data and research as open as possible. It uses data-driven insights to shift the conversation towards high impact policies and empower other advocates to do the same. Founded in 2008 as Sandbag, it formerly focused on analysing, monitoring and reforming the EU carbon market, before rebranding as Ember in 2020. Its team of electricity analysts and other support staff are based around the world in the EU, UK, Turkey, India, China and Indonesia.

Acknowledgement of Country

Ember acknowledges the Traditional Custodians of the many nations across Australia and their enduring connection to Country and the lands, seas and skies. We pay our respects to Elders past and present and extend that respect to all Indigenous Peoples today.

Executive summary

This submission calls for urgent reforms to Method 2 under the National Greenhouse and Energy Reporting (NGER) Determination to ensure accurate, transparent, and scientifically credible reporting of fugitive methane emissions from coal mining. The current methodology has significant gaps, particularly in how site-specific emission factors (EFs) are applied, how sampling and modelling are conducted, reported and verified.

Ember's recent analyses of emissions reporting utilising Method 2 in 2024, and the impact on Australia's historical coal mining fugitives highlight the impact that this emissions accounting shift has had across the coal sector, especially in regards to reported emissions reductions across open-cut coal mining. In addition, recent satellite analysis further highlights the potential distortion of emissions reporting under Method 2, especially its lack of independent verification requirements.

This has already had a significant impact on emissions reporting within the coal sector, and if not urgently improved and updated, risks undermining both the integrity of Australia's national inventory and the effectiveness of emissions reduction policies at state and federal levels.

Specifically, this submission highlights that coal mine fugitive emissions reporting under Method 2 currently lacks requirements for regular updates, robust sampling protocols, or independent verification. Additionally, the current modelling requirements are inadequate for capturing the true complexity of gas migration in geologically dynamic regions like the Hunter Valley and the Bowen Basin.

This submission recommends:

1. Mandate regular updates to emission factors every 3–5 years to reflect operational changes and evolving geological data;

2. Increase the density of boreholes and require geostatistical validation to better represent spatial variability;

3. Extend gas modelling to account for deeper strata and lateral gas migration beyond the pit boundary;

4. Incorporate additional methane sources such as emissions from mine water ponds, waste material, and non-coal strata;

5. Implement stronger verification mechanisms, including independent peer review of sampling and modelling protocols;

6. Require transparency through public disclosure of emission factor methodologies, sampling plans, and raw data;

7. Introduce independent atmospheric verification of methane emissions using satellite, drone, or ground-based measurements to ensure accuracy, particularly in high-emitting regions;

8. Promote basin- or state-level integration of methane monitoring to assess emissions across multiple sites within a broader environmental context, supporting more comprehensive and effective mitigation strategies.

By addressing these gaps, the Clean Energy Regulator can restore confidence in emissions data, align reporting with global methane commitments, and ensure emissions reductions reflect reality—not just revisions in accounting rules.

Introduction and context

Ember welcomes the opportunity to make a submission to the Clean Energy Regulator, with the goal of enhancing Method 2 for Coal Mine Emissions Reporting. Ember previously had played an active role in engaging with the Climate Change Authority's (CCA) in their review of the NGER scheme (CCA review 2023) and we strongly support the need to review Method 2 sampling requirements and standards in order to ensure that Australia's coal mine methane emissions reporting standards apply the best available science, technologies and practices.

This is a critical step to ensure the ongoing scientific integrity of Australia's emissions inventory, but has become a growing concern regarding the NSW Net Zero targets, and the ongoing emissions risk that coal mining may pose to the federal Safeguard Mechanism.

This submission responds to ongoing concerns about the effectiveness of Method 2 under the National Greenhouse and Energy Reporting (Measurement) Determination in quantifying fugitive methane emissions from coal mining. Drawing on technical knowledge and recent insights from Ember Energy's 2025 analysis of Australia's coal emissions paradox, as well as soon to be published assessments of satellite analysis that highlights key concerns regarding open-cut coal mines in NSW, this submission outlines opportunities to improve the reliability, transparency, and representativeness of fugitive emissions data.

Context

Australia's coal mine fugitive emissions have come under intense international scrutiny over the past couple of years. A diverse array of international and peer-reviewed satellite estimates have identified considerably higher emissions from a range of underground and open-cut coal mines.

Preliminary findings from Open Methane utilising a combination of atmospheric modelling and satellite measurements have estimated that Australia's coal mines and gas fields may be emitting twice as much methane as currently reported. More recently, a numerical modelling re-evaluation of current approaches for estimating fugitive emissions at open-cut coal mines found that existing company-led approaches may be underestimating fugitive scope-1 emissions by a factor of 3.6 to 4.2.

Recently, Ember's 2025 assessment of company-led methane estimates highlighted that the shift from state-based to site-specific emissions estimates has consequentially seen a significant reduction in officially reported emissions among the vast majority of mines utilising this methodology.

This builds on a 2024 study that identified a number of open-cut coal mines that had significantly reduced their emissions reporting following a shift from Method 1 to Method 2, including Maules Creek in NSW and Caval Ridge in Queensland. Following this study, energy insights firm Reputex further estimated that the shift towards company-led estimates has consistently decreased reported fugitive methane emissions reporting by 65 – 70%.

Finally, our submission will include preliminary insights from recent satellite analysis of coal mine methane emissions across six key coal mining clusters across Australia, in collaboration with energy intelligence from Kayrros. The preliminary results of this study, which cover approximately four-fifths of Australia's black coal production, indicate fugitive methane levels at least 40% higher than officially reported for the country as a whole. They also offer a comparative assessment of fugitive emissions across open-cut coal mines in New South

Wales (NSW), identifying fugitive emissions levels twice as high as officially reported. This was particularly surprising considering that the study only captured two thirds of black coal production in NSW.

These insights indicate that Method 2 is no longer aligned with the best available science and is failing to provide the reliability, transparency, and verification needed to ensure ongoing trust in Australia's coal mine fugitive emissions inventory.

Relevant Ember assessments

Ember has produced three key assessments that are directly relevant to the ongoing review of Method 2 under the National Greenhouse and Energy Reporting (Measurement) Determination. Together, these reports provide critical evidence that Australia's current approach to estimating coal mine methane emissions is underestimating real-world impacts and failing to reflect the scale of fugitive emissions.

The 2024 report on accounting shifts highlights the potential risk of Method 2 emissions reporting shifts through the lens of specific case studies across NSW and Queensland.

Earlier this year, Ember's also produced an analysis of Australia's coal mining emissions shifts, including a specific focus on Australia's open-cut fugitive emissions estimations approach. This assessment included a comparison of open-cut coal mining production and emissions growth rates over the last thirty five years, as well as a state-by-state comparison of the emissions reporting impacts of Method 2 utilisation in NSW.

Finally, Ember's recent satellite analysis of coal mine methane emissions across six key coal mining clusters in NSW and Queensland indicate fugitive methane levels at least 40% higher than officially reported for the country as a whole. The preliminary study is potentially the first satellite assessment of state coal mine fugitives, and includes a specific comparative reconstruction of open-cut coal mine fugitives in New South Wales (NSW) against satellite estimates and fugitive emissions estimates utilising Method 1.

These reports reinforce the potential emissions reporting gap that has emerged over the last decade, and the explicit need for an overhaul of Method 2 to ensure Australia's emissions data is accurate, verifiable, and aligned with emerging best practices.

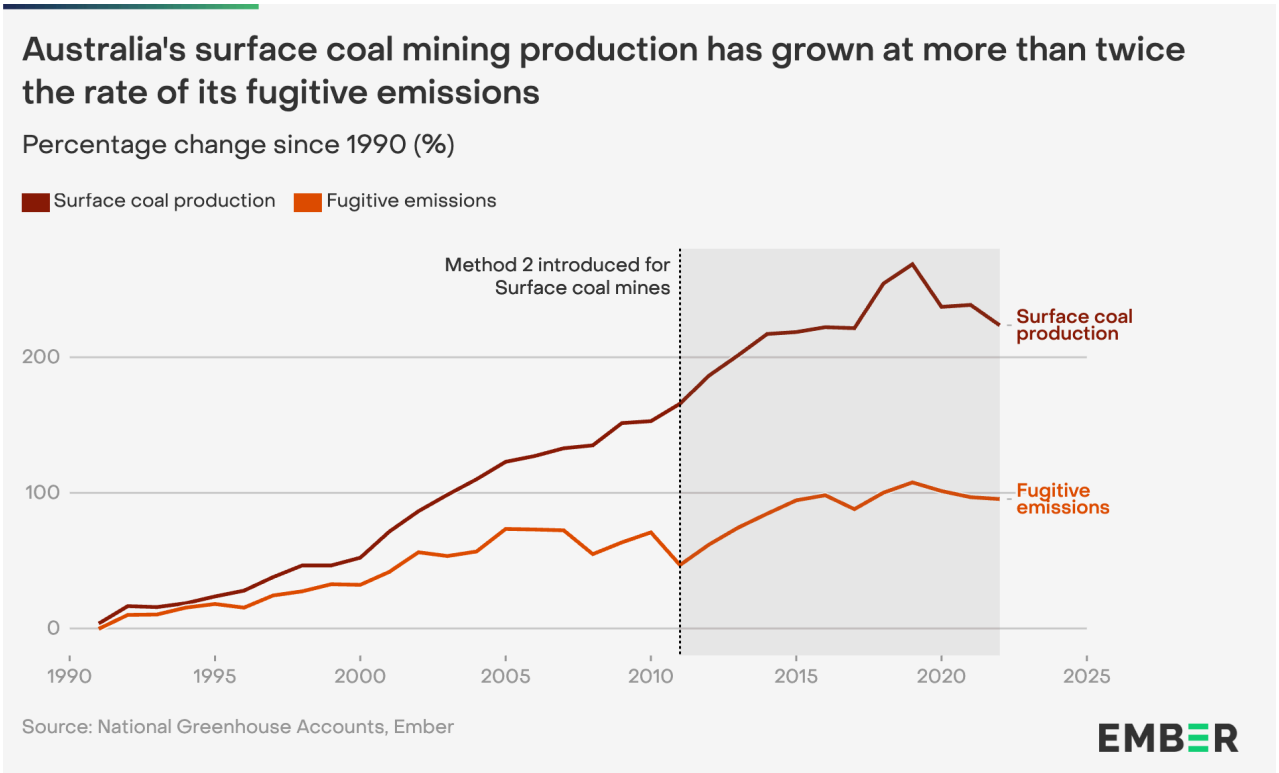
With growing satellite evidence, it is becoming increasingly clear that Australia's open-cut coal mine methane emissions may already be significantly underestimated. The historical trend towards further under-reporting utilising method 2 should therefore be a cause for serious concern.

Without significant transparency amendments to the reporting methodology, the diversification of bottom up sampling, and the crucial back-stop of top-down verification, there is no reason to believe that this trend will not continue.

Production growth is outpacing emissions growth in fugitive coal mines

Between 1990 and 2022, open-cut coal mining in Australia expanded dramatically. Throughout this time, coal production production more than tripled, growing by approximately 224%. However, the reported fugitive methane emissions from this activity did not rise at the same pace. By 2003, emissions had increased by just 53%, and by 2013 the growth was only 74%, with even periods of negative growth recorded despite ongoing production increases.

By the end of 2022, fugitive emissions from surface coal mines had risen by only 95% less than half the rate of production growth over the same period. This widening gap between production and reported emissions raises serious concerns about the accuracy of current methane accounting methods.



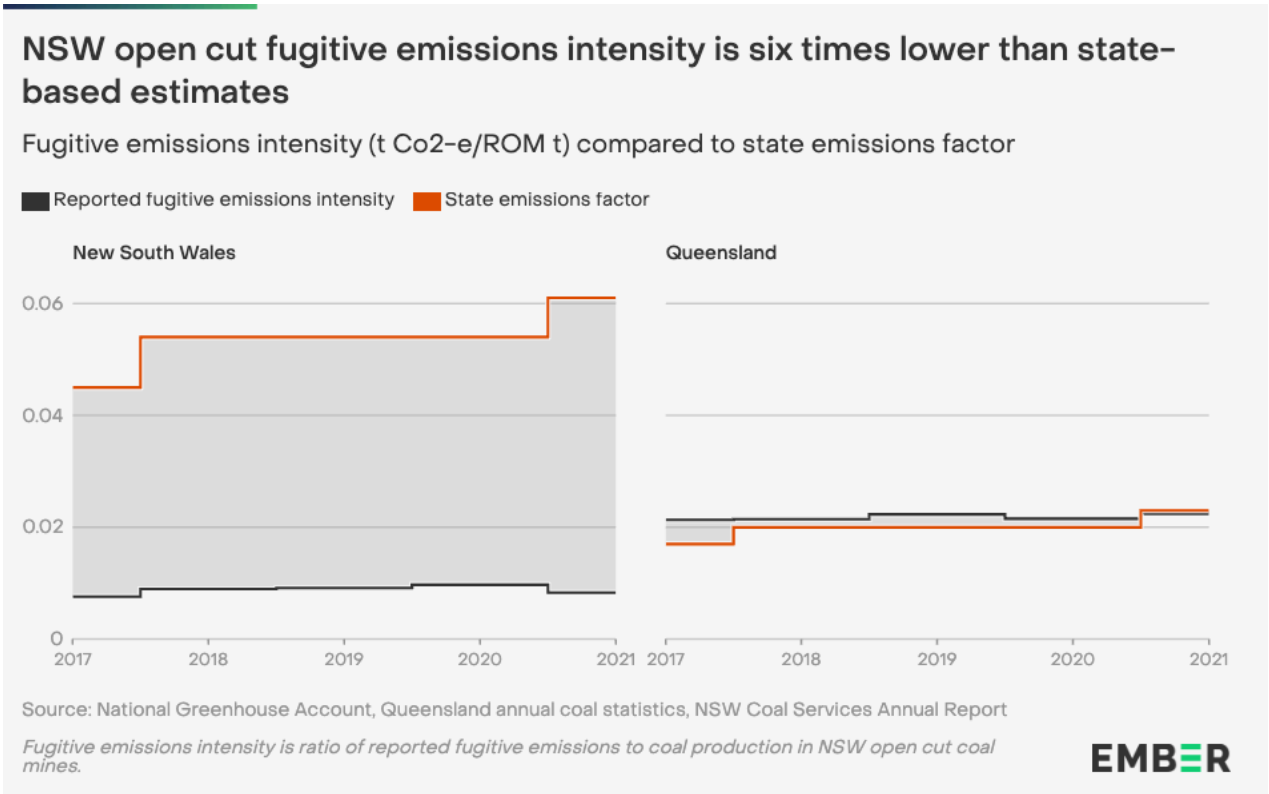
This rate of change is even more significant when compared to Australia's international emissions baseline of 2005. Since that time, open-cut coal production has increased by 45% but fugitive emissions from this same sector have only increased by 13%. As such, since Australia's emissions baseline was set, surface mining fugitive emissions have grown at less than a third of the growth rate of production.

Accounting shift drives emissions reduction

In 2024, Ember's assessment of eight currently operating and two proposed coal mines identified millions of tonnes of CO2-e reductions that had occurred as a result of this accounting shift towards site-specific measurement. Additional research from energy insights firm Reputex has since evaluated the impact of recent accounting shifts on open-cut coal mines across the country.

Their findings estimate that recent shifts from state-led emissions factors to company-led estimates have consistently decreased reported fugitive methane

emissions reporting by 65 to 70%. This shift has significant implications on a mine's obligations under the reformed Safeguard Mechanism. The influence of this reporting shift is especially poignant in NSW. In this recently published report, we utilised the National Greenhouse Accounts, to compare collectively reported fugitive emissions for surface coal mines, against annual coal production estimates, reported at the state level.



This allows us to compare an estimate for fugitive emissions intensity across both states, and how it has changed over the last 5 years. To note, this approach would incorporate reported fugitive emissions from facilities utilising both state-based emissions factors, and those utilising site-specific emissions estimates.

This comparison highlights that fugitive emissions reporting across coal mines in Queensland is largely in line with what would be expected under the state-based emissions factor.

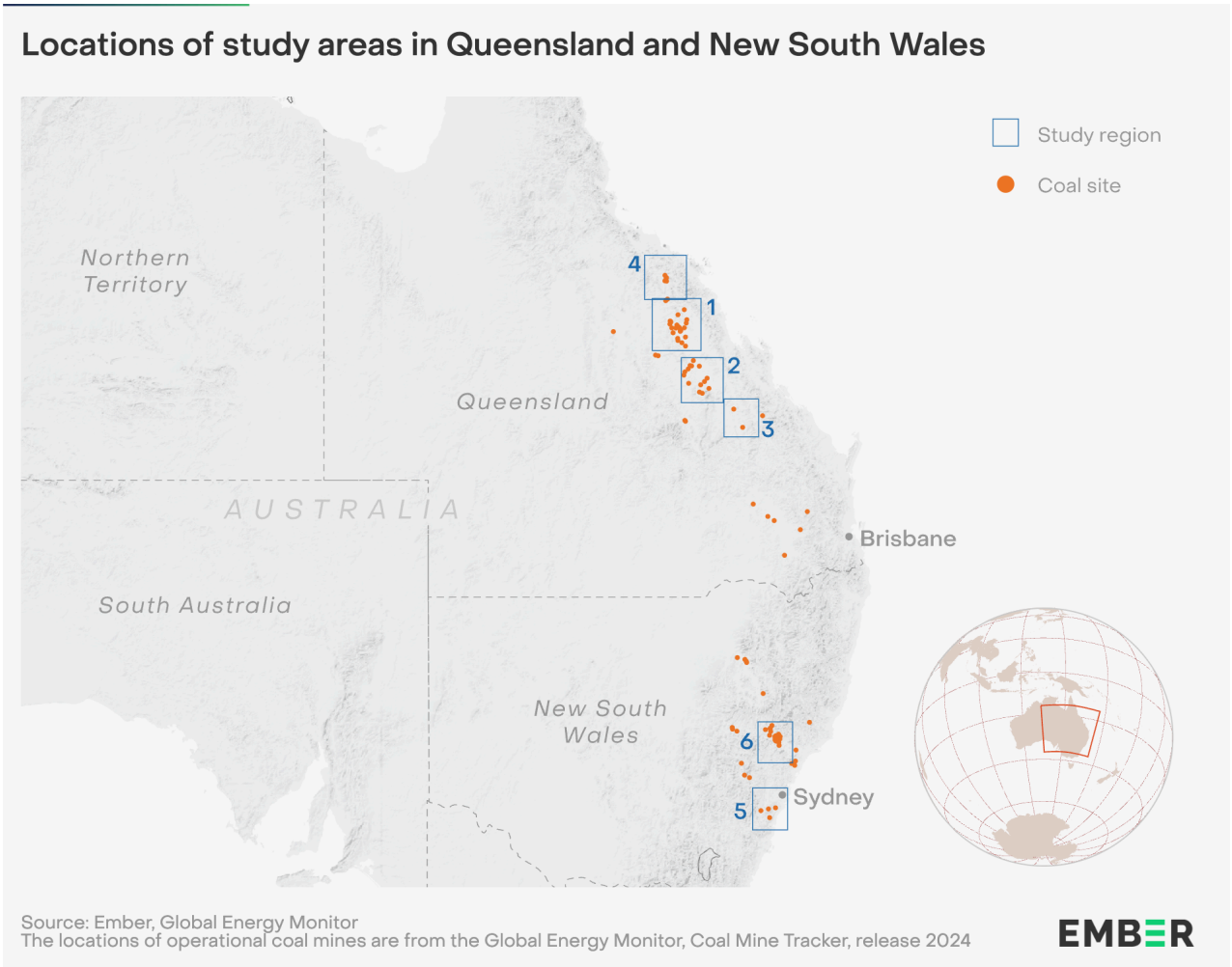
In NSW however, where the use of site-specific emissions estimates is far more widespread, we find that the reported fugitive emissions intensity of open-cut mines is six times lower than the state-based emissions factor. It would also be significantly lower than the state-based emissions factor estimate for QLD.

This highlights a clear mismatch between collectively assessed emissions factor averages, compiled by state environmental regulators, and individually reported emissions estimates, compiled by individual mine operators. These results raise the urgent need for in-depth regulatory and methodological review.

Satellite assessment of coal mine fugitives

In our recent preliminary study study, we sought to contribute to the growing body of evidence through a satellite assessment of fugitive methane emissions from coal mines across New South Wales (NSW) and Queensland. The collaborative study with energy intelligence firm Kayrros, utilised TROPOMI satellite observations across six coal mining clusters while controlling for wind effects and non-fossil methane sources. The locations of the coal mining clusters are shown below.

Our findings in New South Wales (NSW) indicate a significant departure from officially reported emissions. While the state reported 379 kt of methane in 2020, our satellite study identified 721 kt of methane that year, while only accounting for approximately 61% of the state's coal production. While this estimate has an uncertainty range of 566 - 876 kt, this still represents a significantly higher figure than official reporting.



In 2021, our satellite estimate had a similar finding. While officially reported coal mine methane emissions dropped to 329 kt of methane, our satellite estimate identified 679 kt of methane with an uncertainty range of 533 - 825 kt of methane. This represents 106% higher emissions, while only capturing 64% of all coal production in the state that year.

A full methodology of our approach is available here

Reconstructing the impact of Method 2 on NSW

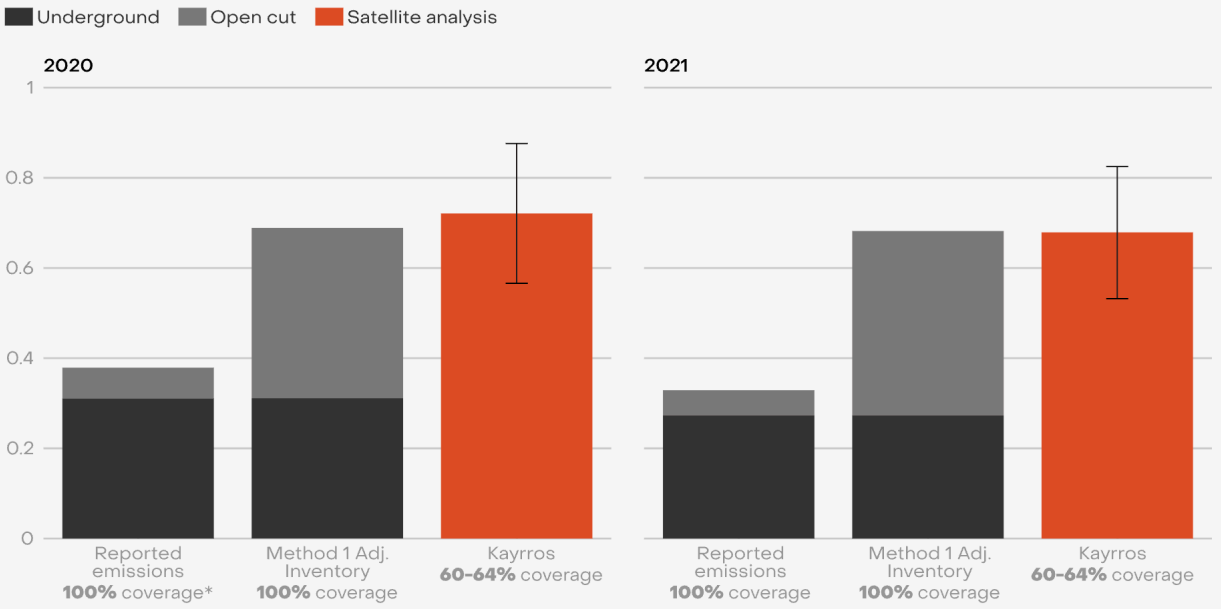
In this study, we sought to identify the potential implications of shifting away from state-based emissions factors in NSW by reconstructing the estimated fugitive

emissions from open-cut mines and comparing them to our satellite estimates. To do so, we multiplied the state's open-cut coal production by the state-based emissions factor for fugitive emissions, and added this to the officially recorded fugitive emissions from underground coal mines in 2020 and 2021.

We then compared this adjusted emissions inventory to the official emissions inventory for all coal mines, and our satellite emissions estimate below.

Satellite analysis suggests a significant impact of Method 2 on open cut fugitive emissions accuracy

Coal mine methane emissions (Million tonnes CH4) in NSW



Source: National Greenhouse Accounts, Kayrros and Ember analysis
*New South Wales's total coal production.
The study area covers Illawarra and Hunter Valley coal fields only.

In Method 1 adjusted inventory scenario, open cut coal fugitive emissions are estimated using NSW state-based emissions factor for that year.

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The result of this reconstruction indicates that our satellite emissions estimates, covering only 60% to 64% of NSW's coal production, have identified fugitive emissions 90% greater in 2020 and 107% higher than reported emissions in 2021.

This shows a closer correlation to total estimated emissions from our adjusted Method 1 inventory reconstruction in both years, however, this reconstruction represents potential fugitive emissions from all coal mines across the state, not just those within our satellite study area.

TROPOMI as an effective tool for satellite verification in Australia

There is a large amount of freely available satellite data on open platforms such as the IMEO's Methane Alert and Response System, Carbon Mapper and Kayrros Methane Watch. These platforms provide emissions data at the precise moment a satellite passes overhead. While useful for identifying methane hot spots and leaks, these collective datasets still lack the frequency of coverage needed for a direct comparison or quantification of annual emissions reports.

Assessing coal mine methane emissions at a national or basin-level requires satellite coverage over large regions with frequent and repetitive overpasses. The TROPOMI satellite instrument used in this study provides unique, global daily coverage of methane concentrations. As such, it is widely used in similar studies aiming to quantify and verify global and country level methane inventories.

The TROPOMI satellite is an area concentration mapper, measuring methane over large regions at high temporal frequency. This is in contrast to point-source imagers which detect methane at the facility level, and offer much finer spatial resolution but require targeted observations. This presents a critical trade-off between point-source imagers with higher-resolution and infrequent data in comparison to area mappers, with lower resolution with frequent coverage.

TROPOMI's spatial resolution is 7 km × 5.5 km, which is limited in its ability to detect methane emissions from individual coal mines, but can be used to effectively verify emissions across clustered areas, as has been shown in this study. Despite these limitations, we believe that the TROPOMI satellite is an effective tool for comparing satellite-derived methane estimates with reported emissions data, and could be readily incorporated within Australia's fugitive emissions inventory.

Fortunately, Australia offers some of the most favourable conditions for satellite methane monitoring, with relatively clear skies and bright, flat surfaces. Data coverage from TROPOMI can be affected by environmental conditions, such as cloud cover, mountains and surface brightness, but a recent study by Ember estimated that 91% of Australia's annual coal production occurs in regions well-suited for methane monitoring.

Specific methodological questions

This section of the submission responds to specific concerns raised by the Clean Energy Regulator, regarding the effectiveness of Method 2.

Insufficient Borehole Requirements

The current requirement of a minimum of three boreholes per gas domain is not adequate to quantify spatial continuity in two or three dimensions. This density is insufficient in complex geological settings like the Hunter Coalfield, where small-scale faulting, dykes, and high gas variability demand much denser sampling.

Recommendation:

1. Increase minimum borehole density and mandate geostatistical validation (e.g., variogram modelling) to confirm that borehole spacing captures spatial heterogeneity.

Inadequate Vertical Extent of Gas Modelling

Method 2 requires that gas models extend only 20 metres below the final pit floor. This buffer is arbitrary and does not account for vertical gas migration driven by natural faults and fractures, pressure drops from blasting or overburden removal or residual gas in deeper strata.

Methods 2 and 3 also do not currently account for gas moving laterally through exposed highwalls, a known issue in underground mining and potentially relevant

for open-cut mines, especially in geologically complex regions like the Bowen Basin.

Methane emissions from coal mining come not only from the coal seam being mined but also from surrounding geological layers. These emissions are influenced by factors like fracturing of the rock, removal of overburden, and pressure changes in the surrounding strata. Features such as faults and volcanic intrusions may affect gas content and emissions, but are not factored into reporting methods despite being well mapped in mines such as Hail Creek.

Research presented by Abouna Saghafi, a key intellectual influence on the development of Method 2, has shown that actual emissions can be up to four times higher than the methane content of the coal seam alone. Methane may also be released from disturbed soils, coal stockpiles, and water management areas, but these are currently excluded from emissions estimates. While early imaging suggests these are minor sources, their cumulative impact is unknown.

Recommendations:

2. Require site-specific justification for vertical limits and expand the default extent (e.g., 50–100m) in high-risk geological settings.
3. Require independent re-assessment of site-specific emissions factors on a periodic basis
4. Require atmospheric verification of emissions levels on a periodic basis. This could be site specific or at a basin level.

Risk of Biased Sampling and Peer Review

Current guidance allows sampling plans to be reviewed by internal personnel from the same company, and the use of “expert judgement” in determining sample representativeness, per ACARP guidelines. However, this lack of third party independence as well as the potential vested interests presented by the incentive

structures of the reformed Safeguard Mechanism introduces potential bias and undermines confidence in reported data.

Recommendations:

5. Sampling programs and gas modelling should be validated by independent third-party experts
6. Sampling should be required to adhere to appropriate gas sampling standards outlined in Method 3 at a minimum
7. Quantitative statistical tests should be applied to assess sample representativeness;
8. Prohibit internal peer review without explicit conflict-of-interest disclosure.

Missing Methane Sources in ACARP Guidance

The ACARP guidelines and NGER Method 2 do not adequately account for the following potential emissions sources from spontaneous combustion or decomposition of coal waste. They also fail to account for methane emissions from potential non-coal strata and lateral gas migration beyond lease boundaries.

The Hunter Coalfield, as documented in geological studies, is marked by high fault frequency, deep weathering and strong lateral gas variability. The current generalised approach fails to account for this complexity.

Recommendation:

9. Update the guidelines to include these sources and require appropriate periodic monitoring, review and independent modelling.
10. Require modelling domains and sampling plans to explicitly incorporate known structural geology and gas anomalies.