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10 April 2025

To: Department of Climate Change, Energy, the Environment and Water
Re: Proposed updates to the National Greenhouse and Energy Reporting (NGER) scheme

The Institute for Energy Economics and Financial Analysis (IEEFA) is grateful for the opportunity to present its submission to the 2025 Public Consultation on the National Greenhouse and Energy Reporting (NGER) scheme. IEEFA is an energy finance think tank that 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.

IEEFA is generally supportive of the proposed 2025 amendments and encourages the urgent review of Method 2 in coal mining sector. On reviewing the proposed 2025 amendments and the NGER forward work plan, IEEFA recommends:

- **Renewable fuels:** IEEFA supports the adoption of market-based reporting of emissions from consumption of biomethane and hydrogen, if it is accompanied by a robust measurement, reporting and verification (MRV) process.

- **Fugitive emissions from oil and natural gas operations:** IEEFA supports the revised factors for carbon dioxide (CO_2) and methane (CH_4) emissions (in Method 2) and the proposal that Method 2B is made available for gas flared during natural gas production available to natural gas transmission and distribution facilities.

- **Waste:** IEEFA supports the proposal enabling reporters to account for biosolids diverted to biochar production and an update to the nitrous oxide (N_2O) emission factor for effluent discharged to estuaries, and other minor technical updates to improve clarity and operation of the scheme.

- **Urgent review of Method 2 for open-cut coal mines:** IEEFA recommends phasing out of Method 2, in favour of Method 3, with its improved sampling and independent verification requirements. This should be paired with a more rigorous approach to gas estimation modelling. In addition, top-down methods from aerial or satellite monitoring should be adopted to verify coal mine methane emissions.

Please do not hesitate to contact us for any further information.

Kind regards,

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1. Proposed 2025 amendments to the NGER scheme

A. Market-based reporting of emissions from consumption of biomethane and hydrogen

Recommendations.

IEEFA recommends that:

1. The adoption of market-based reporting of emissions from consumption of biomethane and hydrogen as outlined in the consultation paper, providing there is full disclosure to the customer about the actual emissions reduction from blending hydrogen or biomethane with methane gas, compared with consuming 100% methane gas.

2. The reporting of emissions from the consumption of biomethane and hydrogen must be accompanied by a robust measurement, reporting and verification (MRV) process. Studies have shown that methane leaks from the biogas and biomethane supply chain can be higher than methane leaks from natural gas production, so any undetected leaks from biomethane could undermine public support for this emerging energy source.

Discussion

IEEFA provides conditional support to the proposal for market-based reporting of emissions from consumption of biomethane and hydrogen. IEEFA has reservations about the economic and environmental benefits of blending hydrogen in gas pipeline networks.[1] However, it does see some merit in encouraging the production and consumption of biomethane as a strategy to decarbonise a proportion of the gas network, particularly for the hard to abate gas users.

Hydrogen

IEEFA would like to see full transparency in any market-based reporting method about the impact of blending hydrogen in gas pipeline networks, regarding both the energy content in the pipeline, and the impact on greenhouse gas (GHG) emissions. The same transparency should be applied to the use of biomethane.

Hydrogen blending in gas pipeline networks has been proposed by gas pipeline firms as part of an effort to promote 'renewable gas', which is a contentious marketing strategy as there are limitations on the volume of hydrogen that can be blended in existing gas networks. Australian gas distribution businesses have small-scale pilot projects to deliver blends of 10% hydrogen by volume to parts of their gas networks. However, due to the low energy density of hydrogen, it can only deliver up to 3% of the energy content in these blends and hence mitigate up to 3% of annual reticulated gas emissions.[2]

[1] IEEFA. 'Renewable gas' campaigns leave Victorian gas distribution networks and consumers at risk. 17 August 2023. Page 4.
[2] Ibid. Page 8.

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It should be made clear in any reporting of emissions resulting from hydrogen blending in gas pipelines that the volume of hydrogen does not correlate to the actual emissions it may reduce relative to gas. The reporting of emissions from hydrogen blended in gas networks must reflect the source of hydrogen production, specifying whether it is made from fossil fuels or from renewable energy.

IEEFA notes this NGER scheme proposal does not include an emissions factor for the release of nitrous oxide for the combustion of hydrogen. It would be preferable that a temporary emissions factor is adopted so that it is not misconstrued as being emissions-free. An IEEFA study has concluded that the electrification of energy consumption would be more economic than pursuing hydrogen blends in gas networks or an investment in a 100% hydrogen pipeline network.[3]

Biomethane

IEEFA recognises that the inclusion of biomethane blended into gas networks under the NGER scheme could stimulate the production and consumption of biomethane, albeit at a relatively modest rate of increase without further market incentives. It will also make biomethane eligible for recognised certificates for 'renewable gas' when blended into a gas network.

Nevertheless, IEEFA is of the view that the prevailing economics of biomethane production in Australia warrant an investment in electrification of energy consumption over biomethane production.[4]

The proposed amendments to the NGER scheme for the introduction of market-based reporting of emissions from consumption of biomethane should also disclose the emissions associated with the biomethane production. This varies depending on feedstock source, with an estimate of the emissions from the decomposition of the feedstock in the natural environment. This comparison will provide full transparency of emissions and if there is no increase in emissions it could provide further public support for biomethane.

This variation in emissions intensity from biomethane production should be reflected in the reporting of emissions from each process, rather than the use of a uniform emissions factor for all biomethane. Biomethane comes from the anaerobic decomposition of waste material in landfill sites. It also comes from crop feedstock, such as wheat or barley, or animal manure, following the anaerobic digestion of these agricultural inputs.

IEEFA understands that gas network operators factor in different gas losses from their respective gas distribution or transmission networks, of which methane can also vary. For instance gas distribution networks in Victoria and South Australia had gas losses, also known as UAFG (unaccounted-for gas), at an average of 3.9% in 2023.[5] In contrast pipeline operator Jemena reports estimated losses of 2.2% for its UAFG, which represents the difference between the quantity of gas measured entering the network and the quantity of gas that is measured on delivery.[6] The network operators must account for this loss, and these losses should be factored

[3] IEEFA. 'Renewable gas' campaigns leave Victorian gas distribution networks and consumers at risk. 17 August 2023. Page 9.
[4] Ibid. Page 9
[5] Australian Energy Regulator (AER). 2024 Electricity and gas networks performance report, September 2024. Page 70
[6] Jemena Gas Networks (NSW) Ltd. 2025-30 Access Arrangement Proposal. 28 June 2024.

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into the volume of renewable gas certificates that could be issued if these proposed amendments are accepted. This volume of gas loss would be the same for the blending of biomethane in gas networks.

Studies have shown that there is the risk of methane leakages all along the supply chain. Biomethane is made from biogas or digestate, which is a byproduct from the anaerobic digestion of organic waste.[7] This includes landfill waste, plant feedstock and manure.[8] Biomethane is produced when carbon dioxide is removed from biogas.[9] Carbon dioxide accounts for around 40% of the biogas and the remaining 60% is methane.[10]

A study published in 2022 concluded that "methane emissions (from biomethane) could be more than two times higher than previously estimated, and the digestate-handling stage contributed to the largest methane emissions along the supply chain".[11] The digestate is the remaining material, which can be both in a solid and liquid state, after anaerobic digestion of a biodegradable feedstock.

The share of methane leaks from biomethane supply chains are estimated at 5.97%. This value is higher compared with natural gas leaks because enormous quantities of methane can still be emitted from the biomethane and biogas supply chains, including digestate handling, anaerobic digesters, upgrading units, feedstock storages and transmission, storage, and distribution stages.[12] There is an economic incentive to avoid such losses since methane releases represent lost energy production and reduced revenues for the operators.[13]

It is therefore important to have a robust MRV process in place for any market-based reporting of emissions from the biomethane supply chain. A robust MRV process will not only provide more GHG data but also provide a better understanding of the economic opportunities for biomethane producers to capture leaking methane.

The International Energy Agency (IEA) noted in a 2017 report "the public acceptance of biogas facilities is strongly dependent on the proof of low emissions. Besides methane there are other gases such as ammonia and nitrous oxide (a significant GHG), which might be emitted from biogas systems."[14]

There are multiple devices for emissions measurements, including portable imaging infrared (IR) cameras that "have been developed based on passive remote gas detection by infrared spectro-radiometry".[15] These cameras can typically detect leaks at a distance from zero metres to at least

[7] Anaerobic digestion is the biological process where bacteria break down organic matter in the absence of oxygen and produce biogas, which is mainly methane and carbon dioxide.
[8] Renewable and Sustainable Energy Reviews. Role of methane to offset natural gas. November 2023. Page 1.
[9] One Earth. Methane emissions along biomethane and biogas supply chains are underestimated. 17 June 2022. Page 724.
[10] Renewable and Sustainable Energy Reviews. Role of methane to offset natural gas. November 2023. Page 1.
[11] One Earth. Methane emissions along biomethane and biogas supply chains are underestimated. 17 June 2022. Page 725.
[12] Renewable and Sustainable Energy Reviews. Role of biomethane to offset natural gas. November 2023. Page 4.
[13] European Commission. Methane emissions in the biogas and biomethane supply chains in the EU. An analysis to update the greenhouse gas emissions accounting methodology of Renewable Energy Directive Annex VI. 2024. Page 8.
[14] IEA Bioenergy. Methane emissions from biogas plants. 2017. Page 6.
[15] Ibid. Page 11.

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30-40 metres, depending on the size of the leak and the conditions. Remote sensing systems are another method of detecting emissions from the biogas/biomethane supply chain.[16]

There are also steps that should be taken to minimise methane leaks from the biomethane supply chain. According to the IEA, emissions from digestate storage should be minimised by using a cover to any enclosed digestate storage facility.[17]

IEEFA acknowledges that the two types of certificates that can be issued are backed by governments and would add some creditability to this nascent market. The Renewable Gas Guarantee OF Origin (RGGO) is issued by GreenPower, which is administered by the New South Wales (NSW) Department of Climate Change, Energy, the Environment and Water.[18] The other certificate, the Product Guarantee of Origin (PGO), is registered under the Guarantee of Origin (GO), which is an Australian government-backed emissions accounting framework.[19]

IEEFA also recognises that a customer that buys a renewable gas certificate from a producer cannot also use an Australian carbon credit unit (ACCU) and must choose between one or the other.[20]

B. Fugitive emissions from oil and natural gas operations

IEEFA supports the proposed amendments to the NGER scheme to:

- Update the emissions factors used in Method 1 and Method 2A for gas flared during oil and natural gas operations.
- Make Method 2B available for gas flared during natural gas production and also make it available to natural gas transmission and distribution facilities.
- Require additional reporting of data used to estimate fugitive emissions from flaring during natural gas production.

IEEFA also encourages the Department to "continue to explore opportunities for new methods to better capture the impact on emissions of facility-specific flaring activities during natural gas transmission and distribution, including abatement activities".[21]

[16] Ibid. Page 12.
[17] IEA Bioenergy. Methane emissions from biogas plants. Page 4.
[18] Greenpower home page.
[19] Department of Climate Change, Energy, the Environment and Water (DCCEEW). Guarantee of Origin (GO) scheme.
[20] DCCEEW. National Greenhouse and Energy Reporting (NGER) Scheme, 2025 Public Consultation. 28 February 2025. Page 12.
[21] DCCEEW. National Greenhouse and Energy Reporting (NGER) scheme 2025 Public Consultation. 28 February 2025. Page 18.

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2. NGER scheme forward work program

A. Review of Method 2 for estimating fugitive emissions from open cut coal mines

Key Recommendations

IEEFA recommends that the NGER scheme:

- Develop or adopt Australian standards to govern the quality assurance of sampling and analysis of coal mine methane.
- If these standards exist within Method 3, this should be updated and adopted as the minimum required method for estimating open-cut coal mine emissions.
- The reporting of methane emissions must be accompanied by a robust MRV process. Such a process should require independent verification, as is mandated in Method 3. In addition, top-down methods of verifying emissions from aerial or satellite monitoring or other monitoring stations should be adopted.

IEEFA recommends a number of changes that could be introduced with low regulatory cost to strengthen the existing method 2. These include:

1. **Review Method 2 for open-cut coal mines.** IEEFA supports the Climate Change Authority's December 2023 review of the NGER scheme, which recommended "as a matter of urgency, review Method 2 for extraction of coal in open cut coal mining for extraction of coal in open cut coal mining with respect to sampling requirements and standards".[22]
2. **Increase the number of samples** required to be taken to estimate gas. The current requirement is for three samples to be taken per gas domain. In the open-cut mega mines, each gas domain can contain many hundreds of millions of tonnes of coal.
3. **Revise the factor for low gas zones**. As suggested by the University of Wollongong, reduce by an order of magnitude the gas detection threshold.
4. **Improve gas sampling methods,** with clear criteria to inform whether sampling is associated with geological structures, compromised samples or air contamination issues, including those identified by the experts.
5. **Limit sampling adjacent to existing mined areas.** Otherwise, gas samples will not account for where the gas may have already been released with drilling, mining or blasting activities.

[22] Climate Change Authority. 2023 Review of the National Greenhouse and Energy Reporting Legislation. December 2023.

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Additionally, several promising developments that could strengthen reporting should be investigated, including:

1. **Verify with top-down methane observations,** using instruments from satellites, aircraft or other monitoring stations. As noted in a recent International Methane Emissions Observatory (IMEO) study on Hail Creek, "While this study focuses on a single high-emitting mine, aircraft-based approaches should be applicable to most open-cut coal mines across the country and can play an increasingly important role in verifying methane emissions in Australia's National Inventory."[23]

2. **Update gas testing** with ongoing drilling activities, such as with routine exploration or resource definition drilling across the mining footprint to include in-field gas sampling and testing.

Finally **independent expert verification** should be required, such as under Method 3, such that the gas reservoir model and associated emissions produced are determined with an associated confidence level.

Discussion

Australia needs a more rigorous approach to estimating the methane gas pollution emitted from open-cut coal mining. Evidence is emerging from a range of sources that point to potential underreporting of methane emissions from open-cut coal mines. Method 2 provisions could be amplifying such underreporting.

IEEFA's analysis indicates that estimating methane emissions using Method 2 has resulted in an approximate 76% fall in self-reported emissions per unit of coal produced in NSW and a 41% decrease in Queensland (Qld) compared with Method 1 default factors. This is based on estimated data from 2022-23, compared with current Method 1 rates.

Miners get to choose how they measure methane emissions and how they model the gas coming from the coal mines. Most now adopt Method 2, and some have dramatically reduced their reported emissions by doing so. These emissions are not required to be independently technically audited and are inherently uncertain given the wide variability of methane intensity in various coal seams along with a range of other factors that can affect sampling results. Method 3 may offer higher levels of assurance but is not used.

Changes to the NGER scheme reporting methods used by companies are likely to be resulting in increased underreporting, with reported emissions being lower, not higher.

Associate Professor Bryce Kelly from the University of New South Wales (UNSW) notes: "We need precise, reliable data to guide efforts to curb atmospheric pollution and slow climate change."[24]

[23] Environmental Science & Technology Letters. Insights into Elevated Methane Emissions from an Australian Open-Cut Coal Mine Using Two Independent Airborne Techniques. 25 March 2025.
[24] UNSW. Coal mine methane emissions much higher than previously reported: study. 26 March 2025.

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A more rigorous approach would incorporate site-specific borehole spacing determined through numerical modelling, removal of the 'low gas zone' factoring approach, improved sampling quality assurance procedures, clear guidelines for identifying and excluding compromised samples, and integration with alternative verification methods such as aerial surveys and/or gas-adapted coal resource drilling.

Methane coming from coal mines are the largest single source of methane pollution released from man-made activities, accounting for 20% of all industrial emissions, according to the National Greenhouse Gas Inventory.[25] Of the 100-plus operating coal mines in Australia, approximately 10 have some form of methane abatement operating. Coal methane emissions are not expected to decrease materially between now and 2030. Compared with other developed countries such as the USA, where coal's contribution is 8%, the scale and urgency of addressing coal mine methane emissions in Australia is critical.

The NGER scheme acknowledges that uncertainty in open-cut emissions is higher than underground coal mines. Emissions uncertainty is growing as coal expansion in Australia is predominantly sourced from open-cut mines.

Industry, investors, financiers and customers demand confidence in assessing their potential emissions liability. They require assurance as to the future liability from investing in, operating or purchasing from mines that contain an embedded carbon emissions liability – the extent of which is defined by the NGER reporting requirements. Industry is increasingly being challenged to understand, and in turn report, its emissions footprint. Such pathways to net zero are demanded by their investors.

Supporting analysis

Division 3.2.3 of the National Greenhouse and Energy Reporting (NGER) Measurement Determination sets out three levels available to estimate emissions from open-cut mines – Methods 1, 2 and 3.

1. Method 1 relies on an average level of emissions, across all the mines in the state. It is being removed for large miners from FY2026, following recommendations from the Climate Change Authority.[26]

2. Method 2 references guidelines for obtaining gas samples from the coal, drilled before mining, used to build a gas reservoir model.

3. Method 3 has "an increased expectation in regard to standards used".

[25] DCCEEW. National Greenhouse Gas Inventory: Quarterly updates.
[26] Climate Change Authority. 2023 Review of the National Greenhouse and Energy Reporting Legislation. December 2023.

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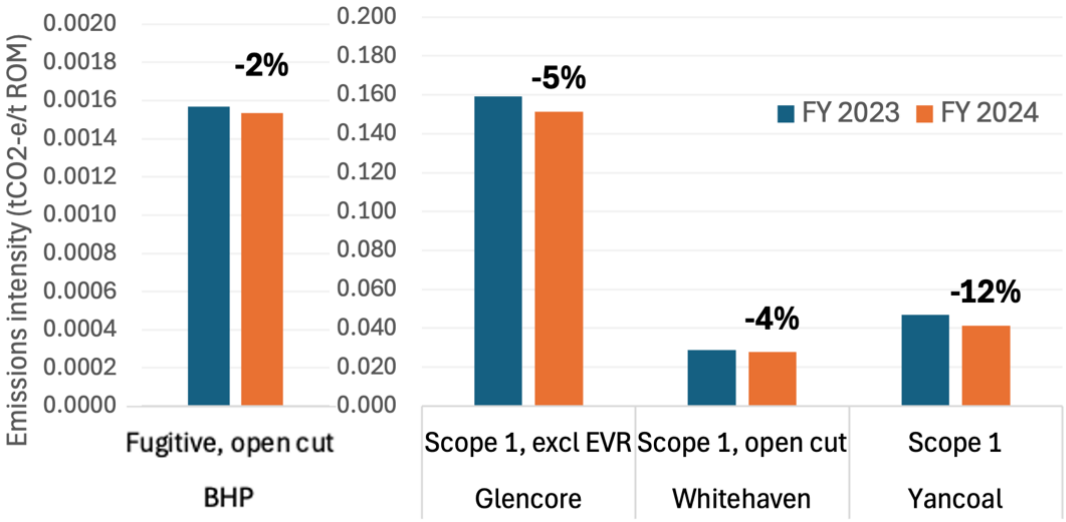
Lower emissions intensities are reported under Method 2

In FY2023, 21 Safeguard Mechanism (SGM) facilities used Method 1, and 27 facilities used Method 2, with no facilities using Method 3.[27] With the removal of Method 1 reporting for large coal miners required by FY2026, it is expected that most of the open-cut coal mine SGM facilities will have already moved to Method 2, well ahead of schedule. Major coal miners in Australia have confirmed they have switched their reporting of all open-cut facilities to Method 2, including BHP, Glencore and Whitehaven, except for Whitehaven's Blackwater mine. These miners all reported a fall in the open-cut mines emissions intensities per unit of coal production in FY2024 (see Figure 1).

Figure 1: Reported emissions intensity – major coal miners.



Source: Company annual reports.
Note: Only BHP separately reports fugitive emissions by mine, all others report Scope 1 total emissions. BHP and Whitehaven only report open-cut mines. Glencore and Yancoal report all mines in aggregate.

The reported fugitive emissions intensity rates for large mines across NSW and Qld demonstrates a stark departure from the previous "Method 1" approach. A comparison of reported results to the state-based factors for the top 20 emitting mines is shown in Figure 2.

[27] DCCEEW. Certification as Impact Analysis Equivalent – 2023 Climate Change Authority Review of the National Greenhouse and Energy Reporting Legislation. 7 June 2024.

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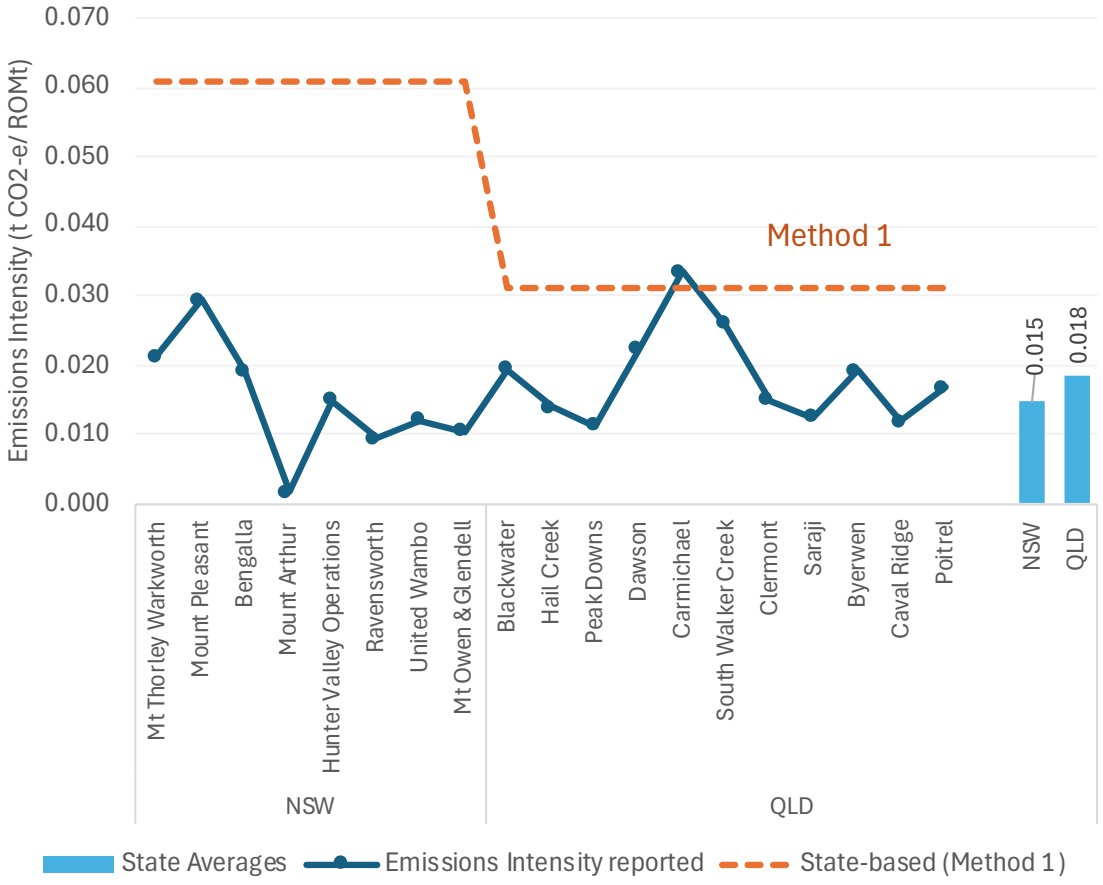
Figure 2: Actual reported emissions intensity vs state-based factor



Source: Common Capital, IEEFA.

The figure indicates the reported methane emissions per unit of coal produced is approximately 76% lower in NSW and 41% lower in Qld compared to Method 1 default factors, based on estimated data from 2022-23. The anticipated release of the Safeguard facility data for 2023/24, including the separate reporting of fugitive methane emissions should be reviewed to verify this finding.

Miners Whitehaven and BHP have published sustainability/climate transition plan reports for 2024 containing details at a mine level. Their reports show that at mines that have switched to Method 2 during the past five years, emissions fell dramatically. Emissions dropped by 60% and 90% for the Maules Creek and Caval Ridge mines respectively (see Figure 3).

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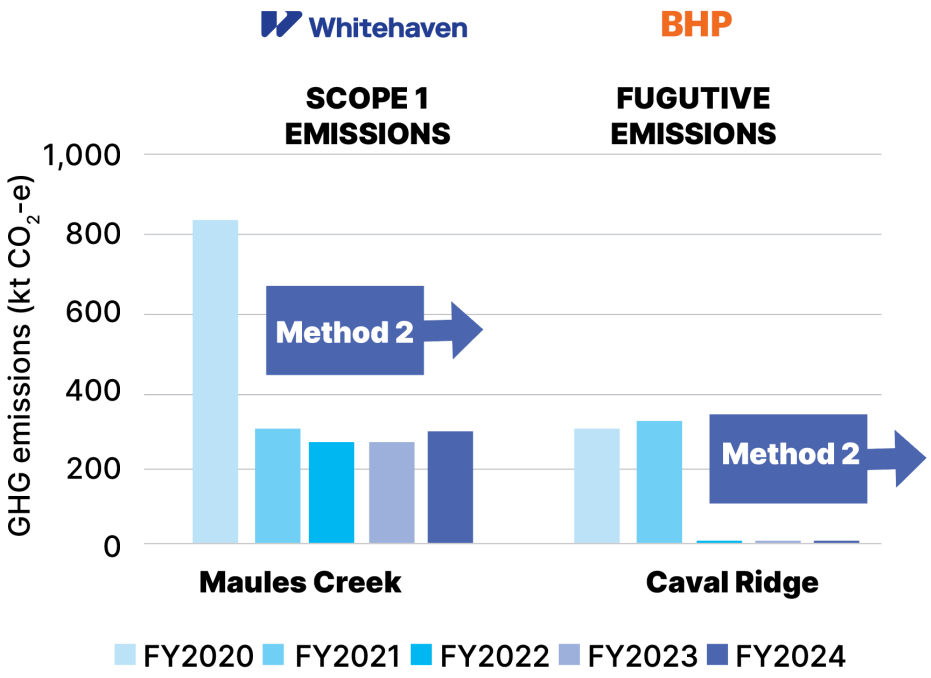
Figure 3: Significant changes to reported fugitive emissions intensity due to a shift from Method 1 to Method 2 reporting.



Sources: BHP and Whitehaven sustainability reports.
Note. Shows emissions reported based on 100% operational ownership. Caval Ridge is operated by BMA with 50% equity from BHP. IEEFA

Glencore stated in its 2024 annual report, "During 2024, we transitioned three of our open-cut mines (Hail Creek, Clermont and Collinsville) to the most accurate regulated method available in Australia for open-cut fugitive emissions measurement, Method 2."[28] This was despite Method 3 not being used.

Potential underreporting in open-cut coal mines

In 2024, IEEFA research identified significant methane underreporting in fossil fuel extraction, including estimated emissions about three times higher than reported for open-cut coal mining in Australia.[29] This was based on data from the IEA and ClimateTRACE, noting that there is a high level of uncertainty in any estimation of open-cut mine emissions.

Other studies involving satellite observations of methane releases from Australian surface coalmines found significant discrepancies from what is reported.[30]

[28] Glencore. 2024 Annual Report. 18 Mar 2025.
[29] IEEFA. Prioritising methane abatement makes economic sense. 12 December 2024.
[30] Open Methane. Groundbreaking satellite monitoring tool shows significant underestimation of methane emissions from fossil fuel sites. 9 October 2024.

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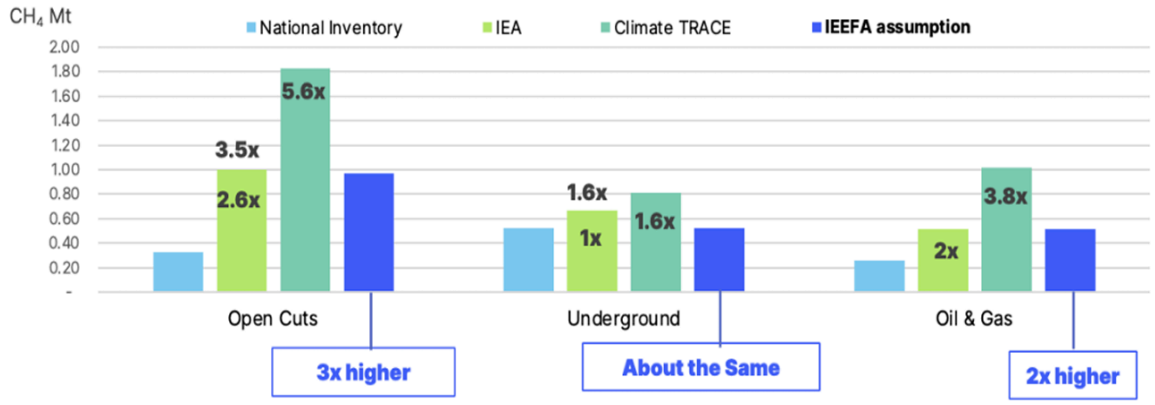
Figure 4: Estimates of methane emissions underreporting



Source: IEEFA analysis based on Australian government, IEA, ClimateTRACE.
Note: The IEA does not report on underground and open-cut mine methane estimates separately; IEEFA considered a range of underreporting factors based on underground emissions, varying between reported levels and Climate TRACE levels.

Issues identified with using Method 2

In July 2024, the Independent Expert Advisory Panel for Mining (IEAPM) provided advice to the NSW government on the Hunter Valley Operations Continuation Project.[31] It highlighted accuracy risks associated with the Method 2 approach to fugitive gas estimation used in the Hunter Valley North 'low gas zone' area:

- Nitrogen was present in the reported gas test results – which could indicate potential contamination of test samples and potentially underreporting of methane gas levels.
- Additional gas sample(s) may be required to test an area that is currently classified as a low gas zone, due to samples used having come from affected coal adjacent to a dyke.

Further details around reporting from low gas zones under Method 2 comes from an academic paper, *Estimation of fugitive emissions from open-cut coal mining and measurable gas content*, by the University of Wollongong.[32] It considered the Method 2 approach to determining low gas zones flawed, due to the standards containing an artificially high gas detection threshold and an associated low amount of gas assumed for the low gas zone. The result was that low gas zones underreport gas considerably.

This effect is exaggerated when the proportion of methane in the gas is highest (such as in many coal mines). The study considered that modern gas instruments have a detection limit well below the Method 2 threshold and so should be lowered by an order of magnitude.

[31] IEAPM. Advice Re: Hunter Valley Operations Continuation Project (SSD-11826681 and 11826621). July 2024.
[32] University of Wollongong. Estimation of fugitive emissions from open cut coal mining and measurable gas content. 2013. *A Saghafi*.

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In March 2025, a University of Queensland study assessed the pre-drainage of open-cut coal mines in the Bowen Basin.[33] The study indicates the high gas content of the coal seams mined will give rise to methane emissions being reported under Method 2 that are four to six times higher, when compared with Method 1. The study points out inadequacies in Methods 2 and 3, in that "they fail to capture emissions from the mine face during non-mining and post-mining periods. Additionally, discrepancies arise when pre-drainage production is considered (such as methane abatement)." The study estimates that pre-drainage abatement can reduce emissions by 38% when flaring of methane is used, and higher for other scenarios.

Opportunities for the NGER scheme to promote use of MRV

A recent research paper by the IMEO was the first study to conduct high-resolution independent top-down verification of methane emissions from Queensland's Hail Creek mine.[34] The study involved aerial surveys using methane monitoring equipment.

Glencore has confirmed in its 2024 Annual Report that it now uses Method 2 reporting for all its open-cut mines. In the case of Hail Creek mine, this has caused an increase in the reported fugitive emissions, compared with Method 1.

The IMEO study compared observed emissions with the Method 1 values. It found an emissions intensity rate (million tonnes (Mt) of carbon dioxide-equivalent (CO_2e) per annum (pa)) of 2.36±0.46 from one aircraft and 2.77±1.30 from the other, during 2023. Comparing these central estimates if sustained over a one-year period, the data implies methane emissions approximately eight to nine times higher than the Method 1 rate of 0.31Mt of CO_2e pa.

The study found significant disagreement between bottom-up and top-down methods. The Clean Energy Regulator reported that the reported Emissions Intensity Determination (EID) for FY2023-24 for Hail Creek is 0.05811 per run-of-mine (ROM) tonne.[35] It produced 9.593Mt ROM in FY2023/24, according to the Queensland Government, so the total reported Scope 1 emissions for the year was 0.56Mt of CO_2e. On that basis the observed methane emissions are four to five times higher than the total Scope 1 reported emissions for the mine.

The IMEO study noted the high degree of methane emissions emanating from the pit highwall following mining. It made a number of observations for improved gas sampling, such as is undertaken with Method 2. It found that "Methods 2 and 3 do not consider lateral gas migration via exposed highwall" as observed in the study, and that "gas is emitted not only from the mined coal seam but also from adjacent and underlying seams and gas-bearing strata. This occurs due to preexisting fractures, the fracturing of seams during mining, and the removal of overburden and adjacent earth, which reduces the pressure on the coal seams."

Other issues the study raised that are not captured by Method 2 and 3 include:

[33] University of Queensland. Improved estimation methods for surface coal mine methane emissions for reporting, beneficial use, and emission reduction purposes and relative to Australia's safeguard mechanisms. 18 March 2025.
[34] Environmental Science & Technology Letters. Insights into Elevated Methane Emissions from an Australian Open-Cut Coal Mine Using Two Independent Airborne Techniques. 25 March 2025.
[35] Clean Energy Regulator. Emissions intensity determination data for safeguard facilities.

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- "emissions from strata below a depth of 20 m beneath the pit floor, despite evidence that contributions from deeper underburden vary across mines due to differences in geo-mechanical properties and mining intensity"; and

- "in situ biological methane production within water management ponds, disturbed soils, and exposed coal stockpiles".

The IMEO study notes that "it remains unclear whether these discrepancies are representative of other mines in the region." While there are potential issues with attributing diffuse emissions to specific coal mines, this issue could be addressed, by instead attributing an emissions 'bucket' across a broad area such as coal mining basins or regions encompassing groups of co-located coal mines in order to verify their collective emissions.

Other opportunities lie in continuous gas monitoring like Sigra's Gas Content Without Coring (GCWC) system.[36] Unlike traditional testing of a coal 'core' that is retrieved from drilling and tested in a lab, this in-field method captures gas directly from drilling fluid (mud) in open-hole drilling. It promises benefits including reduced 'lost-gas' uncertainty, because it maps gas content vertically across all strata, not just targeted coal seams. The method could be employed more expansively as it can be adapted to open hole drilling. It continuously samples gas as drilling is performed. Combining gas sampling with coal exploration and resource drilling could significantly reduce the cost of gas coring and testing, and improve the reliability of the results. This could replace or supplement the costly cored borehole methods that are used to establish gas measurements often distributed across a wide area.

[36] Sigra. Gas Content Without Coring.