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Prioritising methane abatement makes economic sense

Governments must urgently address the lack of financial incentives to reduce emissions from coal, oil and gas

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Key Findings

Methane is jeopardising Australia's emissions reduction targets; it is expected to account for 68%-95% of Australia's targeted emissions by 2035, 78% of New South Wales' and even exceed Queensland's.

Australia could abate two-thirds of its fossil fuel methane emissions using readily available technologies, at a net cost of about A$1 per tonne of coal in coalmining, and at a net financial benefit in the gas sector due to the option to sell the methane captured.

Current policies are ineffective at reducing methane emissions, primarily due to inadequate measurement and settings in the Safeguard Mechanism, with insufficient financial incentives for companies to act.

Federal and state governments must act urgently to address the problem, by enhancing financial drivers and regulating for companies to take best-practice methane abatement action.

Executive Summary

Methane has contributed about 30% of the post-industrial increase in global temperatures. Action to reduce methane emissions can provide benefits within decades due to its relatively short atmospheric life and its much stronger warming potential compared with carbon dioxide (CO_2).

Australia makes an oversized contribution to global methane emissions due to its high relative production of fossil fuels and agricultural exports. Government projections do not expect methane emissions to decrease materially between now and 2035, while CO_2 emissions are expected to halve. Under current settings, Australia's methane emissions could even increase in that period due to underreporting correction and new fossil fuel developments. This is at odds with Australia's commitment to reduce methane emissions under the Global Methane Pledge.

It is now well established that methane emissions in Australia are underreported. In many instances, methane emissions are estimated using fixed emissions intensity factors based on the quantity of production, rather than via satellite monitoring, remote sensing or direct measurement. New data providers have found that Australia's methane emissions have been grossly underreported, particularly from fossil fuel production. The suspected underreporting is particularly high for the gas sector and open-cut coalmines – with some providers suggesting open-cut mine emissions could be nearly six times as high as reported.

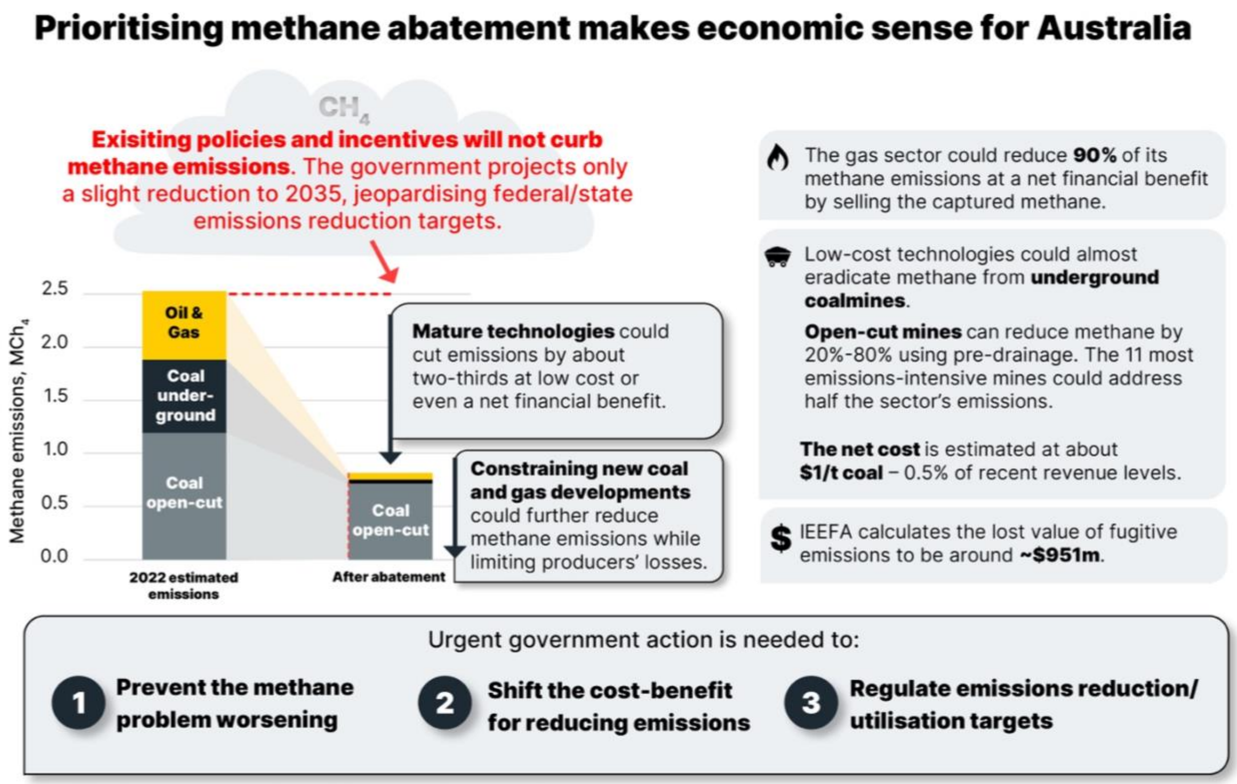
Australia's large pipeline of proposed coal and gas developments could worsen its methane problem. Metallurgical coal production is expected to grow, with metallurgical coal generating more methane than thermal coal. Satellite data suggests we could be vastly underestimating emissions from proposed new projects, providing limited insight into their potential impact at approval stage. In addition, open-cut mining is growing faster than underground mining, which may be in part due to more favourable emissions reporting and Safeguard Mechanism settings for open-cut mines. Given the long lifetimes of new mine developments and extensions, and the fact methane emissions are harder to abate for open-cut mines, this could lock in high emissions for decades and require all other sectors to make faster and deeper cuts to emissions.

As a result, methane emissions are putting federal and state emissions reduction targets at risk. Correcting for likely underreporting, and assuming, as per government projections, that methane emissions remain approximately stable to 2035, they would represent 68%-95% of the indicative targeted emissions by 2035 for Australia, 78% of New South Wales (NSW)'s targeted emissions and even exceed Queensland's, according to IEEFA's calculations.

Prioritising fossil fuel methane abatement makes economic sense

The International Energy Agency (IEA) found that reducing methane emissions from fossil fuels has the most potential to quickly reduce overall methane emissions. Two-thirds of emissions can be abated through mature technologies at low cost, or even with financial benefits. Because methane is the main component of natural gas, capturing it means it can be sold or utilised.

In Australia, IEEFA found that 67% of methane emissions from fossil fuels could be abated using readily available technology, at a cost below A$30 per tonne of CO_2-equivalent (tCO_2e). In the gas sector, the majority of actions would deliver a material financial benefit, so that about 90% of emissions could be reduced at no net cost overall. In the coal sector, potentially 59% of methane emissions could be abated, and the average abatement costs translate to about A$1/t saleable coal across the industry, or approximately 0.5% of recent income levels. In addition, underreporting means methane reduction costs may have been overestimated to date.



Source: IEEFA Calculations. Note: Fugitive methane emissions are natural gas escaping into the atmosphere. IEEFA

While open-cut mines typically emit less methane than underground mines per unit of coal produced, their sheer volume means they represent the majority of Australia's coalmine methane emissions.

In underground coalmines, methane is already pre-drained from coal seams before operations, but the amount pre-drained could increase. Most underground methane emissions are generated by ventilation air methane (VAM), the air from the underground mine shaft that must be ventilated for safety reasons. The main opportunities to reduce methane emissions from underground mines are to: abate VAM, detect and repair leaks to increase the volumes of methane captured in pre- and post-drainage, prevent venting and regulate flaring, and enhance post-mining capture, which can also support communities facing mine closures.

In the vast majority of open-cut mines, no action is taken to capture methane. Open-cut mines can reduce methane emissions via methane pre-drainage or reducing production. While pre-draining technology is readily available, the industry asserts that it is too difficult or costly to employ. Recent examples suggest that with the right policy settings, it is financially feasible. The emissions intensity of open-cut mines varies widely, and targeting high emitters first could deliver high reductions.

In the gas sector, methane is emitted through the entire supply chain, with about two-thirds coming from production and one-third from transmission, distribution and storage. About 90% of methane emissions could be abated through best-practice equipment and processes, at a net financial benefit overall since the recovered methane can be sold in domestic and international markets.

These cost-effective solutions could also alleviate tight domestic gas supply in Australia. IEEFA calculates about 76 petajoules (PJ) of methane could be recovered across the coal and gas sector – more than twice the amount of gas anticipated to be required for power generation in the National Electricity Market in 2025. This represents a lost value of about A$951 million.

Reducing production is the only method that allows for a 100% reduction in methane emissions, especially from open-cut coalmines. In scenarios aligned with 2.4°C and 1.7°C of global warming respectively, the IEA expects global coal production to fall by 30% or 50% by 2035, with Australia facing similar trends. It also estimates that global LNG markets will face an enormous supply glut, pushing prices to below production costs if LNG markets are to absorb the new supply. IEEFA analysis has shown that many proposed coalmines and gas fields are unlikely to be profitable, and the financial situation of existing projects could worsen.

Policies ineffective at driving action

Fossil fuel methane emissions appear to have risen under the Safeguard Mechanism, whose shortcomings limit its effectiveness at driving reductions. In addition, while some methane abatement projects are eligible to earn revenue via the Australian Carbon Credit Unit (ACCU) scheme, this is not attracting investment. Overall, the financial incentives are insufficient to drive company action. The lack of clarity over companies' actual emissions makes it harder to develop a business case for their reduction. Companies also face capability gaps, and prioritise other, more profitable uses of capital.

Australia lags other major fossil fuel producers – the US, China and the EU – in its adoption of effective methane abatement technology. Government intervention is urgently needed to tackle the problem, and address market failures. The figure below summarises IEEFA's recommendations for governments at federal and state levels. Experience in other regions shows that a combination of price signals and regulation can be effective at driving comprehensive action to reduce methane.

URGENTLY FIX
EXISTING PROCESSES

Scrutinise coal and gas development approvals

- New developments should be scrutinised on their net cost/ benefits.
- Make approvals of new projects or expansions/extensions conditional on comprehensive methane plans.

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Improve methane measurement

- Stop low order methods for open cut coalmines and oil and gas.
- Develop and move to higher order methods based on direct measurement and independent verification.
- Develop top-down methods for monitoring and verification.

DRIVE METHANE ABATEMENT
OPTIONS INCLUDE:

Regulation

- Require best practice equipment and processes in the gas sector.
- Require VAM abatement and enhanced drainage and leak repair in underground mines, plus enhanced pre-drainage in open-cut mines, starting with the highest emitters.
- Further limit venting and flaring.
- Regulate post-operating emissions.

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Price Signals

- Enhance existing price signals by amending the Safeguard Mechanism.
- Facilitate access to generate carbon credits for methane abatement.
- Consider new mechanisms such as a methane tax or tax incentives.
- Extend existing schemes to provide financial support to first movers and to cover post-operation emissions.

1. Introduction

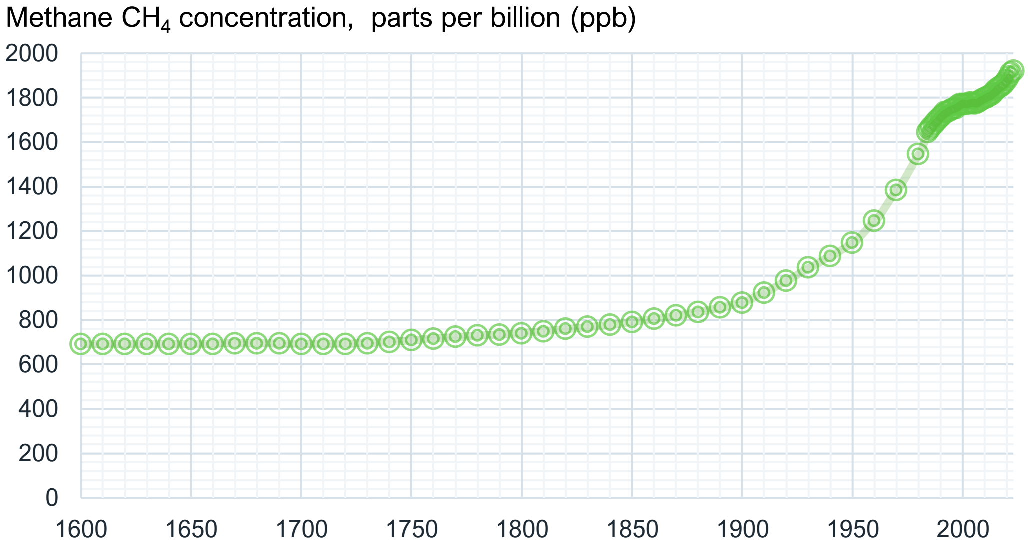
1.1 A critical contributor to global warming

Methane (CH_4) is a greenhouse gas that accounts for about 30% of the post-industrial increase in global temperatures.[1] This makes it the second-largest contributor to climate change after carbon dioxide (CO_2). Global methane emissions have increased 20% over the past 20 years, an annual increase of 61 million tonnes of CH_4 emissions, or 1.7 billion tonnes of CO_2-equivalent (CO_2e) every year.[2,3] The increasing rates of methane emissions since the 2010s have been found to be primarily attributable to fossil fuel-related activities, which contributed as much as agriculture and waste combined to the observed increases in methane emissions during this period.[4] Despite most of the world signing the Paris Agreement since 2016, the concentration of methane in the atmosphere continues to grow, increasing at higher rates between 2020 and 2022 than in previous years.[5]

[1] International Energy Agency (IEA). Global Methane Tracker 2020. March 2024.
[2] CSIRO. Global Methane Budget 2024: 2000-2020. September 2024.
[3] Using a 28 global warming potential (GWP) for methane over a 100-year time horizon.
[4] United Nations Environment Programme & Climate & Clean Air Coalition. Global Methane Assessment: Benefits and costs of mitigating methane emissions. 2021. Page 17.
[5] Earth System Science Data. Global Methane Budget 2000-2020. 6 June 2024.

Additionally, the number of super-emitters, sites that emit more than 100 kilograms of methane per hour, up from 15,000 in 2023 to 20,000 sites in 2024.[6]

Figure 1: Global atmospheric methane concentration, 1600-2023



Sources: Journal of Geophysical Research Atmospheres, 1998; National Oceanic and Atmospheric Administration (NOAA) Global monitoring laboratory, 2024; IEEFA. Note: Values for 1600-1984 are based on Greenland and Antarctic ice core samples; after 1984 they are based on NOAA direct air sampling.

While much attention has been given to the need to reduce CO_2 emissions, achievement of global emissions reduction targets will require methane emissions to decrease significantly as well. The International Energy Agency (IEA) estimates that fossil fuel methane emissions will need to fall by three-quarters by 2030 to meet the 1.5°C target.[7] The Global Methane Assessment conducted by the United Nations Environment Programme found that addressing methane emissions was the most cost-effective greenhouse gas reduction strategy.[8]

Taking action to reduce methane emissions can provide benefits within decades due to the gas's relatively short atmospheric life and strong warming potential. In recognition of the importance of methane reduction, Australia joined the Global Methane Pledge in 2022, a voluntary commitment "to reduce global methane emissions across all sectors by at least 30% below 2020 levels by 2030".[9]

[6] Economic Times. World may be merely scratching the surface on the scope of climate-changing methane emissions. 1 November 2024.
[7] IEA. Global methane tracker 2024. March 2024.
[8] United Nations Environment Programme. Global Methane Assessment: Benefits and Costs of Mitigating Methane Emissions. 6 May 2021.
[9] Minister for Climate Change and Energy. Australia joins Global Methane Pledge. October 2022.

Box 1. Understanding methane reporting and carbon dioxide equivalence

The short-term global warming potential (GWP) of methane is much higher than CO_2. Despite having different effects on global warming, methane is often reported as a unit of carbon dioxide equivalence (CO_2e), where the quantity of methane emissions is converted into an equivalent quantity of CO_2 to illustrate the higher warming effect methane has in the atmosphere.

To convert one tonne of methane emissions into CO_2e, governments or reporters choose whether to use a 20-year or a 100-year time horizon. The Clean Energy Regulator and CSIRO continue to report an outdated GWP value for methane, of 28, which equates one tonne of methane to 28 tonnes of CO_2e over a 100-year time horizon. The Intergovernmental Panel on Climate Change (IPCC)'s updated 6th report specifies a GWP of 29.8 for fossil fuels methane. The International Energy Agency (IEA) estimates that a tonne of methane has a GWP equivalent to up to 30 tonnes of CO_2e over a 100-year period.[10]

Note: Any analysis throughout this report that converts methane and CO_2e utilises the 28 GWP over a 100-year period.

1.2 Australia's methane emissions are underreported

In most instances, methane emissions are estimated using fixed emissions intensity factors based on the quantity of production, rather than via satellite monitoring, remote sensing or direct measurement.

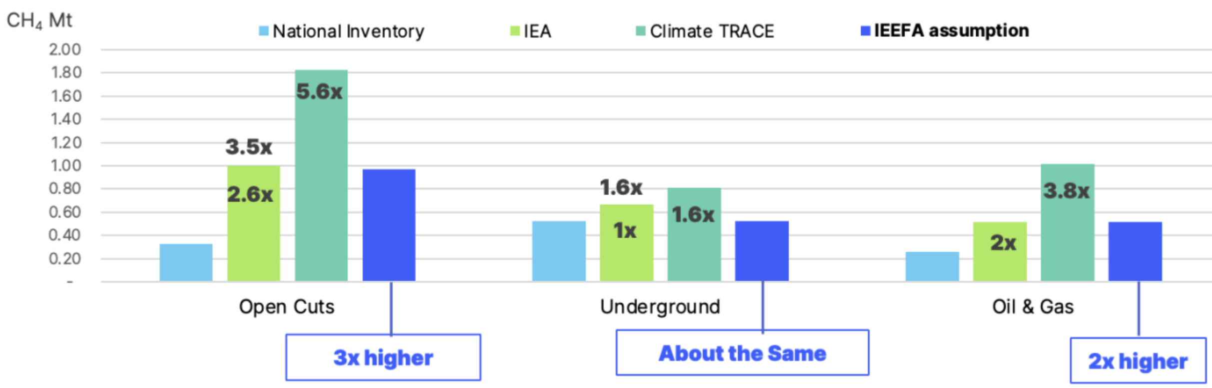
The IEA estimates that emissions from Australian coal, oil and gas production could be underreported by more than 86%.[11] However, the Superpower Institute has found they are likely to be underreported by 100% or more, and that Climate TRACE data is a closer fit to Open Methane's observed methane emissions data than the Australia government's national inventory data.[12] Climate TRACE data shows fossil fuel methane emissions could be more than three times higher than reported. The suspected underreporting is particularly high for the gas sector and open-cut coalmines, with some data providers suggesting open-cut coalmine methane emissions could potentially be almost six times higher than reported.[13]

Australia's national inventory reports methane emissions from fossil fuels at 32 million tonnes (Mt) of CO_2e in 2022, of which 24MtCO_2e was from coalmining, 7MtCO_2e from oil and gas production, and 2MtCO_2e from the incomplete combustion of fossil fuels.[14] In contrast, available data from Climate

[10] IEA. Understanding methane emissions. March 2024.
[11] IEEFA. Gross under-reporting of fugitive methane emissions has big implications for industry. 5 July 2023.
[12] Superpower Institute. Open Methane. 9 October 2024.
[13] Climate TRACE. Data downloads. December 2024.
[14] Department of Climate Change, Energy, the Environment and Water (DCCEEW). Australia's National Greenhouse Accounts. Emissions inventories. Paris Agreement inventory.

TRACE shows this figure may be significantly higher at more than 70MtCO_2e of methane emissions from coalmining alone. The IEA estimates total methane emissions from fossil fuels to be almost double national inventory estimates at 60MtCO_2e (Figure 2).

Figure 2: Estimates of methane emissions underreporting



Sources: Department of Climate Change, Energy, the Environment and Water (DCCEEW); IEA; Climate TRACE; IEEFA. 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.

There is a high level of uncertainty around actual methane emissions. Based on our assessment of available data sources, where representing potential underreporting, we assume in the rest of this report that:

- Underground coalmining methane emissions are as reported.
- Open-cut coalmining methane emissions are about three times reported levels.
- Oil and gas production methane emissions are about two times reported levels.

These assumptions broadly align with the IEA data. They are based on the best available data; however, issues and inaccuracies in methane estimates remain. As improved data becomes available and satellite observations and remote-sensing technologies improve, we will revise our estimates in future publications, particularly of site-specific methane emissions.

The underreporting of methane stems from the use of measurement approaches in Australia that are not fit for purpose. The emergence of satellite and remote-sensing emissions data is shining a light on the uncertainty of existing methane reporting, both in Australia and internationally.

In December 2023, the Climate Change Authority (CCA) recommended a range of adjustments to measurements methodologies, including recommendations to:

- Phase out the use of Method 1 (the lowest-order or simplest methodology, based on default emissions factors multiplied by production levels) for open-cut coalmines.
- Review Method 2 (which estimates emissions based on industry-based sampling, but does not require independent review, is open to inaccuracies and could allow underreporting to worsen).

- Resource the department to establish higher-order estimation methods.
- Develop top-down verification to help refine and reconcile bottom-up measurements.[15]

The government responded to these recommendations, agreeing or agreeing in principle to all recommendations regarding methane measurements. It agreed to review Method 2 for emissions estimation, but not with the urgency the CCA recommended.[16] However, the government's response did include a commitment to establish an expert panel led by the Chief Scientist to provide advice on top-down verification methods.

Underreporting of methane emissions means Australian governments are unlikely to have reliable estimates of emission levels for key sectors, including coal, oil and gas. This, in turn, means that emissions reduction plans are unlikely to be designed in a way that will drive sufficient reductions to meet targets.

This issue could also increase total abatement costs across the economy if it results in implementation of abatement options that are ineffective or inefficient (i.e. not least cost), or if it distorts the incentives faced by major emitters to reduce methane emissions. It may result in cost-shifting away from major methane emitters to other industries, governments and consumers generally (if correction of underreporting of methane emissions consequently requires greater decarbonisation elsewhere in the economy).

1.3 Australia's oversized role in global methane emissions

According to the IEA, Australia was the 12th largest methane emitter globally in 2023, emitting 1.6% of global methane despite having "just over 0.3% of the world's population".[17] This is driven by Australia's globally significant fossil fuel and agricultural export-orientated industries. In 2023, Australia was the largest metallurgical coal exporter, second-largest thermal coal exporter and second-largest LNG exporter (in some years it is the world's largest). Australia was also the sixth-largest source of coalmine methane globally in 2023.[18] Australia is also the largest lamb, sheep and goat meat exporter in the world, and the second-largest beef exporter as of 2023.

The IEA estimates Australia produced more than seven million tonnes of methane emissions in 2023. This places Australia's methane pollution about three times higher than other developed economies such as the UK, France and Germany, and about five times higher than the methane emissions from our major trading partners Japan and Korea.[19]

[15] CCA. 2023 review of the national greenhouse and energy reporting legislation. December 2023. Page 9.
[16] DCCEEW. Australian Government response to the Climate Change Authority's 2023 Review of the National Greenhouse and Energy Reporting legislation. August 2024. Pages 10-15.
[17] IEA. Global methane tracker 2024. Data. March 2024.
[18] Ibid.
[19] Ibid.

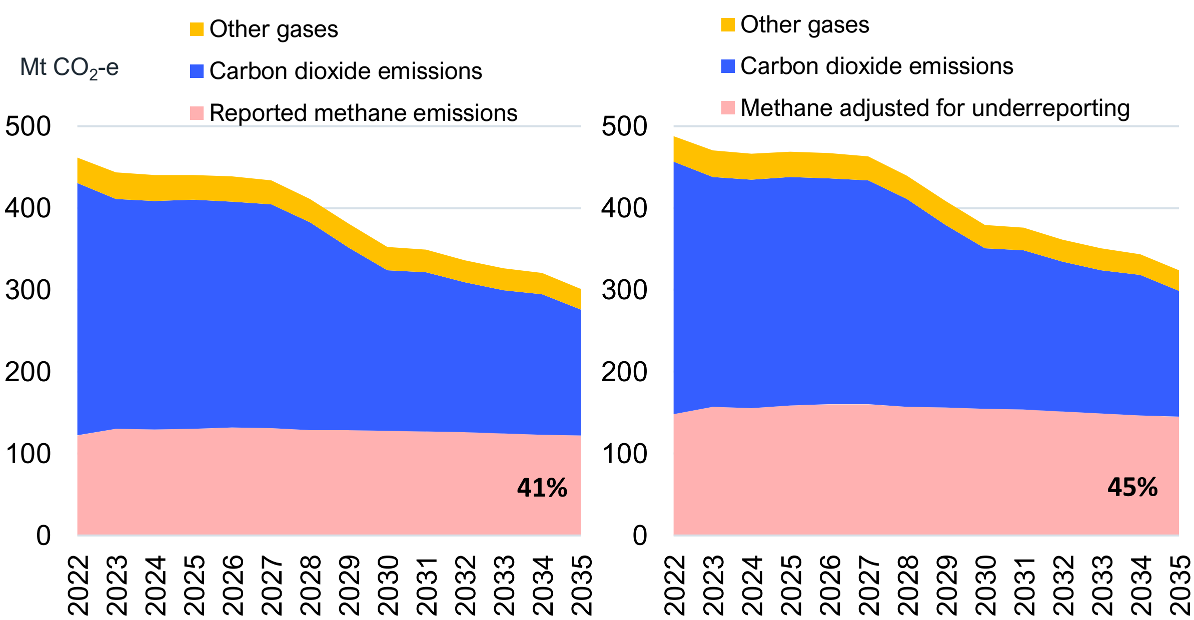
2. A large and worsening problem

2.1 A growing component of Australia's emissions

Methane contributes 28%-30% to Australia's greenhouse gas (GHG) emissions accounts, according to Australian government data.[20,21] Methane emissions are not forecast to decrease by 2035, while CO_2 emissions are forecast to nearly halve, according to DCCEEW projections.[22] As a result, methane emissions are expected to be of a similar magnitude to CO_2 emissions by 2035, representing 41% of Australia's total emissions.

If correcting for estimated underreporting of fossil fuel methane emissions, then methane would represent about 45% of Australia's emissions by 2035 under current policy settings (Figure 3). This underscores the need for urgent action by governments for methane abatement in Australia.

Figure 3: Australian government emissions projections



Source: DCCEEW.[23] Note: November 2023 projections adjusted with IEEFA assumptions of underreporting (right).

[20] DCCEEW. Australia's National Greenhouse Accounts. Emissions inventories. Paris Agreement inventory.
[21] DCCEEW. National Greenhouse Gas Inventory Quarterly Update: March 2024.
[22] DCCEEW. Australia's National Greenhouse Accounts. Emissions projections.
[23] Ibid.

2.2 Methane emissions risk Australia's GHG reduction targets

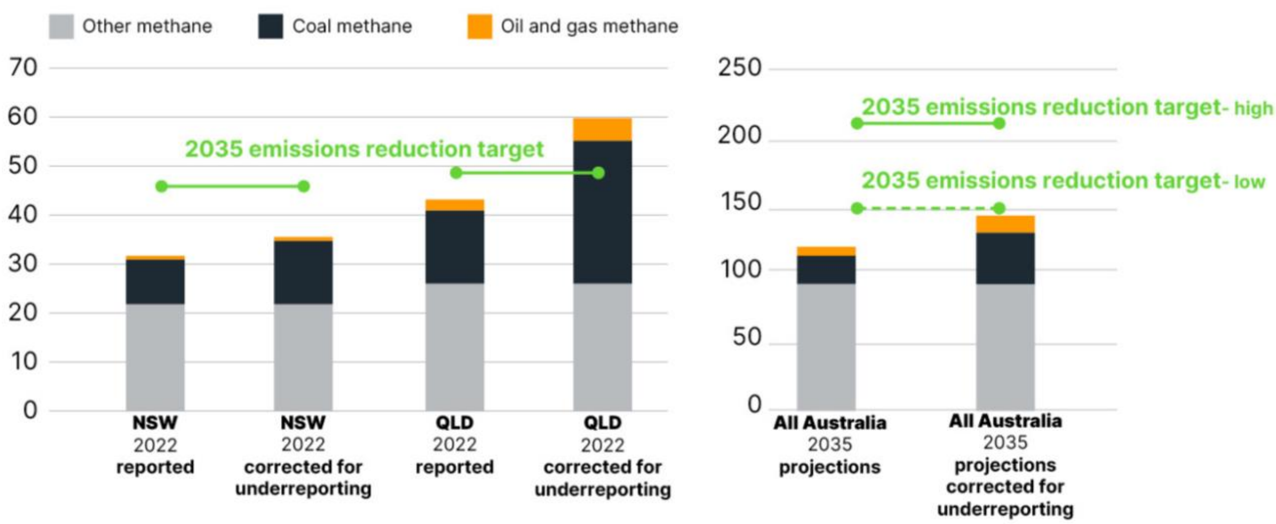
Australia has legislated emissions reduction targets for domestically produced GHG emissions, represented in CO_2e terms. It has done so both federally and within states and territories. Nationally, Australia has legislated a net zero target by 2050, with an interim GHG emissions reduction target of 43% below 2005 levels by 2030.[24] The Australian government has also committed to reducing methane emissions explicitly through the Global Methane Pledge, under which signatories have committed to reducing global methane emissions by 30% by 2030 (relative to 2020 levels).[25,26] Australia is considering a 2035 emissions reduction target, with the CCA indicating that its recommendation would likely be in the range of a 65%-75% reduction below 2005 levels.[27]

However, at the national level, as outlined above, the government expects methane emissions to increase 3% between 2020 and 2030, and to decrease only 1% by 2035. If fugitive methane emissions were corrected to account for likely underreporting, methane emissions could increase by about 27MtCO_2e by 2030, or a further 20% on 2020 levels.[28] This would leave Australia a long way from achieving its international commitments, and facing a difficult task to achieve its future emissions reduction targets. Indeed, correcting current projections for underreporting would bring methane emissions to 145MtCO_2e by 2035. This would represent 68% to 95% of Australia's targeted emissions by 2035, according to the CCA's indicated target range (Figure 4).

At the state level, methane emissions are also a risk for certain states' emissions reduction targets. New South Wales (NSW) has legislated even stronger interim targets than the federal government, with a 50% cut on 2005 levels by 2030 and a 70% reduction by 2035, before reaching net zero by 2050. [29] Similarly, Queensland (QLD) has legislated a state-level GHG emissions reduction target of 30% by 2030 and 75% by 2035 on 2005 levels, with a target of net zero by 2050.[30]

[24] DCCEEW. Net Zero. Last updated 18 October 2024.
[25] Global Methane Pledge. About the Global Methane Pledge.
[26] Minister for Climate Change and Energy. Australia joins Global Methane Pledge. 22 October 2022.
[27] CCA. MEDIA RELEASE: Targets, Pathways and Progress issues paper released for consultation. 11 April 2024.
[28] DCCEEW. Australia's National Greenhouse Accounts. Emissions projections.
[29] NSW Climate and Energy Action. The Climate Change (Net Zero Future) Act 2023. 30 November 2023.
[30] Queensland Government. Queensland's 2035 Clean Economy Pathway. February 2024. Page 5.

Figure 4: Methane emissions vs NSW and QLD 2035 reduction targets (left) and potential 2035 emissions reduction range for Australia (right), MtCO2e



Sources: Australian, NSW and Qld governments, CCA, IEEFA analysis

Figure 4 shows that if methane emissions stayed at 2022 levels to 2035, they would represent a very significant component of targeted 2035 emissions in NSW and Queensland, at 69% and 90% respectively. In addition, if methane emissions were adjusted by IEEFA's assumptions of underreporting, as stated earlier in this report, this would represent 78% of NSW's targeted 2035 emissions, and 124% of Queensland's targeted 2035 emissions, making that state's target unachievable.

2.3 Australia's fugitive methane problem could get worse

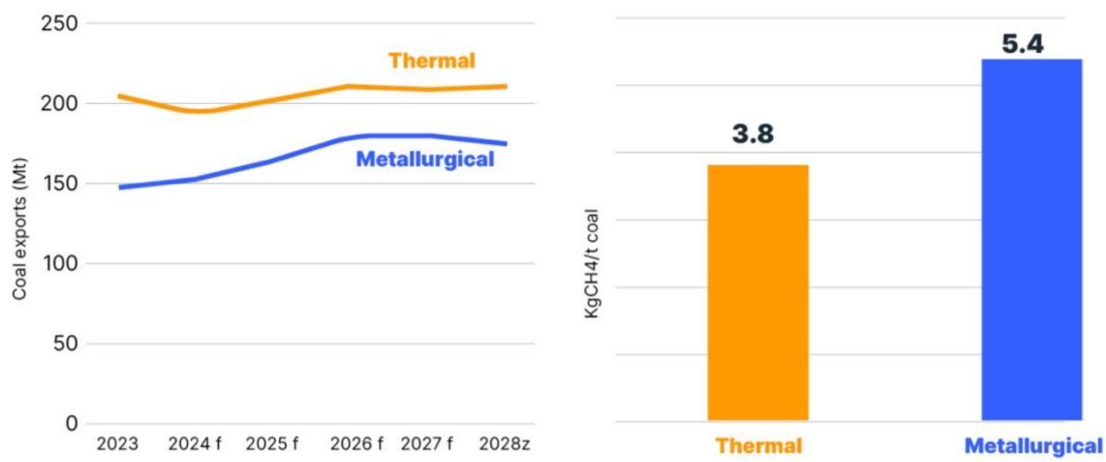
Australia's methane emissions could increase if nothing is done. Open-cut coalmines are getting bigger, volumes mined are increasing, and there is a pipeline of major gas projects and new coalmines and expansions proposed. Satellite data suggests that the current understanding of the methane emissions associated with proposed new projects is poor, providing limited insight regarding a project's potential impact at the approval stage.[31]

Methane-intensive metallurgical coal production is expected to increase. Australia has one of the biggest pipelines of new coalmines in planning and development of all coal-exporting countries. According to Australian government forecasts, coal production will grow in coming years, led by metallurgical coal export volumes growth until 2026 before declining out to 2028.[32] This has

[31] Energy and Climate. Methane Emissions from Superemitting Coal Mines in Australia Quantified Using TROPOMI Satellite Observations. 29 November 2021.
[32] Department of Industry, Science and Resources (DISR). Resources and Energy Quarterly March 2024. 28 March 2024.

implications for the future of Australia's coalmine methane emissions because metallurgical coalmines emit more methane emissions on average than thermal coalmines. Estimates vary on the magnitude of the difference, with the IEA estimating that metallurgical coal is about 40% more emissions intensive than thermal coal in Australia, and Wood Mackenzie estimating it is about three times as emissions-intensive globally.[33] Additionally, higher-quality coal typically generates more methane than lower-quality coal.[34] The latest NSW Net Zero Commission's annual report asserts that coalmine expansions or extensions in the state would require all other sectors to make faster and deeper cuts to greenhouse emissions.[35]

Figure 5: Australian coal export volumes (left), and methane intensity (right)

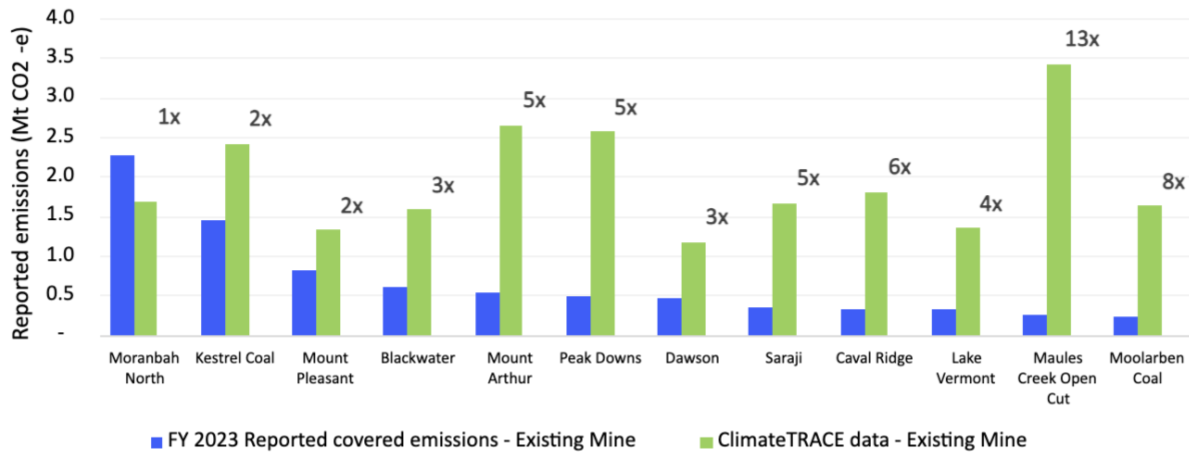


Source: Australian government forecasts and projections, IEA, IEEFA

Uncertainty is high around the methane emissions associated with proposed coalmine developments. Figure 6 shows the level of suspected underreporting at several mines with expansion plans, as well as the variability of emissions and underreporting levels (noting that in some cases, the mine type for the proposed development differs from the existing mine). It shows how urgent it is to better understand the actual methane emissions intensity of mines to inform approval processes. Surface miners already conduct vertical core drilling (drilling into the coal seam) for coal quantity and quality assessments. They could also assess the gas content of the coal seams via this process.[36]

[33] Wood Mackenzie. Putting coal mine emissions under the microscope. 29 April 2021.
[34] Elsevier. Coal Bed Methane Theory and Applications (2nd edition). 2020. Chapter 1a, 'The origin of coalbed methane'.
[35] NSW Net Zero Commission. 2024 Annual Report. 1 November 2024. Page 43.
[36] University of Wollongong. Reduction of fugitive methane emissions from open cut coal mines. February 2023. Page 129.

Figure 6: Potential underreporting from coalmines with expansion plans



Sources*: Clean Energy Regulator, Safeguard Mechanism, facility data 2022-23; Climate TRACE, Data Downloads. Notes. Climate TRACE figures are taken for calendar year 2023, and Safeguard Mechanism facility data reflects the covered emissions reported for FY2022-23 so this is not a direct comparison. Climate TRACE data refers to emissions quantity in 2023 reported in CO2e using a 100-year horizon; Safeguard Facility data reflects total greenhouse gas emission data not just methane emissions data, as this will only be disaggregated by greenhouse gas type from FY2024-25.*

Regulatory settings favour open-cut mine growth, where methane emissions are harder to abate. IEEFA analysis has shown that in NSW, Australia's largest open-cut coalmines are getting larger. Combined coal sales for the "big six" mines in NSW grew by more than 20% during 2023 to August, compared with a decline of 3% for the remainder.[37] This could be partially explained by more favourable regulatory settings – as methane emissions from open-cut coalmines are likely to be underreported, and the Safeguard Mechanism puts little, if any, constraints on open-cut mine emissions (see Shortcomings limit Safeguard Mechanism's effectiveness).

The full pipeline of proposed or planned coalmine expansions and extensions undergoing EPBC approval consideration is included in Appendix A. It shows that, of the 35 developments under consideration, 26 are for open-cut mines. Given that it is much harder to abate emissions from open-cut mines than underground mines (see Prioritising methane abatement makes economic sense), this could restrict methane emissions reduction in Australia should they be approved.

The methane intensity of open-cut coalmines is likely to increase. The bigger a surface mine gets – the deeper it digs – the more methane it releases. Open-cuts were previously limited to the removal of overburden to depths of 60 metres, but more recently this has increased to depths of 120 metres to access more coal resources, resulting in higher volumes of emissions.[38]

[37] IEEFA. Why Australia's coal mines are getting bigger. 22 November 2023.
[38] University of Wollongong. Reduction of fugitive methane emissions from open cut coal mines. February 2023. Page 129.

Proposed gas developments could add to Australia's methane emissions. The Australian government expects LNG production volumes to decline slightly in coming years.[39] There is significant uncertainty around future gas production levels, which will ultimately depend on whether gas producers reach final investment decisions on a range of proposed projects (see Appendix B). If these projects proceed, they could drive significant increases in Australian gas production, and hence in associated methane emissions, unless producers implement methane abatement technologies for all new projects.

In practice, project proponents are likely to face a range of hurdles (including regulatory approvals and access to infrastructure), and some proposed projects may not come to fruition.

3. The economic case for methane abatement

3.1 Existing technologies could slash fugitive emissions

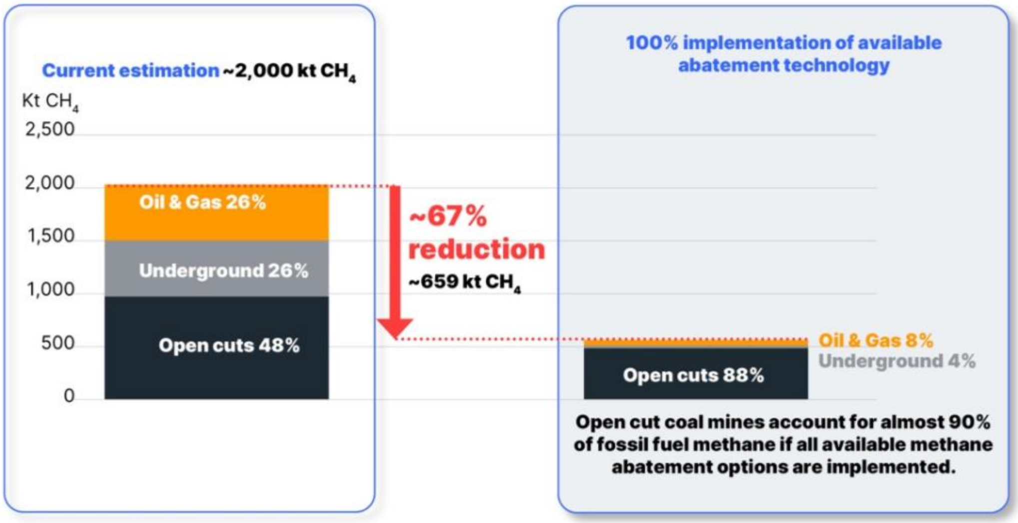
Methane abatement efforts should be prioritised to those sectors where effective technology is already available, and where the potential for abatement is highest. The IEA found that "cutting emissions from fossil fuel operations has the most potential for major [methane emissions] reductions in the near term".[40] Globally, the IEA estimates that 75% of methane emissions reductions from the fossil fuel sector are required by 2030 to limit global warming to 1.5°C.[41] It estimates that two-thirds of global fossil fuel methane emissions could be abated through the deployment of readily available technologies, "often at low – or even negative – cost".[42,43]

Independent analysis of feasible methane abatement in Australia's energy sector by Rystad Energy had similar results, estimating that 65% of methane emission reductions are possible by utilising existing abatement technologies in the oil and gas and coalmining sectors (based on government-reported methane emissions data).[44] Rystad also found that these abatement actions would cost less than A$30/t$CO_2$e, with the majority of methane reductions coming at a net financial benefit in the oil and gas sector, given that the captured methane can be sold. Captured methane can also often be used locally or sold in coalmining, which decreases the net costs of implementing actions, and in some cases could present net economic benefits.

Using assumed underreporting estimates, IEEFA analysis finds that approximately 59% of coalmine methane emissions could be abated using existing technology, leading to an overall potential reduction of fossil fuel methane of 67% (Figure 7).

[39] DISR. Resources and Energy Quarterly September 2024. 30 September 2024. Page 49.
[40] IEA. Methane Abatement. Last updated 25 April 2024, accessed 20 Nov 2024.
[41] IEA. Global methane tracker 2024. Section 4.0 Methane emissions in a 1.5°C pathway. March 2024.
[42] IEA. World Energy Outlook 2024. October 2024. Page 234.
[43] IEA. Methane Abatement. Last updated 25 April 2024, accessed 20 Nov 2024.
[44] Rystad Energy. Methane Tracking Technologies Study, Final Report Public Version. 18 October 2023.

Figure 7: Fossil fuel fugitive methane emissions abatement potential, Australia



Sources: Australian government, IEEFA, Rystad. Note. Assumes only maximum 40% efficacy of pre-drainage could occur across all surface mines. Emissions are based on Climate TRACE estimates

3.2 Underground coalmines can lead the way in abatement

Methane has long been a hazard to underground coalmine operators, and has required pre-drainage activities to ensure worker safety and to prevent explosions or fires.[45] However, there is room for underground coalmines to increase the amount of methane captured during pre-drainage activities.

Pre-drainage is typically estimated to capture between 20% and 60% of coal seam methane. However, CSIRO helped develop a methane capture system with a Glencore Hunter Valley mine that increased methane drainage efficiency from 60% to 80%.[46] Multiple studies are targeting the ability for pre-drainage at coal seams that have lower permeability, meaning methane is released slower.[47,48] Improving borehole sealing performance can also improve methane capture efficiency, and reduce fugitive emissions.[49]

After underground mines conduct methane pre-drainage, coal seams continue to release methane during the mining process. This means underground coalmines are required to ventilate the air from within the mine for a range of reasons, including safety. If there are no abatement measures in place, this ventilation air methane (VAM) is released into the atmosphere. VAM generally contains low

[45] International Journal of Coal Geology. A survey of the microbial populations in some Australian coalbed methane reservoirs. 2 October 2008. Pages 14-24.
[46] CSIRO. Mine methane capture technologies. 13 January 2021.
[47] International Journal of Mining Science and Technology. A case study of gas drainage to low permeability coal seam. July 2017.
[48] Energy Science & Engineering. An improved method for high-efficiency coal mine methane drainage: Theoretical analysis and field verification. 9 October 2018.
[49] Coal Science Technology. Analysis on major borehole sealing methods of mine gas drainage boreholes. 2014.

concentrations of methane, but due to the sheer volumes of VAM vented from underground mines, it accounts for approximately 70%-80% of their Scope 1 emissions.[50]

While spending longer to capture greater volumes of methane via pre-drainage could delay production at underground mines, it can also present economic benefits by reducing operating costs over the long run. This is because the power consumed by ventilation systems can be among the highest operational expenses at underground mines, and the more methane captured during pre-drainage, the lower the volumes of methane expected in the shaft during mining.[51] This has additional safety benefits to mine workers by reducing risks of fire or outbursts. Underground coalmines in Australia also implement methane post-drainage, commonly known as "goaf drainage", and there is potential to increase the amount of methane drained after mining.

Mature technologies could be applied to abate most fugitive emissions from underground coalmines:

- **Abating VAM.** Established technologies allow low-concentration VAM to be either combusted or used for heat or power generation. Regenerative thermal oxidisers (RTOs) are one form of VAM abatement, and are a mature, safe technology that can combust methane at low concentrations. RTOs have been demonstrated and implemented in coalmines in China and the US since the early 2000s.[52] Australian governments are funding Australia's first full-scale RTO project at the Kestrel underground metallurgical coalmine in the Bowen Basin in Queensland. New technologies are also being developed that allow VAM to be concentrated, or abated at even lower concentrations, which would further increase the amount of VAM that can be abated, and enable it to be utilised instead of combusted.[53,54] China is a global leader in VAM abatement with 13 operational projects,[55] and it proposes to make it mandatory for underground coalmines to "process coalmine gas with a concentration of 8% or less and ventilation air methane using flameless oxidation technology to produce heat for power generation".[56]

- **Leak detection and repair (LDAR) and rerouting.** Simple improvements to existing technology and plugging leaks can reduce emissions from an underground coalmine. Refining gas drainage borehole and placement design, optimising suction and purity control, and enhancing water management in pipelines at underground coalmines can help reduce methane gas leaking into the atmosphere. These upgrades can be made in a relatively short

[50] US Environmental Protection Agency. Sources of Coal Mine Methane. 27 August 2024.
[51] UNECE. Best Practice Guidance for Effective Methane Drainage and Use in Coal Mines. 2010. Page xiv.
[52] UNECE. Best Practice Guidance for Effective Methane Drainage and Use in Coal Mines, Second Edition. December 2016. Page 63.
[53] CSIRO. Ventilation air methane abatement. 2 April 2021.
[54] CSIRO. VAMMIT trials: tackling methane emissions in mining. 25 October 2024.
[55] Global Methane Initiative. International Coal Mine Methane Project List. Last updated 2 August 2024.
[56] Institute For Governance & Sustainable Development (IGSD). China proposed strengthened regulatory action and additional market measures to mitigate coal mine methane emissions. 30 July 2024.

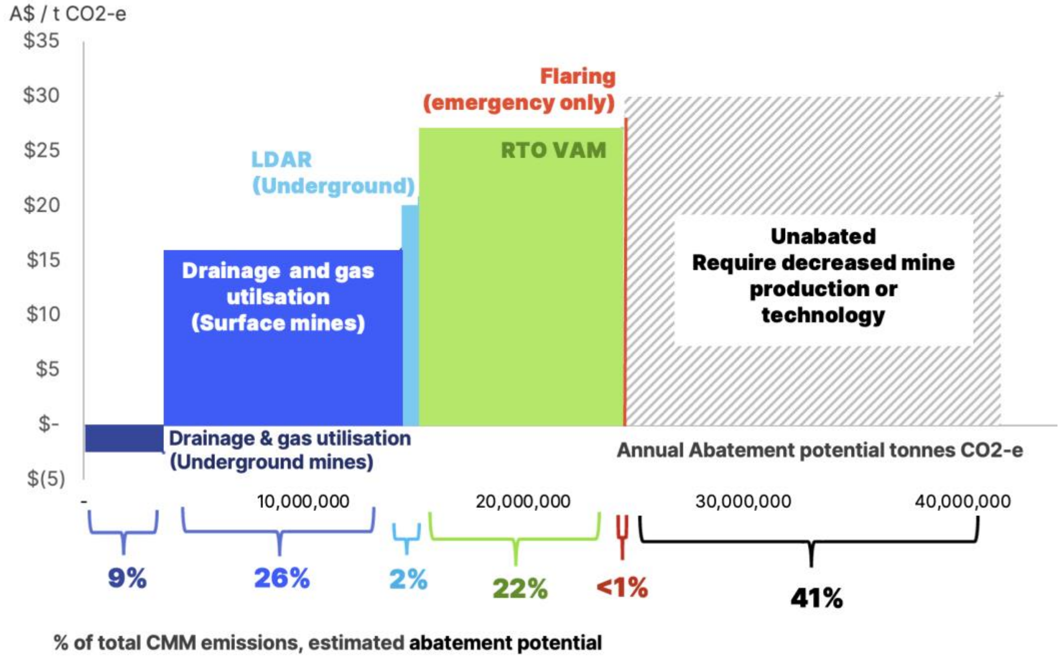
timeframe – within a year – at a low net cost. The reduction potential per mine from these improvements could be 3%-10% of methane emissions.

- **Utilising the methane captured through pre- and post-drainage.** Most methane captured during pre- and post-drainage is flared, which materially reduces its emissions by turning it into CO_2. Flaring 1 cubic metre of gas, assuming 98% methane concentration, still results in about 2.6 kilograms of CO_2e emissions.[57] Additionally, flaring is not 100% effective at combusting methane. Under the IEA's Net Zero Emissions (NZE) scenario, all non-emergency flaring would need to be eliminated globally by 2030.[58] Instead, utilising the methane can displace other gas use, and generate revenues or reduce costs for coalminers. Glencore's Oaky Creek, Integra and Bulga coalmine operations send methane captured from pre-drainage to specially designed power plants that utilise the methane to generate electricity, reducing their grid electricity purchases.[59] Anglo American provides gas from its underground coalmines in Queensland to adjacent power stations operated by EDL.[60] Utilising the methane captured is particularly valuable in the context of the tight domestic gas supply expected in Eastern Australia in coming years.[61] (For a full list of coalmine methane projects in Australia, see Appendix B.)

- **Enhancing methane capture post-closure.** The methane capture and recovery technologies discussed above can continue even after mining ceases. Examples of this exist in other countries. In 2015, the US captured and utilised about 5.3 billion cubic feet of methane (about 5.6 petajoules/PJ) from 40 abandoned coalmines.[62] These projects are seen as a way to "stimulate economic development in communities affected by coalmine closures".[63] In Germany, more than 100 cogeneration plants were installed on coalmines during mining, and many are still operating, fuelled by the abandoned mine methane.[64] However, the continued operation of these plants depends on the coal-seam gas reservoir, rate of decline, and ongoing mine dewatering activities.

[57] World Bank. Gas flaring explained. Accessed 7 November 2024.
[58] IEA. Tracking Clean Energy Progress 2023. Gas Flaring. July 2023.
[59] Glencore. Fact sheet methane emissions. 6 July 2022.
[60] Anglo American. Anglo American Interim Results 2024. 25 July 2024.
[61] AEMO. Gas market outlook signals need for new investment. 21 March 2024.
[62] US Environmental Protection Agency. Abandoned Coal Mine Methane Opportunities Database. July 2017. Page 1.
[63] Berkeley Lab. Abandoned coal mines methane reduction. Lessons from the United States. October 2023. Page 3.
[64] UNECE. Best practice guidance for effective management of coal mine methane at national level: monitoring, reporting, verification and mitigation. 2021. Page 38.

Figure 8: Methane marginal abatement cost curve (MACC), Australian coalmine sector



Sources: Rystad; National Inventory data adjusted to IEEFA stated assumptions of underreporting. Notes: Combined underground and open-cut mines have been integrated into surface and underground abatement totals and assumptions at a 50% split. MACC assessment is based on a high-level analysis. Rystad notes regarding pricing assumptions: Project costs and technical viability of abatement technology deployment vary heavily site to site; Volumes considers respective abatement efficiency for each technology option; excludes combustion-related emissions. Utilisation costs modelled for large underground met coalmine, gas assumed to be sold at 30% discount to 2018-23 YTD wholesale gas prices, with additional pre-drainage costs for surface mines. Seal and reroute costs based on interview findings for sealing and pressure balancing operation for large underground met coalmine, no gas sale assumption. RTO costs outlined based on commercial technology prices for 10-year RTO system for VAM emissions alongside industry interview figures. Flaring assumed to be enclosed.

All these solutions are estimated to cost below A$30/tCO2e, with increased gas utilisation having a net financial benefit due to the potential to reduce costs or generate revenues. The average net cost translates to about A$1/t coal across the industry, or about 0.5% of recent revenue levels.[65] Additionally, if underground miners increased the volume of methane captured via pre-drainage, the methane marginal abatement cost curve (MACC, Figure 8) would likely change to show a larger volume of methane abatement via pre-drainage. This could translate into lower volumes of methane being emitted as VAM from underground mines, reducing their overall net costs of methane abatement.

(For a list of companies operating or offering methane abatement technologies for coalminers, see Appendix C.)

[65] Based on Rystad cost estimates, compared with production and revenue figures from DISR, Resources and energy quarterly: September 2024.

Box 2: More information needed on abandoned mine methane in Australia

When mining stops, a mine continues to emit lower levels of methane, potentially quite steadily and for an extended time.[66] Abandoned and closed coalmines and mines under care and maintenance are not required to report methane emissions, because methane estimation techniques are calculated based on coal production. In Australia, coalmines can remain in a care and maintenance status for decades, limited only by the term of the mining licence. The Australian government estimates abandoned mines across Australia emitted 35,000 tonnes of methane in 2019, but the data carries significant underreporting risks.[67] A June 2024 report estimated that abandoned mine methane emissions in the EU totalled 200,000 tonnes of CH_4, or 5.6MtCO_2e a year.[68,69] In the US, abandoned coalmines were estimated to emit 12.5% of the country's coalmine methane emissions in 2021.[70] Additionally, a 2021 report found that while Glencore's Ravensworth underground coalmine was in care and maintenance from 2014 to 2020 – and not subject to reporting annual methane emissions – it released the equivalent of more than 1MtCO_2 during that time.[71]

The myth that filling coalmines with water will stop methane emissions. The United Nations Environment Programme guidelines continue to recommend flooding abandoned coalmines to reduce methane emissions.[72] Filling coalmines with water does not entirely stop methane emissions from the site, and can produce a range of additional risks, as outlined in IEEFA's previous analysis on mine voids.[73] An increasing body of research has also found that flooding or letting open-cut or underground coalmines fill with water can become an ongoing source of methane emissions indefinitely.[74,75,76]

[66] US Environmental Protection Agency. Abandoned Coal Mine Methane Opportunities Database. Page 1.
[67] Ember. Tackling Australia's Coal Mine Methane Problem. 8 June 2022.
[68] Global Energy Monitor. The hidden threat, Abandoned coal mine methane emissions in the EU. June 2024. Page 1.
[69] Using a GWP figure of 28 over a 100-year time horizon.
[70] Berkeley Lab. Abandoned coal mines methane reduction. Lessons from the United States. October 2023. Page 3.
[71] Australian Conservation Foundation. Methane: Creating a stink for Australia and the climate crisis. August 2021. Page 12.
[72] United Nations Environment Programme & Climate & Clean Air Coalition. Global Methane Assessment: Benefits and costs of mitigating methane emissions. 2021. Page 16.
[73] IEEFA. Filling the voids: Pumped hydro proposals could see taxpayers financing mine rehabilitation. 8 August 2024.
[74] BioScience. Greenhouse gas emissions from reservoir water surfaces: A new global synthesis. 1 November 2016.
[75] European Geosciences Union. Methane emissions due to reservoir flushing: a significant emission pathway. 4 October 2023.
[76] Banpu Energy Australia. Underground pumped hydro energy storage project: Final Report. 1 July 2022. Page 33.

3.3 Pre-drainage only a partial solution for open-cut mines

At open-cut mines, methane is released from the main coal seam being mined, as well as from the overlying seams as overburden and coal is removed. The amount and rate of methane emissions from an open-cut mine are determined by the gas composition and the permeability of the coal seams, and are strongly influenced by the rate of mining.[77]

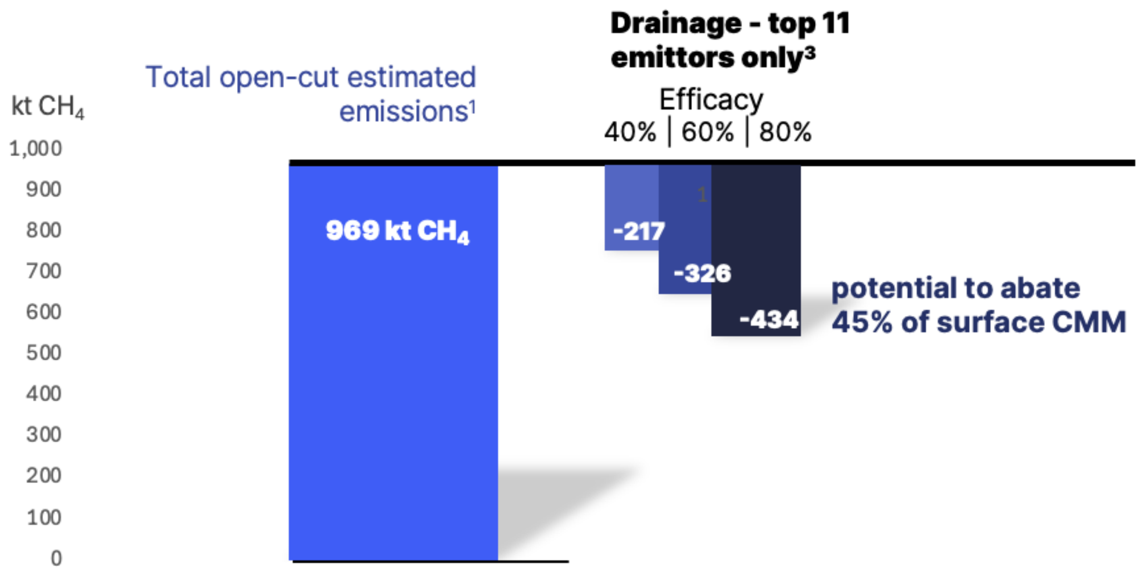
Methane pre-drainage from surface coalmines involves capturing methane via boreholes either from within the mining pit or from the surface. Despite widespread methane pre-drainage at underground mines, surface mine operators maintain that the technology is too difficult or too expensive to employ. Pre-drainage often does not occur because it can affect mining operations, as well as due to challenges encountered operating against an open-cut high wall.[78] Pre-drainage of methane, while most effective at removing methane, requires adequate (years) of planning, gas testing and trials, and actual drainage before mining the affected area. However, there are options to conduct some methane drainage between periods of mining or during mining operations. Additionally, the pre-feasibility study report for pre-drainage at the surface Hunter Valley Operations mine asserted that the Safeguard Mechanism is incentivising consideration of pre-drainage at open-cut mines,[79] however more needs to be done to encourage action.

Overall, Rystad estimates that drainage and gas utilisation in open-cut mines costs about A$15/t$CO_2$e on average, net of methane sales revenues and/or utilisation benefits. Emerging examples in Queensland suggest methane drainage at surface mines is possible, and under certain conditions could be financially viable. Coronado Resources has implemented a trial of a methane pre-drainage system at its Curragh mine, using the methane to displace some diesel used in its truck fleet.[80] Stanmore Resources has received government funding to capture methane for at least 15 years to power a new 20 megawatt gas-fired power station to be completed by 2027. That power station will offset Stanmore's South Walker Creek mine's entire electricity requirements.[81]

Given the variable methane intensity of open-cut mines, higher-emitting mines could be prioritised. Based on Safeguard Mechanism and Climate TRACE data, the 11 highest-emitting open-cut coalmines in Australia contribute more than half of the total methane emissions from open-cut mines.[82,83] Targeting these mines first could result in abatement of up to 45% of coalmine methane emissions, depending on drainage effectiveness. These mines could also present a better financial case for pre-drainage due to the higher volume and therefore value of the methane captured.

[77] University of Wollongong. Reduction of fugitive methane emissions from open cut coal mines. February 2023. Page 129.
[78] Ibid.
[79] CoalBed Energy. Feasibility of Pre-drainage Capture for Hunter Valley Operations, 6 November 2023. Page 7.
[80] Coronado Global. Gas pilot project at Curragh complex. Accessed 8 November 2024.
[81] Mining Magazine. Funding secured for coal seam methane project. 27 August 2024.
[82] Climate TRACE. Data Downloads. November 2024.
[83] Clean Energy Regulator. Safeguard facility reported emissions data 2022-23. 21 November 2024.

Figure 9: Abatement potential from methane drainage at surface coalmines



Sources: Climate TRACE, Data Downloads; IEEFA analysis. Notes: 1. Current estimation based on National Inventory report methane emissions for 2022, adjusted based on IEEFA's stated underreporting for open-cut coalmines of 3x. 2. Range of reduction potential differs based on efficacy of drainage process, which is estimated to be between 20-80% but ultimately will be site and technology specific. 3. Top 11 open-cut coalmine methane emitters are identified based on Climate TRACE data, and are subject to error. The selected sites include the Mt Thorley Warkworth, Lake Vermont, Curragh, Maules Creek, Loy Yang, Goonyella-Riverside, Mt Owen, Mt Arthur, Rolleston, Blackwater and Wilpinjong coalmines.

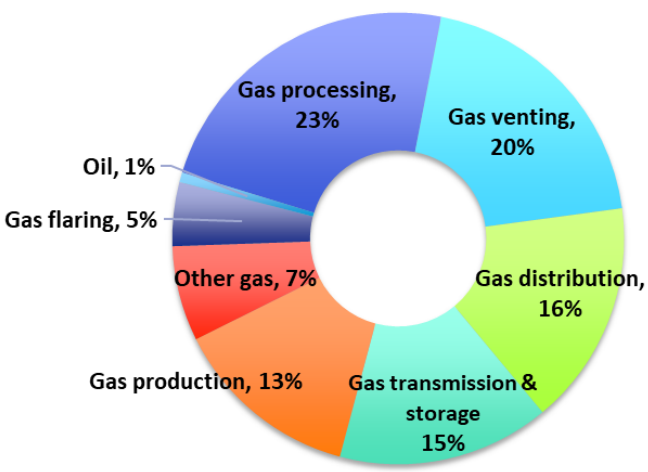
Reducing production is the only method that allows for a 100% reduction in methane emissions from coalmining, especially open-cut mines. The IEA estimates global coal production will reduce by about 30% or 50% by 2035 in scenarios aligned with 2.4°C and 1.7°C of global warming respectively.[84] Australia's coal production would follow similar trends.[85] IEEFA has raised questions about the economic case for multiple mine expansions in progress, which are unlikely to be profitable.[86] The United Nations Economic Commission for Europe (UNECE) found that ultimately the largest reduction of lifecycle coalmine methane emissions can only be achieved by closing mines.[87] In its sectoral pathway analysis, the CCA includes fossil fuel production reductions in both of its scenarios.[88]

[84] IEA. World Energy Outlook 2024. October 2024. Page 151.
[85] Ibid. Free Dataset.
[86] IEEFA. New coalmines could deliver zero royalties and a methane headache for Queensland. 5 April 2024.
[87] UNECE. Best practice guidance for effective management of coal mine methane at national level: monitoring, reporting, verification and mitigation. 2021. Page 37.
[88] CCA. Sector pathways review. 2024. Page 119.

3.4 Monetising oil and gas methane abatement

In the oil, gas and LNG sectors, fugitive methane emissions can arise throughout the supply chain. This can include emissions stemming from flaring or venting activities, but may also include "routine methane losses from innumerable small, undetected or unreported leaks across the … gas value chain".[89] About two-thirds of fugitive methane emissions are generated in gas production, and about one-third is generated in the transmission, distribution and storage of gas. Gas exploration and decommissioning activities can also generate fugitive methane emissions.

Figure 10: Reported methane emissions by oil and gas activity, 2022



Source: DCCEEW[90]

As mentioned earlier, national inventory figures are likely to be materially underreported. International evidence suggests that methane emissions are prevalent throughout the gas and LNG production and supply process.[91] For example, it is estimated that upstream and midstream fugitive methane emissions could equal up to 2.8% of US gas production, and losses during LNG liquefaction could amount to 3.5 grams of methane per kilogram of LNG. Transporting LNG contributes further to methane emissions, both through LNG boil-off and incomplete combustion in LNG tankers powered by gas engines.

In light of the above, methane abatement in the oil and gas sectors relates to ending the use of flaring and venting, and identifying and addressing methane leaks from oil, gas and LNG

[89] Wood Mackenzie. Mission invisible: Tackling the oil and gas industry's methane challenge. November 2023.
[90] DCCEEW. Australia's National Greenhouse Accounts: Emissions Projections. Accessed 25 November 2024.
[91] Energy Science & Engineering. The greenhouse gas footprint of liquefied natural gas (LNG) exported from the United States. October 2024.

equipment.[92] In practice, a range of existing technologies can readily be utilised to abate methane emissions from oil and gas, including:

- Leak detection and repair regimes to identify and address methane leaks from oil, gas and LNG equipment, such as pumps and compressors.
- Replacing high-loss equipment (that emits methane) with upgraded equipment, including electric equipment (that does not vent methane) and air compressor systems (rather than gas-driven pneumatic systems).
- Recovery of methane vapour that might otherwise be vented, such as from storage tanks (and methane that has 'boiled off' during the transport of LNG).
- Deploying electricity-powered equipment.[93]

In Australia, the oil and gas industry body, the Australian Energy Producers (AEP – formerly the Australian Petroleum Production and Exploration Association), noted the availability of suitable technologies to abate methane emissions, and highlighted a number of case studies that clearly demonstrate the potential for Australia's oil and gas sectors to reduce their methane emissions.[94] Rystad has similarly noted this potential, suggesting that the adoption of existing technologies would facilitate a 90% reduction in Australia's oil and gas methane emissions.

These technologies are in many cases also cost-effective, due primarily to the value associated with selling the additional methane captured. Oil and gas producers may also benefit if measures to lower their methane emissions also reduce their regulatory costs (noting that methane emissions contribute towards reportable emissions under Australia's Safeguard Mechanism).

In a global context, the IEA estimates about two-thirds of oil and gas methane emissions could be abated at zero cost (assuming average gas prices in line with those between 2017 and 2021).[95] The remaining interventions are likely to cost less than US$20/t$CO_2$e.

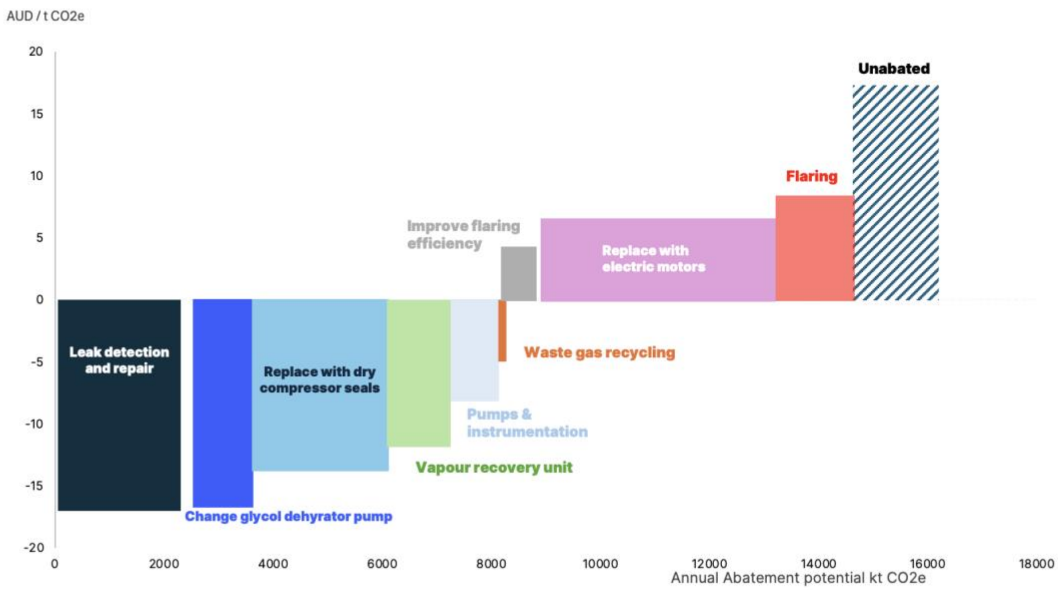
This is similar to estimates for Australia. For example, Rystad estimates that more than half of Australia's oil and gas fugitive methane emissions could be abated at a negative cost (assuming the methane that is captured is sold at 2021 average Western Australia (WA) LNG netback prices). Rystad further estimates that up to 90% of methane emissions could be abated at a maximum cost of less than about A$250/tonne CH_4, which equates to a cost of about A$4.50 per gigajoule. This is much lower than the typical cost of gas in Australia. In addition, this is equivalent to about A$8.40/t$CO_2$e (assuming a GWP of 29.8), which will be cost-effective if oil and gas producers are required to offset the emissions through the surrender of carbon credits – in Australia, ACCUs are trading about A$39/t$CO_2$e.[96] While some measures are relatively more expensive, implementing all

[92] IEA. Curtailing Methane Emissions from Fossil Fuel Operations. October 2021. Page 24.
[93] Wood Mackenzie. Mission invisible: Tackling the oil and gas industry's methane challenge. November 2023.
[94] AEP. Australia's cleaner energy future. October 2022. Pages 4-5.
[95] IEA. Marginal abatement cost curve for methane from oil and natural gas operations, 2023. March 2024.
[96] Core Markets. Carbon and renewable energy market prices. Accessed 4 November 2011.

existing and available options for methane abatement in the oil and gas sectors is likely to have an effective negative cost overall.

The costs could be even lower when accounting for the likely scale of underreporting. Many of the interventions to reduce methane emissions in oil and gas production rely on equipment upgrades, with the costs the same regardless of how much additional methane is captured. In practical terms, this means that to the extent that methane abatement captures more methane than anticipated (due to the underreporting of fugitive methane emissions), the costs may be even lower per unit of methane than estimated by Rystad.

Figure 11: MACC, Australian oil and gas sector



Source: Rystad Energy.[97] Notes: Rystad's estimated marginal abatement cost curves reflect its analysis of abatement technologies. Rystad notes that particular abatement technologies, such as replacing compressor seals, may have different costs for a given level of abatement. For example, Rystad notes that replacing compressor seals will have a cost between negative A$390 and A$460 per tonne of CH_4 captured. Given data limitations, we have modelled each technology with a single cost estimate based on the most conservative estimate. Specifically, we have used the highest cost estimate for each technology.

However, despite the strong financial case for methane abatement, the oil and gas sectors in Australia, and globally, continue to emit large volumes of methane. Governments are taking steps to improve methane emissions measurement. The European Union's Methane Regulation, announced on 27 May 2024, states that the oil and gas industry will have to measure, monitor, report and verify methane emissions according to the highest monitoring standards.[98] This standard was developed by the Oil and Gas Methane Partnership 2.0 (OGMP 2.0) – the United Nations Environment

[97] Rystad Energy. Methane Tracking Technologies Study: Final Report. October 2023. Pages 30-32.
[98] European Commission. New EU Methane Regulation to reduce harmful emissions from fossil fuels in Europe and abroad. 27 May 2024

Programme's flagship oil and gas reporting and mitigation scheme.[99] Under the US Inflation Reduction Act legislation passed in August 2022, the US requires oil and gas companies to conduct empirical methane emissions measurement within two years.[100]

Box 3. Reducing gas production and use can deliver multiple economic benefits

Another way to reduce methane emissions is to reduce the production and use of gas in Australia. Most of Australia's gas production is exported as LNG, primarily to LNG buyers in Asia.[101] A practical consequence of this is that a large portion of Australia's methane emissions arise due to Australia's LNG production and export. However, LNG markets face an uncertain future. A massive wave of new supply is set to enter LNG markets in coming years, outstripping demand growth and driving down LNG prices.

The impending supply glut will have two likely consequences. The first is that there will be no need for any additional LNG capacity for at least the next decade. The IEA's latest World Energy Outlook forecast that even under a 2.4°C scenario, there will be no need for any additional LNG capacity (above existing and under construction capacity) until 2040 at the earliest.[102]

The second is that LNG industry financial returns are likely to suffer due to lower prices caused by more intense competition between sellers, and by demand shifting to more price-sensitive markets.[103] The IEA estimates that generating large volumes of new demand would "need prices at around USD3-5/MBtu [million British thermal units] to make gas attractive as a large-scale alternative to renewables and coal, but delivered costs for most new export projects need to average around USD8/MBtu to cover their investments and operation".[104]

These returns could suffer further if new LNG or LNG backfill projects (beyond those under construction) reach final investment decision and add to the glut of new LNG supply. In Australia, any new gas field developments intended for export could add to our methane emissions inventory while placing further downward pressure on LNG prices. This would therefore depress returns across the remainder of Australia's LNG industry (which will likely be increasingly exposed to LNG spot markets as existing LNG contracts expire).[105]

In Australia's domestic gas markets, there are opportunities reduce gas demand while generating other economic benefits. For example, IEEFA modelled a number of residential and industry electrification and energy efficiency interventions, and found that these interventions would lower

[99] United Nations Environment Programme. The Oil & Gas Methane Partnership 2.0 (OGMP 2.0).
[100] US Environment Protection Agency. Fact Sheet Proposed Rule.
[101] IEEFA. The future of Australian LNG. June 2024. Page 9.
[102] IEA. World Energy Outlook 2024. October 2024. Page 51.
[103] IEEFA. The future of Australian LNG. June 2024. Page 29.
[104] IEA. World Energy Outlook 2024. October 2024. Page 19.
[105] IEEFA. The future of Australian LNG. June 2024. Page 26.

energy bills while reducing gas demand enough to avoid the possibility of supply gaps (including on peak gas demand days).[106,107]

3.5 Fugitive methane's value in a tightening gas market

Reducing fugitive methane emissions could also improve domestic supply outlooks (provided this additional gas were supplied to the domestic market). S&P Global Commodity Insights estimated that by reducing venting, flaring and leaks in Australia's oil and gas sector, companies could profitably capture and bring to market an additional 2 billion cubic metres, or about 80PJ, of gas annually.[108,109]

In 2022, reported fugitive methane emissions from oil and gas production, transmission and use equated to about 15PJ, which could increase to about 30PJ given the likely magnitude of underreporting in Australia. To put this into context, this equates to about 45%-91% of the 33PJ of gas anticipated to be required for power generation in the National Electricity Market in 2025 (noting that the Australian Competition and Consumer Commission's estimate is well below historical levels of gas consumption for electricity generation).[110]

IEEFA estimates that if oil and gas producers had abated 90% of reported fugitive methane emissions, they could have increased their revenue by as much as A$189 million, assuming this was sold into LNG markets.[111] Accounting for the potential scope of underreporting means the forgone revenue is equivalent to A$308 million on the domestic market, or up to A$378 million on the LNG markets (Table 1).

Fugitive methane emissions from coalmining would, if captured and utilised, further increase gas supply or reduce gas demand (though as noted elsewhere in this report, monetising methane from coal mines can be more difficult in practice, particularly where there is little existing infrastructure). Our analysis suggests that utilising available methane abatement technologies at coalmines could capture almost 49PJ of additional methane, which could potentially be sold into domestic gas markets or used for other purposes (such as electricity generation at coal mines). Using domestic gas prices from 2024 as a proxy for the value of this methane, we estimate that abatement could have a value to coalminers as high as A$643 million. This adds up to a total equivalent value of captured fugitive methane of A$951 million.

[106] IEEFA. Reducing demand: A better way to bridge the gas supply gap. November 2023. Page 6.
[107] IEEFA. No shortage of solutions to gas supply gap. April 2024. Page 5.
[108] S&P Global Commodity Insights. Levers for capturing methane emissions to improve gas availability. December 2022. Page 5.
[109] DCCEEW. National Greenhouse and Energy Reporting (NGER) Scheme – 2024 proposed updates. Submission from the Environmental Defense Fund. Page 13.
[110] ACCC. Gas Inquiry 2017-30 June 2024 interim report. June 2024. Page 20.
[111] Based on 2021 prices, before Russia expanded its invasion of Ukraine.

Table 1: Lost value from estimated fugitive methane emissions (2024 prices)

Oil and gas sector	Potential methane capture (PJ)	Domestic market forgone revenue (A$M)	LNG markets forgone revenue (A$M, 2024)
Total potential to capture methane	26.90	308	378
Coalmining sector	**Potential methane capture/use (PJ)**	**Equivalent value (A$M)**	
Underground mines			
Drainage & LDAR	8.9	115	
VAM abatement	18.9	245	
Open-cut mine drainage	21.6	282	
Coalmines total	*48.8*	*643*	
Oil and gas + coal total	*75.7*	*951*	

For underground and open-cut coalminers looking to sell captured methane after drainage, their ability to do so will depend on the effective utilisation of the gas production profile. Typically, a nonlinear flow of gas is available for use. This makes capacity sizing for end use difficult due to factors such as determining the number of power generation units to employ. The methane concentration captured during the drainage process also varies, and the gas production volumes tend to form peaks and troughs, which in practice can present a challenge for effective methane abatement and for the business case for selling.

This increased gas supply could place downward pressure on domestic gas prices while helping to ensure industries reliant on gas are able to secure firm gas supply, which has been an issue for some gas users.

4. Policies ineffective at driving action

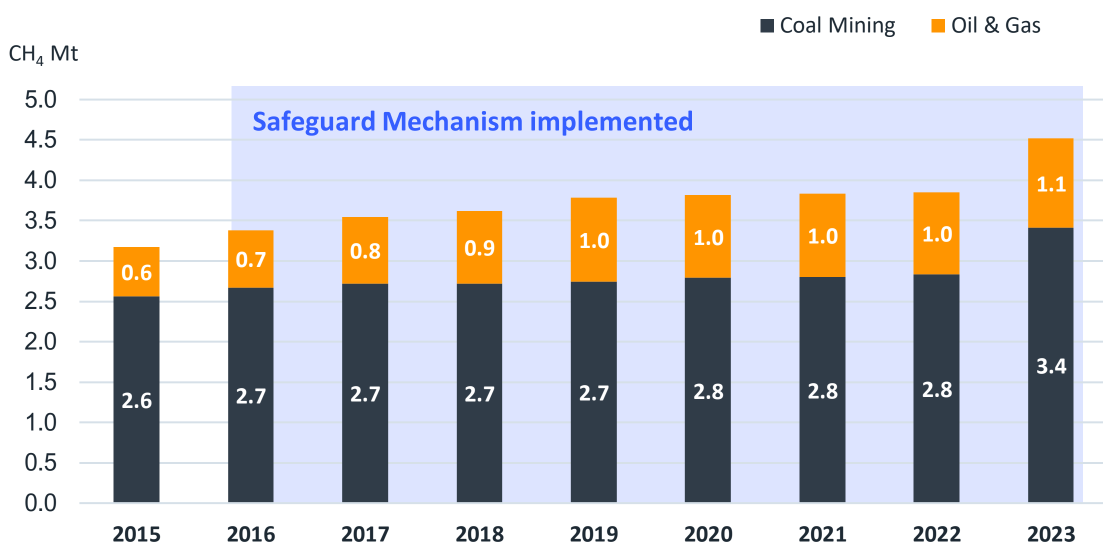
4.1 Safeguard has negligible impact on methane emissions

Australia's policy approaches to address GHG emissions do not appear to have had any material impact on reducing methane emissions from the coalmining and gas sectors. The Australian government's Safeguard Mechanism is the primary mechanism for Australia to reduce fugitive energy GHG methane emissions.[112] According to both Climate TRACE and IEA data, methane emissions from the coalmining and gas sectors in Australia have risen since 2015 despite the

[112] DCCEEW. Safeguard Mechanism. 17 October 2024.

Safeguard Mechanism commencing in 2016.[113,114] Additionally, DCCEEW projections show that methane emissions are not expected to decline by 2030.[115]

Figure 12: Australian coalmine and gas methane emissions, 2015-2023



Sources: Climate TRACE, IEEFA analysis

The latest Safeguard Mechanism reforms will be implemented from FY2024-25, so their impact will not be shown in the data in Figure 12. Although the reforms will help increase transparency in reporting by requiring facilities to report on methane and CO_2 separately, the reforms themselves will not improve the ability of the Safeguard Mechanism to support decarbonisation efforts if the underreporting issue is not fixed.

4.2 Shortcomings limit Safeguard Mechanism's effectiveness

Issues with **emissions measurements** and the Safeguard Mechanism reduce the incentive for facilities to reduce methane emissions:

- **Baselines have increased for coalmines.** Under the Safeguard Mechanism, Australia's largest industrial facilities – those emitting more than 100,000tCO_2e a year – are subject to "emission baselines", which are intended to cap the level of emissions permitted per facility each year. These baselines are designed to decrease each year to 2030 (generally by 4.9%pa), which in turn requires facility operators to implement measures to reduce their

[113] IEA. Methane Tracker. 2024.
[114] Climate TRACE. Data Downloads. 2024.
[115] DCCEEW. Australia's National Greenhouse Accounts. Emissions projections. November 2023.

emissions.[116] However, IEEFA's analysis has found that the baselines for 28 coalmine sites have been readjusted upwards under the Safeguard Mechanism to the extent that, in aggregate, the baselines from coalmining safeguard facilities actually increased by 261,475tCO_2e from FY2016-17 to FY2022-23. In comparison, the aggregate change in baselines of all other safeguard facilities (excluding coalmines and oil and gas facilities) was a reduction of almost 7MtCO_2e in the same period.[117]

- **Baselines do not require emissions reductions for major coalmines.** A 2023 review by Energy & Resource Insights found that six of the top 10 coalmines in Australia – the major open-cut coalmines – have no effective emissions limits under the scheme. Instead, they will be allowed to increase their emissions due to increasing baselines.[118]

- **Underreporting means safeguard facilities' coverage is inaccurate**. IEEFA's analysis based on Climate TRACE data found that due to the underreporting of methane emissions, up to 23 coalmines should have reported under the Safeguard Mechanism in FY2022-23 but didn't (Figure 13).

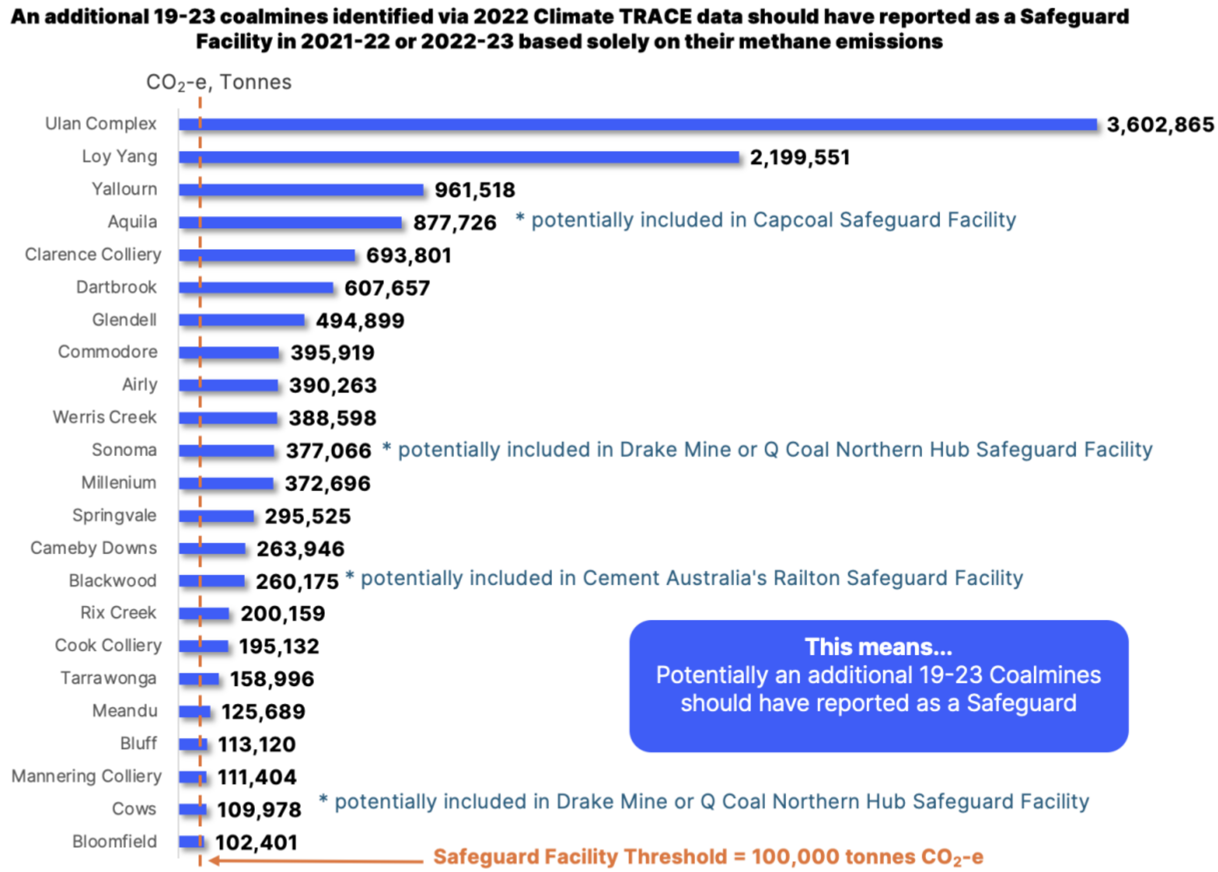
- **Underreporting means baselines and reduction rates are inappropriate**. The scope of underreporting means baselines set under the Safeguard Mechanism are not likely to reflect the actual scale of decarbonisation required. IEEFA analysis has found that, based on IEA methane estimates, the FY2020-21 baseline should actually be about 24MtCO_2e higher, which in turn would require major emitters to lower their emissions twice as quickly by 2030.[119]

- **Measurement methods remove incentive to act.** Under lower methane measurement methods, coal methane emissions are calculated using a fixed emissions intensity factor multiplied by coal production, which means that efforts to reduce the emissions intensity of mining will not result in any official emissions reductions. This issue will not necessarily be addressed by the government's agreement to phase out Method 1 for methane emissions estimates in coalmines if Method 2 remains and Method 3 is not reviewed. Reporting of open-cut coalmines under Method 2 still poses multiple levels of risk for methane emissions underreporting to occur, with the potential for it to worsen.

- **Unlimited access to carbon offsets.** The ability to meet Safeguard Mechanism liabilities through carbon offsets can reduce the incentive to implement emissions reduction actions, even if they come at a similar cost, due to the lower effort and capital requirement.

[116] DCCEEW. Safeguard Mechanism.
[117] IEEFA analysis, based on Clean Energy Regulator. Safeguard facility reported emissions data. 16 May 2024.
[118] Energy & Resources Insights. Money for nothing: Australia coal mines under the reformed safeguard mechanism. October 2023.
[119] IEEFA. Gross under-reporting of fugitive methane missions has big implications for industry. 5 July 2023. Page 4.

Figure 13: Potential additional coalmines the Safeguard Mechanism should cover



Source: Clean Energy Regulator, Climate TRACE, IEEFA

4.3 Carbon credits rarely used to incentivise methane capture

The Australian Carbon Credit Unit (ACCU) scheme also enables some methane abatement projects to generate carbon credits.

Safeguard facilities that reduce their emissions below the annual required reductions can earn Safeguard Mechanism Credit (SMC) units, which can be traded with other safeguard facilities that have not been able to reduce their GHG emissions below the required amount.

A list of Australia's reported coalmine methane abatement projects was issued in 2024 by the Global Methane Initiative. Although Australia has 31 planned or operational methane abatement projects at coalmines, only 12 are generating carbon credits for flaring or power generation, and no Ventilation Air Methane projects are part of the ACCU scheme. A review of operational Australian projects on the list reveals that most were started in the early 2000s and have declined in recent years.[120] This

[120] Global Methane Initiative. International Coal Mine Methane Project List. 2 August 2024.

suggests that the commercial environment in Australia for the abatement of coalmine waste gas is not attracting new investment, in the absence of government funding assistance, whether carbon credits are being earned or not. This also highlights that the ACCU and SMC schemes are not incentivising VAM abatement at underground coalmines. (For a list of methane abatement projects, see Appendix B.)

4.4 Financial incentives insufficient to drive company action

We have discussed a number of financial incentives available to drive methane emissions reductions, including the potential revenue available for oil and gas companies, carbon credits and avoidance of Safeguard Mechanism compliance costs. However, the evidence shows that these are not sufficient to drive action.

In IEEFA's opinion, the lack of clarity for companies over their actual methane emissions could make it harder for them to develop a business case for implementing methane abatement technologies. In oil and gas, a lack of effective methane monitoring means companies are generally unlikely to have a clear idea of their methane emissions, and therefore the financial case for implementing methane abatement technologies.[121] The use of methane emission factors, rather than direct measurement, to calculate methane emissions under the National Greenhouse and Energy Reporting (NGER) framework likely compounds this issue for Australian coal, oil and gas companies. As discussed previously, this issue will not necessarily be addressed by the agreed phase-out of Method 1 for methane emissions estimates, and higher-order measurement methods are needed to facilitate accurate methane emission measurement.

JP Morgan has noted that, "Despite the positive economics of abatement in many instances, barriers to action may include a lack of awareness of the problem, low-quality emissions data, capability gaps, infrastructure constraints, and relative profitability compared to other uses of capital."[122]

Additional considerations include the option to buy carbon offsets instead of reducing emissions to meet regulatory requirements, and the potential impact on production timelines of solutions such as methane pre-drainage. For oil and gas companies, the costs of offsetting methane emissions are likely to be small relative to their revenue and profits, undermining the financial case for abatement. For example, if oil and gas producers were to use offsets to meet their required reduction in emissions under the Safeguard Mechanism, the estimated cost (at 2024 ACCU prices) would be slightly more than A$120 million.[123] This is a fraction of the Australian gas sector's total income, with LNG export revenue alone of more than A$42 billion in FY2020-21, and about A$92 billion in FY2021-22.[124]

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[121] Eco-Business. "The technologies are there": How oil and gas companies must go beyond pledges to abate methane and cut emissions. February 2024.
[122] JP Morgan. The Methane Emissions Opportunity. November 2023. Page 7.
[123] IEEFA. Gross under-reporting of fugitive methane emissions has big implications for industry. 5 July 2023. Page 5.
[124] ABS. Australian Industry: Mining industry, by industry subdivision. 31 May 2024.

In addition, given that some methane abatement technologies are not in use in Australia, a risk premium is likely to exist for “first of a kind” projects.[125]

As more information on the actual magnitude of methane emissions becomes available, oil and gas companies are starting to acknowledge the benefits of methane abatement.[126] More than 140 companies have joined the Oil and Gas Methane Partnership 2.0 (OGMP 2.0) to lower their methane emissions (although Woodside is the only Australian company to join so far).[127] At the same time, there is also an increasing awareness of the risks associated with methane emissions, which is why in 2023 insurer Chubb announced “new underwriting criteria for Oil & Gas extraction projects that will require clients to reduce methane and flaring emissions”.[128]

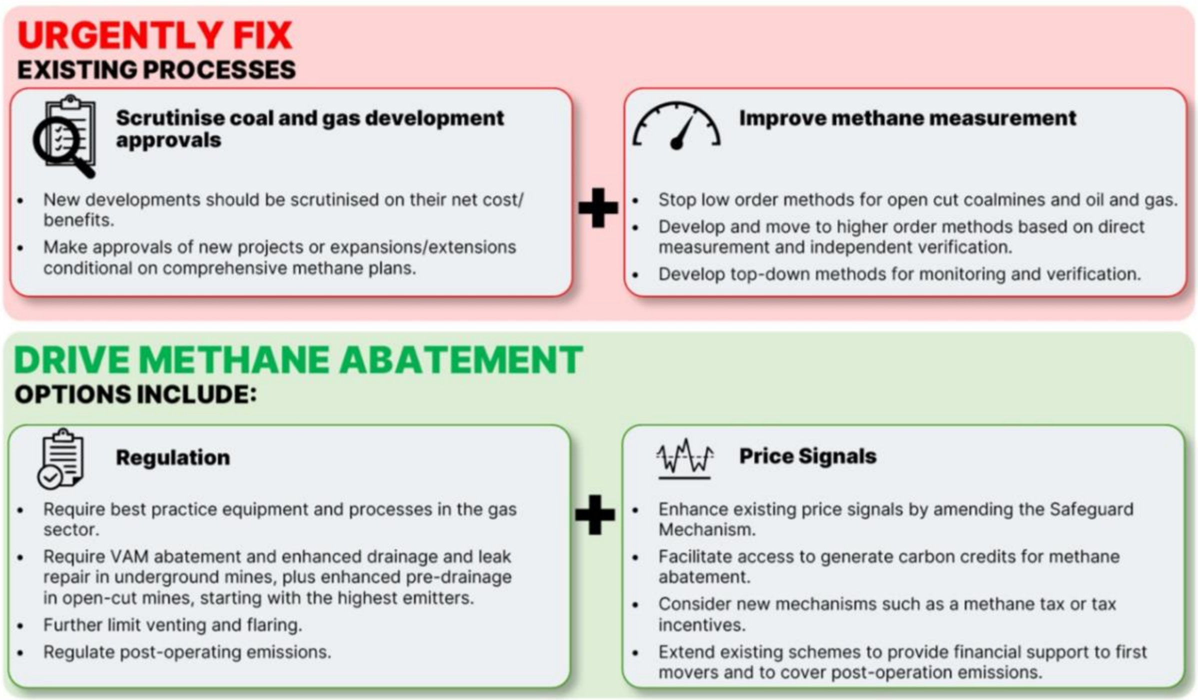
5. Recommendations for government

Governments have a range of policy and legislative levers available to them to incentivise and increase methane abatement practices. However, it is critical that these are implemented with urgency to maximise effectiveness of emissions reduction, to increase the cost-effectiveness of rolling out these abatement solutions, and to mitigate the climate change impacts of fugitive methane emissions.

Implementing abatement options that target the highest emitters, and recognise the difference between open-cut and underground coalmines by location and type of coal, will also be critical for governments. Most of the policy options discussed below could be implemented either at federal or state level, especially for the states most exposed to methane emissions, such as NSW, Queensland and WA.

[125] CSIRO. GenCost 2023-24. May 2024. Pages 26-27.
[126] JP Morgan. The Methane Emissions Opportunity. November 2023. Page 7.
[127] Oil and Gas Methane Partnership. Our Members. Accessed 6 November 2024.
[128] JP Morgan. The Methane Emissions Opportunity. November 2023. Page 8.

Figure 14: Summary of recommendations for government



Source: IEEFA

The IEA states there are many different policy approaches that can be taken to drive down methane emissions, but that "they all have one thing in common: they change the cost/benefit analysis for companies and drive them to internalise the societal cost of methane pollution".[129]

5.1 Urgently fix existing processes

Scrutinise approvals of new coal and gas developments. As discussed in previous sections, it is likely that many new coal and gas projects could deliver no financial benefits to their investors and governments while contributing significant methane emissions, and worsening the financial outlook of existing projects. New developments should be scrutinised on their net cost/benefits to Australia, using realistic estimates of their future financial viability given the expected reductions in global demand, and accurate estimates of their methane emissions.

New mines and mine extension approvals should require a gas drainage feasibility study, including an independent third-party gas reservoir model validation as a condition before assessment and approval, rather than as a condition following approval. This enhanced scrutiny could be applied through existing state approval processes, or at the federal level – for example, through the Safeguard Mechanism's requirement that the Minister for Climate Change and Energy should take

[129] IEEFA. Growth in Australian open-cut coalmining raises urgency of methane abatement. 5 February 2024.

action if emissions are expected to breach the scheme's emissions targets.[130] Particular scrutiny should be applied to new open-cut coalmines, at least until technology improvements enable stronger methane emissions reductions for this mine type.

Make approvals of new projects or expansions/ extensions conditional on comprehensive methane plans. Early planning is key to effective methane abatement, especially in open-cut coalmines, where the most effective methane reduction actions need to occur before mining starts. New project approvals should be made conditional on implementation of comprehensive methane abatement plans.

A clear rule for new approvals would provide investors with certainty, and provide a signal to shift development plans to projects with lower residual methane emissions, in contrast to current incentives that, for example, encourage development of open-cut coalmines instead of underground mines.

This should include the rehabilitation cost estimates and proposals that miners submit as part of their environmental impact statement (EIS) given the residual methane risk. The rehabilitation options to manage abandoned mine methane should also be considered at the approval stage, such as whether a mining operator intends to flood the mine at the end of its life as a form of methane abatement.

Improve methane measurement, reporting and verification (MRV). Evidence is fast mounting of significant underreporting of fugitive methane emissions, particularly from open-cut coalmines. If this is not addressed, all other processes cannot work appropriately: companies cannot accurately assess the business case for methane emissions reduction; new projects' cost/benefits cannot be accurately assessed; and the Safeguard Mechanism cannot effectively drive methane emissions down – either through a lack of inclusion of emissions-intensive facilities, or through "watered-down" financial incentives to act given companies are only penalised for a fraction of their emissions.

Measurement needs to move away from lower-order methods relying on assumed emissions-intensity factors, towards real measurements, as agreed by the government. This includes the bottom-up approaches of urgently phasing out Method 2 and reviewing Method 3 for open-cut coalmines, and developing higher-order methods, as well as top-down methods for independent monitoring and verification. For example, the US and the EU are increasingly utilising satellite data to help understand methane emissions, and identify super-emitter events.[131,132]

Should the Australian government delay any improvements in methane measurement, the most affected state governments such as Queensland, NSW and WA, could set up their own measurement

[130] DCCEEW. Safeguard Mechanism Reforms Factsheet. May 2024.
[131] United Nations Environment Programme. How a groundbreaking satellite system is aiming to reduce methane emissions. 1 August 2023.
[132] The White House. Accelerating progress: delivering on the U.S. methane emissions reduction action plan. December 2023. Pages 3 and 5.

and reporting guidelines. (For the data options readily available to governments to measure and monitor methane emissions, see Appendix E.)

5.2 Drive methane abatement through regulation…

Regulation is often used to address "market failures" – for example where companies or individuals don't take up opportunities that present a positive financial or economic case due to non-financial barriers. This is the case for some fugitive methane sources. As a result, governments in other countries are already taking steps to regulate methane emissions.

Require the implementation of best-practice equipment and processes in the gas sector. As mentioned in this report, reducing methane emissions in the gas sector would come at a net financial benefit for companies, and could help alleviate upcoming gas market tightness on both Australia's east and west coasts. In light of this, the gas industry presents a logical priority for urgent government intervention. Key priorities include ending venting and flaring (except in emergencies), mandating the use of suitable equipment, and requiring that companies implement leak detection and repair regimes. These practices have been incorporated by a range of companies in various regions, including by British oil and gas companies in the North Sea, and by Chevron in the US's Permian Basin.[133,134] The US proposed a new rule to require advanced leak detection in its gas pipelines, which is expected to reduce emissions from those pipelines by up to 55%, and create up to A$2.3 billion annually in benefits.[135]

Require the implementation of VAM abatement measures, leak plugging and rerouting in underground mines. China is already proposing regulation to make VAM capture and utilisation mandatory.[136] One of the benefits of this solution is that it could be implemented without requiring improvements in methane measurement and reporting.

Require pre-drainage of open-cut coalmines, starting with the highest emitters. While open-cut coalmines on average produce less emissions than underground coalmines, they represent the majority of coal methane emissions due to their sheer number. Methane emissions from the gassiest open-cut mines are potentially four times higher than reported, according to data from Climate TRACE. This data shows that the 11 gassiest open-cut mines may each contribute more than 1MtCO_2e of methane emissions a year, whereas the 11 gassiest coal mines according to the Clean Energy Regulator each contribute more than 300,000 tonnes. Either way, the top 11 mines from both of these sources account for more than half of the methane emissions from open-cut coalmines.

[133] Methane Guiding Principles. Case Study: The North Sea Methane Action Plan. September 2023.
[134] Methane Guiding Principles. Chevron: Managing methane in shale and tight assets in the United States. September 2023.
[135] The White House. Accelerating progress: delivering on the U.S. methane emissions reduction action plan. December 2023. Page 2.
[136] IGSD. China proposed strengthened regulatory action and additional market measures to mitigate coal mine methane emissions. 30 July 2024.

It would therefore be justified for government to require pre-drainage of coalmines, starting with the gassiest mines. A progressive implementation schedule would avoid disruptions to production, and help mitigate the largest sources of methane emissions from open-cut coalmining.

Make venting illegal, and only permit flaring in emergency situations. North Dakota in the US has already banned methane venting, and Texas has restricted it.[137] In the context of the tight gas markets expected on Australia's east and the west coasts by 2030, implementing regulation to encourage the utilisation of captured methane would make sense given its benefits for the economy. While several states already have regulation in place to limit venting and flaring, it was found that Queensland's regulation – for example – could be strengthened by limiting the amount of methane that can be flared or vented, or by requiring justifications when flaring or venting is undertaken.[138]

Regulate post-operating methane emissions. This could include:

- Requiring continued monitoring of methane emissions post-operations.
- Setting restrictions on the timeframe for which a mine can remain in care and maintenance.
- Requiring methane abatement to be part of rehabilitation requirements, and factored into estimated rehabilitation costs for mines.
- Requiring methane abatement activities to continue while a mine is in care and maintenance.
- Restricting filling mines with water as a form of methane abatement.

5.3 … and/or price signals

There are a range of ways to provide stronger price signals for methane reduction. These solutions rely on first improving methane measurement.

Amend the Safeguard Mechanism. Due to a number of factors, the Safeguard Mechanism is ineffective at driving emissions reductions, particularly in coalmines. To make it more effective, the Safeguard Mechanism would need to rely on more accurate methane measurement, and baselines for coalmines should be adjusted to require actual emissions reductions. In addition, there should be a limit to the use of carbon offsetting allowed, to ensure mines and oil and gas facilities have an incentive to reduce their emissions rather than offsetting them when the costs are comparable. One potential implementation pathway would be for methane emissions to be treated separately to CO_2 emissions – so that only methane credits could be used to meet methane reduction requirements. This could drive the full implementation of mature technologies at oil and gas facilities and

[137] US Energy Information Administration. Natural gas venting and flaring in North Dakota and Texas increased in 2019. December 2020.
[138] Environmental Defenders Office. Plugging the Leaks: Mapping Methane Regulation in Queensland. July 2024. Page 14.

underground coalmines in the near term, supported by open-cut coalmines wishing to take more time to implement pre-draining technologies so as not to disrupt production.

Facilitate access to carbon market revenues. The government could facilitate ACCU and SMC certification for mine operators implementing proven methane abatement options or to incentivise early coalmine closure. In the US, revenue from voluntary carbon markets and from California's cap-and-trade market have played a key role in driving methane capture projects in abandoned coal mines.[139] In China, access to international carbon markets through the Clean Development Mechanism (CDM) supported the implementation of VAM abatement projects.[140] Accurate measurement of fugitive methane emissions would likely increase the financial benefits associated with methane abatement actions. A methane-specific market could also be created to increase the incentive to reduce methane emissions.

Implement a methane tax. Implementing a material methane tax would increase company management attention and provide a more effective financial incentive. The US has already implemented a methane tax, which "starts at US$900 per metric ton for 2024 reported methane emissions, increasing to US$1,200 per metric ton for 2025 emissions, and US$1,500 per metric ton for emissions years 2026 and later".[141] This is equivalent to about A$46/t$CO_2$e in 2024, increasing to A$76/t$CO_2$e by 2026. The key difference from the Safeguard Mechanism is that a methane tax would cover all methane emissions, whereas the Safeguard Mechanism only provides a financial incentive to reduce emissions below the baseline. Examples from other countries show that a price on carbon can drive emissions reduction action. In Germany, carbon pricing has incentivised the development of at least 39 coalmine methane abatement projects since the early 2000s.[142] A methane tax could also be implemented at the state level, providing states with a lever to address their methane emissions without relying on the federal Safeguard Mechanism. Revenue from a methane tax could be fully or partially reinvested to support methane reduction.

Provide tax incentives. Governments could offer tax incentives to coalmine or oil and gas operators to support methane abatement implementation. For instance, in the US, abandoned coalmine methane capture was incentivised through the waiving of royalties on methane captured and utilised at coalmines.[143]

Provide financial support for first movers. Government support could help address the risk and cost premium faced by first movers. Programs such as the Low Emissions Investment Partnerships (LEIP) in Queensland could help address this issue and be expanded to other states. In IEEFA's

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[139] Berkeley Lab. Abandoned coal mines methane reduction. Lessons from the United States. October 2023. Page 13.
[140] UNECE. Case study: VAM – China.
[141] US Environmental Protection Agency. Waste emissions charge. October 2024.
[142] University of California Berkley. Voluntary Registry Offsets Database v2024-10, Berkeley Carbon Trading Project. November 2024
[143] Berkeley Lab. Abandoned coal mines methane reduction. Lessons from the United States. October 2023. Page 13.

opinion, any program of this type should be focused on supporting “first of a kind” projects, and need to be complemented by other policies to drive meaningful action.

Provide direct funding or grants. In limited situations, direct government funding or grants could be used to address some sources of methane emissions. For example, the US provides funding to “repair or replace old, high risk, leaky methane pipes” and to “plug, remediate, and reclaim orphaned oil and gas wells”.[144]

Extend schemes to post-operation emissions. If methane emissions MRV improves, the Safeguard Mechanism may cover closed and abandoned coalmines, or mines placed in care and maintenance, to ensure that mines that continue to emit large volumes of methane post-production face financial incentives to reduce their emissions. This could also be addressed by setting more stringent requirements on post-mine methane emissions abatement strategies in mines’ rehabilitation requirements. A methane tax could also cover those cases. Alternatively, the Safeguard Mechanism could be extended to cover all coalmining and all oil and gas projects in Australia, to account for the uncertainty around methane reporting in this space.

6. Conclusion

Methane emissions are not on track to be reduced in Australia, and could even increase due to ineffective policies, gross underreporting undermining the understanding of the impact of new developments (and existing operations), and a large pipeline of new coal and gas projects.

Conversely, addressing methane emissions could be done with readily available technologies, at a low cost and often with a net financial benefit due to the ability to sell or utilise the methane captured. This could also help alleviate the imminent excess gas demand expected on both Australia’s coasts.

Australia lags other major fossil fuel producers – the US, China and the EU – in its adoption of effective fossil fuel methane abatement technology. Urgent action from government is needed, which could be delivered at the federal level, or at state level for most affected states such as Queensland, NSW and WA. Overall, Australian governments, both state and federal, must decide whether they will incentivise implementation of abatement technology by changing the cost/benefit of action, or whether they will introduce new legislative requirements.

Ultimately, the most effective way to reduce methane emissions from fossil fuels is to reduce production, which will also be in Australia’s best economic interests given the expected decreases in demand for our fossil fuel exports. For example, adding new LNG capacity in the context of a major global supply glut could drive further reduction in prices, challenging the financial viability of existing

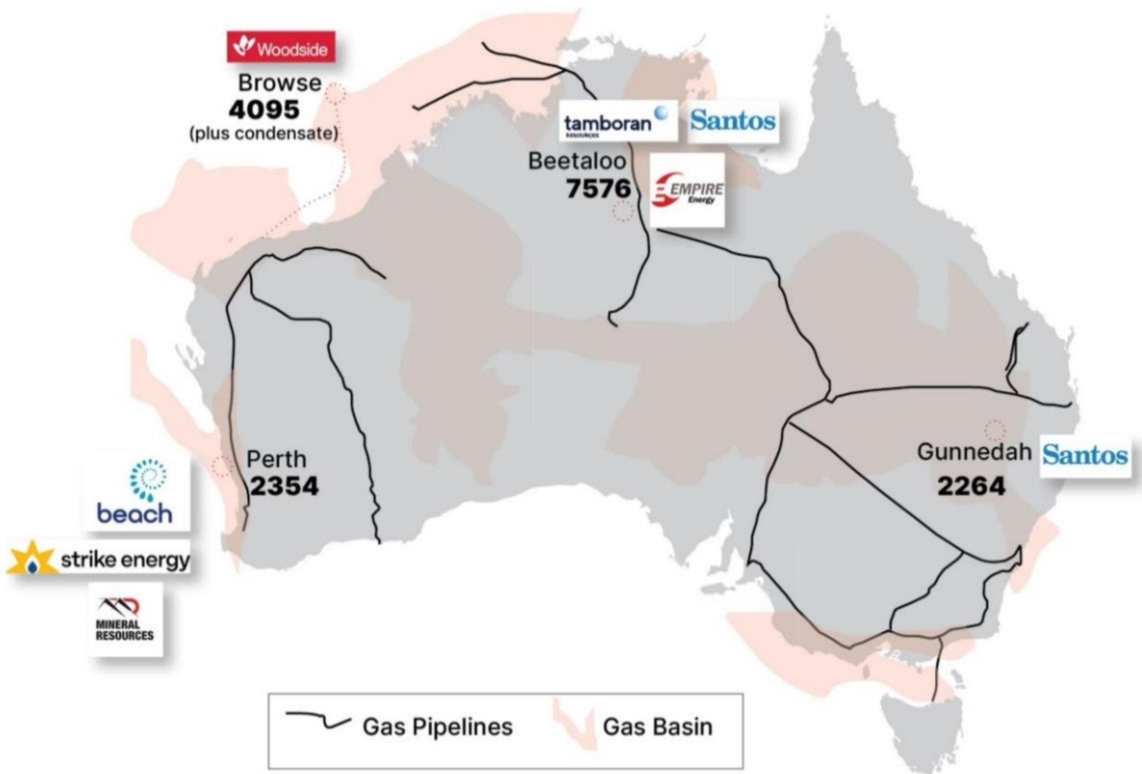
[144] The White House. Accelerating progress: delivering on the U.S. methane emissions reduction action plan. December 2023. Pages 4-5.

projects while increasing methane emissions, placing Australia's GHG reduction ambitions further out of reach.

Appendix A: Proposed new mines or mine expansions undergoing EPBC approval

Project Name	Project Type	State	Mine Type	Coal Type
Alpha North Coal Mine Project	Greenfield - New Mine	QLD	Open Cut	Thermal
Baralaba South Project	Greenfield - New Mine	QLD	Open Cut	Thermal | PCI
Blackwater Mine – North Extension Project	Brownfield - Expansion	QLD	Open Cut	Metallurgical
Blackwater South Coking Coal	Greenfield - New Mine	QLD	Open Cut	Metallurgical
Caval Ridge Horse Pit	Brownfield - Extension	QLD	Open Cut	Metallurgical
Coppabella Mine Humbug Gully Project	Brownfield - Extension	QLD	Open Cut	Thermal | PCI
Dawson West Project	Greenfield - New Mine	QLD	Underground	Thermal
Kestrel West Mine Extension	Brownfield - Extension	QLD	Underground	Metallurgical
Lake Vermont Meadowbrook project	Greenfield - Extension	QLD	Open Cut & Underground	Metallurgical | Thermal
Meandu Mine King 2 East	Brownfield - Expansion	QLD	Open Cut	Thermal
Middlemount Coal Mine - Southern Open Cut	Greenfield - Extension	QLD	Open Cut	Metallurgical | Thermal
Millmerran Mining Lease Conversion Project	Greenfield - Extension	QLD	Open Cut	Thermal
Moorlands open cut coal mining project	Greenfield - New Mine	QLD	Open Cut	Thermal
Moorvale South Extension Project	Brownfield - Expansion	QLD	Open Cut	PCI
Moranbah South Coal Project	Greenfield - New Mine	QLD	Underground	Metallurgical
New Lenton Coal Project	Greenfield - New Mine	QLD	Open Cut	Metallurgical | Thermal
Peak Downs Mine Continuation project	Brownfield - Expansion	QLD	Open Cut	Metallurgical
Rolleston Coal Mine Continuation Project	Brownfield - Extension	QLD	Open Cut	Thermal
Saraji East Mining Lease project	Greenfield - New Mine	QLD	Underground	Metallurgical
Saraji Mine Grevillea Pit Continuation Project	Brownfield - Extension	QLD	Open Cut	Metallurgical
Vulcan Coal Mine – Matilda Pit and Ancillary Infrastructu	Brownfield - Expansion	QLD	Open Cut	Metallurgical
Vulcan South Coal Mine	Greenfield - New Mine	QLD	Open Cut	Metallurgical
Walton Project	Greenfield - New Mine	QLD	Open Cut	PCI
Winchester South	Greenfield - New Mine	QLD	Open Cut	Metallurgical | Thermal
Angus Place West	Brownfield - Extension	NSW	Underground	Thermal
Bloomfield Colliery Continuation Project - Modification	Brownfield - Extension	NSW	Open Cut	Thermal
Boggabri Coal Mine Modification 10	Brownfield - Extension	NSW	Open Cut	Metallurgical | Thermal
Boggabri Coal Mine Modification 8	Brownfield - Extension	NSW	Open Cut	Metallurgical | Thermal
Clarence Colliery Secondary Extraction of the 918 and 9	Brownfield - Extension	NSW	Underground	Thermal
Maules Creek Continuation Project	Brownfield - Extension	NSW	Open Cut	Metallurgical | Thermal
Moolarben Coal Complex OC3 Extension Project	Brownfield - Extension	NSW	Open Cut	Thermal
Mount Pleasant Modification 7	Life of Mine Extension	NSW	Open Cut	Thermal
Mt Arthur Coal MOD 2 (Pathway to 2030)	Brownfield - Extension	NSW	Open Cut	Thermal
Newstan Mine Extension Project	Brownfield - Extension	NSW	Underground	Metallurgical | Thermal
Ulan Coal Modification 6 - Underground Mining Extensio	Life of Mine Extension	NSW	Underground	Thermal

Appendix B: Proposed new gas developments and estimated 2P reserves/2C resources, PJ



IEEFA

Appendix C: Coalmine methane projects in Australia

Number of projects by mine and state		Type of mine	Status of project	Type of project/s			Generating ACCUs
Australia Total operational or planned	**31**						**12**
New South Wales	**14**						
Ashton Coal Project	**1**	Underground, Longwall	Operational	Enclosed Flare			
Bulga Mining Complex	**2**	Underground, Longwall	Operational	Enclosed Flare	Power Generation		
Integra (Glennies Creek) Coal Mine	**1**	Underground, Longwall	Operational	Power Generation			Yes
Mandalong	**3**	Underground, Longwall	Flaring is Operational, Power Generation and VAM is stalled	Enclosed Flare	Power Generation	**VAM Destruction**	Yes, For Power Generation
Appin Coal Mine	**3**	Underground, Longwall	Operational	Flaring (Unknown Type)	Power Generation	**VAM Destruction**	Yes, For Power Generation
Tahmoor Colliery	**3**	Underground, Longwall	Operational	Enclosed Flare	Power Generation		Yes, For Power Generation
Wambo Mine	**1**	Underground, Longwall	Operational	Enclosed Flare			

Number of projects by mine and state		Type of mine	Status of project	Type of project/s		Generating ACCUs	
Queensland	**17**						
Capcoal Underground (aka German Creek)	**2**	Underground, Longwall	Operational	Enclosed Flare	Power Generation		Yes
Carborough Downs Coal Mine	**2**	Underground, Longwall	Operational	Flaring (Unknown Type)	Power Generation		
Dawson Mine	**1**	Open-cut	Operational	**Gas Sales to Pipeline**			
Grosvenor Coal Mine	**2**	Underground, Longwall	Operational	Power Generation			Yes
Ironbark No 1	**2**	Underground, Longwall	Operational	Flaring (Unknown Type)	Power Generation		Yes, For Power Generation
Moranbah North Mine	**1**	Underground, Longwall	Operational	Power Generation			Yes
Oaky Creek	**4**	Underground, Longwall	Operational	Enclosed Flare	Power Generation		Yes, For Power Generation
Kestrel Coal Mine	**2**	Underground, Longwall	Planned/ Operational	Power Generation	Ventilation Air Cooling – Gas Generator Systems		Yes
North Goonyella Coal Mine (AKA Centurion)	**1**	Underground, Longwall	Planned/ Operational	Power Generation			Yes

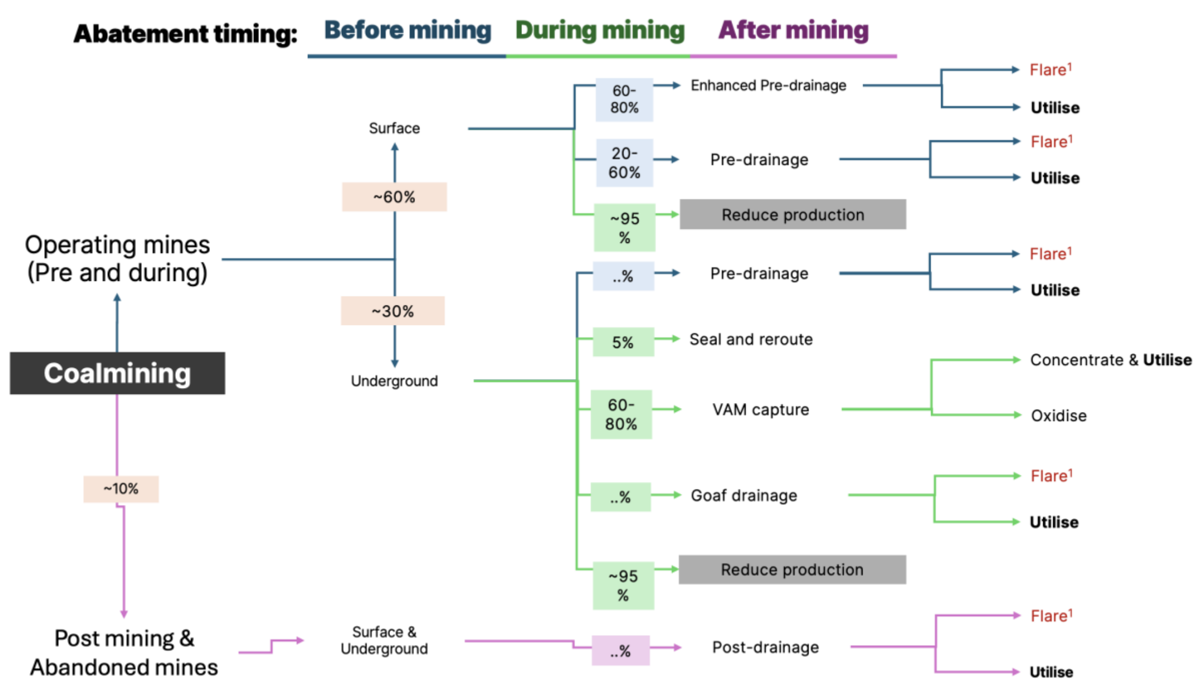
Sources: Global Methane Initiative;[145] International Coal Mine Methane Project List; Australian Government, Clean Energy Regulator, ACCU Project and Contract Register. Note: Excludes projects that have been shut down or cancelled.

[145] Global Methane Initiative. International Coal Mine Methane Project List. 2 August 2024.

Appendix D: Overview of coalmining methane abatement technologies

The available coalmine methane abatement options depend on the type of coalmine, the gassiness of the mine, and quality of infrastructure on site. The figures below are indicative only.

Figure 15: Coalmine methane potential abatement options



Source: IEEFA. Note: Flaring is included for emergency use only.

Appendix E: Methane abatement technology providers in Australia

Abatement Technology	Known technology providers
Leak Detection and Repair	Klinger, SGS, Applus, Team, Air Labs, Intero
Flaring	Aereon, Evonik, John Zink Hamworthy Commission, Inoplex, Gasco, Eneraque, LMS energy
Coalmine methane gas utilisation	Arrow Energy, Xenith, LMS Energy
VAM Abatement RTO	CSIRO, Anguil, Dürr, John Zink Hamworthy Commission
VAM abatement catalytic oxidisation	Mining3 , LETA, CSIRO,

Sources: Rystad, CSIRO, IEEFA. Note: This table provides an overview of known abatement technology providers operating in Australia by the authors at the time of publication. Additional providers may be present or changes in availability or operational status of companies may occur.

Appendix F: Methane emissions data availability and options for governments

The alternative estimates of methane associated with fossil fuel production come from the IEA, Open Methane, Global Energy Monitor (GEM) and Climate TRACE. While there is a difference in the year of measurement, the GEM and Climate TRACE datasets broadly align in terms of total methane contained in operating coalmines. They do not take account of any mitigation activities in place.

A validation of the Climate TRACE data was performed by Open Methane, which compared the Climate TRACE data and Australia's national inventory data reported by the DCCEEW with satellite observations.[146] Open Methane found the Climate TRACE data more closely aligned than the national inventory data, and reported a high degree of confidence that the true methane emissions are higher than those estimated and reported in the national inventory.[147] Climate TRACE reported total methane emissions in Australia 2.5 times higher than the official statistics in Australia's national inventory.[148]

Potential changes to the National Greenhouse and Energy Reporting (NGER) scheme requirements can assist in improving the accuracy of reporting methods in Australia if successfully implemented. However, risks of further underreporting, particularly at open-cut mines, remain.[149] This is discussed in more detail in IEEFA's submission on the NGER 2024 proposed updates.[150]

Technology advancements mean new data sources will become more accurate and more widely available, such as increased use of remote-sensing techniques with satellite measurements. However, at the time of writing the most comprehensive methane emissions estimates and observations available for Australia are listed in Table 2.

[146] Open Methane. Open Methane's First Results Build the Urgent Case for Improved Emissions Measurement. 30 April 2024.
[147] Ibid.
[148] Ibid.
[149] Renew Economy. In the fog of Grosvenor fire, has Labor gone backwards on coal mine methane emissions reporting? 5 July 2024.
[150] IEEFA. Submission: National Greenhouse and Energy Reporting (NGER) scheme – 2024 proposed updates. 29 May 2024.

	Date range	Period	Source	Last updated	Link	Gas reported	Granularity
Government / Intergovernmental sources							
Clean Energy Regulator – Safeguard Mechanism Facility Data	2016-17 to 2022-23	FY	Self-reported or self-estimated data	16 May 2024	https://cer.gov.au/markets/reports-and-data/safeguard-facility-reported-emissions-data#safeguard-facilities-data-2022%E2%80%9323	CO_2e only	Site-specific
DCCEEW – National Greenhouse Gas Inventory	Jun 2005 to Mar 2024	Quarterly	Company reported or estimated data	March 2024	https://www.dcceew.gov.au/climate-change/publications/national-greenhouse-gas-inventory-quarterly-update-march-2024#dcceew-main	CO_2 and CH_4 in CO_2e terms	National and Industry-specific
International Energy Agency	2023	Calendar		August 2024	https://www.iea.org/data-and-statistics/data-product/greenhouse-gas-emissions-from-energy	CO_2 and CH_4	National, Energy and Agriculture
Non-government sources							
Climate TRACE	2015 to 2023	Calendar	Updated emissions factors based on production	December 2024	https://ClimateTRACE.org/	CO_2 and CH_4	National, Industry and Site-specific
Global Energy Monitor	2024	Calendar	Updated emissions factors based on production	March 2024	https://globalenergymonitor.org/projects/global-methane-emitters-tracker/	CO_2 and CH_4	National, Industry and Site-specific
Open Methane	Jan-Jun 2023	Both	Satellite and Remote-Sensing Technology	In Progress (TBA)	https://openmethane.org/	CO_2 and CH_4	National, and $5km^2$ Specific

About IEEFA

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

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