Environment Protection Authority

Proposed Greenhouse Gas Mitigation Guide for NSW Coal Mines

CONSULTATION DRAFT

July 2025

Acknowledgement of Country

The NSW Environment Protection Authority acknowledges the Traditional Custodians of the land on which we live and work, honours the ancestors and the Elders both past and present and extends that respect to all Aboriginal people.

We recognise Aboriginal peoples' spiritual and cultural connection and inherent right to protect the land, waters, skies and natural resources of NSW. This connection goes deep and has since the Dreaming.

We also acknowledge our Aboriginal and Torres Strait Islander employees who are an integral part of our diverse workforce and recognise the knowledge embedded forever in Aboriginal and Torres Strait Islander custodianship of Country and culture.

Aboriginal artwork by Worimi artist Gerard Black

How to make a submission

We invite you to give us feedback on this proposed guide.

Submissions can be:

- made online on the Have Your Say page
- posted to

  Manager, Climate Change Policy
  NSW Environment Protection Authority
  Locked Bag 5022
  Parramatta NSW 2124

- emailed to climatechange.review@epa.nsw.gov.au.

Executive summary

This mitigation guide provides state-specific and up-to-date guidance on opportunities for NSW coal mines to reduce greenhouse gas emissions. It represents a significant step change in the way greenhouse gases are managed in NSW. It is drafted for a non-technical audience so that community members and the mining sector alike are clear on what measures are available and where they can be used.[1]

Greenhouse gas emissions from coal mines made up about 12% of NSW total emissions in 2021–22.[2] Reducing greenhouse gas emissions at coal mines is an important step in supporting NSW to achieve its legislated emissions reductions targets. The coal mining sector emits approximately 30% of NSW's methane emissions and is the largest source of methane emissions licensed by the NSW Environment Protection Authority (EPA), releasing around 60% of these emissions.[3] This is why the EPA has prioritised developing a greenhouse gas mitigation guide for coal mines ahead of developing guides for other industries.

This guide supports coal mining companies to develop plans to reduce their emissions

The mitigation guide sets out the greenhouse gas mitigation measures that will need to be considered by operators of existing coal mines and proponents of new coal mining projects and modifications as part of their planning application or their climate change mitigation and adaptation plan (CCMAP). The EPA expects coal mine licensees to consider this mitigation guide and implement mitigation measures at each licensed premises, when preparing their CCMAPs.

The guide signals proposed future regulatory requirements

The EPA is signalling these proposed requirements in advance so that industry can implement the measures before these requirements are introduced and come into effect. This also provides licensees the opportunity to access NSW and Commonwealth grants and accrue carbon credits, where eligible, before the requirements are in place. If these requirements are introduced, these opportunities may not be available, as many funds have a regulatory additionality test.[4]

Reducing fugitive methane emissions

In 2022, fugitive emissions from coal mining, which are mainly methane, made up about 9% of total NSW scope 1 greenhouse gas emissions. Around 80% of coal mine fugitive emissions were from underground coal mines, and about 20% from surface mines.[5]

Methane warms the Earth much faster than carbon dioxide and so taking early action to reduce methane emissions will help to slow the rate of atmospheric warming.

The EPA expects underground coal mines to avoid or minimise fugitive methane as set out in Table 1.

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[1] See the *Glossary of terms and abbreviations* section for meanings of terms and abbreviations used in this mitigation guide.

[2] Australian Government, 'Australia's National Greenhouse Accounts - Emissions by state and territory', Cth Department of Climate Change, Energy, the Environment and Water website, 2025, accessed 29 May 2025; and Boulter et al. 2022, 'Non-road diesel engines – cost-benefit analysis: final report', Cth Department of Climate Change, Energy, the Environment and Water, Canberra.

[3] NSW EPA 2025d, 'Improving measurement of fugitive methane emissions', NSW Environment Protection Authority, Parramatta.

[4] Actions that are required by law are often not eligible for government grants or to accrue carbon credits.

[5] NZC 2024, '2024 Annual Report', November 2024, Net Zero Commission, Parramatta.

Table 1 EPA expectations for fugitive emissions reductions at NSW coal mines[6]

Mitigation objective	Proposed EPA requirement and expected commencement	Criteria
Destroy methane in drainage gas at underground mines	**By July 2027**: gas drainage with flaring or utilisation is in place.	Active (operational) underground mines that: • are located outside of the Western coalfields, and • emit (or are likely to emit) >25,000 tonnes carbon dioxide equivalent per year (t CO_2-e/year) (scope 1).
Minimise methane entering ventilation air by addressing methane leaks from old mine workings at underground mines	**By July 2027**: methane leaks have been detected and are managed.	Active (operational) underground mines that: • emit (or are likely to emit) >100,000 t CO_2-e/year (scope 1)
Destroy ventilation air methane (VAM) at underground mines	**By July 2030**: VAM abatement is installed on mine shafts. In 2028, the EPA will review whether the safety issues for VAM regenerative thermal oxidation (RTO) have been resolved before implementing mandatory requirements.	Underground mines that: • will be in an active (operational) mining phase beyond July 2032, and • emit (or are likely to emit) >100,000 t CO_2-e/year (scope 1).

Gas drainage and destruction of methane is a relatively cost-effective and mature technology at NSW underground mines and should be a greenhouse gas mitigation action that can be implemented immediately at most underground coal mines. Gas drainage and destruction of methane could also be feasible at some surface mines. The EPA is seeking feedback on whether this requirement should apply to both underground and surface coal mines.

All ventilation air methane (VAM) management technology, including VAM regenerative thermal oxidation (RTO), on a mine site is considered part of a mine's operations for mine safety purposes. Under NSW work health and safety legislation, coal mine operators are required to eliminate, minimise and manage risks to health and safety. In 2028, the EPA will consider the outcomes of the VAM RTO trials in NSW and Queensland, including any safety issues in implementing VAM RTO before requirements are placed on mines.

The EPA has heard from the NSW coal mining industry that the cost of VAM abatement can be a barrier. The EPA's view is that VAM abatement is financially viable for a number of underground coal mines that meet the EPA's criteria. Installing VAM abatement will also assist mining companies to meet their obligations for emission reductions under the Commonwealth Safeguard Mechanism. There may be financial and technical barriers for other underground coal mines.

Reducing diesel emissions

For surface mines, the main opportunity for emissions reduction in the medium term will be through reducing the use of fossil diesel fuel. In 2021–22 emissions from diesel equipment made up around 29% of scope 1 greenhouse gas emissions from the NSW coal mine sector.[7] Diesel vehicles and

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[6] These proposed requirements do not apply to mines in suspended operations (care and maintenance), or those mines going through the mine closure and rehabilitation process.

[7] See Table 3 in section *1.5 Overview of scope 1 emissions from NSW coal mines*.

equipment are widely used at surface coal mines, and to a much lesser extent at underground mines.

The EPA expects coal mines to use low carbon alternatives to fossil diesel from July 2030 if the mine emits more than 25,000 t CO_2-e/year (scope 1) and has large mining machinery and vehicles with >560 kilowatt (kW) capacity, as set out in Table 2.

The NSW Renewable Fuels Strategy (in development) will progress a range of actions to help stimulate supply of renewable fuels in NSW.[8]

Table 2 EPA expectations for diesel emissions reductions at NSW coal mines

Mitigation objective	Proposed EPA requirement and expected commencement	Criteria
Reduce fossil diesel emissions at all coal mines	• **By July 2030**: 5% of fuel used is a low carbon alternative to fossil diesel. • **By July 2035**: 10% of fuel used is a low carbon alternative to fossil diesel. • **By July 2040**: 25% of fuel used is a low carbon alternative to fossil diesel **AND** 75% of large mining machinery and vehicles are zero emissions. • **By July 2050**: 25% of fuel used is a low carbon alternative to fossil diesel **AND** 100% of large mining machinery and vehicles are zero emissions.	All mines that: • emit (or are likely to emit) >25,000 t CO_2-e/year (scope 1). (Large mining machinery and vehicles means >560 kW capacity).

The EPA understands that there is capacity within the existing biofuel production facilities in NSW, Queensland and Victoria to help meet the 2030 low carbon fuel target. There is also capacity within the market for a smaller target, earlier. As a result, we seek views on whether the EPA should progress a requirement for 2.5% of fuel used at NSW coal mines to be a low carbon alternative to fossil diesel by 2027.

Feasibility will be taken into account

Each mine is unique, with different geology, geography, emissions characteristics, operations and environment. These differences may mean the required measures are not feasible in some circumstances. Coal mine licensees will have the opportunity to seek a short time extension or exemption from the proposed requirements. Any exemption may be time limited.

For the exemption, we propose that the licence holder demonstrates that the measure is not feasible at their site, by providing a pre-feasibility assessment that includes both qualitative and quantitative data and which has been independently verified by an appropriate expert.

Funding is available

The NSW Government's High Emitting Industries fund offers grants that can help mines that emit 90,000 t CO_2-e or more per year to develop and deploy capital projects to reduce their emissions, such as those discussed in this guide.[9] Coal mines captured by the Commonwealth's Safeguard

[8] NSW Government, 'Building a thriving renewable fuel industry in NSW', NSW Climate and Energy Action website, 2024, accessed 29 May 2025.

[9] NSW Government, 'High Emitting Industries', NSW Climate and Energy Action website, 2022, accessed 29 May 2025.

Mechanism also have the opportunity to generate Safeguard Mechanism credit units for emissions reductions below their Safeguard baseline.[10]

Supporting the NSW legislated emissions reduction targets

The latest NSW emissions projections show that NSW is not on track to meet the state's legislated 2030 and 2035 emissions reduction targets.[11] The expectations set out in this guide will help support emission reductions and reduce the abatement gap. This guide will also support implementation of recommendations from the Joint Standing Committee on Net Zero. The Committee recommended government consider implementing regulatory changes to encourage the earlier adoption of low emissions technologies.[12]

[10] Australian Government, Safeguard Mechanism credit units, Clean Energy Regulator website, 2025, accessed 29 May 2025.

[11] NSW EPA, 'Climate', NSW State of the Environment 2024 website, NSW Environment Protection Authority, 2025, accessed 2 July 2025.

[12] NSW Government, 'NSW Government Response to the Net Zero Commission 2024 Annual Report and the Parliamentary Inquiry Report by the Joint Standing Committee on Net Zero Future', NSW Climate and Energy Action website, 2025, accessed 2 July 2025.

Contents

How to make a submission ... iii

Executive summary ... iv

1 **Background and overview ... 1**

1.1 Background ... 2

1.2 Development of this mitigation guide ... 3

1.3 Objectives of the mitigation guide ... 3

1.4 Scope of the mitigation guide ... 3

1.5 Overview of scope 1 emissions from NSW coal mines ... 5

2 **Scope 1 emissions: fugitive methane ... 7**

2.1 Fugitive methane emissions at NSW coal mines ... 8

2.2 Mitigation measures for fugitive methane ... 8

2.2.1 Gas drainage with flaring or utilisation ... 9

2.2.2 Ventilation air methane (VAM) at underground mines ... 11

2.2.3 Progressive mine capping and sealing at underground mines ... 14

2.2.4 Summary of mitigation measures for fugitive methane ... 15

2.3 EPA expectations for fugitive methane ... 16

Consultation questions: Scope 1 emissions – fugitive methane ... 17

3 **Scope 1 emissions: diesel combustion ... 19**

3.1 Diesel emissions at NSW coal mines ... 20

3.2 Mitigation measures for diesel combustion emissions ... 20

3.2.1 Standard industry measures ... 20

3.2.2 Electrification ... 21

3.2.3 Low carbon fuel substitution ... 22

3.2.4 Summary of mitigation measures for diesel emissions ... 24

3.3 EPA expectations for diesel emissions ... 24

4 **Scope 1 emissions: minor sources ... 27**

4.1 Mitigation measures for minor scope 1 emissions ... 28

4.2 Guidance for minor scope 1 emissions ... 28

5 **Scope 2 emissions ... 29**

5.1 Scope 2 emissions at coal mines ... 30

5.2 Mitigation measures for scope 2 emissions ... 30

5.2.1 Energy efficiency measures ... 30

5.2.2 Reducing the emissions intensity of electricity 31
5.2.3 Summary of mitigation measures for scope 2 emissions 33
5.3 Guidance for scope 2 emissions 33
6 Scope 3 emissions 34
6.1 Overview 35
6.2 Examples of opportunities to reduce scope 3 emissions 35
6.3 Guidance for Scope 3 emissions 36
7 Exemptions and time extensions 37
7.1 Proposed process for seeking to be exempt from an EPA requirement 38
7.1.1 Proposed pre-feasibility assessment content 38
7.1.2 How long would an exemption last? 39
7.2 Requests to extend the timeline for implementation 39
7.3 Due dates for exemption and timeline requests 40
References 41
Glossary of terms and abbreviations 47
Glossary of terms 48
Abbreviations 50

1

Background and overview

1.1 Background

The NSW Environment Protection Authority (the EPA) has a legal requirement to develop environmental quality objectives, guidelines and policies to ensure protection of the environment in NSW from climate change. This is a statutory duty that the EPA must discharge under the *Protection of the Environment Administration Act 1997*, as confirmed by a court judgement in 2021.

In 2023 the EPA published its *Climate Change Policy* and *Climate Change Action Plan 2023–26*.[13] These documents outline the EPA's regulatory approach and actions to address the causes and consequences of climate change in NSW. They support and build upon the NSW Government's climate change policies and initiatives, and assist with meeting the net greenhouse gas emission reduction targets enshrined in the *Climate Change (Net Zero Future) Act 2023*.

In early 2025, the EPA published the *NSW Guide for Large Emitters,* which requires proponents of large greenhouse gas emitting proposals to prepare a greenhouse gas assessment as part of the planning assessment process.[14]

The EPA is also progressively requiring all its licensees to develop climate change mitigation and adaptation plans (CCMAPs) and has published *Climate Change Mitigation and Adaptation Plans: Proposed Mitigation Requirements* for public consultation.[15]

To support the requirements of the *NSW Guide for Large Emitters* and CCMAPs, the EPA is producing separate guides on greenhouse gas mitigation for key industries. The first of these − this guide − is for the NSW coal mining sector (the 'mitigation guide'). Proponents of coal mining activities will need to consider this mitigation guide when preparing their environmental impact assessments as part of the development approvals process. Existing coal mine licensees will need to develop an individual CCMAP and consider this mitigation guide and implement mitigation measures at each licensed premises, when preparing their CCMAPs.

This mitigation guide fills a gap in the available information on emissions abatement relevant to NSW coal mines by providing clear, state-specific, up-to-date and publicly available guidance on opportunities for coal mines in NSW to reduce their greenhouse gas emissions.[16]

The NSW Government's High Emitting Industries fund offers grants to help mining and manufacturing facilities to reduce their emissions. Funding is available to help mines (and manufacturing facilities) that emit 90,000 t CO_2-e or more per year develop and deploy capital projects to reduce their emissions, such as those discussed in this guide.[17]

Coal mines captured by the Commonwealth's Safeguard Mechanism also have the opportunity to generate Safeguard Mechanism credit units for emissions reductions below their Safeguard baseline.[18]

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[13] NSW EPA 2023a, 'EPA Climate Change Policy', NSW Environment Protection Authority, Parramatta; NSW EPA 2023b, 'Climate Change Action Plan 2023–26', NSW Environment Protection Authority, Parramatta.

[14] NSW EPA 2025a, 'NSW Guide for Large Emitters', NSW Environment Protection Authority, Parramatta.

[15] NSW EPA 2025b, 'Climate Change Mitigation and Adaptation Plans: Proposed Mitigation Requirements', Consultation draft, NSW Environment Protection Authority, Parramatta.

[16] EMM 2025, 'Greenhouse Gas Mitigation Guide for NSW Coal Mines: Literature Review and Industry Scan' found that there is no comprehensive, publicly available guidance on reducing greenhouse gas emissions relevant to the NSW coal mining industry.

[17] NSW Government, 'High Emitting Industries'.

[18] Australian Government, 'Safeguard Mechanism credit units'.

See the *Glossary of terms and abbreviations* section for meanings of terms and abbreviations used in this mitigation guide.

1.2 Development of this mitigation guide

To support the development of the mitigation guide, the EPA has drawn on a range of information and feedback, including:

- **Literature review:** The EPA commissioned EMM Consulting to undertake a review covering both Australian and international literature. The *Literature Review and Industry Scan* covers coal mining processes and emission sources, existing guidance, existing and emerging measures for managing greenhouse gas emissions at coal mines, and methane utilisation.[19]
- **Industry Scan:** This involved interviews with coal mining companies and industry experts to determine the practical applicability of measures that were identified in the literature review, and to determine what measures were currently and likely to be implemented in the short to medium term. The Industry Scan report is included in the literature review.[19]
- **Independent Expert Review Panel**: The EPA established an expert panel to review and provide feedback on the relevance and suitability of the mitigation guide to NSW coal mines.[20] The EPA accepted and incorporated the vast majority of the panel's feedback into this guide. Where we have not directly incorporated the panel's feedback, we have included a consultation question for public feedback.
- **Climate change advisory groups:** The EPA shared a draft of this guide with its climate change advisory groups ahead of public consultation.[21]
- **Interviews with stakeholders** identified by members of the EPA's climate change advisory groups.

The next stage of feedback involves broad public consultation on this proposed mitigation guide before the guide is finalised. See the *How to make a submission* section.

1.3 Objectives of the mitigation guide

The objectives of the mitigation guide are to:

- support NSW to meet its emissions reduction targets legislated under the Climate Change (Net Zero Future) Act
- assist coal mining companies to prepare a greenhouse gas assessment report (a requirement of *NSW Guide for Large Emitters*) and CCMAP
- drive onsite abatement and outline the EPA's expectations in terms of the mitigation measures to be implemented at NSW coal mines.

1.4 Scope of the mitigation guide

[19] EMM 2025, 'Greenhouse Gas Mitigation Guide for NSW Coal Mines: Literature Review and Industry Scan'.

[20] Stewart M, Williams R, Thompson S, Su S, Kook S, 2025, 'Independent Expert Review Panel Report: Review of the EPA's draft Greenhouse Gas Mitigation Guide for NSW Coal Mines, and accompanying draft literature review', 14 April 2025.

[21] NSW EPA, 'Climate change advisory groups,' NSW Environment Protection Authority website, 2025, accessed 29 May 2025.

The mitigation guide covers:

- underground and surface coal mines in NSW
- the mine design phase (planning process) and the active mining phase
- all relevant greenhouse gases, focusing mainly on methane and carbon dioxide
- the EPA's expectations for scope 1 emissions, and general guidance for scope 2 and scope 3 emissions.

This mitigation guide does not:

- provide a detailed technical explanation of coal mining processes or greenhouse gas mitigation measures and technologies
- apply to emissions from closed or abandoned mines
- provide proposed requirements and guidance for emissions measurement (see Box 1)
- cover corporate strategies and frameworks for reducing or disclosing emissions
- include detailed costs of mitigation measures
- cover strategies for the use and disclosure of offsets and carbon capture and storage[22]
- seek to address reductions in greenhouse gas emissions from the coal mining sector that are associated with reducing overall coal production in NSW.[23]

Box 1. Identifying and quantifying greenhouse gas emissions

Emissions identification and quantification is a critical first step of any greenhouse gas management process. It is important to accurately identify and quantify emissions to design an appropriate mitigation strategy. It is also important to continue to quantify emissions over time, to understand the effectiveness of any mitigation strategy.

This mitigation guide is not intended to provide proposed requirements for emissions identification and quantification for NSW coal mines. Action the EPA is taking to help improve measurement of emissions is outlined in the EPA's *Proposed Climate Change Licensee Requirements* and *Climate Change Mitigation and Adaptation Plans: Proposed Mitigation Requirements*.[24]

Both proposed and existing mines will need to provide a credible estimation of scope 1 and 2 emissions based on the latest National Greenhouse Account Factors and National Greenhouse and Energy Reporting (NGER) methods for estimating emissions.[25] In 2024, the Clean Energy Regulator

[22] Carbon capture and storage (CCS) technologies may have a role to play in abating residual carbon dioxide emissions from NSW coal mining activities in the future. However, this technology is outside the scope of this mitigation guide as there are a number of practical limitations with respect to their application to coal mines in NSW (e.g. no available storage sites for captured CO_2). These limitations are described in: EMM 2025, 'Greenhouse Gas Mitigation Guide for NSW Coal Mines: Literature Review and Industry Scan'. There is research and development currently underway for CCS technologies in the coal industry.

[23] The NSW planning process is the pathway that approves the level of coal production for individual coal projects. The EPA's regulatory functions do not involve amending development consents or setting strategic government policy direction on these matters.

[24] NSW EPA 2025c, 'Proposed Climate Change Licensee Requirements', Consultation draft, NSW Environment Protection Authority, Parramatta; NSW EPA 2025b, 'Climate Change Mitigation and Adaptation Plans: Proposed Mitigation Requirements', Consultation draft.

[25] Australian Government, 'National Greenhouse Accounts Factors', Cth Department of Climate Change, Energy, the Environment and Water website, 2024, accessed 29 May 2025; Australian Government, 'National Greenhouse and Energy Reporting Scheme', Clean Energy Regulator website, 2025, accessed 29 May 2025.

released a guideline for estimating scope 1 and 2 emissions and energy from coal mining. This guidance is periodically updated, so make sure you are using the latest version.[26]

1.5 Overview of scope 1 emissions from NSW coal mines

Scope 1 (direct) greenhouse gas emissions from coal mines made up about 12% of NSW total emissions in 2021–22.[27] The main sources of scope 1 emissions from NSW coal mines are fugitive emissions (mainly methane) and diesel emissions (mainly carbon dioxide). These are considered in detail in section 2 and section 3, respectively.

Reducing fugitive methane emissions from coal mines is a priority for the EPA. Methane is a potent greenhouse gas that can warm the Earth faster than carbon dioxide. Methane is approximately 28 times more effective than carbon dioxide at trapping heat in the atmosphere over a 100-year timeframe.[28] However, over a 20-year time frame, it is approximately 82.5 times more effective.[29] This is due to methane's very short atmospheric lifetime (approximately 12 years), which means its greenhouse effect is concentrated in the short term. As methane warms the Earth much faster than carbon dioxide, reducing methane emissions is important for slowing the rate of atmospheric warming.

The agriculture sector is the largest source of methane emissions in NSW, however only a small proportion of the agriculture sector is regulated by environment protection licences. The EPA is initially focusing on regulatory requirements for its licence holders. Over time this will broaden to other sectors beyond the EPA's licensees and include analysing policy and regulatory options to support the broader economy adopt best practice emissions reductions. This work is being undertaken in collaboration with colleagues across the NSW Government.[30]

The coal mining sector is the largest source of methane emissions licensed by the EPA.[31] Of the fugitive emissions from coal mining, around 80% were from underground coal mines, while around 20% were from surface mines.[32]

Table 3 shows a breakdown of emissions from the NSW coal mining sector by source. Table 4 shows a breakdown of methane emissions across NSW as well as by the sectors licensed by the EPA.

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[26] Australian Government, 'NGER reporting guides', Clean Energy Regulator website, 2025, accessed 29 May 2025.

[27] Australian Government, 'Australia's National Greenhouse Accounts - Emissions by state and territory', Cth Department of Climate Change, Energy, the Environment and Water website, 2025, accessed 29 May 2025; and Boulter et al. 2022, 'Non-road diesel engines – cost-benefit analysis: final report', Cth Department of Climate Change, Energy, the Environment and Water, Canberra.

[28] Australian Government, 'Global warming potential', Clean Energy Regulator website, 2025, accessed 29 May 2025.

[29] IPCC 2021, 'Chapter 7: The Earth's Energy Budget, Climate Feedbacks, and Climate Sensitivity', in *Climate Change 2021: The Physical Science Basis*, Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, Intergovernmental Panel on Climate Change, Cambridge and New York.

[30] NSW Government, 'NSW Government Response to the Net Zero Commission 2024 Annual Report and the Parliamentary inquiry report by the Joint Standing Committee on Net Zero Future'.

[31] NSW EPA 2025d, 'Improving measurement of fugitive methane emissions'.

[32] Australian Government, 'Australia's National Greenhouse Accounts - Emissions by state and territory'.

Table 3 Scope 1 greenhouse gas emissions from the NSW coal sector by source, 2021–22

Source	Greenhouse gas emissions (Mt CO_2-e/year)	Percentage of emissions from the coal sector	Percentage of NSW total emissions
Fugitive emissions from surface mines	1.9 Mt[(a)]	14%	2%
Fugitive emissions from underground coal mines	8.0 Mt[(a)]	57%	7%
Non-road diesel mining equipment (mainly from surface mines)	4.0 Mt[(b)]	29%	4%

Table notes:

Mt CO_2-e/year = million tonnes of carbon dioxide equivalent per year.

(a) Australian Government, 'Australia's National Greenhouse Accounts - Emissions by state and territory'.

(b) Estimate based on data from: Australian Government, 'Australia's National Greenhouse Accounts - Emissions by state and territory'. The non-road diesel portion for coal mines was estimated using: Boulter et al. 2022, 'Non-road diesel engines – cost-benefit analysis: final report'.

Table 4 Methane emissions from NSW and EPA licence holders by sector, 2021–22

Sector	Methane emissions in NSW (Mt CO_2-e/year)[(a)]	Percentage of NSW methane emissions[(a)]	Methane emissions from EPA licence holders (Mt CO_2-e/year)[(a)]	Percentage of methane emissions from EPA licence holders[(b)]
Coal mining	9.0 Mt	28%	9.0 Mt	58%
(Underground coal mining)	(7.1 Mt)	(23%)	(7.1 Mt)	(46%)
(Surface coal mining)	(1.8 Mt)	(6%)	(1.8 Mt)	(12%)
Landfills and wastewater treatment	4.2 Mt	13%	4.2 Mt	27%
Agriculture	16.0 Mt	51%	1.0 Mt	6%
Oil and gas	0.5 Mt	<2%	0.5 Mt	3%
Other (electricity generation, stationary energy, etc.)	1.8 Mt	26%	0.8 Mt	5%

Table notes:

Mt CO_2-e/year = million tonnes of carbon dioxide equivalent per year.

(a) Australian Government, 'Australia's National Greenhouse Accounts - Emissions by state and territory'.

(b) NSW EPA 2025d, 'Improving measurement of fugitive methane emissions'.

Reducing methane emissions will significantly contribute to NSW achieving its target of net zero emissions by 2050 under the Climate Change (Net Zero Future) Act.[33]

Reducing diesel emissions from coal mines is also a priority for the EPA. Diesel emissions are known to adversely affect human health (e.g. contribute to particle pollution) and contain carbon dioxide and short-lived climate pollutants.[34] Diesel vehicles and equipment are widely used at surface coal mines, and to a lesser extent at underground mines.

[33] The EPA's fugitive methane fact sheet provides more information about the importance of reducing methane emissions and actions the EPA is taking to address these emissions. See: NSW EPA, 'Fact sheet: fugitive methane', NSW Environment Protection Authority website, 2024, accessed 29 May 2025.

[34] Diesel emissions contain **black carbon** (a component of fine particulate matter), which is a short-lived climate pollutant. Diesel emissions also contribute to the formation of **tropospheric ozone**, which is also a short-lived climate pollutant.

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Scope 1 emissions: fugitive methane

2.1 Fugitive methane emissions at NSW coal mines

This mitigation guide has a strong emphasis on reducing fugitive methane emissions at coal mines. As NSW underground coal mines contribute significantly more methane emissions than surface mines, many of the measures in this section focus on underground mines.

The amount of methane that is released from mines depends on several factors, including the depth of the coal seam, gas content, its permeability and thickness. As a result, there is considerable variability in the amount and concentration of methane from seam to seam, and this level of methane concentration influences the effectiveness and technical viability of mitigation measures.

Methane is explosive in concentrations in air from 5% and poses a serious safety risk, particularly in active underground mines.[35]

2.2 Mitigation measures for fugitive methane

Most methane mitigation measures described in this mitigation guide involve the oxidation of methane to carbon dioxide. In simple terms, this means turning methane into carbon dioxide and water by reacting it with oxygen. Oxidation significantly reduces the overall global warming potential of the mine gas. However, oxidation does not *eliminate* greenhouse gas emissions completely because carbon dioxide is still ultimately released to the atmosphere.

It is important that methane emissions are minimised over the entire life of the mine (mitigation measures vary according to the mining phase). It is also important that emissions are minimised as early as possible to reduce the impact on global warming.

The most effective approach is to make a comprehensive plan at the mine design phase for the management of all sources of mine gas from the premises over the life of the mine.

A comprehensive plan for gas management could include, for example, planning for progressive gas drainage, the destruction or utilisation of methane in drainage gas, optimised mine ventilation, the destruction of methane in ventilation air, identification and management of gas in areas outbye (away from) active (operational) mining, and gas management during the mine closure process. Methane has the potential to be a resource (e.g. to generate electricity), rather than just a waste product.

The gas management plan may include justification for prioritising methane capture and destruction at one phase of the mining process over another. This prioritisation process can be described and justified as part of a pre-feasibility assessment, where needed (see section 7).

[35] Statutory requirements for the control and monitoring of methane levels at underground coal mines are intended to mitigate safety risks. See Work Health and Safety (Mines and Petroleum Sites) Regulation 2022 (section 76 Control and Monitoring of Methane Levels).

2.2.1 Gas drainage with flaring or utilisation

Gas drainage is the process of drilling holes into the coal seam and surrounding strata and draining a proportion of the gas. This reduces the amount of methane released to the atmosphere during mining operations. Gas drainage can occur at all phases of the mining process, as described in Table 5. Venting may be required from time to time for safety or maintenance reasons.

Methane in drainage gas at high enough concentrations can be destroyed by combustion using flaring or using the methane for beneficial purposes, such as energy generation, as described in Table 6.

Gas drainage for the purposes of flaring or utilisation is generally feasible at 'gassy' mines[36] with thick (>3 m) coal seams, where the methane gas content is >5 cubic metres per tonne (m^3/t); and where methane concentrations in the drainage gas are >25–30% (i.e. once the gas has been removed from the seam).[37]

The Industry Scan found that gas drainage is relatively common at NSW underground mines and is considered to be a mature technology, as it is primarily done for safety and/or production reasons.[38]

There were no examples of gas drainage at NSW surface mines identified in the Industry Scan (although some surface mines were considering it). This is because it is not common for surface mines to have a methane content high enough to make drainage practical. Shallow seams tend to have lower methane content. Logistical challenges include the need to drain multiple seams and accommodating gas drainage logistics in an operating mine (pit room, overburden/coal removal, haulage, backfilling).

The EPA's expert panel noted that there may be opportunities to drain gas at some surface mines. Permeability is enhanced as overburden is progressively removed, and this has potential to enable gas drainage in short time scales within operational cycles (see section 2.2.4).

Some NSW surface mines are also considering modifications to mine deeper coal seams, which can contain higher methane gas contents. Gas drainage in these circumstances should be prioritised, and if this is not feasible, then the disturbance of the seam should be avoided.

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[36] In NSW, gassy coal mines (with a higher methane content), are typically located in the Central, Southern, Newcastle and parts of the Lower Hunter coalfields, although some mines in the Upper Hunter and Gunnedah coalfields are also gassy. Coal seams in the Western coalfields generally have a lower methane and gas content due to geology.

[37] Personal communication EPA's expert panel; and CSIRO 2024, 'A Techno-economic Analysis of Coal-mine Fugitive-emission Reduction Strategies in Australia', October 2024, Commonwealth Scientific and Industrial Research Organisation, Canberra.

[38] EMM 2025, 'Greenhouse Gas Mitigation Guide for NSW Coal Mines: Literature Review and Industry Scan'.

Table 5 Gas drainage at different phases of mining

Mining phase	Underground mines	Surface mines
Active mine (operational)	**Pre-drainage** This is general industry practice in underground mines, where horizontal boreholes are drilled into the seam from either within the mine workings (for underground mines) or from the surface. Gas then flows out of the coal seam through the boreholes into a pipeline collection system. **Active drainage (or post-drainage)** This type of drainage aims at capturing a portion of the gas before it can enter the mine workings. This involves drilling boreholes from the surface or within underground parts of the mine to capture gas released by the mining process. This usually involves partially draining the voids left after longwall mining. It can also involve drilling boreholes within the underlying or overlying coal seams, to extract gas released by the mining process (this is also sometimes undertaken as part of the pre-drainage process). Typically, pre-drainage activities involve **dewatering** before gas production, however post-drainage activities (e.g. surface to seam gas wells) do not require the longwall goaf to be dewatered before gas production.	For surface mines, gas drainage can be difficult for a wide range of reasons, including mine logistic (pit room, overburden/coal removal, haulage, backfilling). Mines can take advantage of permeability enhancement due to progressive stripping of overburden.
Active mine (mine closure and rehabilitation process)	During the mine closure process, gas capture systems can be put in place to direct gas to pipelines where it can be flared or utilised, where possible.	N/A

Table 6 Methods for destroying methane in drainage gas

Method	Description	Feasibility guidance	Industry Scan
Flaring	This involves burning methane in a flame. The main methods are 'open flaring' (burning using an open flame), and 'enclosed flaring' (burning in a controlled, enclosed environment). Flares can achieve a methane destruction efficiency of greater than 99%;[39] although some methane can escape as a result of incomplete combustion.	The variability in methane concentrations and other gas reservoir properties across the site and flow rates of drainage gas may impede the ability to flare drainage gas.	The Industry Scan found that gas drainage with flaring occurs at about five NSW underground coal mines. Some advisory group members note that additional underground mines are planning to install flares. There were no examples of gas drainage and flaring at surface mines (although some were considering it).
Gas utilisation	This involves using the methane in the drainage gas for beneficial purposes. These uses can include, for example, power generation, injection into natural gas pipelines, chemical feedstock and vehicle fuels. Methane utilisation is considered to be a mature/commercial technology for some uses such as electricity generation, while other uses are in the research and development stage (e.g. vehicle fuels – see section 3.2.3). Utilisation usually involves the assistance of a third party such as a company that specialises in generating electricity from methane gas.	The suitability of drainage gas for a particular use depends on its quality, such as the methane concentration and the stability of supply. Methane flow rates are closely linked to the mining cycle, which means that there is variability in flow rates over time. This variability may impede gas utilisation.	Gas drainage with methane utilisation occurred or is planned at three to six NSW mines. There were no examples of gas drainage and utilisation at surface mines (although some were considering it).

2.2.2 Ventilation air methane (VAM) at underground mines

Methane is explosive in concentrations in air ranging from 5% to 15% and poses a serious safety risk. To manage this issue, underground mines must inject sufficient fresh air to dilute methane concentrations to provide safe working conditions and to reduce the risk of explosions. To achieve this, the diluted coal seam gas is exhausted from the mine and diverted to the surface through large-scale ventilation systems. Any methane that is in this ventilation air is referred to as 'ventilation air methane' (VAM).

VAM is exhausted from ventilation shafts at low concentrations, typically in the range of 0.1% to 1.0%, which requires accurate measurement. Methane destruction methods such as flaring and methane utilisation (see section 2.2.1) are not possible at these low concentrations.

The *Work Health and Safety (Mines and Petroleum Sites) Act 2013* and the Work Health and Safety (Mines and Petroleum Sites) Regulation 2022 contain stringent safety requirements for mine ventilation.[40] Mines are also required to develop a ventilation control plan under the Regulation.[41]

[39] UNECE 2024a, 'Best Practice Guidance on Ventilation Air Methane (VAM) Processing', United Nations Economic Commission for Europe, Committee on Sustainable Energy Group of Experts on Coal Mine Methane and Just Transition, Nineteenth session, Geneva.

[40] These requirements include that methane concentrations in the general body of air must not exceed 2% by volume. See Work Health and Safety (Mines and Petroleum Sites) Regulation 2022 (section 76 Control and Monitoring of Methane Levels).

[41] NSW Resources Regulator 2021, 'Technical Reference Guide: Ventilation Control Plan', Department of Regional NSW.

Avoiding VAM

Fix methane leaks from old mine workings

The EPA's expert panel noted that methane emissions from old mine workings within active mining leases can make up a significant proportion (>60%)[42] of VAM. An existing mitigation method involves identifying methane leaks in these old mine areas (outbye, or away from, active mining panels) and prioritising the higher leakage sources for resealing and/or using ventilation balance methods. This method can be implemented relatively quickly and easily, and is likely to have a significant impact on reducing emissions (>20%). Some advisory group members note that this is a common activity at many NSW mines and one of the most cost-effective abatement measures available to mine operators.

Destroying VAM

Destroying VAM through the use of VAM abatement technologies can significantly reduce greenhouse gas emissions (in terms of tonnes CO_2-e) in gassy underground mines. The only existing method for destroying VAM includes regenerative thermal oxidation (RTO) (see Table 7).

Emerging methods include regenerative catalytic oxidation (RCO), and VAM enrichment with utilisation (see Table 8), however the EPA's expert panel noted that these emerging VAM mitigation measures are not likely to be practical without many more years of research.

Table 7 Existing method for destroying VAM at underground mines – regenerative thermal oxidation (RTO)

Method	Description	Feasibility guidance	Industry Scan
Regenerative thermal oxidation (RTO)	RTO involves oxidising the methane in air (i.e. methane reacts with oxygen in air) at high temperatures (e.g. 850 to 1,200°C) in a flow reverse reactor that transfers oxidation heat to a solid medium, and then back to incoming air to raise its temperature to the ignition temperature of methane. The process can be self-sustaining without requiring additional fuel input when the VAM concentration is not less than its minimum concentration requirement. Various types of full-scale VAM RTO plants have been trialled and operated at coal mines around the world. In Australia, there have been RTO demonstrations projects, but not widespread adoption of the technology. There are currently only two RTO installations, both at the Appin Coal Mine in NSW.	RTO technology is considered to be mature/commercially available for the destruction of volatile organic compounds. It results in the conversion of methane to carbon dioxide. As a guide, RTO may be feasible at gassy underground mines[a] with VAM concentrations between 0.2% and 1.0%[b] when they are proved to be suitable for Australia's mine conditions. The operational range of VAM concentration would be different for each type of RTO[c]. Coal mining industry representatives advise that RTO suppliers guarantee down to only 0.4% methane concentration. Suppliers EPA talked to guarantee down to 0.2%.	The Industry Scan found that use of RTO is rare at underground mines and not currently in operation in NSW.

Table notes:

(a) In NSW, gassy coal mines (with a higher methane content) are typically located in the Central, Southern, Newcastle and parts of the Lower Hunter coalfields, although some mines in the Upper Hunter and Gunnedah coalfields are also gassy. Coal seams in the Western coalfields generally have a lower methane and gas content due to geology.

(b) UNECE 2025, 'Best Practice Guidance on Ventilation Air Methane', United Nations Economic Commission for Europe, Geneva.

[42] This is variable but can be up to 80% (EPA's expert panel).

(c) The VAM concentration operating ranges for VAM RTO providers include: Biothermica 0.3 to 1.2%, Dürr 0.15 to 1.1%, ICE-CMM China 0.2%. See UNECE 2024b, International Workshop on Best Practices in Coal Mine Methane Monitoring, Capture and Use, Workshop Summary and Highlights, United Nations Economic Commission for Europe, Geneva.

Table 8 Emerging methods for destroying VAM at underground mines

Method	Description	Status
Regenerative catalytic oxidation (RCO)	RCO differs to RTO only with respect to the use of a catalyst. The VAM is passed over the catalyst, typically made of precious metals like platinum and palladium, which allows the methane to oxidise at a lower temperature (e.g. 350 to 650°C). RCO can also operate at lower VAM concentrations than RTO. RCO may be the only option for some NSW mines with very low minimum VAM concentrations.	RCO technology is considered to be in the research and development to pilot-scale demonstration stage. There have been pilot-scale trials of a modified (catalytic) version of CSIRO's VAMMIT system at Appin Coal Mine in NSW.[a] RCO technology may have fewer safety challenges, compared to RTO, due to the lower operating temperatures.
VAM enrichment and utilisation	'VAM enrichment' refers to technologies that separate methane and increase its concentration, enabling its recovery and use (e.g. to generate electricity).	VAM enrichment is an emerging technology in the research and development stage.

Table notes:

(a) EMM 2025, 'Greenhouse Gas Mitigation Guide for NSW Coal Mines: Literature Review and Industry Scan'. See Box 8.

Box 2. Measurement of VAM

Effective management of VAM requires accurate monitoring because of the very low methane concentrations. Currently under the National Greenhouse and Energy Reporting (NGER) Scheme, mines have the option to do periodic or continuous emissions monitoring to estimate their fugitive methane emissions. The number of samples taken for periodic emissions monitoring can vary site to site and add to the uncertainties of the emissions estimated. In addition, methane concentrations are highly variable, limiting the accuracy of periodic measurement. Continuous monitoring of methane concentrations is necessary to test whether VAM abatement technology can be deployed. The EPA understands that many mines have implemented continuous monitoring of VAM concentrations for safety reasons.

The EPA has set out methane measurement requirements in the *Proposed Climate Change Licensee Requirements*.

Mines in suspended operations (care and maintenance)

During suspended operations, ongoing access to underground workings is needed. Air flow and ventilation to the underground is needed to ensure that the underground mine is a safe working environment. However, ventilation fans may be operated at a lower air throughput (speed).

For mines with RTO units installed, the lack of coal production may result in VAM concentrations that are too low for RTO to operate efficiently. However, the *Best Practice Guidance on Ventilation Air Methane* provides examples of measures to keep the VAM concentration at or above the minimum level required for mitigation.[43] This may include taking actions to reduce the volume of air moved by the main ventilation fans while still maintaining full safety in all parts of the mine. Such actions

[43] UNECE 2025, 'Best Practice Guidance on Ventilation Air Methane', United Nations Economic Commission for Europe, Geneva.

could include shutting off certain parts of the mine or increasing the efficiency of the air flow in other ways.

2.2.3 Progressive mine capping and sealing at underground mines

Once active (operational) coal mining has finished at a site, fugitive emissions can potentially still occur via seals/shafts, venting pipes, shaft covers, surface cracks and geological discontinuities. Without proper sealing, fugitive emissions can continue to be emitted for decades. Emissions can initially be high following mine closure, but they will decline gradually over time as the source decays or once the shaft is submerged under water.[44]

The most effective way to reduce emissions once mining operations have finished is to allow natural mine flooding through ground water infiltration. This is standard industry practice. However, mines can take from a few years to decades to completely flood, and over this time gas may escape if not sealed and closed.

In NSW, once active (operational) coal mining has finished at a site, the mine must progress through a mine closure process with the end result being that the mine is completely sealed. Ventilation shafts and other openings can be sealed by filling them with gravel or concrete. Mine workings can also be temporarily capped as mining progresses across the site.

The Work Health and Safety (Mines and Petroleum Sites) Act and the Work Health and Safety (Mines and Petroleum Sites) Regulation contain stringent safety requirements for mine sealing that must be undertaken before a mining lease can be relinquished.[45]

Mine sealing is considered a 'high risk activity' under the Regulation, and mining companies must comply with stringent guidelines for methane management.[46]

Monitoring and gas capture can continue in mines going through the closure process up until the final seals are put in place.

Some decommissioned mines are required to report emissions under the NGER scheme. Emissions could be material depending on a number of factors, such as the gassiness of the mine, time since decommissioning and the proportion of mine void flooded.[47]

Mines with suspended operations (care and maintenance) must retain active monitoring and ventilation controls. Parts of active mines may be progressively capped (temporarily sealed), however the mine retains the capability to monitor and capture emissions.

Mine sealing can produce other environmental issues such as saline seeps which give rise to water pollution, and needs to be carefully considered. There are cases where flooding of old mine workings resulted in acid mine drainage and saline seeps which required solutions like water treatment plants. The NSW Resources Regulator has detailed guidance on groundwater and surface water management through the mine rehabilitation process that must be followed.[48]

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[44] UNECE 2021, 'Best Practice Guidance for Effective Management of Coal Mine Methane at National Level: Monitoring, Reporting, Verification and Mitigation', ECE Energy Series No. 71, United Nations Economic Commission for Europe, Geneva.

[45] General safety obligations for mine operators are set out in the *Work Health and Safety (Mines and Petroleum Sites) Act 2013*. Specific requirements for mine sealing are set out in clause 71 of the Work Health and Safety (Mines and Petroleum Sites) Regulation 2022.

[46] NSW Resources Regulator 2024a, 'Guide – Notifying the Regulator of a high risk activity', NSW Department of Primary Industries and Regional Development, July 2024, Queanbeyan.

[47] CER 2024, 'Estimating emissions and energy from coal mining guideline', Clean Energy Regulator, Canberra, August 2024

[48] Resources Regulator 2024b, 'Guidance Note – Groundwater and surface water', NSW Department of Primary Industries and Regional Development, Queanbeyan.

2.2.4 Summary of mitigation measures for fugitive methane

Table 9 provides a summary of mitigation measures for fugitive methane.

Table 9 Summary of mitigation measures for fugitive methane

Mitigation measure	Mine type	Mining phase[a]	Readiness (Literature Review)[b]	Industry Scan[c]
Gas drainage with flaring	Underground	Active mine	Commercial/mature	At five NSW mines in 2024
	Surface	Active mine (pre-drainage)	Gas drainage at surface mines: Research and development (R&D)[d] Flaring: Commercial/mature	Nil (but some mines are considering)
Gas drainage with utilisation	Underground	Active mine	Gas drainage at underground mines: Commercial/mature Utilisation: Existing to emerging (depending on use)	Installed or planned at three to six mines in NSW
	Surface	Active mine (pre-drainage)	Gas drainage at surface mines: R&D Utilisation: Existing to emerging (depending on use)	Nil (but some mines are considering)
Avoiding VAM – fix methane leaks from old mine workings	Underground	Active mine (operational phase only - but relates to old mine workings within the mining lease)	Existing[e]	N/A[e] - Some advisory group members have noted this is common practice at mines
VAM destruction – regenerative thermal oxidation (RTO)	Underground	Active mine (operational phase only)	Mature/commercial[f]	Rare
VAM destruction – regenerative catalytic oxidation (RCO)	Underground	Active mine (operational phase only)	R&D to demonstration (the EPA's expert panel noted that RCO is not likely to be practical without many more years of research)	Nil
VAM destruction – VAM enrichment with utilisation	Underground	Active mine (operational phase only)	R&D (the EPA's expert panel noted that RCO is not likely to be practical without many more years of research)	Nil
Progressive mine capping and sealing	Underground	Active mines (those in suspended operations; or going through the closure process)	Standard practice – stringent requirements for sealing	Common

Table notes:

(a) See the *Glossary of terms and abbreviations* section.

(b) EMM 2025, 'Greenhouse Gas Mitigation Guide for NSW Coal Mines: Literature Review and Industry Scan'. See Tables 3.11 and 3.15 (from CCA 2024 and IEA 2023).

(c) EMM 2025. See Table 4.14.

(d) While gas drainage at surface mines is considered to be at the R&D stage, the EPA's expert panel noted that enhanced permeability (due to progressive overburden removal) has potential to enable gas drainage in short time scales (within operational cycles).

(e) This method was identified by the EPA's expert panel. It was not identified in the Literature Review and was not part of the Industry Scan (EEM 2025).

(f) However, there are outstanding concerns about the safety of RTO that need to be resolved.

2.3 EPA expectations for fugitive methane

The EPA expects the mitigation measures in Table 10 and Table 11 to be implemented at NSW coal mines by the dates indicated, unless an exemption or time extension is sought and granted by the EPA. To seek an exemption, coal mining companies will need to demonstrate that the measure is not feasible at their site by providing a pre-feasibility assessment that is independently verified by a fugitive methane expert (see section 7).

Table 10 Drainage gas – expected mitigation measures for methane from July 2027[a]

Mitigation objective	Proposed EPA requirement and expected commencement	Criteria
Destroy methane in drainage gas at underground mines Examples: • gas drainage with flaring • gas drainage with methane utilisation.	**By July 2027**: gas drainage with flaring or utilisation is in place.	Active (operational) underground mines that: • are located outside of the Western coalfields[b], and • emit (or are likely to emit) >25,000 t CO_2-e/year (scope 1).

Table notes:

(a) These proposed requirements do not apply to mines in suspended operations (care and maintenance), or those mines going through the mine closure and rehabilitation process.

(b) In NSW, gassy coal mines (with a higher methane content) are typically located in the Central, Southern, Newcastle and parts of the Lower Hunter coalfields, although some mines in the Upper Hunter and Gunnedah coalfields are also gassy. Coal seams in the Western coalfields generally have a lower methane and gas content due to geology.

Table 11 Ventilation air methane (VAM) – expected mitigation measures for methane from July 2027[a]

Mitigation objective	Proposed EPA requirement and expected commencement	Criteria
Minimise methane entering ventilation air by addressing methane leaks from old mine workings at underground mines Examples: • resealing • ventilation balance methods.	**By July 2027**: methane leaks have been detected and managed.	Active (operational) underground mines that: • emit (or are likely to emit) >100,000 t CO_2-e/year (scope 1).
Destroy ventilation air methane (VAM) at underground mines Examples: • RTO • RCO • VAM enrichment	**By July 2030**: VAM abatement is installed on all mine shafts. In 2028, the EPA will review whether the safety issues for VAM RTO have been resolved before implementing mandatory requirements.	Underground mines that: • will be in an active (operational) mining phase beyond July 2032, and • emit (or are likely to emit) >100,000 t CO_2-e/year (scope 1).

Table notes:

(a) These proposed requirements do not apply to mines in suspended operations (care and maintenance), or those mines going through the mine closure and rehabilitation process.

The EPA acknowledges even if it is technically feasible to implement VAM RTO at some NSW underground coal mines, safety and cost-effectiveness can be barriers.

1. Safety of VAM RTO

All VAM management technology, including VAM RTO, on a mine site is considered part of a mine's operations for mine safety purposes.

Under NSW work health and safety legislation, coal mine operators are required to eliminate, minimise and manage risks to health and safety. This includes undertaking risk assessments, establishing and implementing a safety management system and principal hazard plans. Coal mine operators will need to ensure that any safety risks associated with implementation of VAM are managed. The NSW Resources Regulator provides information and guidance about safety and other regulatory obligations to mine operators.

VAM RTO units are currently operational or have been trialled across the globe, including in the UK, USA, China and Australia (NSW)[49]. New trials are also commencing in NSW and Queensland.

In 2028, the EPA will consider the outcomes of the VAM RTO trials in NSW and Queensland, including any safety issues in implementing VAM RTO, before any mandatory requirements are imposed.

2. Cost-effectiveness of VAM RTO

The EPA has heard from the NSW coal mining industry that the capital and maintenance costs of VAM RTO can be high, particularly to meet NSW safety requirements.

The EPA's view is that VAM RTO could be cost-effective at a number of underground coal mines that meet the criteria, particularly where the carbon reductions can be monetised. For example, coal mines captured by the Commonwealth's Safeguard Mechanism also have the opportunity to generate Safeguard Mechanism credit units (SMCs) for emissions reductions below their Safeguard baseline. The demand for SMCs (and associated prices) is also likely to increase over time.[50]

There may be financial and technical barriers for other underground coal mines. Recent analysis of practical fugitive emissions abatement including VAM RTO suggests it is viable for a number of NSW coal mines.[51]

We recognise that first movers (early adopters) of a commercial technology can incur higher costs and risks. The NSW Government's High Emitting Industries fund offers grants to help NSW's highest emitting facilities reduce their emissions, and could support coal mine operators in adopting VAM RTO and other greenhouse gas mitigation technologies.[52]

The above issues have been taken into account in the development of this mitigation guide. The intention is that the timeframes set out in this guide will enable the industry and the NSW Government to address any potential barriers and to prepare for the costs of any changes in practice.

Consultation questions: Scope 1 emissions – fugitive methane

The EPA's expectations in this draft mitigation guide have a strong focus on reducing fugitive emissions at underground mines. However, there is also potential to bring forward emission reductions for surface mines.

It is not common for surface mines to have a methane content high enough to make drainage practical. Shallow seams tend to have lower methane content. However, we know that some NSW

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[49] UNECE 2025, 'Best Practice Guidance on Ventilation Air Methane'.

[50] CCA 2023, '2023 Review of the Carbon Credits (Carbon Farming Initiative) Act 2011', Climate Change Authority, December 2023.

[51] CSIRO 2025 , 'A Techno-economic Analysis of Coal Mine Fugitive-emissions Reduction Strategies: An assessment of options for New South Wales', March 2025, Commonwealth Scientific and Industrial Research Organisation, Canberra; CSIRO 2024, 'A Techno-economic Analysis of Coal-mine Fugitive-emission Reduction Strategies in Australia', October 2024.

[52] NSW Government, 'High Emitting Industries'.

surface mines are considering modifications to mine deeper coal seams, which can contain higher methane gas contents.

The EPA's expert panel has noted that gas drainage at surface mines is possible in certain circumstances. As surface mines extend into deeper/gassier seams, there are opportunities to require gas drainage and flaring similar to the proposed requirements for underground mines, noting that the site-specific context will determine whether it is feasible.

Q2.1 If surface mines were required to pre-drain gassy seams and destroy methane before mining commences, what factors would impact feasibility?

3

Scope 1 emissions: diesel combustion

3.1 Diesel emissions at NSW coal mines

Diesel engines are used at mines because they are durable, reliable and flexible; they cover wide ranges of capacity and rated power. Large vehicles and equipment include haul trucks, bulldozers, excavators, loaders and graders. Various smaller diesel vehicles and equipment are also used at underground and surface coal mines, including loaders, forklifts, trucks, generators, compressors, pumps and drills.

Coal extraction, processing and transport involves the combustion of significant quantities of fuel. The hauling of overburden and coal at surface mines accounts for the largest proportion of diesel use in the coal mining sector.

3.2 Mitigation measures for diesel combustion emissions

This section describes measures for reducing diesel emissions at different phases of coal mining operations. This section also describes the technology readiness of the different measures and how widely they are currently implemented at NSW coal mines.

Broadly, mitigation measures involve reducing diesel consumption through a range of efficiency measures, transitioning to vehicles and equipment with higher emissions standards, switching to low carbon fuels and electrification.

3.2.1 Standard industry measures

NSW mining companies have already implemented various mine planning measures to maximise operational efficiency, which reduces diesel fuel consumption (and costs) while also reducing greenhouse emissions. Companies routinely review the effectiveness of these measures and make adjustments where necessary to minimise diesel consumption. These standard measures include:

- **Mine layout planning**, such as designing haul routes to minimise energy consumption (e.g. shorter route lengths, reducing gradients, and avoiding unnecessary stops).
- **Haul road management**, such as regular maintenance to ensure that gradients and rolling resistance are minimised.
- **Vehicle fleet planning**, such as:
  - procurement that prioritises fuel efficiency at the vehicle level (e.g. more efficient engines, use of lightweight materials), and that prioritises fit-for-purpose vehicles
  - tailoring the overall fleet to minimise fuel consumption (e.g. larger, more efficient diesel haul trucks can reduce the amount of fuel required per tonne of material hauled).
- **Operational efficiency measures**, such as:
  - scheduling operations to minimise material handling
  - payload management (i.e. so that haul trucks carry the optimal amount of material to maximise fuel efficiency – and potentially reduce the number of trucks needed in the fleet)
  - trip planning, vehicle utilisation planning, and vehicle rationalisation.
- **Equipment maintenance** in accordance with manufacturers' specifications.
- **Minimising engine idling** for vehicles and equipment.
- **Driver training** to minimise fuel consumption.

The EPA is also working with NSW coal mines to bring emissions standards for non-road diesel equipment into line with global best practice and to encourage the uptake of cost-effective low emission technologies in NSW.

In 2025, the EPA intends to introduce licence conditions that require coal mines to transition to non-road diesel equipment that meets **US EPA Tier 4 final** emissions standards as a minimum or better (for example zero emissions equipment) for all non-standby vehicles and equipment used on the surface of the facility.[53] This is an outcome of the EPA's 2024 public consultation on the regulation of coal mines in NSW.[54]

3.2.2 Electrification

There has been significant research and development into electrification of mine vehicles and equipment, including the trialling and procurement of battery electric vehicles, fuel cell electric vehicles and diesel-electric hybrid vehicles. In addition to reducing diesel emissions at mine sites, electric vehicles are likely to have reduced maintenance costs and improved reliability, and form a clearer pathway to future automation. Some of the main developments are currently taking place at iron ore mines. For example, Fortescue and Liebherr Mining have announced a partnership to jointly develop autonomous haulage at iron ore mines, including an intention to use fuel cell and battery electric technology.[55] Technology for battery electric vehicles of the size used at NSW coal mines is not at the same level of maturity or trial stage.

Battery electric vehicles

Electric trucks and loaders for **underground mines** have been on the market for several years, with a slow but steady adoption.[56] The batteries for underground haul trucks do not require a capacity of more than 500 kilowatt hours (kWh), making them easier to electrify than surface haul trucks.

For the large haul vehicles used in **surface coal mining**, there is future potential for on-board battery power to replace diesel power. Surface haul trucks need large batteries (1.5 to 1.6 megawatt hour [MWh] capacity) and cooling systems. Viable options are expected from 2030. The main barrier at this stage is cost (i.e. cost of batteries, cooling system, charging infrastructure and long downtime during charging, battery swapping stations).[57]

The Industry Scan did not identify any examples of electric haul trucks at NSW coal mines.

Hydrogen fuel cell electric vehicles

Hydrogen fuel cells convert hydrogen fuel into energy (by using an electrochemical reaction with hydrogen gas and oxygen). This produces electricity which powers the electric motor that drives the vehicle. Manufacturers and mining companies are researching and developing various hydrogen fuel cell technologies. Potential barriers to the uptake of fuel cell electric vehicles include cost, the lack of renewable hydrogen supply and suitable vehicles, low durability, high hydrogen purity requirements and safety issues associated with onsite hydrogen storage.

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[53] US EPA 2004, 'Control of Emissions on Air Pollution from Nonroad Diesel Engines and Fuel: Final rule', Federal Register, Vol. 69, No. 124, 29 June 2004, US Environmental Protection Agency.

[54] NSW EPA, 'Regulation of coal mines', NSW Environment Protection Authority website, 2025, accessed 29 May 2025.

[55] Fortescue 2024, Fortescue signs US$2.8 billion green equipment partnership with Liebherr for zero emission mining solutions, ASX release, 25 September 2024.

[56] IDTech EX 2024, 'Electric Vehicles in Mining 2024-2044: Technologies, Players, and Forecasts'.

[57] FBICRC 2023, 'An Overview Of Australia's Mining Vehicle And Mining Equipment Electrification', Future Battery Industries Cooperative Research Centre Ltd, August 2023.

Hydrogen fuel cell technology is at the demonstration stage.

Cable-tethering

Cable-tethering involves the connection of electrical equipment to a fixed power supply via a cable. This may be feasible for fixed mining equipment, or vehicles that do not need to cover large distances. However, the use of tethering can be challenging at surface mines (e.g. where haul trucks at surface mines need to travel large distances).

Cable-tethering is a mature technology. The Industry Scan found some examples of large equipment at NSW surface mines that are cable-tethered, such as draglines and shovels.

3.2.3 Low carbon fuel substitution

Low carbon fuels (e.g. biodiesel, renewable diesel, renewable hydrogen, and methane utilisation) can help to reduce greenhouse gas emissions from coal mining by replacing fossil diesel.[58] They are likely to act as an interim measure while electrification develops. The cost of these fuels can vary significantly based on feedstock, logistics and production technology.

Biodiesel

Biodiesel (produced from vegetable oils and waste fats) has been available for several decades but mainly for light vehicles. It is usually only blended with fossil diesel in small amounts. Barriers to widespread adoption include limited supply in the quantities needed to support coal mines.[59] It can be blended with fossil diesel at a 5% blend with minimal risk of engine operability issues. It could potentially be used as a direct replacement for diesel.

There is enough biodiesel production capacity on the east coast of NSW to support a 5% low carbon fuel mandate by 2030.

The Industry Scan found that there had been some trials of biodiesel at NSW coal mines, however, supply was a key issue.

Renewable diesel

An emerging alternative to fossil diesel is synthetically refined 'renewable diesel'. Renewable diesel can be produced from a wide variety of renewable feedstocks. Unlike biodiesel, renewable diesel has similar chemical and physical properties to fossil diesel and behaves similarly to fossil diesel when combusted in an engine, although, renewable diesel has a slightly higher energy density and burns cleaner than fossil diesel. Conceivably, renewable diesel could become a transitional fuel while other technologies – such as electrification and hydrogen – are being developed.

Renewable diesel is a fairly recent technology, and the supply chain is still developing. While renewable diesel is currently not produced commercially in Australia, this is likely to change in the coming years.[60] Demand-side signals and commitments will also help support investment in the renewable diesel supply chain. In March 2025, the Australian Government announced $250 million

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[58] Fossil diesel refers to diesel fuel that is derived from crude oil (which is formed over millions of years).

[59] NSW coal mines used ~51 petajoules (PJ) (over 1,300 ML) of diesel a year in 2024 (Cth DCCEEW 2024a 'Australian Petroleum Statistics 2024', Cth Department of Climate Change, Energy, the Environment and Water, Canberra).

[60] For example, there are several Queensland-based proposals that have progressed and have a liquid fuel production potential in excess of 1 billion litres.

in funding to support the production of low carbon liquid fuels.[61] The NSW Renewable Fuels Strategy (in development) will also aim to diversify and expand NSW's local renewable fuel industry.[62]

Renewable methanol

Through simple modifications, diesel engines can run as dual-fuel engines with a portion of the energy supplied by renewable methanol. Due to the ease of technology adoption, marine engine manufacturers have already commercialised methanol-diesel dual-fuel engines for cruise ships and ferries.[63] The technology involves an installation of methanol injector in the intake manifold, replacing a portion of the air with fuel. The air-fuel mixtures later burn together with diesel inside the cylinder.

Renewable hydrogen

There is current research and development into supplementing diesel internal combustion engines with hydrogen fuel (hydrogen-diesel direct injection dual-fuel technology[64]). This technology allows diesel engines to run primarily on hydrogen. Not to be confused with hydrogen fuel cell electric vehicles (section 3.2.2), this new technology will allow existing diesel engines to be converted to hydrogen burning spark ignition engines or to be retrofitted to run on hydrogen as well as diesel. This means that haul trucks may be retrofitted instead of disposed of. There are several companies providing retrofitting solutions.[65]

Hydrogen internal combustion engines share the same uptake barriers of the fuel cell electric vehicles, such as the lack of renewable hydrogen supply and safety issues associated with onsite hydrogen storage.

Methane utilisation (drainage gas)

There may be opportunities for methane in drainage gas to be used beneficially onsite as vehicle fuel. For example, trials of dual-fuel technology for mining trucks have been underway at a Queensland surface coal mine since 2023.[66] While the trial commenced using natural gas brought onsite, the trial is expanding into natural gas produced from the mine site. The technology allows methane from drainage gas to be used as a diesel fuel substitute. While the combustion of methane gas still results in carbon dioxide emissions, the global warming potential of the gas is significantly reduced (see section 2.2), lowering the overall emissions profile of the mine.

There may be opportunities in the future for this technology to be used at surface mines in NSW that are accessing deeper, gassier coal seams.

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[61] King 2025, 'Low-carbon liquid fuels of the Future Made in Australia', media release, The Hon Catherine King MP, Minister for Infrastructure, Transport, Regional Development and Local Government, 6 March 2025.

[62] NSW Government, 'Building a thriving renewable fuel industry in NSW'.

[63] For example, see MAN Energy Solutions, 'A methanol refit for passenger ships', MAN Energy Solutions website, accessed 29 May 2025.

[64] See UNSW, 'Converting diesel engines to run on hydrogen', UNSW Sydney website, accessed 29 May 2025.

[65] For example, see Liebherr, 'Pioneering work in the quarry: Liebherr and STRABAG test hydrogen wheel loader', Liebherr website, 2024, accessed 29 May 2025; and KEYOU, 'KEYOU develops hydrogen-powered dump truck for global construction equipment leader Komatsu', KEYOU website, 2025, accessed 29 May 2025.

[66] This project is a partnership between Mine Energy Solutions and Thiess at the Curragh Mine Complex. MES, 'Mine Energy Solutions / Thiess Partnership Announcement', Mine Energy Solutions website, 2012, accessed 29 May 2025; and Thiess, 'Investing in transitional technologies', Thiess website, 2024, accessed 29 May 2025.

3.2.4 Summary of mitigation measures for diesel emissions

Table 12 provides a summary of mitigation measures for diesel emissions.

Table 12 Summary of mitigation measures for diesel emissions

Mitigation measure	Mine type	Mining phase	Readiness (Literature Review)[a]	Industry Scan[b]
Standard industry measures	All mines	All phases	Standard practice	All mines
Electrification	All mines	All phases	R&D to mature/commercial	Common across a variety of equipment types), not common for large haul trucks
Low carbon fuel substitution	All mines	All phases	R&D to mature/commercial	Some consideration and trials

Table notes:

(a) EMM 2025, 'Greenhouse Gas Mitigation Guide for NSW Coal Mines: Literature Review and Industry Scan'. Tables 3.12 and 3.16 (CCA 2024; Issa et al. 2023; FBICRC 2023; Advisian 2022).

(b) See EMM 2025.

3.3 EPA expectations for diesel emissions

The EPA expects mining companies to continue implementing standard industry measures. This includes continuing to implement standard diesel efficiency measures (and reviewing the effectiveness of those measures over time), and to begin transitioning to US EPA Tier 4 final emission standards or better.[67]

The EPA strongly encourages all mines, including coal mines, to transition their diesel vehicles and equipment to low emission alternatives as soon as possible, while implementing low carbon fuel solutions in the interim. While this guide and these expectations apply to coal mines, the EPA intends to consider similar requirements for all mines and other sectors in the future.

If a coal mine meets the criteria set out in Table 13, the EPA expects the mitigation measures outlined in the table to be implemented by the dates indicated, unless an exemption or time extension from the EPA is sought and granted. To seek an exemption, coal mining companies will need to demonstrate that the measure is not feasible at their site by providing a pre-feasibility assessment that is independently verified by a diesel emissions expert (see section 7).

[67] An outcome of the EPA's 2024 public consultation on the regulation of coal mines in NSW (see section 3.2.1).

Table 13 Diesel emissions – expected mitigation measures from July 2030

Mitigation objective	Proposed EPA requirement and expected commencement	Example measures	Criteria
Reduce fossil diesel emissions at all coal mines	**By July 2030**: **5%** of fuel used at the mine site is a low carbon alternative to fossil diesel. **By July 2035**: **10%** of fuel used at the mine site is a low carbon alternative to fossil diesel. **By July 2040**: • **25%** of fuel used at the mine site is a low carbon alternative to fossil diesel, **and** • **75%** of large mining machinery and vehicles are zero emissions[a]. **By July 2050**: • **25%** of fuel used at the mine site is a low carbon alternative to fossil diesel, **and** • **100%** of large mining machinery and vehicles are zero emissions[a].	Low carbon fuels: • biodiesel • renewable diesel • renewable methanol • renewable hydrogen • methane utilisation (drainage gas). Electrification: • battery electric • hydrogen fuel cell • cable-tethering.	All mines that emit (or are likely to emit) >25,000 t CO_2-e/year (scope 1).

Table notes:

(a) Large mining machinery and vehicles means >560 kW capacity.

The EPA acknowledges that, at present, low carbon fuels are not commercially available from domestic producers in sufficient quantities to enable the full replacement of fossil diesel fuel at NSW mine sites. The EPA understands there is, however, sufficient biodiesel production capacity to support a 5% low carbon fuel mandate by 2030. There is also likely to be capacity within the market for a smaller target, earlier. As a result, we seek views on whether the EPA should progress a requirement for 2.5% of fuel used at NSW coal mines to be a low carbon alternative to fossil diesel by 2027.

Additional actions will be needed to support the 2035 targets and beyond. The NSW Government is progressing a Renewable Fuels Strategy which will progress a range of actions to help accelerate supply of renewable fuels in NSW.[68] Demand-side signals and commitments will also support the acceleration of the industry.[69]

The EPA will review low carbon fuel supply ahead of 2035 and take that into account before specific requirements are placed on coal mines.

[68] NSW Government, 'Building a thriving renewable fuel industry in NSW'.

[69] For example, corporate decarbonisation commitments.

Consultation questions: Scope 1 emissions – diesel combustion

Reducing fossil diesel use is an important measure needed to help bring forward emissions reductions at surface coal mines to support NSW's emissions reduction targets. In addition to the expectations set out in this guide, the EPA is considering whether it is feasible for surface mines to bring forward changes to fleet. For example, transitioning to low emissions vehicles in the 2030s.

There may also be capacity within the biodiesel production market to support a mandate in the 2020s.

The EPA has heard that investing in operational expenditure is more financially feasible than large capital expenditure for coal mines given the remaining life span of the mines. Increasing low carbon fuel use is one option to help deliver that, however, the EPA's expert panel noted that the priority for renewable diesel may be for use in aviation and maritime activities where there are limited alternatives for electrification or low carbon fuels.

Q3.1 Should the EPA progress a regulatory requirement for 2.5% of fuel used at NSW coal mines to be a low carbon alternative to fossil diesel by 2027?

Q3.2 Can coal mines transition to low or zero emissions large mining machinery and low carbon alternatives to fossil diesel sooner?

Q3.3 What are the barriers and opportunities?

4

Scope 1 emissions: minor sources

4.1 Mitigation measures for minor scope 1 emissions

The sources in Table 14 are typically only minor contributors to scope 1 emissions at NSW coal mines and have been included for completeness.

Table 14 Mitigation measures for minor scope 1 emissions

Emission source	Application / emissions source	Mitigation measures
Petrol combustion	Small, portable equipment; on-road vehicles	• Electric battery equipment • Hybrid and battery electric passenger vehicles
Ammonium nitrate fuel oil (ANFO) combustion	Explosives	• Optimising blast strategies to improve coal yield • Recycling or reusing oils and greases, reducing virgin oil demand
Oils and greases	Lubricants on equipment, and cleaning	• Recycling or reusing oils and greases, reducing virgin oil demand • Switching to bio-lubricants
Sulfur hexafluoride (SF_6)	Leakages from cooling gas (refrigerant) in high-voltage electrical switchgear, circuit breakers and transformers	• Company operating procedures • Machine maintenance and replacement (to detect and address leaks) • Gas accounting and tracking • Training in SF_6 handling and use • SF_6 recycling
Coal handling, processing and storage	Methane released from fractured coal after extraction Carbon dioxide and other pollutants released from spontaneous combustion	• Minimising coal handling • Spontaneous combustion management plans • Regular monitoring of the coal temperature in stockpiles • Applying dust suppressants and water to cool coal • Introducing microbial or biochemical agents to stabilise coal • Covering and sealing stockpiles to reduce exposure to air • Enclosing stockpiles with gas capture and flaring
Vegetation removal	Land clearing to begin mining process, which disrupts the natural carbon sinks of vegetation	• Avoiding/reducing vegetation clearing as far as practical • Mulching or composting removed vegetation to avoid rapid decomposition or burning • Rehabilitation of land (especially with native plants) as quickly as possible, and progressively during construction and operations

4.2 Guidance for minor scope 1 emissions

The EPA recognises that many of the mitigation measures for minor scope 1 emissions are standard industry practice. The EPA encourages coal mining companies to continue implementing and reviewing the effectiveness of these measures, and to consider where additional measures could be adopted over time.

Consultation question: Scope 1 emissions – minor sources

The EPA's expert panel noted that these scope 1 sources are minor contributors to the emission profiles of coal mines and that there were limited opportunities to mitigate these sources.

Q4.1 Should the EPA have any requirements/expectations for coal mining companies about reducing minor sources of scope 1 emissions?

5

Scope 2 emissions

5.1 Scope 2 emissions at coal mines

This section of the mitigation guide provides information to help coal mining companies to reduce scope 2 emissions. Scope 2 emissions are indirect emissions primarily associated with the purchase of electricity, as well as the generation of steam, heating or cooling at a site. Scope 2 emissions are generated outside of an organisation's boundaries, such as by an external power station in the case of electricity.

Most NSW coal mines are connected via the electricity grid to the National Electricity Market. According to emissions reported under the NGER Scheme, scope 2 emissions from coal mining in NSW in 2023–24 were 1.5 Mt CO_2-e/year.[70]

At many underground coal mines, most of the large equipment is powered by electricity. The most significant consumers of electricity include longwall/continuous miners, coal conveyor belts, winders and shuttle cars to transport people and materials, and ventilation fans. At both underground and surface mines, coal processing consumes a significant proportion of electricity. A coal processing plant contains many smaller motors operating pumps, fans, conveyors etc.

5.2 Mitigation measures for scope 2 emissions

The greenhouse gas emissions from a given mining process depend on the amount of electricity used by the process and the emission intensity of the electricity source. However, should the site invest in behind the meter renewables[71], or the purchase of renewable energy from the grid, they do have the potential to access electricity at lower/zero emissions intensity. Measures to address scope 2 emissions therefore involve:

- reducing onsite electricity consumption by improving energy efficiency
- sourcing renewable electricity
- investing in onsite renewables.

Box 3. Spot price electricity market

The EPA's expert panel noted that the operations with sophisticated metering and load shifting can take advantage of the electricity spot market to reduce the emissions intensity of their grid electricity. However, changes in spot market emissions intensity are not taken into account in current NGER Scheme greenhouse gas accounting methods.

5.2.1 Energy efficiency measures

Mitigation measures for improving energy efficiency are largely inexpensive and already commonplace. This section focuses on measures associated with the use of electricity that results in reduced total emissions to the site. In this context coal mining companies should consider energy efficiency, energy management and demand response. Taken together, these three sets of activities can reduce the total emissions associated with delivering the same production amount.

It is standard practice for NSW mining companies to implement various measures to improve energy efficiency and reduce greenhouse gas emissions, such as the installation of variable speed drives

[70] Data provided by the Clean Energy Regulator, accessed March 2025.

[71] 'Behind the meter' refers to a renewable power system that is installed directly on the mine site, reducing demand for grid electricity.

and control systems to match load to capacity on conveyor belts, or improving the efficiency of buildings in the design phase. In this area, companies should consider ways to ensure production is delivered at minimum emissions, including:

- traditional energy efficiency installations (standard practice)
- improved energy management through hard (metering) and soft (artificial intelligence and improved control algorithms, training and awareness) measures
- demand response, including load shaping and load shifting (aided by sophisticated management systems) to maximise process throughput and minimise associated emissions.

5.2.2 Reducing the emissions intensity of electricity

The NSW grid is undergoing rapid decarbonisation, and its emission intensity is projected to be significantly lower by 2030 and approaching zero by 2040 (Figure 1).

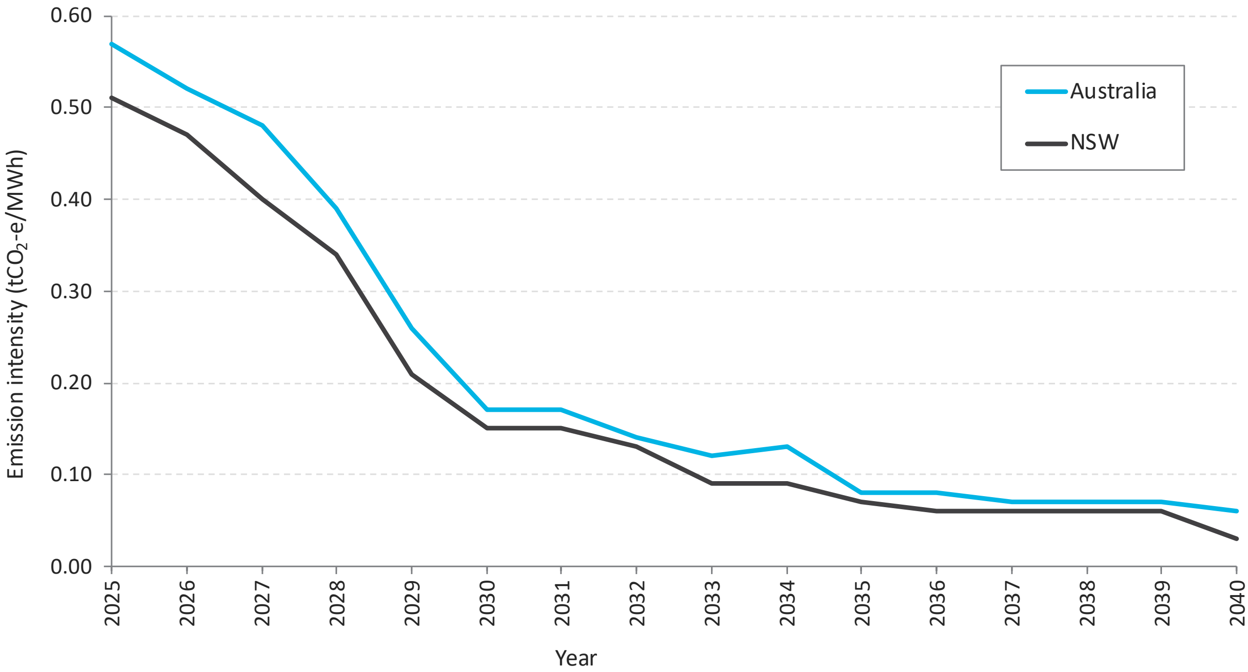

Figure 1 Scope 2 emission intensity of grid electricity in Australia and NSW[72]

The decarbonisation of the NSW grid and its intensity should reduce coal mine scope 2 emissions substantially, even though the demand for electricity at mine sites is likely to increase due to electrification.

Under the Commonwealth Renewable Energy Target (RET), large energy consuming coal mines are required to purchase a certain percentage of their electricity from renewable sources each year.[73] This is achieved through the acquisition of large-scale generation certificates (LGCs). In 2025 this percentage is 18%. The RET is finishing in 2030 and is likely to be followed by mechanisms such as the voluntary Renewable Electricity Guarantee of Origin scheme.[74]

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[72] Cth DCCEEW 2024b, 'Australia's Emissions Projections 2024', Cth Department of Climate Change, Energy, the Environment and Water, Canberra.

[73] Australian Government, 'Renewable Energy Target', Clean Energy Regulator website, 2025, accessed 29 May 2025.

[74] Australian Government, 'Renewable Electricity Guarantee of Origin', Clean Energy Regulator website, 2024, accessed 29 May 2025.

In the meantime, the principal measure that can be taken is to purchase renewable electricity (e.g. through a power purchase agreement or a progressive procurement process with exposure to the spot market).

The future electrification of NSW coal mines will be supported by the development of Renewable Energy Zones, which are intended to encourage investment in renewable generation and storage projects. This should reduce the cost of renewable electricity and create more opportunities for innovative approaches to buying electricity coupled with demand-shaping programs.

Further into the future, there is potential for renewable energy generation to be more widespread at mine sites, probably in combination with energy storage systems (e.g. batteries). Energy storage will be especially important for any off-grid coal mines. However, it is recognised that the grid could disincentivise the construction of onsite renewable electricity generation, as purchase from the grid may be more economical.

The key measures available for reducing emissions intensity at NSW coal mines include:

- onsite renewable electricity generation (wind, solar and geothermal) with energy storage
- purchase of renewable electricity.

Mining companies can reduce the emissions intensity of their electricity consumption through:

- **the installation of onsite (often behind the meter) renewables**. Electricity generated by these systems can be utilised before electricity is drawn from the grid. These systems are usually operated by a third party. Batteries can also be installed to store electricity onsite.
- **the purchase of renewable electricity** from the grid, for example, through:
    - a **power purchase agreement** (PPA), which is a contract between an energy buyer, such as a mining company, and an energy seller, usually a project developer (a wholesale PPA) or electricity retailer (a retail PPA).[75] It is a contract for a fixed price and fixed supply of renewable energy, making it cheaper for businesses to use. PPAs guarantee that a mining company can purchase energy from renewable energy projects like offsite solar farms or wind farms at an agreed price, volume and term.
    - **the surrender of large-scale generation certificates**. Under the Australian Government's Large-scale Renewable Energy Target, LGCs are a financial incentive for the generation of renewable energy from a power station. LGCs are tradable certificates created for eligible large-scale renewable energy power stations. An LGC is equal to 1 megawatt hour (MWh) of renewable electricity generated or displaced by a power station. Many NSW coal mines are large users of grid electricity and have obligations to surrender a certain number of LGCs each year to meet their obligations under the Large-scale Renewable Energy Target.[76] As discussed above, the RET is finishing in 2030 and is likely to be followed by mechanisms such as the voluntary Renewable Electricity Guarantee of Origin scheme.[77]

[75] Wholesale PPAs are available to organisations with high energy consumption (over 60 gigawatt-hours per year [GWH/year]).

[76] Australian Government, 'Large-scale Renewable Energy Target'.

[77] Australian Government, 'Renewable Electricity Guarantee of Origin'.

5.2.3 Summary of mitigation measures for scope 2 emissions

Table 15 15 provides a summary of mitigation measures for scope 2 emissions.

Table 15 Summary of mitigation measures for scope 2 emissions

Mitigation measure	Mine type	Mining phase	Readiness (Literature Review)[(a)]	Industry Scan[(b)]
Energy efficiency measures including demand response and energy management	All mines	All phases	Standard practice/mature	Common
Onsite renewables and batteries and integration of site with electricity generation profiles	All mines	All phases	Demonstration to mature	Uncommon
Purchase of renewable electricity	All mines	All phases	Mature	Uncommon

Table notes:

(a) EMM 2025, 'Greenhouse Gas Mitigation Guide for NSW Coal Mines: Literature Review and Industry Scan'. See Tables 3.14 and 3.18: (Crittenden et al. 2016; FBICRC 2023; CCA 2024).

(b) EMM 2025. See Table 4.16.

5.3 Guidance for scope 2 emissions

The EPA strongly encourages mining companies to implement energy efficiency measures and to reduce the emissions intensity of their grid electricity consumption through measures such as a PPA and the installation of onsite renewable electricity generation, wherever practicable.

Consultation question: Scope 2 emissions

The EPA's expert panel noted that more detailed guidance could be provided on the breadth of energy efficiency, energy management and demand response opportunities available to NSW coal mines. The panel also noted that the RET is finishing in 2030, and that the EPA could consider expectations for the industry to purchase renewable electricity after this date.

Coal mining is only one of the industries that the EPA licenses which include large energy users. The EPA intends to consider scope 2 requirements across all large energy users in the future and will align with the decarbonisation of the electricity grid and potential increases in consumption due to electrification.

Q5.1 Do you have any suggestions about scope 2 requirements for EPA licensees to help inform our future work on scope 2 emissions?

Q5.2 How should the decarbonisation of the grid be considered, if EPA expectations for scope 2 are to be established?

6

Scope 3 emissions

6.1 Overview

This chapter provides information to help coal mining companies to reduce scope 3 emissions. Scope 3 emissions are indirect emissions, other than scope 2 emissions, that are generated in the wider economy.

Scope 3 emissions may occur 'upstream' of a coal mine, such as during the extraction and production of the fossil fuels consumed onsite (e.g. diesel); or 'downstream', such as from the transport of coal to customers, or the end use of coal by a power station.

The topic of scope 3 emissions is therefore very large and complex, and for mining companies, emissions are generally beyond their control. Consequently, this mitigation guide focuses mainly on identifying opportunities for mining companies to reduce their scope 3 emissions.

6.2 Examples of opportunities to reduce scope 3 emissions

By far the largest source of scope 3 emissions in the coal mining sector comes from the downstream use of coal, particularly its combustion in power generation and industrial processes. It is difficult for coal mining companies to reduce scope 3 emissions from the downstream use of coal as the end result is always combustion. However, there are opportunities such as:

- selling coal to buyers who have lower emissions intensities (i.e. buyers that are investing in carbon capture and storage and high-efficiency combustion)
- selling coal to buyers in countries that have strong climate policies and emission reduction targets (e.g. countries that are signatories to the Paris Agreement).

Examples of other opportunities to reduce scope 3 emissions are provided in Table 16.

Table 16 Other opportunities for reducing scope 3 emissions

Aspect	Potential opportunities
Reducing upstream emissions	• Agreements with suppliers, such as: – encouraging manufacturers and suppliers to pursue net zero emissions for their own operations – agreements to implement sustainable transport polices and technologies, such as electric road vehicles, electric rail and renewable electricity supplies – use of green hydrogen in the manufacture of ammonia for explosives (green explosives). • Use of local equipment and materials suppliers, as well as contractors and consultants, where practicable. • Ensuring suppliers have appropriate sustainability credentials. • Reducing embodied carbon, including: – requirements for materials with a low carbon footprint to be built into procurement policies – supporting non-energy markets in the use of coal and waste materials, such as producing asphalt from coal and converting waste into construction materials. • Purchasing green explosives (green ammonia): – green ammonia is a low carbon alternative to traditional ammonium nitrate which is made using fossil fuels. Green ammonia nitrate can directly replace conventional ammonia in mining explosives.[78]

[78] For example see: Cth DCCEEW 2024b, 'Australia's Emissions Projections 2024'; NSW Government, *Green Ammonia Market Study* available at Hydrogen Resources, NSW Climate and Energy Action website; and Nadig 2024, 'Revolutionising mining: the rise of nitrate-free explosive alternatives', Mining Technology website, 16 October 2024, GlobalData.

Aspect	Potential opportunities
Reducing downstream emissions	• Optimising transport routes, and reducing the distance that coal needs to be transported to downstream users. • Agreements with end users of coal (and intermediates), such as: – implementation of sustainable transport polices and technologies (as above) – assistance with transport routes, and reducing the distance that coal needs to be transported – helping international customers to reduce their emissions – requiring the handling and storage of coal to be conducted according to best practice.
Supporting research and development	• Support for the development of low emission technologies, such as: – technologies to reduce emissions from thermal power plant (e.g. advanced boilers and turbines, ammonia injection, co-firing with biofuel) – technologies to reduce emissions from steelmaking – technologies to reduce emissions from shipping (e.g. vessel and route optimisation, and energy-efficient technologies such as hull coatings, and hydrogen and wind-assisted propulsion). • Research into carbon capture and storage, such as: – capturing carbon dioxide from thermal power plant and converting it into solid materials for concrete production – partnerships with industries that use coal or invest in carbon capture and storage technologies to capture and store carbon dioxide emissions from their operations or from coal utilisation.

6.3 Guidance for Scope 3 emissions

The EPA strongly encourages mining companies to implement a variety of measures to reduce their scope 3 emissions, including purchasing green explosives.

Consultation question: Scope 3 emissions

The EPA's expert panel noted that by far the biggest source of scope 3 emissions is the end use of coal. All other scope 3 emissions are very minor by comparison. Including a section on (or specific EPA expectations) for scope 3 emissions without addressing the downstream use of the product could be challenging.

It is beyond the EPA's remit to include specific requirements or limitations on coal mines around the end use of coal. However, there could be opportunities for the mining sector to influence its supply chains to decarbonise. For example, an expectation that the coal mining industry uses green explosives may stimulate a market for these products. A disadvantage to this approach is that it may be inequitable to place these types of scope 3 mandates on coal mines ahead of other NSW industries.

Q6.1 Should the guide include expectations for coal mine companies to address certain scope 3 emissions? For example, an expectation that mines use green explosives?

7

Exemptions and time extensions

7.1 Proposed process for seeking to be exempt from an EPA requirement

This mitigation guide signals the EPA's expectations with respect to implementing measures to reduce scope 1 greenhouse gas emissions at NSW coal mines. It has been informed by extensive technical, expert, financial and economic advice and analysis.

The EPA recognises that the NSW coal mining sector is complex, with a range of mine types, geological characteristics, mine configurations, mining techniques and regulatory requirements. Coal mining companies are best placed to consider, in detail, whether the various mitigation measures described in this mitigation guide are feasible for their operation.

If a mining company determines it is not feasible to implement a mitigation measure, it will be able to seek to be exempt from that requirement. This will need to be supported by documentation that demonstrates the measure is not feasible at the site, by providing a **pre-feasibility assessment** that is independently verified.

If a mine intends to implement a mitigation measure but cannot do so in the timeline set by the EPA, then it can apply to the EPA for an extension (see section 7.2).

7.1.1 Proposed pre-feasibility assessment content

The EPA proposes that the pre-feasibility assessment should consider technical, logistical and financial feasibility.

1. **Technical and logistical feasibility: Is the mitigation measure technically and logistically possible?**
   a. Issues to be considered include safety, commercial readiness, required lead time for implementation, and site-specific mine characteristics. For example, it is not technically feasible to implement drainage and flaring at mines with high carbon dioxide gas content. It is also not technically feasible to implement an RTO where the methane concentration in the ventilation air is too low for the RTO to be self-sustaining.
   b. Where relevant, the coal mining company could describe a comprehensive plan for the management of mine gas over the life of the mine (see section 2.2), including where methane gas capture and destruction will be prioritised (e.g. pre-mine drainage, VAM abatement).
2. **Financial feasibility: Is the mitigation measure cost-effective?**
   a. It is not expected that reductions in emissions should be pursued 'at any cost'. Nor is it expected that the preferred option will always be the lowest-cost option. However, it is important that the preferred option is cost-effective. This will need to be considered on a case-by-case basis.
   b. Companies should ensure their financial feasibility assessment includes the costs of meeting their pollution/emission reduction obligations (e.g. under the Safeguard Mechanism) and opportunities to monetise carbon reductions.
   c. Companies should also consider all available financing options available to them.
   d. The EPA's view is that VAM abatement is financially viable for many underground coal mines that meet the criteria (see Table 9).

The pre-feasibility assessment will need to include evidence to support the coal mining company's position, and include both qualitative and quantitative data. The pre-feasibility assessment will need to be independently verified by an appropriate expert.

New mining proposals and modifications – greenhouse gas assessments

The *NSW Guide for Large Emitters* requires proponents of large greenhouse gas emitting proposals to prepare a greenhouse gas assessment as part of the planning assessment process.[79]

Coal mine proponents will need to have regard to this mitigation guide when preparing their greenhouse gas assessments, and demonstrate that best practice measures to minimise greenhouse gas emissions will be implemented at the site. Proponents will need to have regard to any relevant expectations set out in this mitigation guide. They do not have to apply to the EPA for an exemption. However, if the proposal is inconsistent with the EPA's requirements, then this will have to be justified in the greenhouse gas assessment submitted as part of environmental impact assessments, with supporting evidence.

Existing coal mines – climate change mitigation and adaptation plans (CCMAP)

The EPA expects coal mining companies to identify and progress greenhouse gas mitigation measures at each of their existing licensed mines.

The EPA's *Climate Change Mitigation and Adaptation Plans: Proposed Mitigation Requirements* require licensees to prepare and implement a CCMAP for their operations. Under section 3.2 of the proposed requirements, licensees will need to identify and commit to mitigation measures and specify a timeframe for implementation.[80]

Coal mine licensees will need to have regard to this mitigation guide and implement mitigation measures at each licensed premises, when preparing their CCMAPs. Coal mine licensees are required to benchmark the mitigation actions in their CCMAP against this mitigation guide, including any EPA expectations.

The licensee's application for an exemption, including pre-feasibility assessment, will need to be accompanied by a valid CCMAP.

7.1.2 How long would an exemption last?

The exemptions may be time limited, or ongoing. This may depend on site-specific circumstances.

7.2 Requests to extend the timeline for implementation

If a mine intends to implement a mitigation measure but cannot do so in the timeline set by the EPA, then it can apply to the EPA for an extension. An extension may be reasonable, for example, if the licensee is awaiting planning approval or delivery of equipment from overseas. In these cases, the EPA will consider a short timeline extension. These will be as short as possible. Evidence would be needed to support any request. Mines will need to demonstrate that significant work is underway and all efforts have been made to meet the timeline.

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79 NSW EPA 2025a, 'NSW Guide for Large Emitters'.

80 NSW EPA 2025b, 'Climate Change Mitigation and Adaptation Plans: Proposed Mitigation Requirements', Consultation draft.

7.3 Due dates for exemption and timeline requests

The due dates for requests to extend timelines will be published with the final published version of the guide. Coal mines should allow adequate time ahead of the relevant regulatory requirement coming into effect.

Consultation questions: Exemptions and time extensions

The EPA's expert panel noted that, if undertaken in good faith, requiring mining companies to undertake a pre-feasibility assessment is a practical way for companies to demonstrate to the EPA that they cannot implement a required mitigation measure.

Some advisory group members have suggested that mines that cannot technically implement the proposed mitigation requirement should not have to seek an exemption. The EPA is seeking views on whether the exemption framework should specify the scenarios in which mines will not need to seek exemptions. However, for this to occur, mines will still need to demonstrate, with evidence, why certain mitigation requirements are not feasible.

In terms of cost-effectiveness, the panel noted that access to funding is also an issue that mining companies may need to consider (i.e. how easy the mitigation measure may be to finance).

The EPA notes that the cost-effectiveness of mitigation measures can also be improved where there is opportunity to generate carbon credits or access government funding. For example, Safeguard Mechanism credits units (SMCs) offer opportunities for coal mining companies to monetise carbon reductions. The demand for SMCs and their price is also likely to increase over time.[81] This will likely increase the cost-effectiveness of mitigation measures over time.

Some advisory group members suggested that an objective test for financial viability would be helpful for industry certainty, such as using the Commonwealth ACCU cost containment price as an upper limit on mitigation cost expectations.[82] An alternative option would be to consider the NSW Treasury carbon values that NSW Government agencies must use when valuing the impact of carbon emissions in cost-benefit analysis.[83] A cost-benefit analysis assesses the societal benefits and costs of emissions reduction actions and not the financial feasibility of mitigation actions for specific businesses.

Some advisory group members suggested that there needs to be an avenue for public input into any exemptions process to ensure its robustness and transparency.

Q7.1 Do you have any suggestions to improve the robustness and transparency of the pre-feasibility assessment process, and to reduce compliance costs for licensees?

Q7.2 Should the exemptions process outline the circumstances in which an exemption does not need to be sought on specific technical feasibility grounds?

Q7.3 Any exemptions issued by the EPA would be made public. Should any of the information in the pre-feasibility assessment be made public?

Q7.4 Should there be an avenue for public input into the exemptions process and, if so, how? Is the publication of CCMAPs and progress against CCMAPs sufficient to provide transparency?

Q7.5 Could grounds for an exemption include reducing the equivalent level of scope 1 and 2 emissions on site?

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[81] CCA 2023, '2023 Review of the Carbon Credits (Carbon Farming Initiative) Act 2011'.

[82] Australian Government, 'Cost containment measure', Clean Energy Regulator website, 2025, accessed 29 May 2025.

[83] NSW Government, 'Carbon emissions in the Investment Framework', NSW Treasury website, 2025, accessed 29 May 2025.

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Glossary of terms and abbreviations

Glossary of terms

This mitigation guide uses definitions for coal mine types and mine phases that are, firstly, commonly used in the Australian coal industry and, secondly, relevant to the mitigation of greenhouse gas emissions from coal mines.

This guide refers to various greenhouse gases, emissions scopes and mitigation terms. These terms are fairly common when outlining both emissions sources, mitigation actions and reporting requirements (see Table 17).

Table 17 Glossary of terms – greenhouse gases

Term used in this guide	Definition	Reference
Scope 1 emissions	**Scope 1** emissions are released to the atmosphere as a direct result of an activity, or series of activities (including ancillary activities) that constitute the facility. Scope 1 emissions are sometimes referred to as direct emissions.	*National Greenhouse and Energy Reporting Act 2007* (NGER Act)
Scope 2 emissions	**Scope 2** emissions are released to the atmosphere as a direct result of one or more activities that generate electricity, heating, cooling, or steam that is consumed by the facility but that do not form part of the facility. Scope 2 emissions are sometimes referred to as indirect emissions arising from the indirect consumption of an energy commodity.	NGER Act
Scope 3 emissions	**Scope 3** emissions are indirect emissions other than scope 2 emissions that are generated in the wider economy. They occur due to the activities of a facility, but from sources not owned or controlled by that facility's business. Some examples are extraction and production of purchased materials, transportation of purchased fuels, use of sold products and services, and flying on a commercial airline by a person from another business.	NGER Act

The definitions of mine types used in this migitation guide are given in Table 18. The two general types of coal mine referred to are underground mines and surface mines. For each general type of mine, various mining methods are in use.

Table 18 Glossary of terms – mine types

Term used in this guidance	Definition	Reference
Underground mine	A coal mine that allows extraction of coal by mining at depth, after entry by shaft, adit or drift, without the removal of overburden.	NGER Measurement Determination 2008
Surface mine	A mine in which the overburden is removed from coal seams to allow coal extraction by mining that is not underground mining. Also called open cut mines.	NGER Measurement Determination 2008

The phases of mining that are used in this mitigation guide are summarised in Table 19.

Table 19 Glossary of terms – mine stages

Mine phase	Typical activities at this phase	Synonymous term
Active mine	**Mining is operational** The following activities may take place: • pre-drainage (surface to inseam and underground inseam pre-mining) • active drainage (goaf and adjacent seam drainage) • operation of mining infrastructure (e.g. ventilation fans, monitoring equipment) • progressive temporary seals and caps as mining progresses.	• Operational mine
	Suspension of operations[(a)] (Coal production has ceased) The following activities may take place: • mine continues to be managed and monitored so that access is still possible • ventilation fans remain operational • monitoring continues • mine workings may begin to naturally flood • may include further temporary seals and caps.	• Care and maintenance • Inactive mine[(b)]
	Mine closure and rehabilitation process The following activities may take place: • gas drainage (post-mining) • withdrawal of infrastructure (including monitoring equipment) • mine workings continue to naturally flood • whole-of-mine sealing • rehabilitation process.	• Mine decommissioning • Mine rehabilitation[(c)]
Closed mine	**Mine is fully rehabilitated and closed** • mining lease has been relinquished back to the government • flooding continues naturally over time • no monitoring infrastructure • permanent seals in place.	• Decommissioned mine[(d)] • Abandoned mine[(b)]

Table notes:

(a) Various coal mines in Australia have remained in suspend operations for a number of years, without being fully closed and rehabilitated. Examples in NSW include Russell Vale Colliery, Wongawilli Colliery, Newstan Colliery and Awaba Colliery.

(b) UNECE 2008, 'Glossary of coal mine methane terms and definitions', August 2008, United Nations Economic Commission for Europe, Geneva.

(c) NSW Government, 'What is mine rehabilitation', NSW Resources website, 2025, accessed 29 May 2025,

(d) CER 2024, 'Estimating emissions and energy from coal mining guideline', p. 44.

Abbreviations

A list of abbreviations used in this guide and their meaning is provided in Table 20.

Table 20 Abbreviations

Abbreviation	Definition
ANFO	ammonium nitrate fuel oil
CCMAP	climate change mitigation and adaptation plan
CCS	carbon capture and storage
CO_2	carbon dioxide
CO_2-e	carbon dioxide equivalent
CSIRO	The Commonwealth Scientific and Industrial Research Organisation
EPA	NSW Environment Protection Authority
kW	kilowatt
kWh	kilowatt hour
L	litre
LGC	large-scale generation certificate
m	metres
Mt	million tonnes
MW	megawatt
NGER	National Greenhouse and Energy Reporting
NSW	New South Wales
PPA	power purchase agreement
R&D	Research and development
RCO	regenerative catalytic oxidation
RET	Renewable Energy Target
RTO	regenerative thermal oxidation
SMC	Safeguard Mechanism credit unit
SF_6	sulfur hexafluoride
t	tonne
UN	United Nations
VAM	ventilation air methane

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