LETA

Low Emission Technology Australia

SUBMISSION TO THE NSW EPA CONSULTATION ON PROPOSED CLIMATE CHANGE LICENSEE REQUIREMENTS

INTRODUCTION

Low Emission Technology Australia (LETA) welcomes the opportunity to provide a submission to the NSW Environment Protection Authority (EPA) on its consultation documents:

- *Proposed Climate Change Licensee Requirements* (July 2025).
- *Proposed Greenhouse Gas Mitigation Guide for NSW Coal Mines* (July 2025).
- *Climate Change Mitigation and Adaptation Plans: Proposed Mitigation Requirements* (July 2025).

LETA is a not-for-profit investment fund that accelerates the development and large-scale deployment of technology solutions to reduce and remove greenhouse gas emissions from critical industries like steel, cement and power generation.

LETA members are committed to reducing emissions from the coal value chain and to advancing technologies that achieve this while supporting safe and productive operations. Ventilation air methane (VAM) abatement has been identified by the industry as one of the most promising pathways to achieve these objectives. Methane is a greenhouse gas with a high global warming potential, and reducing emissions from mine ventilation systems provides a practical opportunity for the sector to demonstrate leadership in emissions management.

To date, LETA has – on behalf of the industry – allocated a total of nearly $60 million in VAM abatement projects that have been critical to the research and development of this technology. LETA's investment in VAM abatement is on track to reach almost $100 million by 2030.

Our investments in Regenerative Thermal Oxidisers (RTOs) and catalytic oxidation technologies are designed to build the technical and safety evidence base required to bring forward solutions that are reliable, commercially viable and compatible with Australia's rigorous safety standards. By progressing both relatively mature and emerging technologies, LETA is working to ensure that practical abatement options can be deployed across a range of mine conditions.

The NSW Government has made clear that it is important the industry contribute their fair share of the State's emission reduction goals. LETA supports the direction of travel, but we emphasise that the implementation pathway must be realistic, staged, and grounded in technical and safety evidence.

This submission is informed by LETA's technical work program, engagement with Australian underground coal miners, international best-practice reviews, and our ongoing investment in research, development and demonstration of methane abatement technologies.

Our submission has also been informed by LETA's, and our member's, involvement in NSW EPA VAM abatement workshop, held in Sydney on 1 October 2025. LETA appreciated the opportunity to be involved in the workshop, which featured a productive exchange of information and perspectives between the industry, the NSW EPA, regulators and service providers.

Our submission concentrates exclusively on VAM abatement. We address the practical feasibility of Regenerative Thermal Oxidisers (RTOs) for VAM, the technical realities in New South Wales mine

environments, the economic context, safety requirements, and the development pathway for catalytic oxidation technologies that aim to treat lower methane concentrations at reduced operating temperatures.

Our experience shows that a staged, flexible approach is required. Some technologies are mature and could be deployed in the short term at specific sites. Others, particularly catalytic systems for low methane concentrations, need further research and demonstration before they are commercially viable. Above all, mine safety must remain the first priority.

In summary:

- RTOs can reduce VAM effectively, but only when methane levels and airflows stay within a narrow range. Many NSW underground mines sit below (in some cases, significantly below) the self-sustaining level of about 0.4% methane, with concentrations shifting depending on local geology, where mining is taking place, and production cycles. This means RTOs often cannot run continuously without extra fuel, which cancels out much of the emissions reduction benefit.

- Any system connected to a mine's main ventilation must meet strict Australian safety rules and, relevantly, the specific mine safety rules applying in NSW. These require conservative designs, long connection ducts, and multiple layers of protection. Overseas designs, like those used in parts of the US and China, do not meet these standards and so cannot be directly copied in NSW.

- When methane levels fall to low levels below around 0.4%, there is not enough heat released from oxidation to keep the RTO hot. The system then needs large amounts of extra fuel, which increases costs and can reduce or even reverse the emissions savings. NSW policy should take this cost and performance drop-off into account.

- LETA is investing in catalytic systems that can run at lower temperatures and lower methane levels. These are still early in relatively early stages of development, with work focused on making catalysts last longer, resist dust and contaminants, and connect safely to mine ventilation. The challenge is also to make them affordable at mine scale.

- **In the short-term, LETA recommends the priority be to use RTOs at mines with higher methane levels, run co-funded demonstrations under NSW safety conditions and regulations, and continue investing in catalytic technology. Rules should encourage abatement where it is technically and economically possible, while avoiding unsafe or unrealistic requirements at unsuitable sites. Regulators and mine staff should also be given time to build confidence in operating these systems safely.**

BACKGROUND

Methane is a relatively potent greenhouse gas. Over a 100-year timeframe[1], it traps around 28 times more heat in the atmosphere than carbon dioxide. Because methane breaks down relatively quickly in the atmosphere (about 12 years), cutting methane emissions now can deliver immediate climate benefits while longer-term decarbonisation measures scale up.

The EPA's consultation documents propose a framework that combines:

[1] This is the GWP timeframe consistent with Australia's international greenhouse gas emissions reporting obligations (which is the role and responsibility of the Australian Government). See cer.gov.au/schemes/national-greenhouse-and-energy-reporting-scheme/about-emissions-and-energy-data/global-warming-potential for more information.

- Annual climate change emissions reports (from 2026) to establish a clear and transparent baseline.
- Climate Change Mitigation and Adaptation Plans (CCMAPs) (from 2026–27), requiring licensees to disclose current and future emissions, outline their mitigation measures, and set reduction goals.
- Specific mitigation actions set out in sectoral guides, beginning with coal mining.
- Improved emissions measurement to strengthen accuracy and reliability.
- Greenhouse gas limits in licences to be phased in over time.

The *Mitigation Guide for NSW Coal Mines* sets out detailed expectations:

- Underground mines to install gas drainage and flaring/utilisation systems by July 2027.
- Methane leaks from old workings to be managed by July 2027.
- VAM abatement systems to be installed by July 2030 (subject to review of safety trials in 2028).
- Coal mines with large diesel fleets to progressively adopt low-carbon fuels from 2030, with electrification and zero-emissions equipment expected by 2040–2050.

These proposals represent a significant shift. They move beyond reporting and planning, towards mandatory implementation of specific methane abatement technology on mine sites. They are also inconsistent with the timetable set out by the Australian Government in its Resources Sector Plan, which was released after the NSW EPA consultation documents.

LETA supports the cost effective application of emissions reduction technologies and is investing on the industry behalf to advance the safe and timely development and deployment of emission reduction technologies, such as VAM abatement. However, the technical, operational, and safety realities of underground coal mines mean that not every site will be suitable for immediate or uniform adoption of technologies like RTOs. A staged and flexible approach is essential.

LETA'S WORK IN VAM ABATEMENT

LETA has been investing since 2007 in technologies to support Australian industry to reduce emissions through practical technology pathways. In underground coal mining, VAM is a significant source of fugitive methane. As the NSW EPA is aware, methane has a relatively high global warming potential compared carbon dioxide over 100-year period. This means that near-term reductions can deliver meaningful climate benefits while other decarbonisation measures continue to scale.

LETA's work in VAM abatement has focused on three areas:

- Technical feasibility and safety: development of a functional safety case for VAM abatement systems connected to primary ventilation, including safe connection duct architectures, isolation, flame arrest, dilution, and default to atmosphere on 'trip'.
- Demonstration-readiness for RTOs at suitable sites: working with our members to establish first of a kind demonstrations of VAM abatement at Australian mine sites.
- Catalytic oxidation R&D: pilot-scale work on catalysts that can oxidise methane at lower temperatures and at lower concentrations than are practical for RTOs, with a view to progressive scale-up subject to safety validation and economics.

Crucially, LETA's approach is technology neutral. Our aim is to assess technological solutions to methane abatement against safety, technical feasibility, emissions impact and economic practicality, with an emphasis on real-world deployment at Australian mines.

THE IMPORTANCE OF A CONSISTENT NATIOANAL APPROACH

Every major coal mining facility in NSW is already subject to the national emissions reduction policy approach – the Safeguard Mechanism[2] – will requires annual emissions reduction, of 4.9%, consistent with industry make a comparable contribution to the national emissions reduction task.

The Australian Government recently announced its 2035 emissions reduction task – a range of a 62-70% emissions reduction on 2005 levels[3] – a target that is more ambitious than NSW's 2035 emissions reduction target.

As part of those announcements, made after the NSW EPA released these consultation documents, the Australian Government also released its Resources Sector Plan[4], which sets out how the resources sector – including coal mining – will transition to a net zero economy. It does this by analysing emissions reduction opportunities and the role of technology in each part of the resources sector, including coal mining.

In relation to coal mining, the Plan considers VAM abatement technologies in detail. In relation to implementation timetables, the Plan finds that it expects:

- in the period to 2030, demonstration of coal VAM abatement technology in Australian mines;
- by 2035 scale-up of coal VAM abatement technology in Australian mines and greater use of methane pre-drainage in coal mines; and
- through to 2050, widespread use of VAM abatement and pre-drainage technologies for coal mines.

This timetable broadly aligns with industry work programs and expectations and was informed by rigorous analysis from the Climate Change Authority[5], Department of Industry, Science and Resources and Department of Climate Change, Energy, the Environment and Water and a comprehensive program of industry and broad stakeholder consultation.

This means it will be vital that any requirements imposed by the NSW EPA complement, rather than duplicate, the significant emissions reduction requirements that the Safeguard Mechanism already places each year on the industry, and the incentives that national climate policy approach provides for the industry it develop and deploy emissions reduction technologies. This includes VAM abatement technologies and the timetable and analysis underpinning the Resources Sector Plan.

The NSW EPA has provided little compelling evidence that the arbitrary requirements included in these consultation documents are necessary in the face of the comprehensive national policy approach and what value they add to the emissions reduction task that already faces the industry and in which the industry is already actively investing, including through LETA.

[2] See www.dcceew.gov.au/climate-change/emissions-reporting/national-greenhouse-energy-reporting-scheme/safeguard-mechanism for more information.
[3] See minister.dcceew.gov.au/bowen/media-releases/joint-media-release-setting-australias-2035-climate-change-target for more information.
[4] The Resources Sector Plan is available at www.industry.gov.au/publications/resources-sector-plan.
[5] In their Sector Pathways Review (see www.climatechangeauthority.gov.au/sector-pathways-review for more information) advice provided to the Australian Parliament in late 2024. Commissioned by the Australian Parliament, the review considers the pathways for six sectors – agriculture and land; built environment; electricity and energy; industry and waste; transport and resources – to decarbonise. It identifies barriers and proposes strategies and actions to address them. The resources chapter of the Review considers in detail the role and timetable for implementation of VAM abatement technologies.

TECHNICAL CHALLENGES OF VAM ABATEMENT

Methane concertation limits

Regenerative Thermal Oxidisers (RTOs) are currently the most developed option for treating ventilation air methane (VAM). They work by passing mine air over ceramic beds heated to very high temperatures – usually around 1,000°C – so that methane (CH_4) is oxidised into carbon dioxide and water. Once operating steadily, the system relies on the heat from this reaction to keep itself hot.

LETA's work with project proponents to date shows that RTOs require methane levels of about 0.4% in the incoming air to keep running without supplemental fuel. If levels fall below this, the reaction does not release enough heat to balance losses, and the unit needs extra fuel to stay hot. At very low levels of methane – around 0.2% – the margin becomes so small that continuous operation is not possible.

In theory, an RTO operating at 0.2% methane would require more than 98% of its outgoing heat to be recycled into the incoming air while cooling its exhaust from 1,000°C down to ambient levels (about 45°C) with almost no loss. This level of efficiency is not realistic in real-world mine environments. Current materials, insulation and ductwork cannot consistently achieve it. As of August 2025, no supplier offers guarantees that an RTO can operate sustainably at 0.2% methane on a working mine site.

For this reason, LETA is also investing in catalytic abatement technology. Catalysts trigger oxidation at lower temperatures, usually around 500°C. Because they need less heat, they can work at lower methane concentrations. Figure 1 compares the heat requirements of RTOs and catalysts. Even in an unrealistic scenario of 100% heat recovery, RTOs still demand far more energy because of their higher operating temperature. In practice, RTOs therefore need higher methane concentrations to run efficiently, while catalysts can continue to operate where methane concentrations are lower.

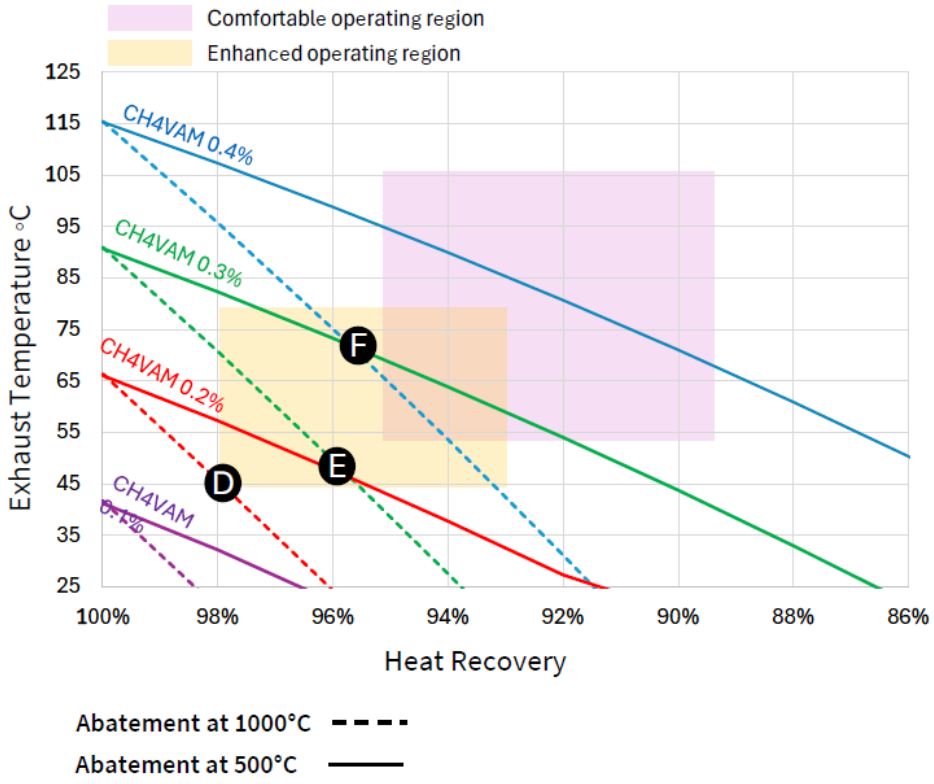

Figure 1

The situation is made harder by the reality of NSW mines. Methane levels fluctuate depending on seam gas content, panel location, ventilation changes, sealing practices, barometric pressure and production schedules. A mine may only occasionally reach 0.4% methane, with long periods at lower levels. A system tuned for 0.4% must also be able to cope with double that level (0.8%), which risks overheating, and half that level (0.2%), which risks extinguishing. While RTOs can be designed to handle some variability, frequent shutdowns and restarts increase wear, raise maintenance costs, and reduce the actual hours of abatement.

The evidence suggests RTOs are best suited to mines with steady, higher methane levels. Only a limited number of NSW mines meet this profile, and even fewer have operating lives beyond 2035. This is why LETA continues to invest on behalf of the industry to support catalytic abatement development, which could broaden the number of suitable sites in the future.

Flow stability and operating range

RTO performance depends on keeping air in contact with the hot bed for long enough while maintaining a uniform temperature. If flow rates or methane levels swing too far, the reaction can extinguish or push the system above safe temperatures. Each unit is designed for a particular operating range. Too much methane at high flow risks overheating the ceramic bed. Too little methane means the reaction dies out and the unit relies heavily on burners.

Mine ventilation is designed to keep workers safe and to meet legal minimums. As the NSW Resources Regulator confirmed at the NSW EPA Workshop on 1 October 2025, adding an RTO into this circuit adds complexity. Even with conservative designs, the oxidiser will still be exposed to the ups and downs of mine operations – production changes, stoppages, seal movements and maintenance events. While control systems can handle moderate swings, frequent operation near the margins increases trips, wear, and the risk of shutdowns that cut abatement performance.

To work well, RTOs need to recover and recycle most of the heat from each cycle. This requires clean, insulated ducts and stable input conditions. In practice, mine air contains water vapour, dust, and small amounts of contaminants. Storms can push cold, damp air into the system. Dust and salts can clog passages, reduce heat transfer, and add to pressure losses. These conditions mean RTOs need strong inlet filtration, drainage, weather protection, and robust refractory materials. Even with these measures, fouling and thermal shock can reduce efficiency over time.

Current abatement options and site integration considerations

Where methane levels and flows are within the design range, RTOs can achieve destruction efficiencies above 90%. But getting them to work safely requires more than just plugging them in. Key factors include:

- enough space near mine shafts for long, safe connection ducts;
- access for construction, maintenance, and emergency bypass;
- compliance with hazardous area rules around shaft outlets; and
- managing visible thermal plumes, noise, and community concerns.

RTOs are designed for a narrow operating window. Too much methane or air pushes them above safe temperatures. Too little methane means they go out and must burn extra fuel. While systems can be fitted with interlocks to manage these swings, these add cost and do not remove the need for relatively stable average conditions.

International pilots have shown that RTOs can sometimes operate at levels below 0.4%, but these results cannot be scaled up to every NSW mine. Designers sometimes specify larger units to lengthen contact time, but this increases size, footprint, and visible impacts. Larger reactors also struggle with sudden spikes that can damage the ceramic beds.

Community engagement and environmental approvals are therefore essential parts of any project. These essential activities will add an uncertain but potentially lengthy period to the timetable required to safely and effectively implement a VAM abatement project. The NSW EPA consultation documents provide no pathway to streamline these requirements in a way that would allow the industry to meet the EPA's arbitrary proposed VAM abatement implementation timetable.

Recognising the technical limits of RTOs, the industry, including through LETA, is also pursuing catalytic abatement. Catalysts reduce the required operating temperature and therefore the methane concentration needed. But catalytic systems must still prove they can last in real mine air, cope with dust and moisture, and meet NSW's appropriately strict safety standards. LETA's research program is addressing these issues through a staged and rigorous step-by-step approach, but catalytic abatement should be seen as a medium-term solution, not an immediate one.

Economic feasibility and policy challenges

The cost of VAM abatement depends heavily on methane concentration and flow stability. Capital costs include the size of the oxidiser, the connection duct, acoustic treatment, stacks, and monitoring equipment. Operating costs include extra fuel, electricity, and regular maintenance. At low methane levels, fuel use quickly dominates and makes projects uneconomic, even if technically possible.

Commercial readiness in NSW also depends on supply chain capacity. Internationally, some pilot projects exist, but only a handful of vendors have mine-scale experience. These supply chain limitations were confirmed at the 1 October 2025 workshop. To roll out at a commercial scale across NSW, Australia would need new manufacturing capacity, local fabrication, trained service teams, and a reliable supply of spare parts. At present, one provider alone could not supply and service every potential site.

Catalytic abatement is still in development, with likely deployment in the 2030s if research milestones are met. These include laboratory validation, pilot trials, reactor and heat system design, ignition and control to Australian standards, and safe integration with mine ventilation.

A stable policy environment that recognises the importance of site suitability, values measured abatement over theoretical potential, and allows for staged adoption as technologies mature will unlock private investment and encourage uptake of VAM abatement technologies. Co-funding for pilots and early deployments would help build the local evidence base, reduce perceived risk, and accelerate learning curves. Importantly, any mandated requirements must be realistic about technical constraints and mine safety, and must allow the regulator to approve or decline installations on a case-by-case basis.

For VAM abatement to succeed in NSW, policy must:

- recognise that not all sites are technically suitable;
- reward measured, real abatement rather than theoretical potential;
- allow staged adoption as technologies mature; and
- support early projects with co-funding to reduce risk and build the evidence base.

Approvals will also need to consider community impacts. Large oxidisers produce visible plumes and noise and require stacks of significant height. Mines close to towns will need careful design and consultation. Early, transparent engagement with communities will help maintain trust and ensure social licence.

SAFETY IS THE CRITICAL REQUIREMENT

Australia, including in NSW, appropriately takes a very cautious approach with regards to any equipment that connects to a mine's main ventilation system. Ventilation must always meet the minimum levels set by law, and nothing can be allowed to increase the risks of explosion, fire, or suffocation. Any abatement unit must therefore be "air-loss neutral" during normal operation and must automatically return the system to its original ventilation path in the event of equipment failure.

Designs also need to stop flames or pressure waves from travelling back into the mine, remove or control possible ignition sources in hazardous areas, and prove that isolation devices will move to and stay in safe positions when required. These principles are written into regulator guidance and are central to mine ventilation plan approvals.

Some overseas projects have used shorter ducts between the main fan and the oxidiser. This makes installation easier and reduces pressure loss, but it also leaves little room for flame arrest, dilution, quenching, and pressure relief. In NSW (as well as Queensland), the standard is stricter: an indirect, longer connection duct is required to fit all these safety features and to give enough residence time to quench any abnormal event.

While international experience is useful, NSW cannot simply copy overseas designs. The NSW approach appropriately demands more conservative margins, proven fail-safe behaviour, and independent ventilation capability. These features are not always built into systems used in the US or China and must be incorporated before approval here.

Areas around shaft outlets and return airways are also classified as hazardous because methane levels can change and combustible mixtures may form under abnormal conditions. Any plant in or near these areas must be designed to avoid ignition, limit hot surfaces, and demonstrate that flames cannot propagate upstream into the mine.

For this reason, RTOs designed for Australian mines must include multiple layers of protection. These include strict temperature limits backed by fast-acting shutdowns, monitoring across the ceramic bed to detect hot spots or cooling, and interlocks that prevent operation when oxygen or methane levels are outside safe bounds.

Each of these points was emphasised by the NSW Resources Regulator at the 1 October 2025 Workshop.

Trials in Australia have shown that RTOs can be operated safely under controlled conditions. But moving from relatively small-scale trials to widespread commercial use will require a stronger evidence base. For the NSW industry, systems will need to show reliable performance in flame arrest, isolation, bypass, and functional safety under NSW rules.

LETA has supported, and continues to support, the engineering work needed to define these safety cases and verification plans. We will continue to invest in building the knowledge and evidence base needed to support safe, large-scale deployment in NSW mines.

CONCLUSION

Reducing methane emissions from NSW coal mines is both necessary and achievable, although the pathway will not be uniform across all operations. Variations in methane concentrations, coupled with stringent safety requirements and economic factors, highlight the need for a targeted and staged approach – prioritising sites with suitable methane profiles for RTO deployment while continuing to advance catalytic systems for lower-concentration environments.

Australia's mine safety standards, including in NSW, are deliberately and appropriately conservative. These high standards require infrastructure and safeguards that differ from many international examples. Applied systematically, they provide a reliable framework to introduce VAM abatement technologies without compromising ventilation integrity or the most critical of requirements – the safety of mine workers.

LETA remains committed to working in close partnership with the NSW Government, regulators, industry, and technology providers to deliver practical, safe, and credible methane abatement outcomes. With appropriate policy settings and sustained investment in demonstration and innovation, NSW can achieve meaningful reductions in fugitive methane emissions while supporting the ongoing contribution of the coal mining sector to regional economies.