Strategies for Mitigating Methane Emissions with Focus on VAM

Dr David Creedy

Sindicatum Sustainable Resources
Vice Chair, UNECE Group of Experts on CMM and Just Transition

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1. Introduction

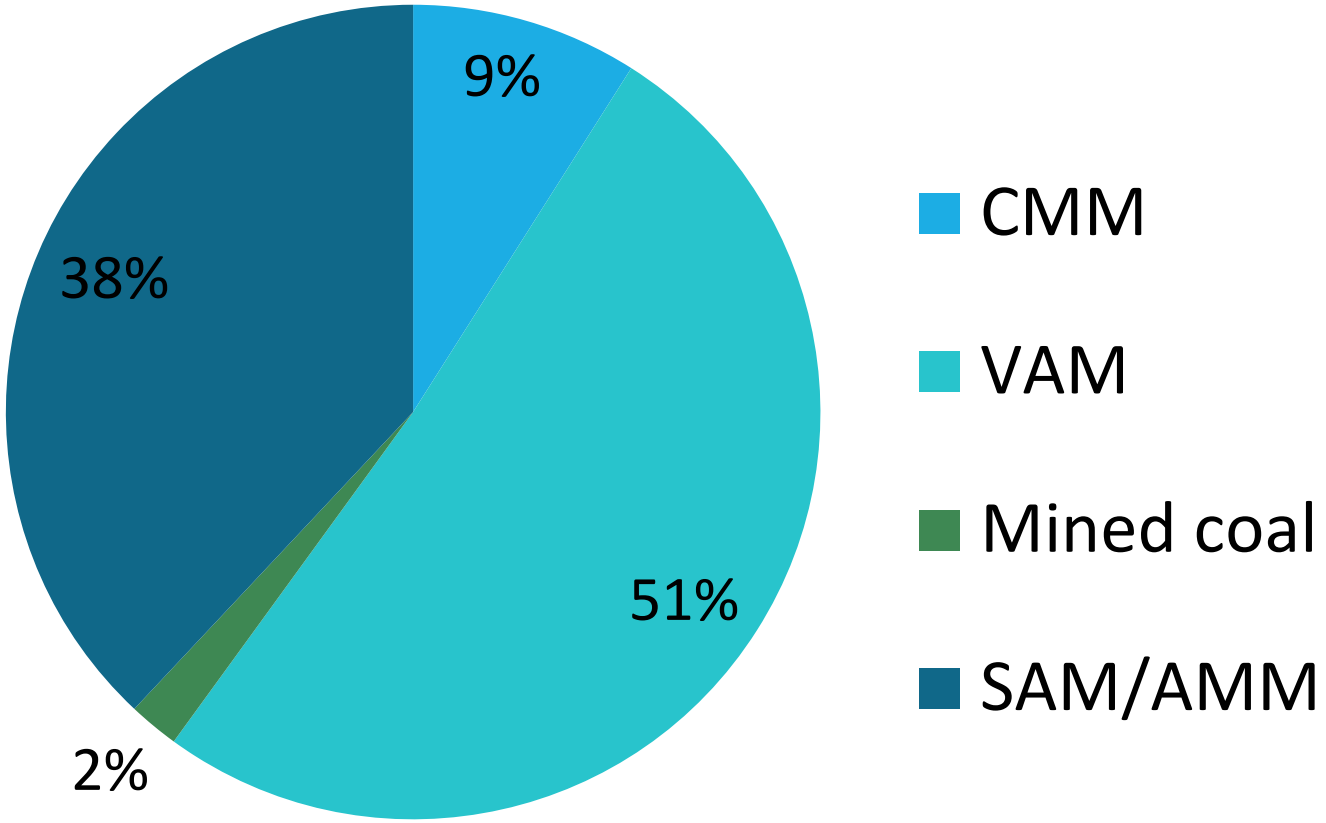
***The world is "not on a good track" to meet its goal of pivoting away from fossil fuels in order to avoid the most dangerous consequences of climate change* (US Climate Envoy John Kerry).**

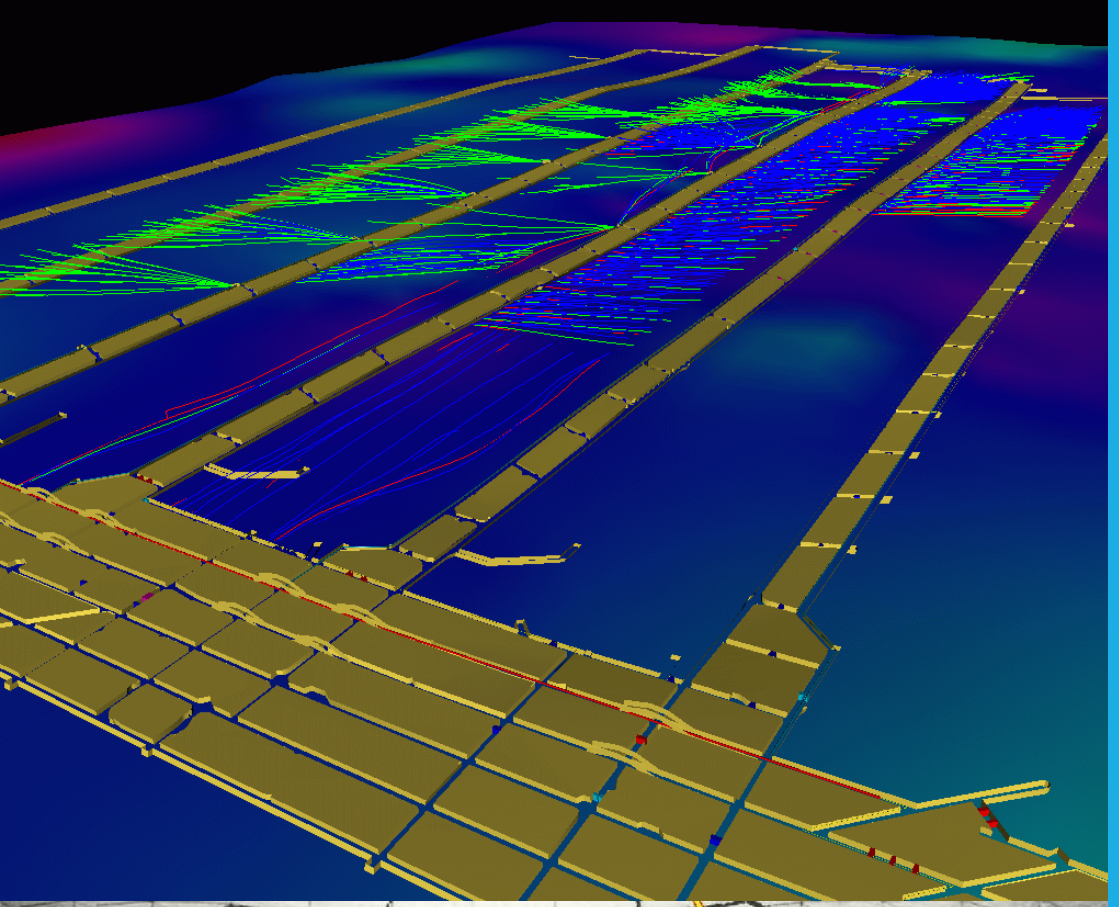
This presentation proposes practical actions using available technology to reduce emissions from coal mines during transition, with special emphasis on VAM mitigation.

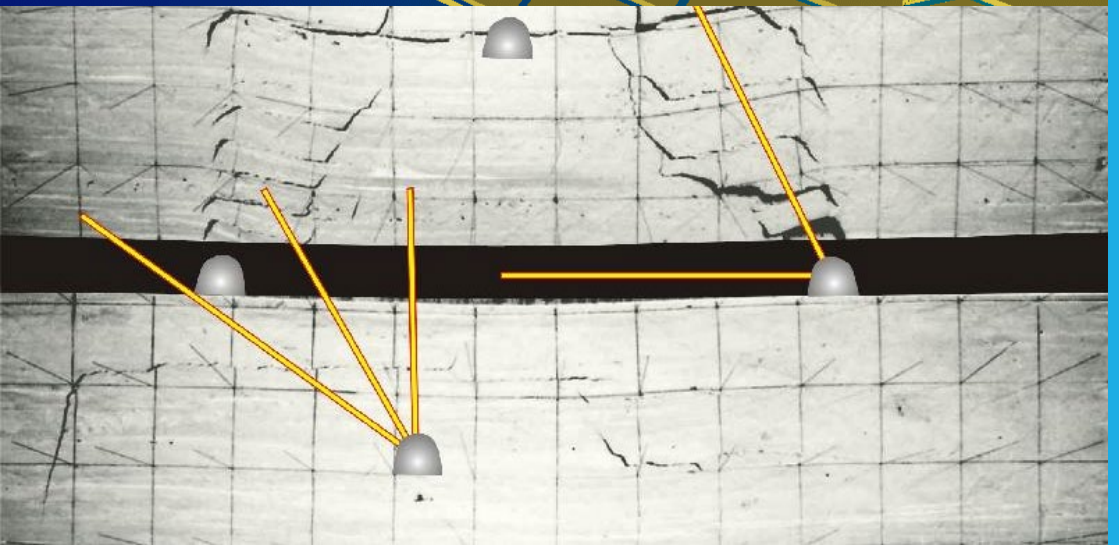
What are the typical sources of coal mine gas?

Assumptions

- 60% of the GIP (gas in place) is emitted while mining
  - 15% is drained
  - 85% emitted as VAM
- 40% of the GIP remains
  - 5% is removed in mined coal







2. Designing for less methane release and more capture, use and destruction at active mines

Emission reduction can be achieved by releasing less methane per tonne of coal mined

Methane emissions from active mines can be reduced to zero by not mining.

Methane emissions from active mines will decrease as coal production is reduced during a transition to clean energy.

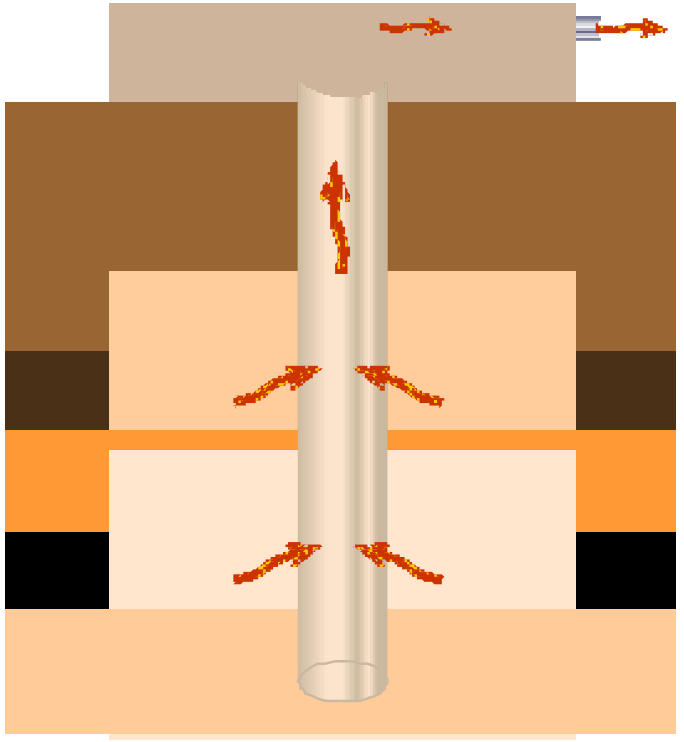
Methane mitigation can be achieved by reducing strata disturbance and hence associated gas release e.g., by adopting such mining methods as shortwall extraction and room & pillar methods.

Emission reduction can be achieved by removing more gas before mining is initiated

- Emissions can be reduced by capturing and using/destroying more gas extracted from vertical surface boreholes or surface to in-seam boreholes with directional drilling. Gas can be extracted from the seam to be worked and from floor and roof seams likely to be de-stressed during mining.

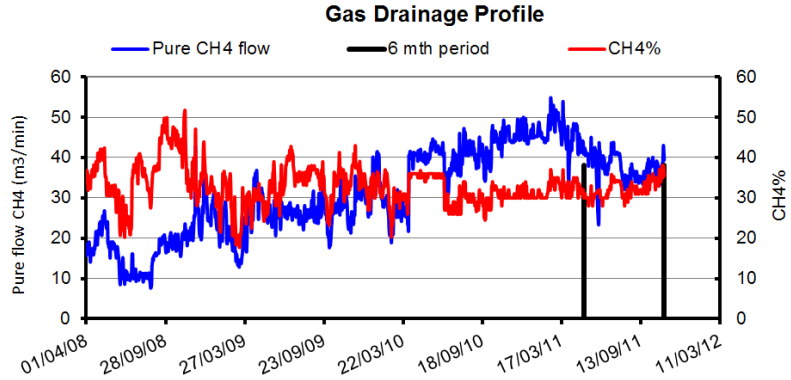
- Emissions can be reduced by underground pre-drainage of the seam to be worked. The financial penalty to the mine of protracted degassing is the time lag between mine development and coal production revenue.

- Coal seam permeability, ‘drillability’ of strata, depth and geology are all critical factors but drilling and pre-drainage technology is continually improving - driven by the tangible benefits to coal production, reduced mining costs and mine safety (reduced gas flows, reduced outburst risk, reduced ventilation costs).



Emission reduction can be achieved by capturing and using/destroying more gas during mining operations

- Design and operate mines in accordance with UNECE best practice to maximise capture and ensure CH4 concentration >25%
- Increase underground pre-drainage.
- Enhance post drainage.
- Ensure drainage of sealed areas (equivalent to AMM in concept but mine staff are available to manage, operate and maintain the programme).
- Use drained CMM for power generation, heating or other uses and destroy all unused methane by flaring.



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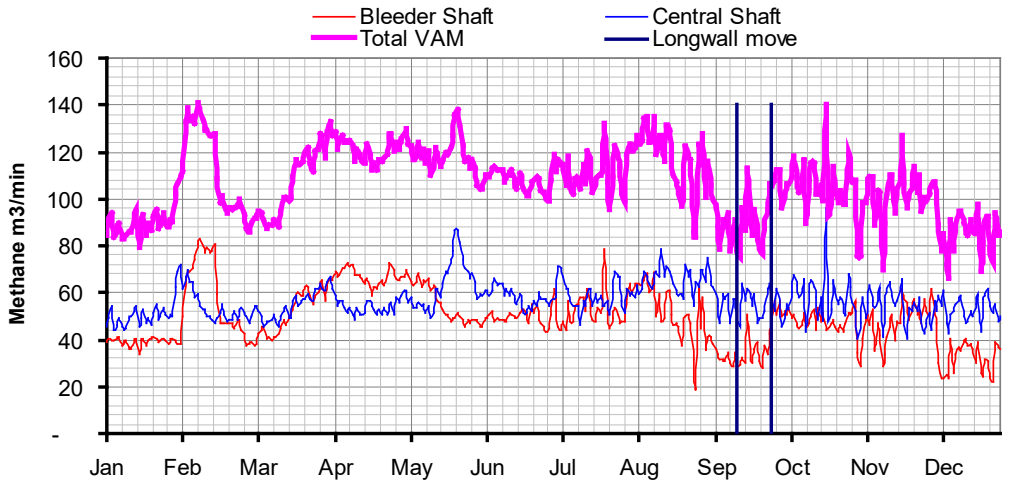
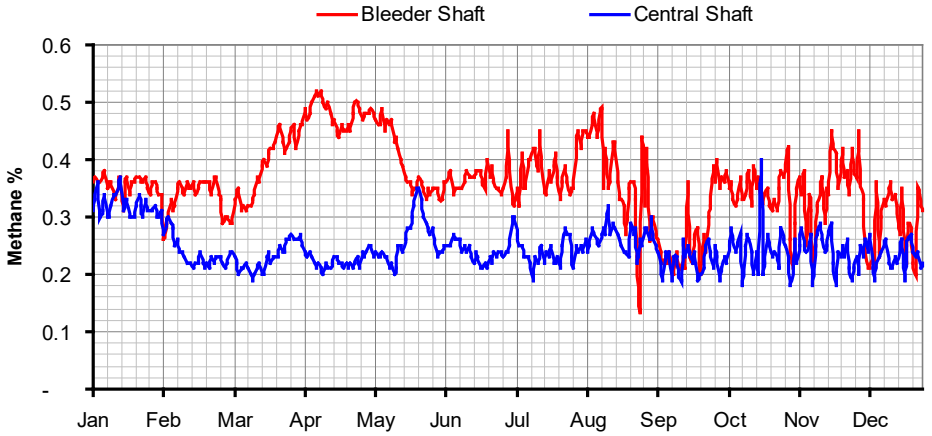




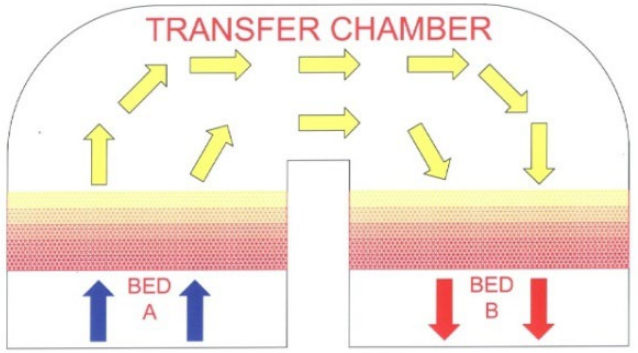
3. Mitigating VAM emissions

Emission reduction can be achieved by oxidising a proportion of the methane emitted in ventilation air

- VAM is the gas that “escaped” the methane capture system - a fugitive emission or a waste product.
- 60-80% of gas emitted from active coal mines is VAM which needs to be urgently addressed to achieve meaningful GHG emission reductions.
- VAM concentrations in different mines typically range from trace to 1%. VAM concentration and flow varies with the coal production cycle and with contributions from sealed areas during barometric pressure drops.
- The maximum permitted VAM concentration in mine airways, shafts and ventilation fans is prescribed in safety regulations.
- VAM can be destroyed effectively by oxidation using existing technologies but due to the capital cost of equipment, electricity consumption, footprint size and absence of financial drivers and supportive policies there are few projects operating worldwide.

Current status of VAM mitigation technology

- Proven technology involves use of regenerative thermal oxidisers (RTOs) or regenerative catalytic oxidisers (RCOs).
- Suitable equipment is commercially available but the system must be designed for the specifics of the mine.
- Safety systems incorporated within current designs have been accepted by the mining regulatory authorities in the countries where VAM RTOs are in operation.
- VAM mitigation only, and in some instances power generation, projects have been successfully implemented in Australia, China, UK and the USA but there are few currently in operation.



Practical experience of VAM emission mitigation

- VAM oxidisers can sustain continuous operation at 0.3 % methane, or even lower, but any carbon revenue is generally too low at <0.6% to justify the costs.
- It is not practical or cost effective to oxidise VAM at low methane emitting mines.
- Designs of VAM applications involve careful choice of materials for heat management within the units.
- Power can be generated using the heat but generally the VAM needs enrichment to provide sufficient energy to achieve viable power generation which can lead to potential safety issues
- Cost of VAM power generation is higher than CMM power generation and not generally commercially viable without subsidy or carbon financing.
- Few companies have the necessary expertise to design, build and maintain VAM technology to achieve sustained high-performance.
- VAM units can be indirectly coupled to any upcast shaft using a capture hood. However, direct connection is feasible if regulations allow.

VAM emission mitigation: barriers to implementation

- No country has mandated that gassy coal mines must mitigate VAM emissions or set total permitted methane emissions for individual coal mines.
- VAM oxidation brings no production or safety benefits to a mine. The mine must provide land for the sizable equipment footprint, a power connection and a physically coupled, or decoupled connection to upcast shaft(s).
- There is no commercial revenue stream without carbon pricing.
- Not all mine shafts are suitable for VAM projects due to very low methane concentrations or space constraints.
- Large units are costly to build and operate; electricity can be a substantial part of the operating cost.
- Project development can be challenging and protracted, and the time from initial investment to revenue and payback is a deterrent to investors unless carbon pricing is high enough to justify the risk.
- Many banks will not lend to coal mining projects although climate change mitigation projects at mines may attract carbon finance where the mechanisms exist.

How could VAM mitigation be encouraged?

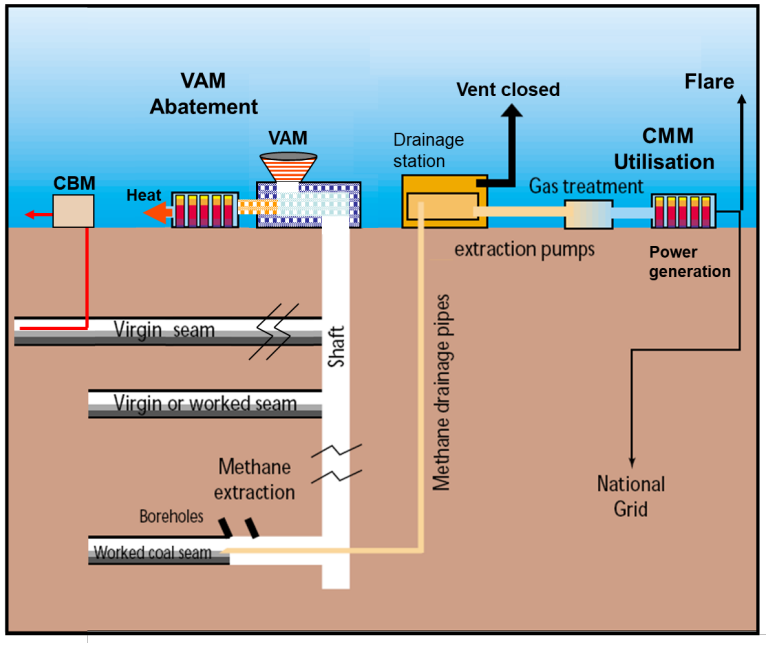
- A total emission reduction target, or cap, could be set for each gassy mine. The mines would then need to consider VAM projects in order to achieve the prescribed reductions.
- Gassy mines would need a strong incentive to implement VAM projects themselves, which could be either:
  - A regulatory requirement, or
  - A standard cooperation agreement and revenue sharing contract template could be devised to encourage third party project developers to implement and manage a VAM project on behalf of a mine.
- Policies and stable carbon prices (offsets or tax), perhaps as high as 20-30USD/t CO2 avoided, would be needed to incentivise action.

4. A mine methane mitigation strategy for countries

A strategy proposal for countries to minimise mine methane emissions

To minimize methane emissions from coal mining, countries could develop mechanisms and measures to:

- Quantify emissions and set total emission targets/caps as a compliance target at individual mines.
- Set targets which require the most **gassy** mines to implement existing, proven technologies in accordance with UNECE best practice guidance.
  - Raise gas drainage standards to maximise capture (increase by 10%) and ensure CH4 concentration >25%
  - Destroy all unused, drained methane by flaring
  - Oxidise a proportion of the VAM at selected shafts that can be practically achieved (e.g., 80%)
- Ensure flaring of unused captured CMM or AMM.
- Introduce regulatory and fiscal policy to enforce and support implementation of the strategy.



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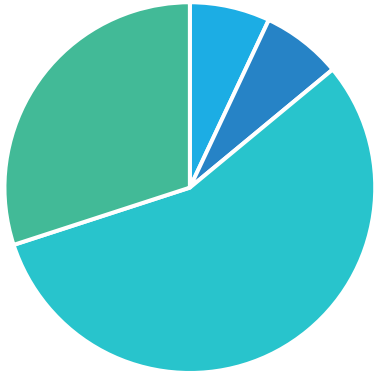
Estimated global emission mitigation potential at active mines

Current emissions



- High gas drained and vented
- High gas drained and used
- High gas VAM emissions
- Low gas mine emissions

Strategy model applied

- High gas drained and used/flared
- High gas VAM oxidised
- High gas VAM emitted
- Low gas mine emissions

Model assumptions

70% of total methane is emitted from gassy mines where gas controls can be enhanced to increase capture by 10%.
All drained gas can be either used or flared.

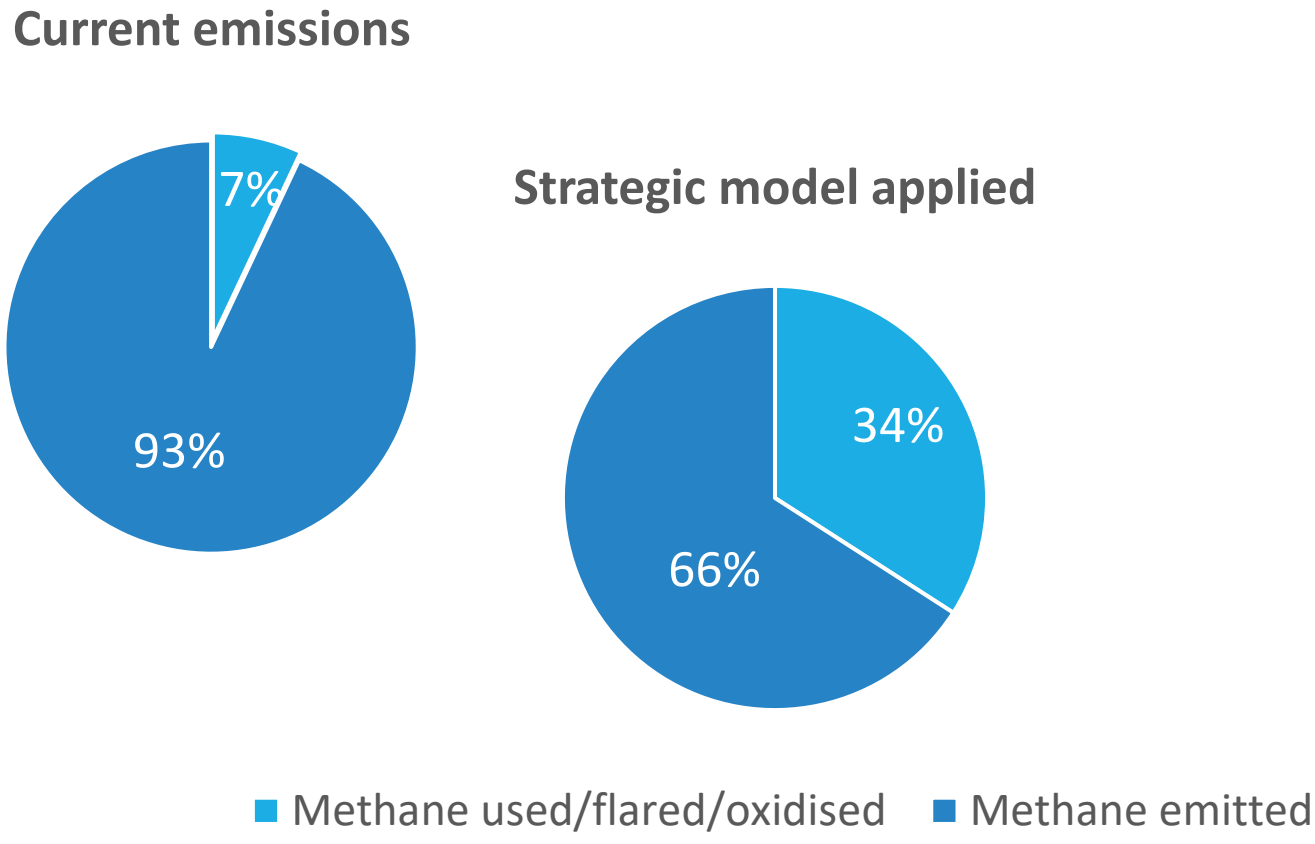
Approx. one third of shafts at gassy mines are amenable to VAM oxidation where 80% of VAM can be destroyed.

Preliminary estimate of the global methane emission mitigation potential at active mines

If the proposed mitigation strategy is applied to gassy mines, preliminary modelling indicates that countries could mitigate overall emissions from working mines by up to 34% by:

- Increasing methane drainage capture by 10% at gassy mines and using or flaring all of the captured gas.

- Installing VAM oxidisers to process about one third of VAM flow from gassy mine shafts and destroy 80% of the VAM emitted from those shafts.



References and further reading

Best Practice Guidance for Effective Methane Drainage and Use in Coal Mines (The second edition). ECE Energy Series No. 47, 18 December 2016. United Nations.

Best Practice Guidance for Effective Methane Recovery and Use from Abandoned Coal Mines. ECE Energy Series No. 64, 12 October 2019. United Nations, Geneva.

Best Practice Guidance for Effective Management of Coal Mine Methane at National Level: Monitoring, Reporting, Verification and Mitigation. ECE Energy Series No. 71, 2021, United Nations, Geneva.

Thank You

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Contact Information:

David Creedy
david.creedy@sindicatum.com
+44 7425656161