Global Energy Monitor

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Coal Mine Methane On the Brink

NEW COAL MINES WILL EMIT ENOUGH METHANE TO RIVAL CO_2 EMISSIONS FROM UNITED STATES COAL PLANTS

Summary

A frenzy of new mine projects and proposals in some of the world's gassiest coal seams could emit enough methane to rival the current CO_2 emissions from coal plants in the United States, according to new data and modeling from Global Energy Monitor.

In a first-of-its-kind analysis, GEM has modeled global methane emissions estimates at the individual mine level, using data on mining depth, coal rank, and production from its newly developed Global Coal Mine Tracker. GEM's methodology follows that of the Model for Calculating Coal Mine Methane (MC2M), developed by experts at Pacific Northwest National Laboratory, Raven Ridge Resources, the U.S. Environmental Protection Agency, and Ruby Canyon Engineering and published in 2020.

The analysis surveys 432 proposed coal mines, most of which are under development in the world's gassiest coal seams. Unless mitigated, methane emissions from these proposed mines, currently in construction or pre-construction planning, would amount to 13.5 million tonnes of methane annually, a 30% increase over current emissions. (Breakdowns of emissions by country, region, and company can be found here.)

The estimated emission of methane by proposed mines translates to 1,135 million tonnes (Mt) of annual CO_2-equivalent (CO_2e) on a 20-year horizon and 378 Mt of annual CO_2e on a 100-year horizon. Based on a 20-year horizon, estimated emissions would exceed the annual CO_2 emissions from U.S. coal plants (952 Mt in 2019). Even when averaged on a longer 100-year horizon, the 378 Mt of annual CO_2e emissions from these new mines would exceed the current CO_2 emissions from coal plants in Germany and South Korea combined.

Depending on the methane-to-CO_2 equivalency used, coal mine methane is responsible for 7.5% to 20% of a typical mine's greenhouse gas emissions, for CO_2e100 and CO_2e20 respectively. However, some mines emit significantly more methane per tonne of coal than others, and for these mines methane is responsible for 20% to 50% of a mine's greenhouse gas emissions, for CO_2e100 and CO_2e20 respectively.

Background

Methane is the second biggest contributor to global warming after CO_2, with a shorter atmospheric lifetime, but much stronger potency and warming potential. During mining, fractured coal seams and surrounding strata emit methane into the atmosphere through vent holes, fissures in the ground, storage piles, and open pits. Unless

mitigated, these sources continue to leak long after a mine has been abandoned.

But just how much methane leaks from coal mines? While numerous studies on methane emissions from oil and gas operations have helped narrow the range of estimates over time, estimates for global, national, and grid-level inventories of coal mine methane emissions are at a more nascent stage and have broadened in recent years.

For 2018, the International Energy Agency (IEA) estimated that operational coal mines worldwide leaked 40 Mt of methane. Yet more recent academic studies suggest that the emissions from fossil fuels, including coal, have been underestimated. In 2018, for instance, Community Emissions Data System estimated global coal mine methane emissions to be 55 Mt.

A 2020 study led by Nazar Kholod of the Pacific Northwest National Laboratory and industry experts developed a methodology to calculate methane emissions at specific depths using coal samples collected from various coal basins worldwide. The study estimated that global coal mine emissions were 69 Mt in 2010, and likely much higher today – outpacing even oil and gas, which emitted about 70 Mt of methane in 2020, according to the IEA. Without mitigation, the study projected a rise in coal methane emissions to 110 Mt by 2030.

Despite being comparable in scale to the methane emissions from oil and gas, methane emissions from coal have received much less attention from researchers and governments than methane emissions from oil and gas. The gap in attention has resulted in a deficit in implementation of measures to mitigate what by all estimates is one of the most significant sources of greenhouse gases.

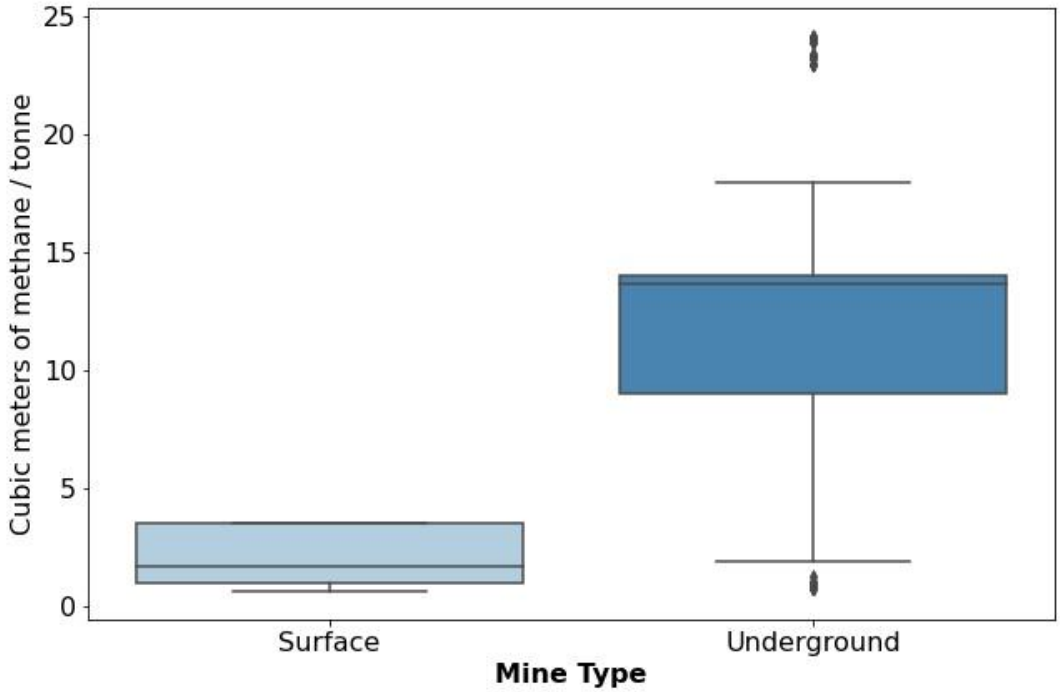
Mine-Level Emissions

Our analysis modeled emissions for operating and proposed mines in the Global Coal Mine Tracker by applying a bottom up approach. In doing so, this model provides a finer resolution of methane emissions, complementing top-down analyses at global and national levels and reconciling the persistent gap in methane emissions measurements.

As of January 2021, the Global Coal Mine Tracker includes all known mines producing 5 million tonnes per annum or greater (433 mines that account for 60% of global coal production) and all proposed mines or mine expansions with a capacity of 1 million tonnes per annum or greater (432 operations totaling 2,281 Mt of capacity).

To track mine-level emissions, we used data on individual mine depth and coal rank from the Global Coal Mine Tracker to estimate methane gas content at each mine, relying on gas estimates at depth from MC2M. By factoring mine-level production, or designed capacity at proposed operations, and emissions factors for surface and underground operations, we modeled methane emissions at each mine.

FIGURE 1. Methane content of coal mines



The median methane gas content for surface coal mines (left) is 1.7 cubic meters (m^3) per tonne with an interquartile range of 1.0 m^3 to 3.5 m^3 per tonne. In comparison, the median for underground mines (right) is eight times higher at 13.7 m^3 a tonne with an interquartile range of 9.0 m^3 to 14.0 m^3 per tonne. Some of the gassiest underground mines reach 24.2 m^3 per tonne (circles in top right). Source: Global Coal Mine Tracker and GEM analysis.

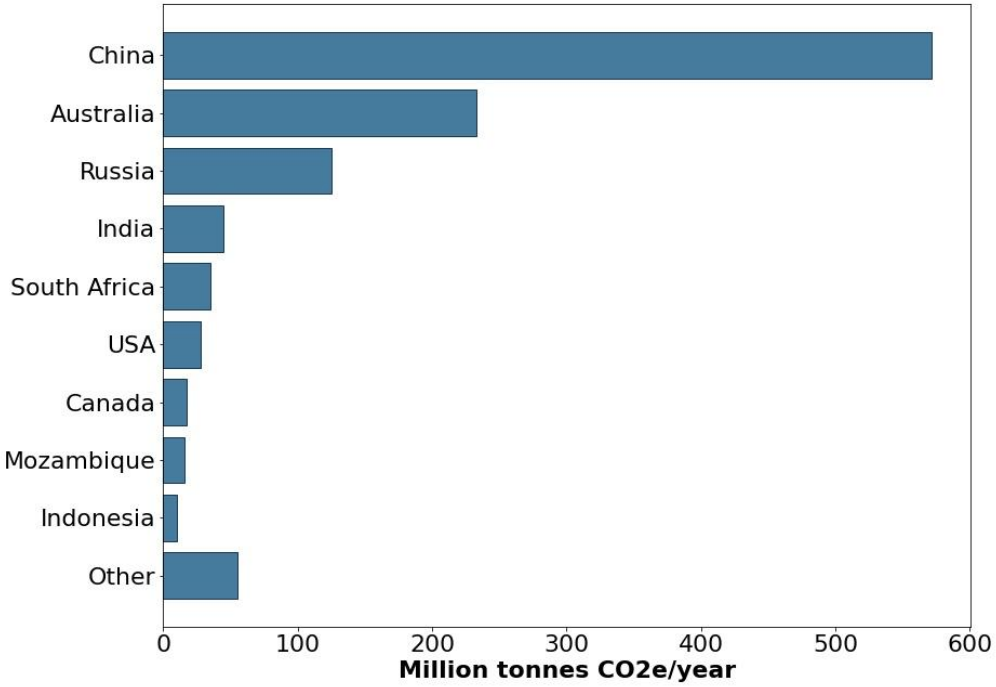
We found that methane increases total greenhouse gas emissions at major operating mines by an average of 19.6%, when measured in CO_2e on a 20-year horizon, or 7.5% when measured in CO_2e on a 100-year horizon. These findings are comparable to estimates by the IEA in its 2019 World Energy Outlook that methane accounted for approximately 9–10% of mine-level emissions on a 100-year horizon in 2018.

Methane Lock-In

Until now, no study has estimated the potential methane emissions from coal mines in development.

According to the Global Coal Mine Tracker, 432 new mines or mine expansions have been announced or are in some stage of exploration, permitting, or construction. If these mines operate as designed, we estimate they will release 13.5 Mt of methane annually, a one-third increase over current IEA emissions estimates, and equal to 1,135 Mt of CO_2e on a 20-year horizon (see Figure 2) or 378 Mt of CO_2e on a 100-year horizon. By comparison, 1,135 Mt of CO_2 exceeds the annual CO_2 emissions of all U.S. operating coal plants; it is also broadly equivalent to the current annual CO_2 emissions of the global aviation industry. Even when averaged on a longer 100-year horizon, the 378 Mt of annual CO_2e emissions from these new mines is comparable to the annual CO_2 emissions from all operating coal plants in Germany and South Korea combined.

FIGURE 2. Annual methane emissions from coal mine proposals



Methane leakage (CO_2e) from proposed coal mines would equal over 1 Gt per year, when measured on a 20-year horizon, led by proposals from China (572 Mt CO2e), Australia (233 Mt CO_2e), and Russia (125 Mt CO_2e). Source: Global Coal Mine Tracker.

New Emitters on the Horizon

By far, the largest potential increase in global coal mine methane emissions comes from 140 new mines currently under development in China. According to U.S. EPA data, operating coal mines in China released 18 million tonnes of methane in 2020. If all China's proposed mines open as designed, we estimate that China will emit an additional 6.8 million tonnes of methane per year from these projects, increasing methane emissions by one-third. Shanxi Province was the single largest source of new emissions in our analysis, consistent with academic studies on methane emissions in the country.

Coal mines in gassy deposits in Queensland, Australia, and Kemerovo, Russia would also contribute to a large increase in methane emissions from mining activities. Australia has 52 new mines under development and Russia has 55, according to our Global Coal Mine Tracker. At present, 44% of proposed capacity in both countries is located in gassy coal regions.

As for the gassiest mines, those with the potential to unleash the most methane relative to their total greenhouse gas emissions, several proposed mines in China, United States, Turkey, Poland, and Uzbekistan could emit 40-50% of their greenhouse gas emissions in the form of methane, ranking among the gassiest mines in the world, as shown in Table 1.

TABLE 1: Gassiest mines under development in 5 countries

Coal Mine	Annual Methane Emissions (Mt CO_2e-20)	Annual Methane Emissions (Mt CO_2e-100)
Boli Mine (China)	10.6	3.5
Longview Mine (United States)	7.6	2.5
Inagzi Baglik Mine (Turkey)	5.2	1.7
Bzie-Debina Mine (Poland)	2.8	0.9
Shargun Mine (Uzbekistan)	1.9	0.6

Although these mines could emit 40-50% of their annual greenhouse emissions in the form of methane, GEM finds that other mine projects with a larger capacity could emit more methane per year on an absolute basis. Those include the Hutton Coal Project and Red Hill Coal Project in Australia, the only non-Chinese proposals to rank in the top 10. Those mine projects, respectively, will emit 60 Mt CO_2e and 17 Mt CO_2e annually on a 20-year horizon, and 20 Mt CO_2e and 6 Mt CO_2e annually on a 100-year horizon, making them some of the largest emitters in the world if they go into development.

Despite the climate impact of gassy mines and coal mine methane more generally, most of these proposed operations have received little public scrutiny or mitigation planning.

Who Will Emit the Most Methane?

With one exception, state-owned enterprises remain the major sources of proposed coal mine methane, including China Coal, Shandong Energy, Coal India, and Shaanxi Coal and Chemical Industry Group.

The exception is Hutton Coal Project, sponsored by Valiant Resources, an independent firm headquartered in Australia, which tops the list. Hutton is the single largest potential methane emitter, according to our analysis, if the mining proceeds as currently planned across all five defined areas without abatement procedures in place.

Should the Hutton Coal Project prove unable to reach its most ambitious production plans, the company's most immediate pursuit is to mine two out of five areas. Those would still emit 29.8 Mt CO_2e over 20 years, and 9.9 Mt CO_2e over 100 years, making it the world's fourth largest proposed emitter in GEM's analysis.

TABLE 2: Methane Emissions by Company for Mines in Construction and Pre-Construction Development

Company	Annual CH_4 Emissions (Mt CO_2e-20)	Annual CH_4 Emissions (Mt CO_2e-100)
Valiant Resources	59.7	19.9
China Coal	41.2	13.7
Shandong Energy	30.7	10.2
Coal India	27.5	9.2
Shaanxi Coal and Chemical Industry Group	25.0	8.2

Gassiest Coal Mines in Operation

Alongside major proposed projects, the Global Coal Mine Tracker has estimated emissions at major operating mines. The world's leading emitters are located in China, with major mines in Shanxi Province releasing the most methane. Just as in proposed mines, the methane leaks from the gassiest operating mines can account for up to 50% of a mine's greenhouse gas emissions on a 20-year horizon. While GEM relied on some capacity figures in China when exact production figures were unavailable, its findings are compatible with a 2019 academic study by scientists at MIT, Harvard, and the Environmental Defense Fund, which concluded Shanxi Province produces the highest levels of coal mine methane in China.

TABLE 3: China's Gassiest Coal Mines

Coal Mine	Annual CH_4 Emissions (Mt CO_2e-20)	Annual CH_4 Emissions (Mt CO_2e-100)
Sihe Mine	19.5	6.3
Yangquan No.1 Mine	18.4	6.1
Chengzhuang Mine	18.0	6.0
Yangquan No.2 Mine	17.6	5.9
Wukuang Guishigou Mine	16.7	5.6

While these major mines in Shanxi Province each emit up to 50% methane relative to total GHG emissions, government policy requires Chinese operators to use drained gas with greater than 30% methane content. But the U.S. EPA has suggested that operators may be circumventing those requirements,

and a 2019 study in Nature suggested those regulations have had "no discernible impact" on continued emissions.

Outside of China, gassy coal mines are operating in Poland, Indonesia, the United States, Russia, Kazakhstan, and Australia. Table 4 ranks major operating mines releasing high levels of methane relative to total emissions across various countries.

As an aside, GEM found that North Korea's mine complexes at Anju and Saebyol may rank as some of the world's worst coal mine methane emitters (with annual emissions of 21 and 24.2 CO_2e over 20 years, respectively). But given the lack of transparency surrounding those operations and the lack of independently verified production figures, the North Korean complexes are excluded here.

At major operating mines, the companies most responsible for global mine methane emissions rank among the world's largest producers, including China's National Energy Investment Group, Coal India, Glencore, China Coal, and Peabody Energy.

TABLE 4: Gassiest Mines in 6 Countries

Coal Mine	Annual CH_4 Emissions (Mt CO_2e-20)	Annual CH_4 Emissions (Mt CO_2e-100)
KPC Operation (Indonesia)	19.3	6
No. 7 Mine (USA)	11.8	3.9
Yalevsky Mine (Russia)	10.7	3.6
Bogatyr Mine (Kazakhstan)	9.5	3.2
Appin Mine (Australia)	9.7	3.2
Budryk Mine (Poland)	8	2.6

Data Gaps & Future Research

As GEM expands the coverage of its Global Coal Mine Tracker, documenting every active coal mine producing 1 mtpa or greater by the fourth quarter of 2021, it will include a fuller account of global methane emissions at the mine level, with bottom-up estimates based on mine specific activity. As of now, the model includes only active emissions and does not factor the full life of mine emissions, including those after the mine has closed or abandoned.

As GEM expands its coverage of operating mines, the data will include more underground operations, which have higher gas contents than surface mines. By some estimates, underground mines emit 10 times more methane per tonne of coal than surface operations. Our survey of major mines is 55% surface operations, but underground mines account for roughly 69-70% of global operations, meaning that when numerous underground mines yet to be tabulated by GEM are added to the totals, it will likely drive aggregate tallies well north of the IEA's 40 Mt estimate for coal mine methane emissions.

Background on Global Energy Monitor

Global Energy Monitor is a nonprofit research organization developing information on fossil fuel projects worldwide. Through its Global Coal Plant Tracker (GCPT) project, Global Energy Monitor has provided biannual updates on coal-fired generating capacity since 2015. GCPT data is used by the International Energy Agency (IEA), the OECD Environment Directorate, UN Environment Programme, U.S. Treasury Department, and World Bank. GCPT data is licensed by Bloomberg LP and UBS Evidence Lab, and is used by the Economist Intelligence Unit and Bloomberg New Energy Finance.

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