We Can Manage What We Measure:
Where Near-term Reductions in Methane are Important and Achievable

Global temperatures are rapidly rising. As Earth warms, damages are mounting from superstorms and wildfires to historic flooding and extreme heat. Two climate co-conspirators are largely responsible — carbon dioxide and methane (chemical names CO_2 and CH_4, respectively) — and Climate TRACE quantifies, tracks, and reports on both of them.

Carbon dioxide's climate contribution is simple but very damaging. Once it is emitted, CO_2 remains intact in the atmosphere, trapping heat for centuries.

By comparison, methane's chemical journey is more complex, driving climate damage at every step along the way. Methane is a climate "super pollutant" given its powerful, near-term warming effect on the planet. If we equate carbon dioxide's warming effect to one blanket wrapped around the Earth, methane – over its ten-to-twelve-year lifetime – wraps more than 80 blankets around the planet. Beyond a decade, some methane reacts to form ground-level ozone, which pollutes the air while also warming Earth. Ultimately, the remaining methane in the atmosphere reacts to form carbon dioxide, adding to the single long-lived blanket around Earth.

Updating global methane inventories is crucial

Climate TRACE estimates that just under 410 million tonnes (Mt) of methane was released into the atmosphere in 2024 and just over that amount was emitted in 2025. That methane is traced back to nearly three million sources in nine emitting economic sectors (and their associated subsectors). Agriculture (animal operations and crops), fossil energy systems (oil, gas, and coal), and waste are consistently the largest contributors to global methane emissions. Together, these sectors account for 97% of total manmade methane emissions. The remaining 3% of methane emissions are estimated to come from the buildings, power, manufacturing, and transportation sectors.

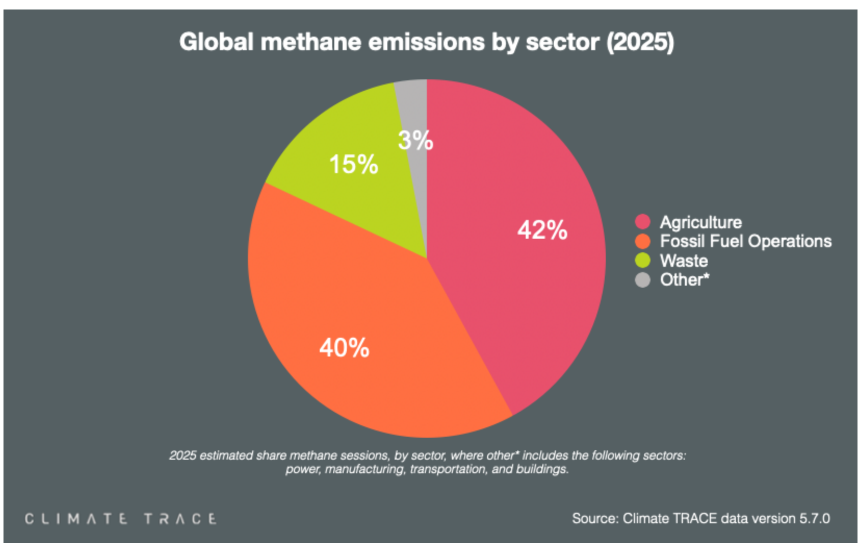

Figure 1. *Global methane emissions by sector, 2025. Agriculture (42%), fossil fuel operations (40%), and waste (15%) together account for 97% of manmade methane emissions; the remaining 3% comes from the power, manufacturing, transportation, and buildings sectors. Source: Climate TRACE (data version 5.7.0).*

A recent methane inventory study uses satellite data and estimates an upper bound of 392 Mt anthropogenic methane emissions in 2023. This closely corresponds to Climate TRACE's methane inventory. Yet, both methane inventories are significantly higher than the UNFCCC methane emissions of 326 Mt, which are mostly self-reported by countries, and are in close agreement with the International Energy Agency (IEA) methane inventory of 345 Mt.

Discrepancies between self-reported methane emissions, IEA, Climate TRACE, and academic studies exist. These gaps - along with the uncertainties they cause - are closing in real time from ongoing measurements, and indicate urgent action is needed to mitigate a methane emissions problem that is far bigger than previously understood.

Following the methane roadmap for climate security

Managing methane from wasted gas is a long time coming. 2026 marks the centuries-long anniversary of the discovery of methane gas from a lake in Italy. So-called "swamp gas" was found bubbling up from the water; it was collected and lit on fire. Scientists may have awakened to methane in 1776, but it took policymakers nearly 250 years to pledge to contain and stop leaking it. Swamp gas is a natural source of methane. Today's concerns revolve around reducing anthropogenic (human-made) methane from oil and gas and other sectors because a hotter planet will liberate increasing amounts of natural methane, heating Earth further still.

In 2021, a majority of the world's nations signed the Global Methane Pledge, which aims to reduce methane emissions by 30% by 2030. Progress has been slow. But the necessity has risen to new heights.

Studies find that while cutting carbon dioxide must continue in earnest, slashing methane emissions now is the most impactful way to keep global temperature increases at safer levels under 2-degrees Celsius, as plotted below. Methane mitigation has immediate benefits because its intense warming capacity can be eliminated with every molecule that remains out of the atmosphere.

Runaway warming can be avoided by simultaneously reducing CO_2 PLUS methane

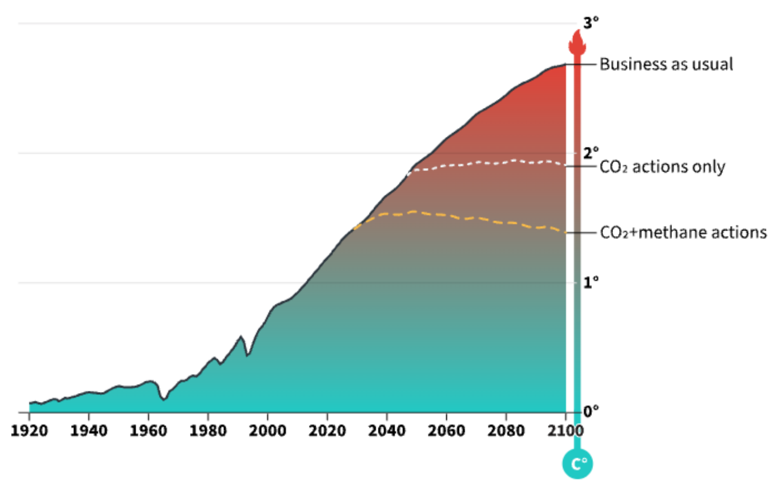

Figure 2. *Projected global temperature rise, 1920–2100, under three scenarios. Source: RMI, September 2024.*

Oil and gas operations offer a unique proposition to slash methane

Climate TRACE estimated 70.4 Mt methane emissions from oil and gas (O&G) production in 2025, down 3.2% from an estimated 72.7 Mt in 2023 and essentially constant with 2024. While more uncertain, the transport of O&G in pipelines and liquefied natural gas vessels is estimated to account for an additional 7.4 Mt methane in 2025.

O&G systems appear to have the largest potential for under counting methane emissions, with a shortfall estimated at 32% below UNFCCC figures. Yet O&G emissions are highly actionable. O&G emissions arise from super-emitter events, both intentional and accidental, as well as from routine flaring and fugitive leaks in system equipment.

The methane emissions relative to oil and gas production—defined as methane intensity and measured in CH_4 emitted per barrel equivalent oil and gas produced—differs greatly by asset. What's most striking is the wide variance in underlying O&G production methane intensities within countries, as RMI's Oil Climate Index plus Gas (OCI+) shows in the plot below. The variance within countries is an indication of technological and economic potential for methane emissions reductions in O&G production. If a country can produce O&G at the lower end already in operation, this holds a promise for future methane mitigation.

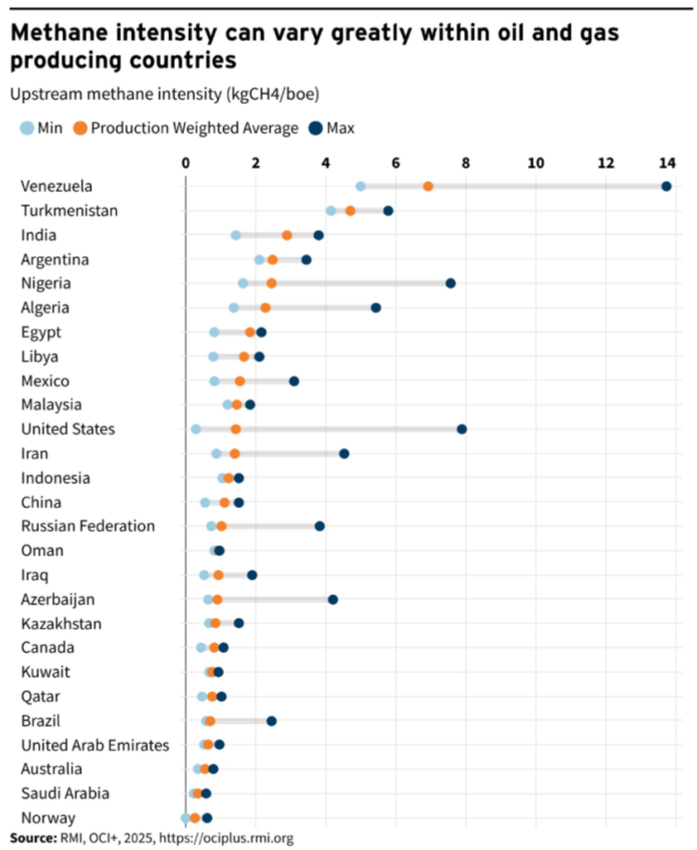

Figure 3. *Upstream oil and gas methane intensity (kg CH_4 per barrel of oil equivalent) by country—minimum, production-weighted average, and maximum. Wide within-country ranges signal substantial technical and economic room for mitigation. Source: RMI, OCI+, 2025.*

Given the high priority placed on reducing methane now, it is logical to focus on the O&G sector. Methane emitted from O&G operations is not simply a waste byproduct. It is a commodity that trades globally and at high prices – something that is even more relevant as the energy market faces continued strain from the ongoing conflict disrupting trade in the Strait of Hormuz. For example, the commodity "natural gas", which when sold is comprised of over 95% methane, has experienced recent price hikes and volatility in the US and abroad due to winter weather patterns and geopolitical conflicts. High gas prices help motivate actions to keep methane in the pipe instead of senselessly releasing it into the atmosphere.

With O&G production occurring in all corners of Earth, knowing where to prioritize O&G methane mitigation is critical. Targeted action improves the chances of achieving durable emissions reductions. Some nations are already moving in the right direction with estimated emissions reductions and promising opportunities for further mitigation.

Some nations require further action to reduce their oil and gas production methane intensities. These include the US and Mexico, where 2025 methane emissions were up even though their O&G production was down or saw no change. The US is currently the world's largest O&G producer with some of the widest-ranging methane intensities. Some 20% of US gas is currently being certified as low leakage and, if this volume is expanded, US methane emissions could be materially reduced. Mexico reaffirmed its Global Methane Pledge ambition at COP30. This requires replacing aging infrastructure, investing in the capture of gas produced alongside oil, and repairing its leaking platforms. Best practices can go a long way. This includes better monitoring, improved flaring and venting controls, leak detection and repair campaigns, and system upgrades.

Several countries saw increases in their O&G volumes produced that likely resulted in higher estimated methane emissions, including Azerbaijan, Kuwait, and Argentina. These countries could also benefit from reducing their methane intensities to bring down their absolute emissions. Still other countries had estimated methane emissions reductions even though their oil and gas production increased. These countries deserve a closer look to determine if and how they reduced their oil and gas production methane intensities, including Kazakhstan, Norway, UAE, Saudi Arabia, China, and Libya.

Coal mine methane can be captured instead of pumped into the atmosphere

The geological processes that produce coal also produce methane gas, which remains trapped in underground coal seams until it gets released during mining operations. Abatement for this sector can categorically be described as either transforming methane into a less potent greenhouse gas (e.g., CO_2) or using methane nearby as an energy source. Some abatement strategies have the potential (at best) to reduce emissions from certain mines by nearly 60%, which is meaningful in the context of the 3-4% of global CO_2-equivalent emissions that the coal mining sector represents.

Climate TRACE estimates that coal mining operations produced 66.8 Mt of methane in 2025. This was a slight decline from 2023, when coal mining released 67.1 Mt of methane. The decline was primarily due to lower mining activity.

Similar to O&G methane capture, instead of treating methane as a waste product and venting or flaring it into the atmosphere, methane captured at coal mines can significantly cut emissions. Overall, Climate TRACE estimates that implementing certain emissions-reduction solutions (ERS) across the coal mining sector today could reduce emissions by at least 45%. Methane recovery and utilization is a primary strategy, capturing methane and using it to power on-site operations. Additional ERS include ventilation air methane (VAM) oxidation and fugitive methane flaring.

Similar to O&G production, methane intensity can vary greatly by country. Here too, many countries that are home to the most methane-intense coal mines are also home to those that are among the least intense. This is a strong indicator that the technical capabilities of capturing methane from coal mining activities are likely available for implementation in these areas.

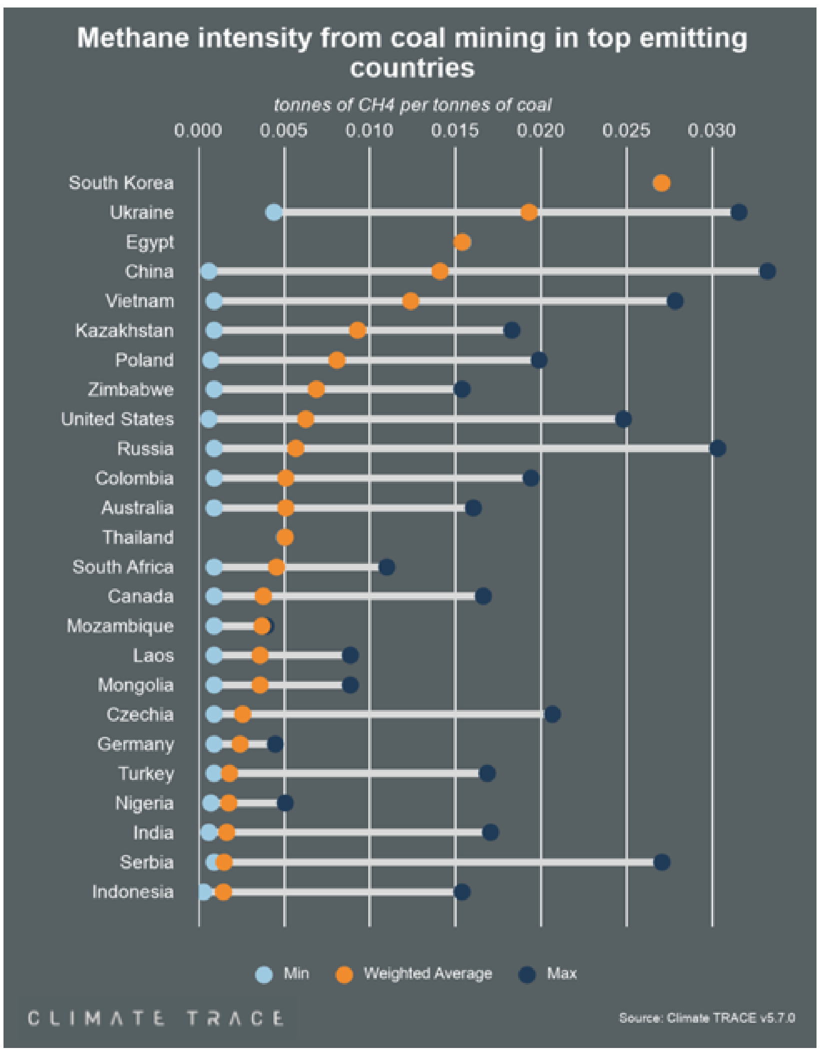

Figure 4. *Methane intensity from coal mining (tonnes CH_4 per tonne of coal) in top emitting countries—minimum, weighted average, and maximum. Source: Climate TRACE (data version 5.7.0).*

Of course, transitioning away from coal is the most effective way to lower methane emissions from coal production. But as coal mines continue to operate, it is critical to ensure they are emitting as little extra methane as possible.

A small number of landfills offer outsized methane wins

An important—but often overlooked—opportunity for near-term methane emissions reductions is in the waste sector, and specifically solid waste disposal.

The disposal and processing of waste resulted in 62.2 Mt of methane in 2025, a slight increase from 61.6 Mt in 2023. Solid waste disposal (disposal of waste in landfills) accounted for 64% of those methane emissions.

The outsized role of a small subset of the world's landfills is striking. The top 10% of emitting landfills globally – 1,373 individual sites monitored by Climate TRACE – account for 70% of all methane emissions from waste.

Climate TRACE identifies landfill diversion, improved cover practices, and landfill gas capture as key emissions-reduction solutions (ERS) in the solid waste sector. Waste diversion reduces the amount of organic material sent to landfills, while improved cover systems limit methane release and gas capture systems collect landfill methane for flaring or energy use. Adding a biocover with high methane oxidation reduces the emissions by 30-40% and coupled with reducing the amount of waste disposed of at sites by 16-20% through diversion (a reasonable estimate based on projected future trends, depending on the country) a total emissions reduction of 40-50% is possible. Co-benefits of utilizing biocover include local air quality improvement, odor and fire risk reduction.

In countries where more than three-quarters of methane emissions come from a small subset of landfills, governments and local leaders have the opportunity to achieve relatively quick wins in methane reduction.

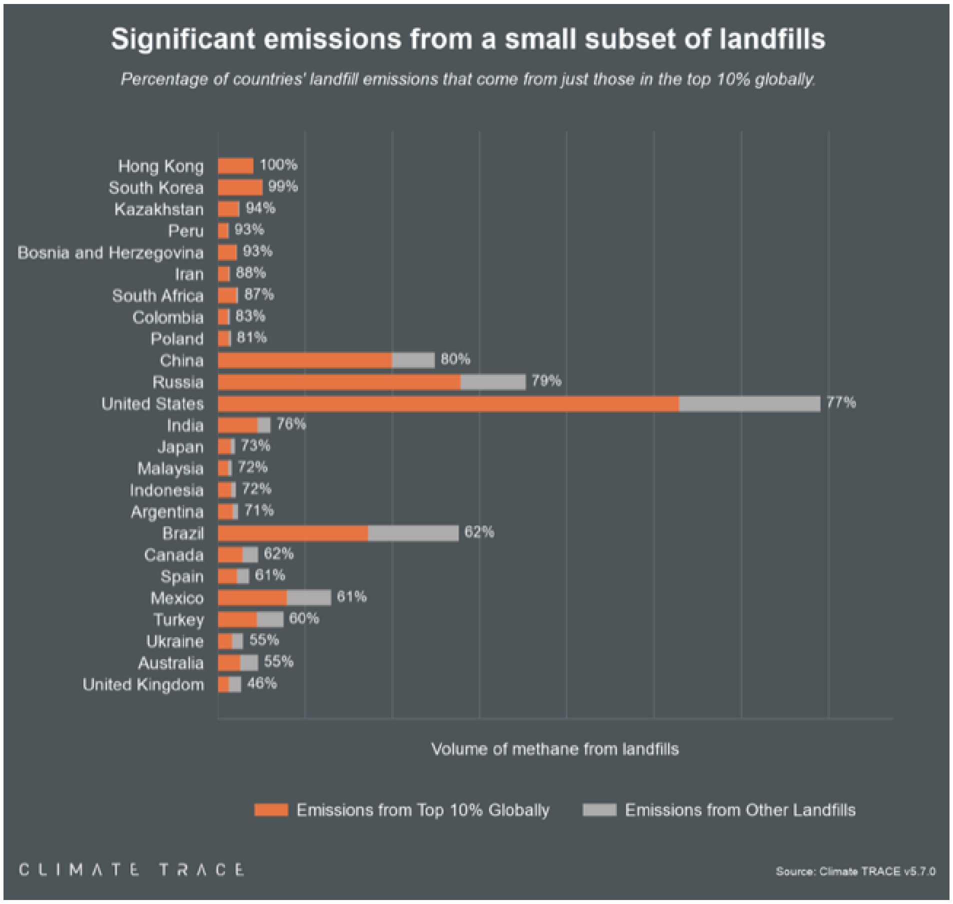

Figure 5. *Share of each country's landfill methane emissions coming from its top 10% of landfills. In many countries the highest-emitting sites account for the large majority of landfill methane. Source: Climate TRACE (data version 5.7.0).*

Agriculture offers the largest but toughest methane challenges

Agriculture is the biggest overall source of global methane emissions, but is perhaps the hardest to abate. Two primary opportunities for methane reductions from agriculture are in reducing enteric fermentation (the methane produced by cows) and in rice production.

Enteric fermentation is the process by which the digestive systems of cattle, sheep, and other ruminant animals produce methane that they emit through belching and flatulence. Climate TRACE tracks enteric fermentation from cattle operations on pasture and in concentrated animal feeding operations (CAFOs), as well as enteric fermentation from other species.

Climate TRACE data show that in 2025, enteric fermentation resulted in 130.7 Mt of methane – a slight increase over 2023's total for the sector, which was 129.8 Mt. Enteric fermentation from cattle alone is the largest source of methane worldwide.

Mitigating methane from enteric fermentation has proven challenging. Scientists are conducting ongoing research into the efficacy, safety, and viability of feed additives to reduce the methane produced in the digestive process. Various governments – the European Union, United States, and Brazil – have adopted feed additives into beef and dairy cattle diets primarily to increase beef cattle weight gain or milk production, with reduced methane emissions a secondary benefit. Global implementation is currently limited, likely due to some countries banning or limiting feed additives, incentives, the additives' cost to implement, impact on dairy and beef prices, quality of products, farmers' lack of familiarity with additives, and consumer skepticism.

Rice is grown in flooded paddies to help suppress weeds that would undermine crop yields. Emissions from rice cultivation are caused by the decomposition of organic material resulting in the growth of methane-producing microbes.

In 2025, Climate TRACE data show that rice cultivation resulted in 26.4 Mt of methane, a nearly 3% reduction from 2023. The top 5 emitting countries monitored by Climate TRACE account for more than 65% of total emissions (India, Thailand, China, Indonesia, Bangladesh). One of the practices that could reduce methane from rice production is implementing a more balanced fertilizer composition. While most farmers primarily focus on the nitrogen content of fertilizers, potassium and phosphorus are the other essential elements of fertilizer. Phosphorus deficiency in rice systems has consequences both for productivity and methane emissions. Balancing fertilizer applications to have a combination of phosphorus and potassium in addition to nitrogen can reduce methane emissions from rice paddies.

When combined with potassium and phosphorus soil amendments, a balanced fertilizer application can reduce net emissions by 21-28% depending on the number of harvests within a production system. Improving the balance of nutrients within fertilizer can improve rice system productivity, particularly in phosphorus deficient systems. Unlike plentiful nitrogen, phosphorus is available in more limited quantities, which makes this solution potentially less accessible to operations without the capital to procure phosphorus fertilizers, even if the potential yield boost may help improve the economic case for these management changes.

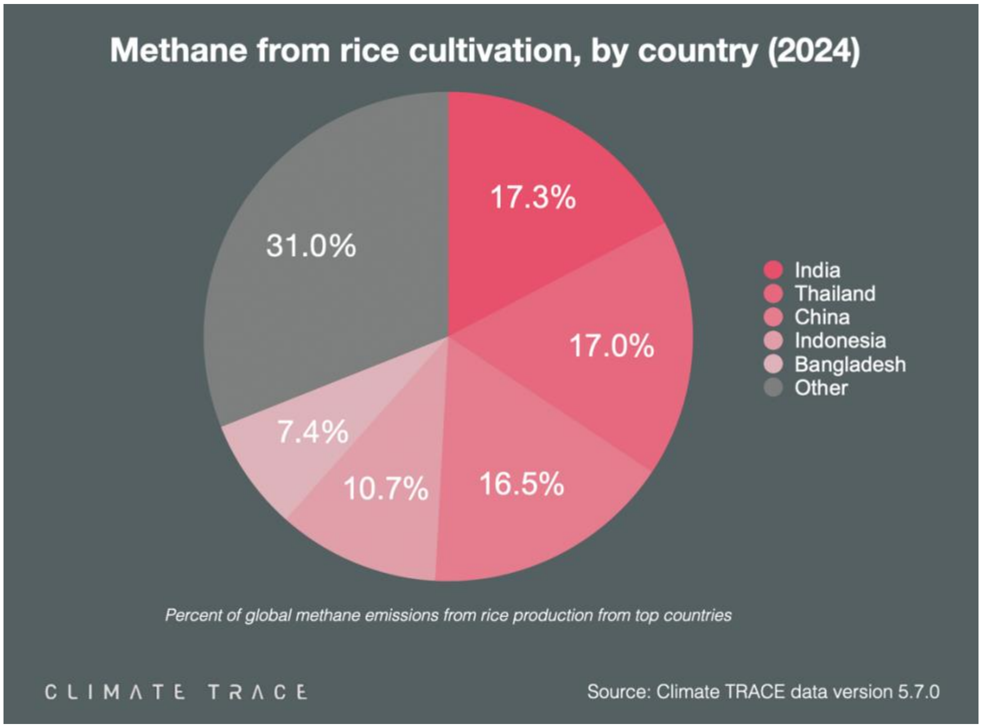

Figure 6. *Methane from rice cultivation by country, 2024. India (17.3%), Thailand (17.0%), and China (16.5%) are the largest sources, followed by Indonesia (10.7%) and Bangladesh (7.4%); together the top five account for more than 65% of global rice-cultivation methane. Source: Climate TRACE (data version 5.7.0).*

Growing Methane Data-to-Global Action

As the axiom goes: "we can manage what we measure." Methane may be invisible, but satellite instruments continue to launch, ground sensors continue to monitor, and analytic tools continue to be refined to make the invisible, visible. Knowing where, when, and how much methane escapes into the atmosphere from human activity is critical to predicting global temperatures.

Measurement also enables action. By calculating how much methane is escaping into the atmosphere and identifying with precision where it's coming from, we can better prioritize action in the short- and long-term. Climate TRACE data show where there are hotspots ripe for intervention so that policymakers, investors, businesses, and other stakeholders can make informed decisions about where they can get the biggest bang for their buck to deliver swift reductions in methane.

This data makes meaningful action on the climate crisis faster and easier. Because mitigating methane now offers safer living conditions on Earth for future generations.

Acknowledgements: The Climate TRACE coalition was formed by a group of AI specialists, data scientists, researchers, and nongovernmental organizations. Current members include Carbon Yield; Carnegie Mellon University's CREATE Lab; CTrees; Duke University's Nicholas Institute for Energy, Environment & Sustainability; Earth Genome; Former Vice President Al Gore; Global Energy Monitor; Global Fishing Watch/emLab; Johns Hopkins University Applied Physics Lab; OceanMind; RMI; TransitionZero; and WattTime. Climate TRACE is also supported by more

than 100 other contributing organizations and researchers, including key data and analysis contributors: Arboretica, Michigan State University, Ode Partners, Open Supply Hub, Saint Louis University's Remote Sensing Lab, and University of Malaysia Terengganu. For this white paper, data and analysis on the oil and gas sectors was provided by RMI; additional analysis was compiled with the use of Climate TRACE's Emissions Reduction Roadmap tool by the Climate TRACE team. For more information about the coalition and a list of contributors, click here.