Global Methane Tracker 2025

International Energy Agency

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Abstract

Methane is responsible for around 30% of the rise in global temperatures since the Industrial Revolution, and rapid and sustained reductions in methane emissions are key to limiting near-term global warming and improving air quality. The energy sector – including oil, natural gas, coal and bioenergy – accounts for more than 35% of methane emissions from human activity and has some of the best opportunities to cut these emissions. The annually updated Global Methane Tracker is an essential tool for raising awareness about methane emissions across the energy sector and the opportunities to bring them down.

The Tracker presents our latest sector-wide emissions estimates – based on the most recent data from satellites and measurement campaigns – and discusses different abatement options along with their associated costs. This 2025 update adds several new elements, including: country-level historical emissions data; an interactive tool to explore international methane initiatives; and estimates of emissions from abandoned fossil fuel facilities. It also features a fully open-access model for exploring abatement options in the oil and gas sector.

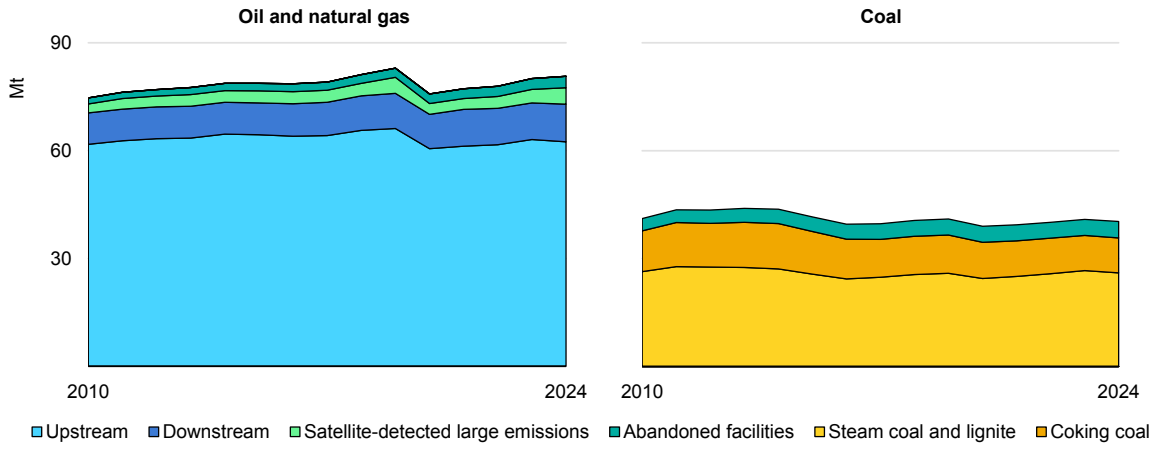
Key findings

Energy-related methane emissions have still not reached a definitive peak

The fossil fuel sector is responsible for nearly one-third of methane emissions from human activity today. Record production of oil, gas and coal, combined with limited mitigation efforts, has kept emissions above 120 million tonnes (Mt) annually. Abandoned wells and mines – included in this year's Global Methane Tracker for the first time – contributed around 8 Mt to these emissions in 2024. Bioenergy production and consumption results in a further 20 Mt of methane, largely from the incomplete combustion of traditional biomass used in cooking and heating in developing economies.

The agriculture and waste sectors are also major sources of methane emissions, but fossil fuel supply offers the greatest potential for immediate reductions in methane emissions. Solutions that lower methane emissions from fossil fuels to near zero already exist, and they could be deployed today at little – or even negative – cost. We estimate that around 5% of global oil and gas production currently meets a near-zero emissions standard (nearly 3 million barrels per day of oil and 130 billion cubic metres of natural gas). Many actors have set targets for lowering methane emissions by 2030, and momentum to drive down methane emissions has grown since the launch of the Global Methane Pledge in 2021 and the Oil and Gas Decarbonization Charter in 2023. Yet so far, few countries or companies have formulated real implementation plans for these commitments, and even fewer have demonstrated verifiable emissions reductions.

Methane emissions from the fossil fuel sector, 2010-2024

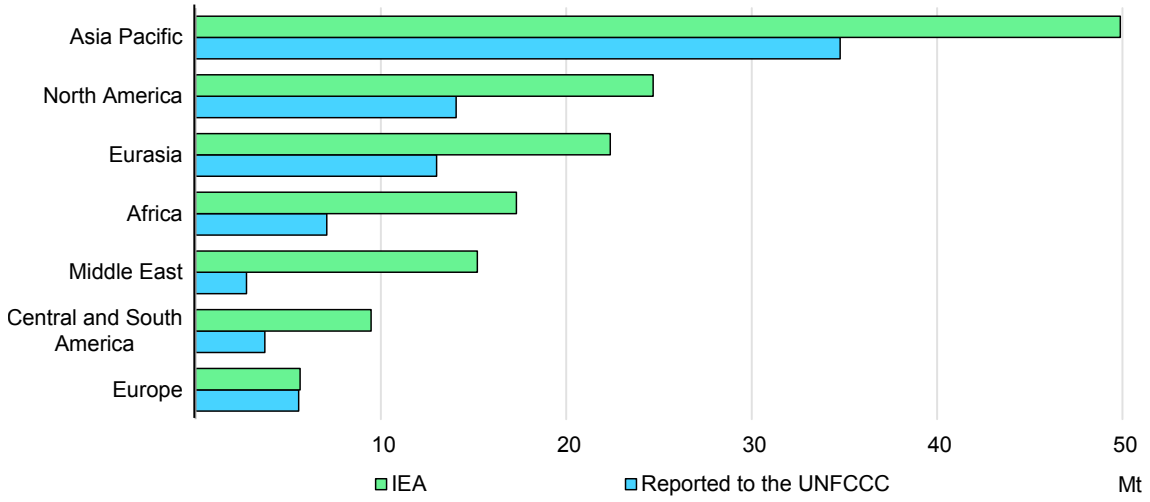


Methane emissions are widely underreported

Little or no measurement-based data is used to report methane emissions in most parts of the world. This is a major issue because measured emissions tend to be higher than reported emissions. Our estimates are based on the latest and best available data including scientific studies, measurement campaigns and large emissions events detected by satellites. As more measured data has become available, it appears that most national inventories are underreporting emissions: our estimate of total energy-related methane emissions globally is about 80% higher than the total reported by countries to the UN Framework Convention on Climate Change (UNFCCC). This gap is narrowest in Europe, where countries regularly submit inventories and some producers report emissions based on measured data.

While existing data and estimates can serve as a basis for action to cut methane emissions, improved data will lead to more efficient resource allocation and better confidence in emissions-reduction efforts.

Energy-related methane emissions reported to the UNFCCC and IEA estimates



Notes: UNFCCC = United Nations Framework Convention on Climate Change. Estimates are based on data for the latest available year.

Sources: IEA analysis based on data from UNFCCC for the latest available year in UNFCCC's GHG Data Interface.

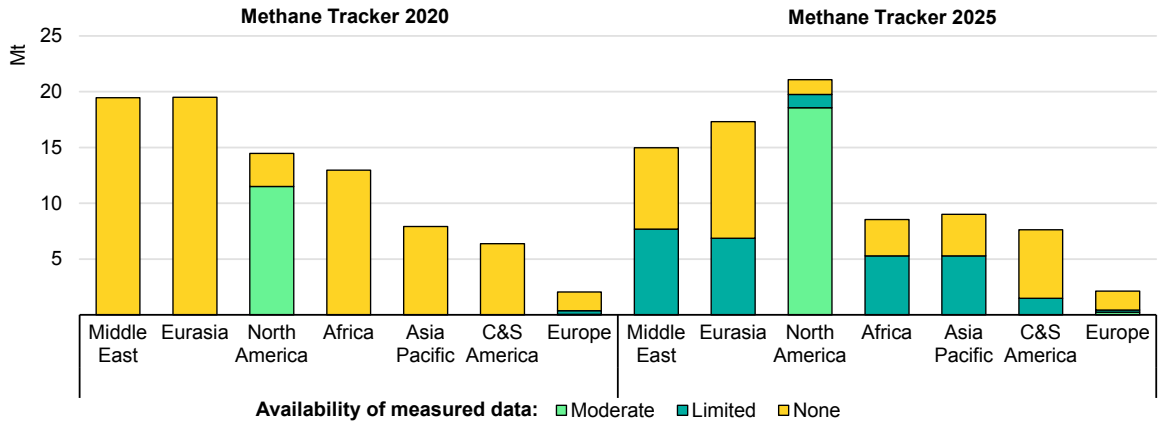
Methane data is improving, but more progress on abatement is possible even with an imperfect understanding of emissions levels

Many countries and companies are looking to improve their methane reporting. Canada recently updated its methodology to reflect improved data, which led to an increase of more than 35% in the volume of reported fugitive emissions from oil and gas. In 2024 some oil and gas companies met the highest level of reporting set by the United Nations Environmental Programme (UNEP) Oil and Gas Methane Partnership 2.0 (OGMP 2.0). Around 10% of emissions reported to OGMP 2.0 are now based on the most stringent data reporting category, including emissions from ConocoPhillips, GRTGaz, Jonah, Snam and TotalEnergies.

Since the first iteration of the Global Methane Tracker in 2020, the growing availability of measurement studies and satellite data has reduced uncertainty in our estimates across all regions. However, significant data gaps remain, especially in parts of the world where satellites struggle to gather useful data – such as in Venezuela, where cloud cover hinders observations, and in the north of Russian Federation (hereafter: "Russia"), where snow and ice make it challenging to observe methane leaks.

Robust measurement, monitoring, reporting and verification (MMRV) procedures and systems are essential for facilitating and tracking emissions reductions. However, there are tried-and-tested policies that have been proven to reduce methane emissions, and which can be implemented as data quality improves. These include leak detection and repair (LDAR) requirements, mandating no- or low-emissions equipment, and restricting routine flaring and venting.

Estimates of oil and gas methane emissions and related data availability



Notes: C&S America = Central and South America. Methane Tracker 2020 estimates are for 2019. Methane Tracker 2025 estimates are for 2024. Availability of measured data refers to estimates that can be derived from direct measurement campaigns or satellite data.

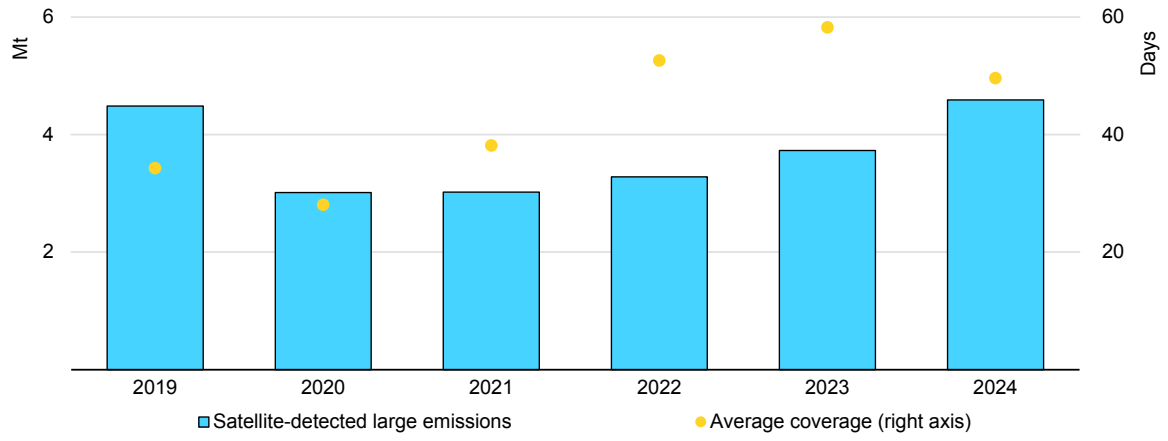
Satellites are providing new insights into the scale and nature of methane emissions

Today there are more than 25 satellites in orbit that can provide insights on methane emissions. New methane-focused satellites became operational in 2024, including MethaneSAT and Tanager-1, which have sensitive detection thresholds and provide high resolution data.

Data from MethaneSAT shows that dispersed sources (i.e. those that emit less than 500 kg of methane per hour) are responsible for a significant portion of the methane released in major oil- and gas-producing basins. This adds to recent evidence from the United States that indicates the importance of addressing both super-emitters and smaller sources. New analysis from Carbon Mapper, which looked at more than 2 000 methane plumes around the world, indicates that about one quarter of emissions sources detected at oil and gas facilities were recurrent (i.e. a leak was detected on multiple occasions at the same location).

Data from Sentinel 5P, which has been operating for a number of years, suggests that emissions from super-emitting methane events at oil and gas facilities rose to a record high in 2024, despite a reduction in coverage (i.e. the number of days where observations were possible).

Satellite-detected large emissions from oil and gas operations and satellite coverage, 2019-2024



Note: Emissions estimates are based on emissions from countries where observations were possible for an average of more than 10 days per year. Average coverage is the average number of days during which observations were possible across the countries in the sample.

Source: Sentinel 5P data processed by Kayrros.

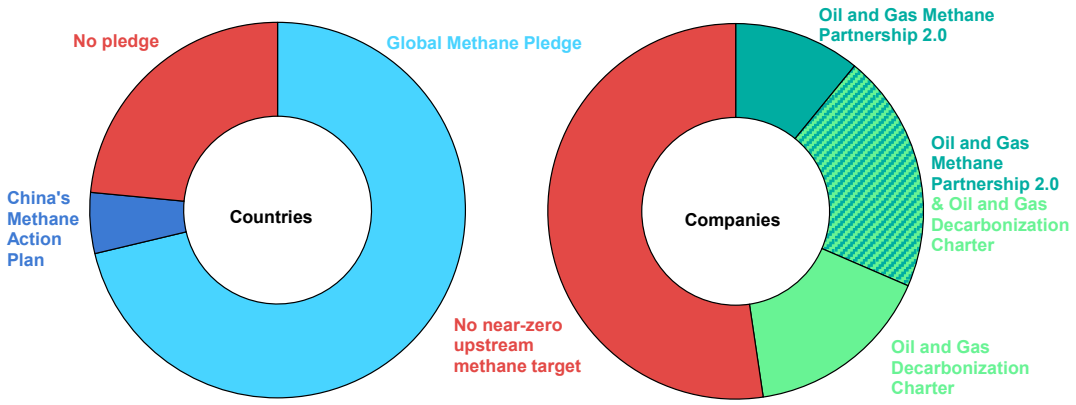
Methane pledges cover around 80% of global oil and gas production, but implementation remains weak

A growing share of oil and gas production is subject to methane abatement commitments, thanks to new participants in the Global Methane Pledge (e.g. Azerbaijan), the Oil and Gas Decarbonization Charter (e.g. PetroChina), the Oil and Gas Methane Partnership 2.0 (e.g. the Nigerian National Petroleum Company) and other methane initiatives. However, several large emitters have yet to commit to methane cuts and about half of the industry has yet to set near-zero methane targets. Most of the oil and gas industry appears to be following the lead of governments as only around 5% of global production is covered solely by voluntary industry pledges.

While it is important to continue building ambition for methane cuts, the immediate focus should be on implementing existing commitments and collaborating to drive down emissions. Regulators can learn from jurisdictions that have implemented tried-and-tested policies. Companies can share best industry practices. Financiers can encourage methane abatement. Everyone can benefit from better and more transparent data. The International Energy Agency (IEA) has been working with partner organisations to deliver support where it is needed most and to ensure that regulators have the knowledge they need to succeed in reducing emissions.

Nearly 100 countries have engaged on national methane action plans, and additional methane policies were announced in 2024. This included new European Union regulation, which includes measures to address methane from imported oil, gas and coal. Several countries are looking to update their Nationally Determined Contributions – the climate action plans that each country submits under the Paris Agreement – to implement methane commitments.

Global oil and gas production covered by countries' methane pledges and by corporate near-zero methane targets



Note: Considers global equity production by company. Oil and Gas Methane Partnership 2.0 is the share of production under reduction targets.

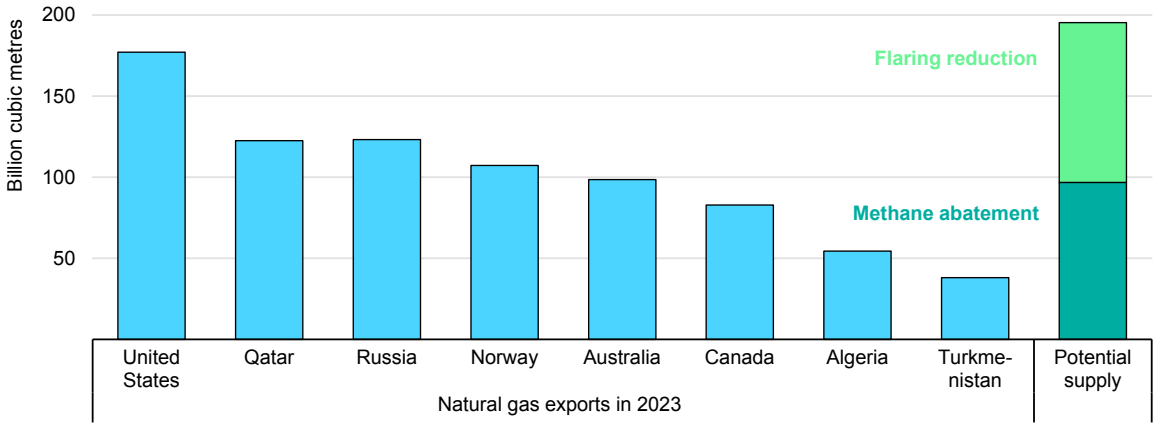
A concerted effort to limit methane emissions could make nearly 100 billion cubic metres of natural gas available to markets

Cutting down on methane and flaring can help improve energy security and ease the supply-demand balance by bringing additional natural gas to market. Around 200 billion cubic metres (bcm) of methane was emitted by the fossil fuel sector globally in 2024. Not all of this could have been captured and used as an energy source, but we estimate that methane abatement could have made nearly 100 bcm of natural gas available. A further 150 bcm of natural gas is flared globally each year, the majority of which consists of routine, non-emergency flaring. Addressing flaring and methane emissions in tandem would facilitate the deployment of solutions to ensure greater volumes of gas reach markets.

A vanguard of countries and companies are already demonstrating that methane emissions can be minimised, but not enough are following their lead: emissions intensities vary more than 100-fold between the best and worst performers.

In April 2025, the IEA and the government of the United Kingdom convened an international Summit on the Future of Energy Security to review the trends shaping global energy security and reflect on the tools needed to address energy security risks. Methane abatement makes a clear contribution to the energy security agenda.

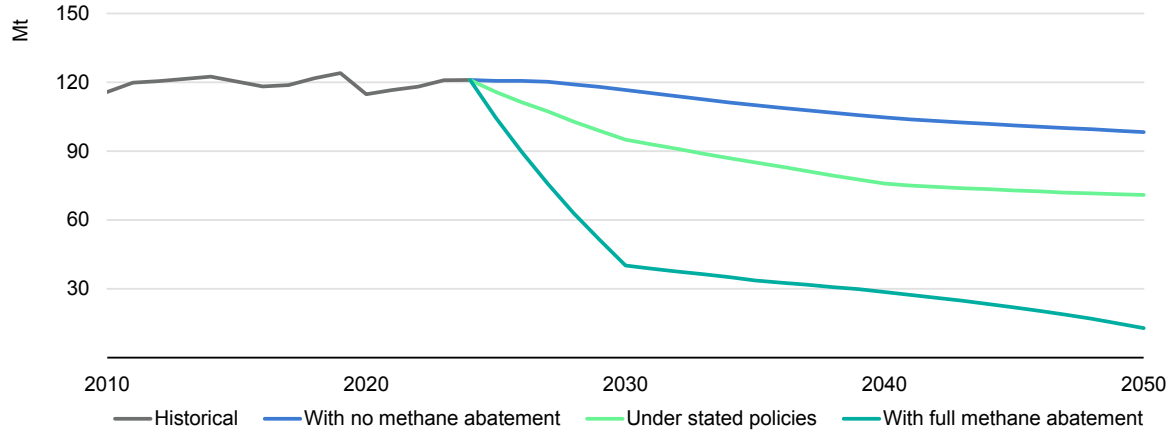
Natural gas exports and potential natural gas supply from reducing routine flaring and methane abatement



Rapid and sustained reductions in methane emissions are essential for limiting global warming

Deploying targeted methane mitigation solutions in the fossil fuel sector would prevent a roughly 0.1 °C rise in global temperatures by 2050 (assuming fossil fuel demand follows the Stated Policies Scenario). This would have a tremendous impact – comparable to eliminating all CO_2 emissions from the world's heavy industry in one stroke. Without targeted action on methane, the risks of severe climate damage increase considerably.

Methane emissions from the fossil fuel sector in the Stated Policies Scenario



Note: "With no methane abatement" assumes constant methane emissions intensities of production, with changes in emissions tied to changes in fossil fuel demand.

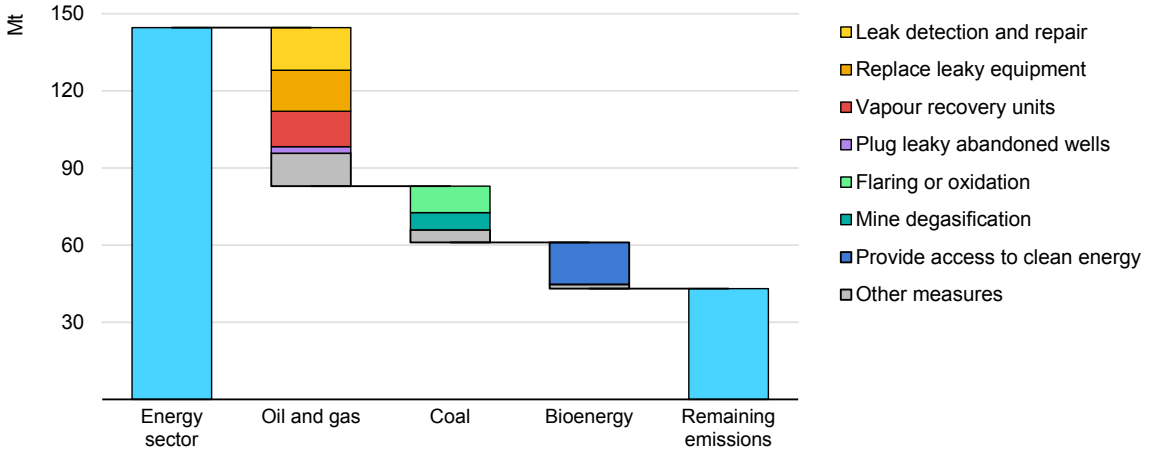
Around 70% of methane emissions from the fossil fuel sector could be avoided with existing technologies, often at a low cost

In the oil and gas sector, abatement solutions include upgrading equipment that emits by design, such as replacing wet compressor seals with dry seals, and using vapour recovery units to recover low-pressure methane flows. For coal, emissions could be reduced through coal mine methane utilisation, or by using flaring or oxidation technologies.

Around 35 Mt of total methane emissions from oil, gas and coal could be avoided at no net cost, based on average energy prices in 2024 (a slight decrease from our 2023 estimate, mostly due to lower gas prices and the addition of abandoned facilities to our estimates). This is because the required outlays for abatement measures are less than the market value of the additional methane gas captured and sold or used.

In 2024, we published the IEA's Methane Abatement Model, which allows users to estimate oil and gas methane abatement potential and the associated cost of abatement by country, segment and reduction technology.

Opportunities to reduce methane emissions in the energy sector, 2024



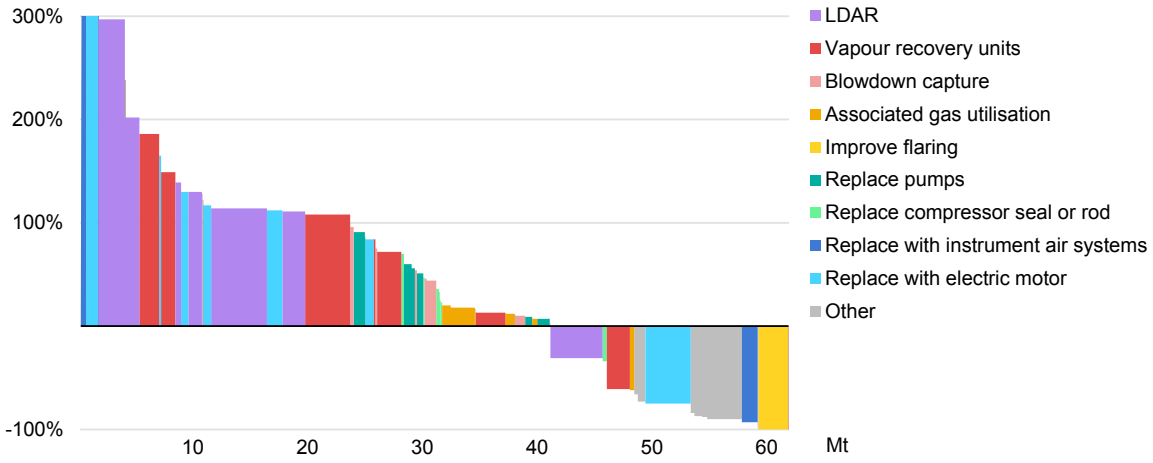
Note: "Other measures" includes efficiency improvements, installing plungers, blowdown capture, installing methane-reducing catalysts, reduced-emission completions and capturing methane emissions from waste streams.

Methane abatement options in oil and gas can deliver very high rates of return

Some methane abatement measures have high upfront capital costs and in many cases there is no route for bringing captured gas to markets, requiring investment in new infrastructure or means of gas transport. Many abatement options can still pay for themselves within a year. In the oil and gas sector, around 30% of the industry's emissions today could be avoided with measures offering rates of return of more than 25% – well above the usual returns sought by oil and gas companies when considering new capital investment.

There are a number of reasons why companies may fail to invest in methane abatement despite these attractive rates of return. For example, companies could be unaware of the scale of the problem or the available solutions. There may be higher-profile opportunities competing for investment resources, or leadership may perceive methane abatement as more costly than it is. There may be split incentives, whereby equipment owners do not directly benefit from reducing methane leaks, the contractual terms prevent methane savings from affecting revenue, or the owner of the gas does not see its full value. Securing capital for required upfront investments can be difficult, especially in developing economies. Companies may struggle to deploy sufficient staff or secure the necessary services to tackle the problem. Or they may not have identified an effective pathway or business case for bringing captured gas to productive use.

Internal rate of return of emissions-reduction measures in oil and gas operations



Note: LDAR = Leak detection and repair. The value of methane captured is based on net-back natural gas import prices in 2024 within each country, based on a societal perspective and assuming no domestic consumption subsidies.

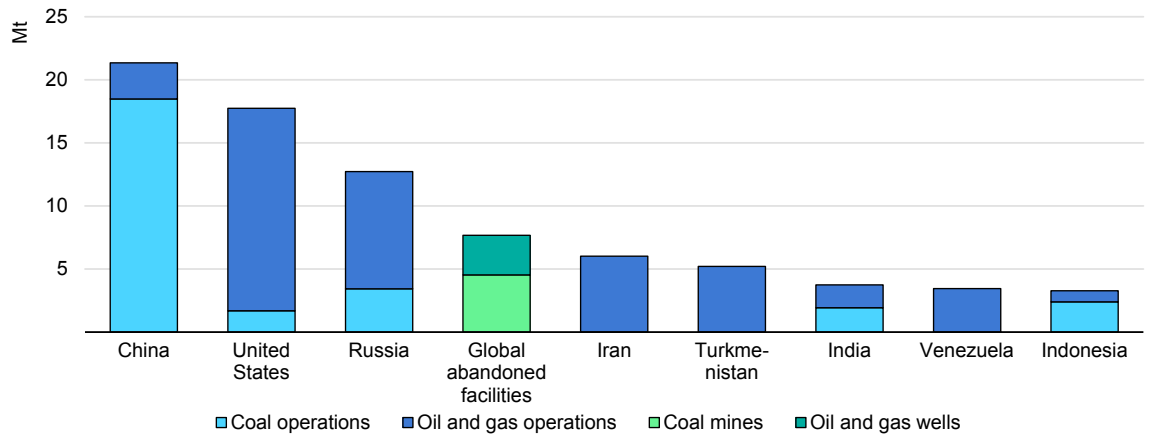
Abandoned facilities emit more methane than some of the largest fossil fuel producers

Abandoned facilities constitute a significant source of methane emissions. Based on the limited data that is currently available, we estimate that there are around 8 million abandoned onshore oil and gas wells globally, as well as a large number of abandoned coal mines. Most properly plugged wells emit negligible amounts of methane. But wells that were not appropriately decommissioned, or that have vents, can continue emitting methane for many years.

Globally, we estimate that abandoned coal mines emitted nearly 5 Mt of methane in 2024 and abandoned oil and gas wells released just over 3 Mt. Combined, these sources would be the world's fourth-largest emitter of fossil fuel methane.

Most emissions result from mines and wells that have recently been abandoned – which makes timely action critical for effective mitigation. Options include plugging and monitoring wells that are no longer operational, sealing abandoned coal mines, and directing methane flows to energy use or oxidation technologies.

Methane emissions from fossil fuel operations for the top eight emitters and from abandoned facilities globally, 2024



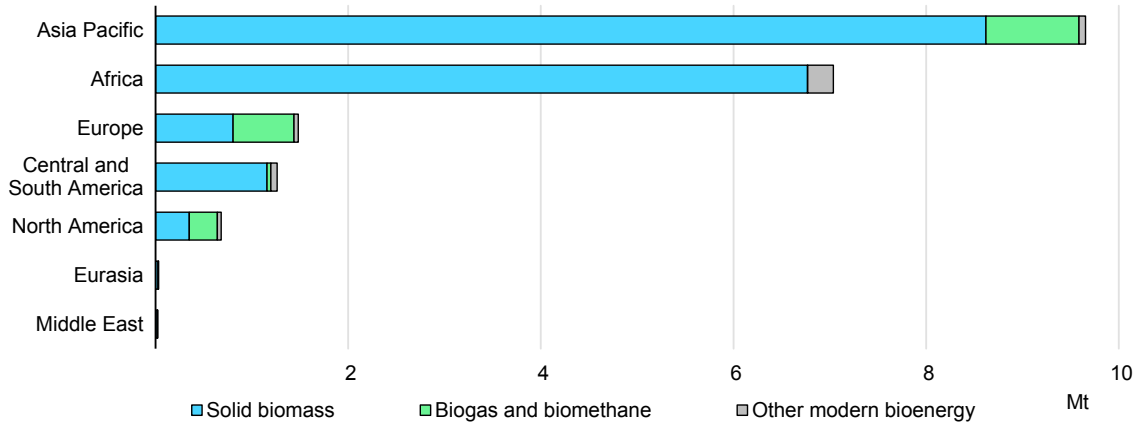
Note: Emissions from abandoned facilities are not included in fossil fuel operations. Abandoned facilities refer to facilities that have been closed and where there are no plans to restart production.

The lack of access to clean cooking is a leading cause of premature death worldwide and a major cause of methane emissions

There are currently more than 2 billion people without access to clean cooking, mostly in developing economies in Africa and Asia Pacific. This contributes to nearly 3 million premature deaths annually, with women and children most at risk. Universal access to modern, clean cooking facilities would deliver substantial gains in equality, health and economic well-being. It would also cut down on a major source of methane emissions.

There are also opportunities to reduce methane emissions from modern bioenergy production. These include upgrading biogas and biomethane facilities with low-emission technologies, deploying solutions like LDAR and thermal oxidisers at these sites, and improving waste management to curb uncontrolled emissions.

Methane emissions from bioenergy



Notes: Estimates from end-uses are for 2022 based on IEA data (2024). Estimates from biogas and biomethane are for 2023.

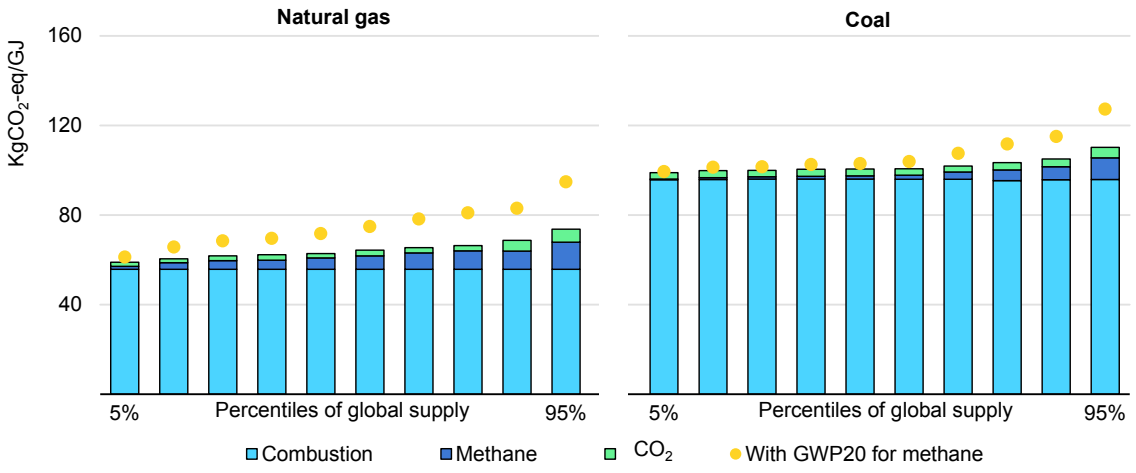
Nearly all of the natural gas consumed today produces fewer lifecycle greenhouse gas emissions than coal

When considering its full lifecycle – including methane and CO_2 emissions from supply and CO_2 emissions from its combustion – the greenhouse gas emissions intensity of natural gas use is generally much lower than that of coal. On average, natural gas results in about 35% fewer emissions than coal, and more than 95% of the natural gas consumed in 2024 had fewer lifecycle emissions than coal. When comparing emissions intensities of electricity generation, gas has a greater emissions advantage due to the higher efficiency of gas-fired power plants versus coal-fired plants.

Natural gas results in lower emissions than coal except when methane emissions from extraction, processing and transport are very high and when the warming impact of methane is considered over a shorter timeframe (e.g. using a 20-year global warming potential [GWP] rather than a 100-year GWP, as used here). The IEA is conducting an in-depth analysis of the full greenhouse gas emissions intensity of liquefied natural gas (LNG) and the options available for reducing these emissions, which will be released in June 2025.

Nonetheless, comparing natural gas only to coal sets the bar too low. The environmental case for gas relies not on surpassing the emissions performance of the most carbon-intensive fuel, but on minimising its own emissions intensity.

Lifecycle emission intensities of global coal and natural gas combusted in 2024



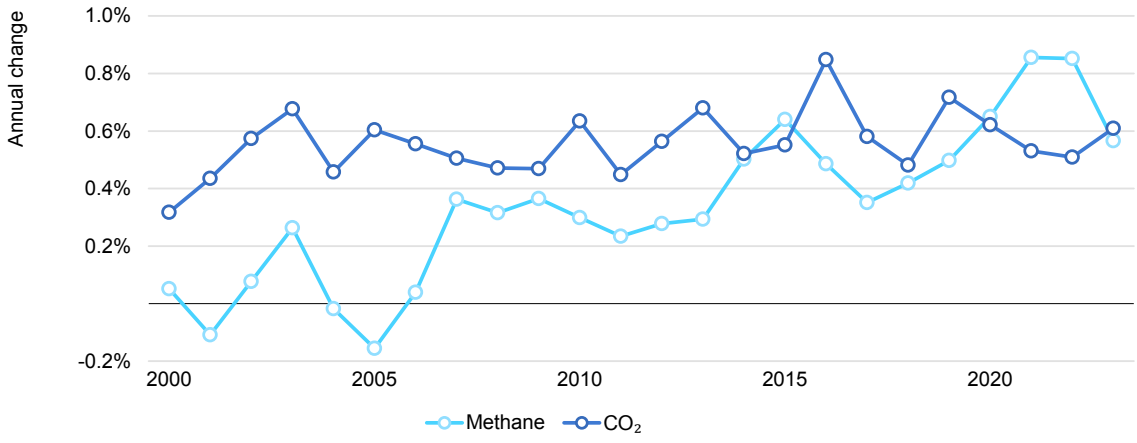
Note: One tonne of methane is considered to be equivalent to 30 tonnes of CO_2, based on the 100-year global warming potential (GWP100) and 82.5 tonnes of CO_2 based on the 20-year global warming potential (GWP20) (IPCC, 2021). Columns show the average emissions intensities of deciles of natural gas and coal combusted globally.

Understanding methane emissions

Methane concentration in the atmosphere continues to rise

The concentration of methane in the atmosphere is now over two-and-a-half times above pre-industrial levels. Atmospheric records show that, in relative terms, methane concentrations have been rising more quickly than those of all other major greenhouse gases – and at a rate faster than in any period since recordkeeping began. This growth is mainly due to mounting emissions from human activity, but there are also indications that a warming climate is driving up emissions from natural sources such as wetlands.

Annual changes in atmospheric CO_2 and methane concentrations, 2000-2023



Source: IEA analysis based on data provided by NOAA Global Monitoring Laboratory, Boulder, Colorado.

Methane is responsible for around 30% of the rise in global temperatures since the Industrial Revolution, and making rapid and sustained reductions in methane emissions is critical for limiting near-term warming. Methane (CH_4) has a much shorter atmospheric lifetime than carbon dioxide (CO_2) – around 12 years, compared with centuries – but it absorbs much more energy while it remains in the atmosphere. Methane also affects air quality because it can lead to ground-level (tropospheric) ozone, a dangerous pollutant. Methane leaks also present explosion risks.

The latest Global Methane Budget estimates annual global methane emissions to be around 610 Mt, with human activity responsible for almost two-thirds of the total and natural sources accounting for the rest.

IEA analysis suggests that the energy sector was responsible for around 145 Mt of methane emissions in 2024 – more than 35% of the total amount attributable to human activity. Oil operations were responsible for around 45 Mt, natural gas operations for nearly 35 Mt, and abandoned wells for around 3 Mt. An additional 2 Mt of methane leaked from end-use equipment. Coal accounted for more than 40 Mt, including over 4 Mt from abandoned mines, plus around 1 Mt from end-use equipment. Around 18 Mt came from the incomplete combustion of bioenergy, mostly from the traditional use of biomass, and another 2 Mt from modern bioenergy production.

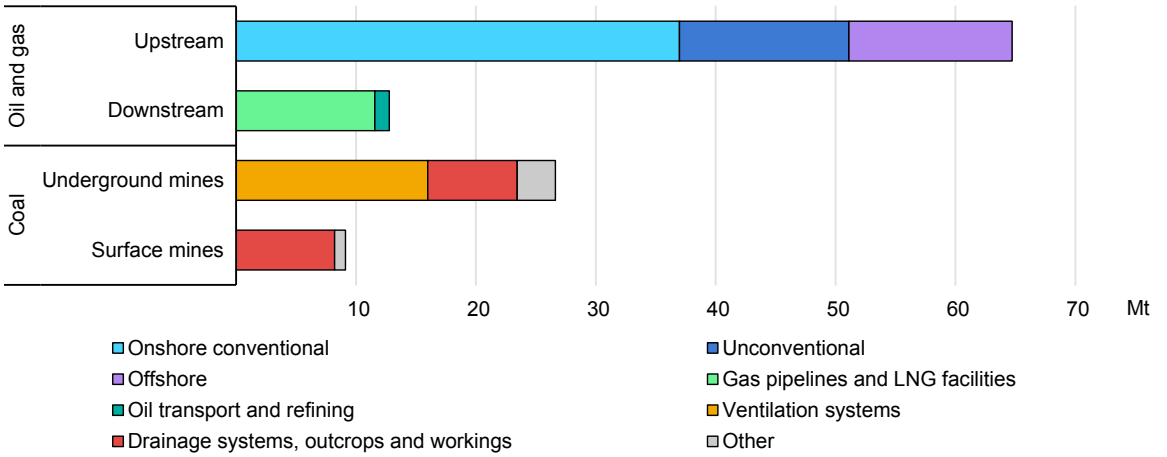
Upstream operations are responsible for the majority of methane emissions from fossil fuel operations

Fossil fuels generate emissions across the supply chain. These can stem from intentional releases, often due to the design of the facility or equipment (e.g. tanks that vent to the atmosphere), operational requirements (e.g. venting a pipeline for inspection and maintenance) or occur for safety reasons (e.g. ventilation systems at coal mines). They can also result from unintentional leaks – due to a faulty seal or leaking valve, for example, or from the incomplete combustion of natural gas (e.g. at flares).

In the oil and gas industry, upstream operations account for nearly 85% of methane emissions, with gas transportation and other downstream operations responsible for the remaining 15%. Upstream sources include all emissions from production, gathering and processing at both onshore and offshore facilities. Most downstream emissions come from gas transportation, including emissions from transmission and distribution via pipelines or as liquefied natural gas (LNG) and regasification. Other downstream sources include storage, refining and oil transport.

Methane emissions from coal production vary depending on mine characteristics. For underground mines, ventilation systems are usually the leading source of emissions. For surface mines, drainage systems, outcrops and workings are the main sources of methane emissions. Post-mining activities such as processing, storage and transport of coal are also sources of emissions, as any methane still trapped in the matrix of the coal can continue to seep out.

Methane emissions from fossil fuel operations, 2024



Notes: "Other" includes emissions from post-mining, incomplete combustion and other fugitive emissions. Excludes emissions from abandoned facilities.

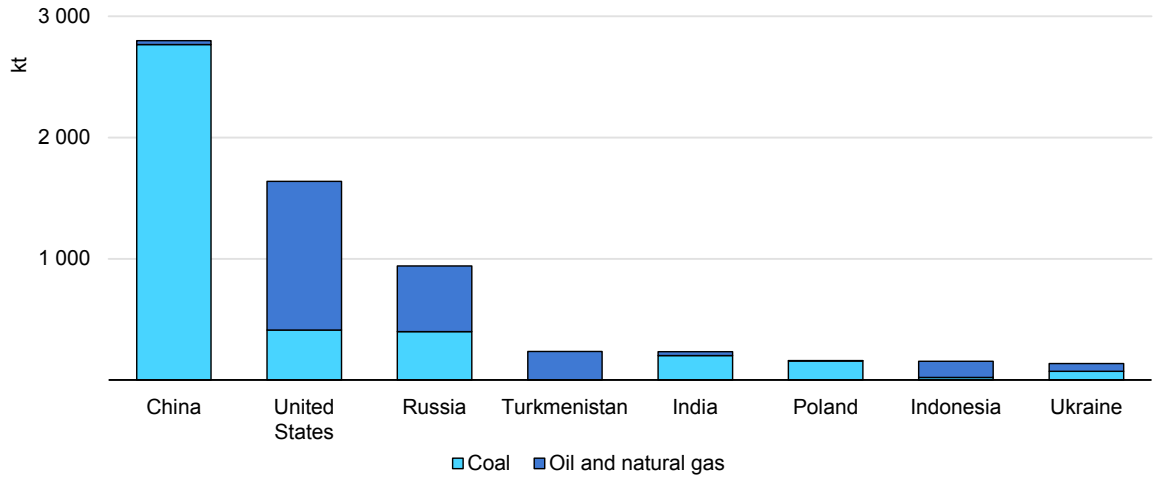
Abandoned coal mines and oil and gas wells account for 5% of energy-related methane emissions

Globally, we estimate that around 8 Mt of methane were emitted from abandoned facilities in 2024. This is based on historical production data, available measurements and information on abandoned facilities (see the Global Methane Tracker Documentation for further information). Abandoned coal mines emitted nearly 5 Mt, around 60% of which came from People's Republic of China (hereafter, "China"). Abandoned oil and gas wells emitted around 3 Mt of methane, with almost 40% coming from the United States.

Not all abandoned mines and well facilities are significant sources of emissions. Properly plugged wells and flooded mines generally emit negligible amounts of methane. Older facilities tend to emit less than recently abandoned ones, especially in the coal sector – but if not properly decommissioned and sealed, they can still emit methane for many years. Depending on the volume of emissions and the available infrastructure, there may be scope to extract and utilise abandoned mine methane, including for power and heat generation.

While current data is limited, we estimate that there are around 8 million abandoned onshore oil and gas wells globally, as well as a large number of abandoned coal mines. This includes almost 4 million abandoned wells and more than 250 000 abandoned coal mines in the United States.

Methane emissions from abandoned coal mines and oil and gas facilities in selected countries, 2024



Note: Shows eight countries with the highest emissions volumes from abandoned coal, oil and natural gas facilities.

Methane emissions from bioenergy are mainly linked to the incomplete combustion of biomass

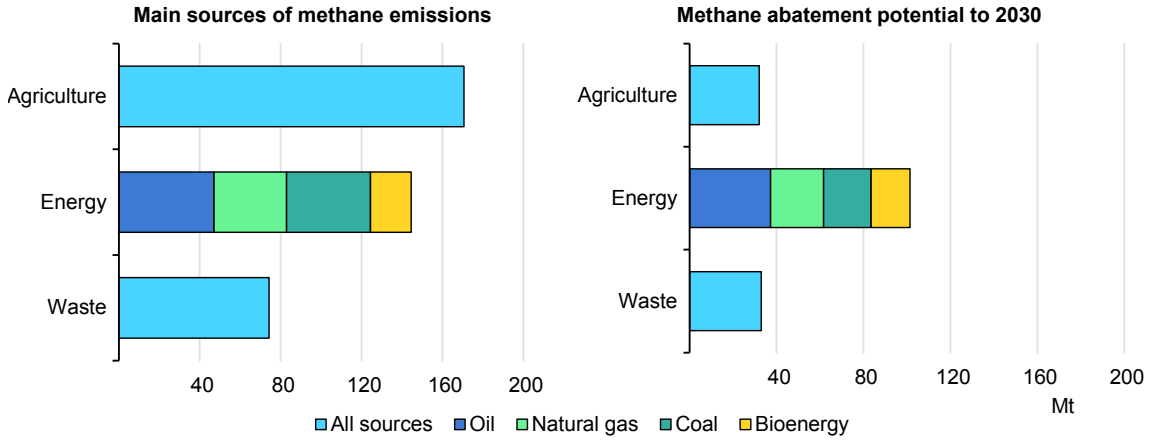
Nearly 18 Mt of global methane emissions resulted from the incomplete combustion of biomass – mostly charcoal, wood, agricultural waste and animal dung used for cooking and heating in developing economies. Modern bioenergy production and use resulted in a further 2 Mt. Anaerobic digestion plants, landfill gas recovery systems and wastewater treatment plants are all potential sources of fugitive methane emissions from biogas and biomethane production. Several feedstocks used to produce biogas and biomethane cause methane emissions from their decomposition (e.g. manure), although this is not always the case (e.g. energy crops). Methane emissions from modern bioenergy production and use can be reduced with the use of best available technologies, leak detection and repair (LDAR) programmes and measures to improve combustion efficiencies.

Addressing fossil-fuel methane represents one of the fastest and most cost-effective ways to lower emissions globally

The fossil fuel sector likely offers the greatest potential for rapid and low-cost reductions in methane emissions. We estimate that around 70% of methane emissions from this sector could be reduced with existing technology. Oil and gas methane emissions can be reduced by around 75% through well-known measures such as LDAR programmes, upgrading leaky and high-emitting equipment or plugging leaky wells. In the coal sector, methane emissions could be halved

through effective coal mine methane utilisation in mines, or by deploying flaring or oxidation technologies when energy recovery is not viable. Achieving universal access to clean cooking and modern heating would eliminate the vast majority of emissions from the incomplete combustion of bioenergy.

Methane emissions from human activity and their abatement potential



Sources: Methane emissions for agriculture and waste are based on data from the Global Methane Budget (2024). Methane abatement for agriculture and is waste is taken from UNEP's Global Methane Assessment (2021).

Around 30% of fossil-fuel methane emissions in 2024 could have been prevented at no net cost

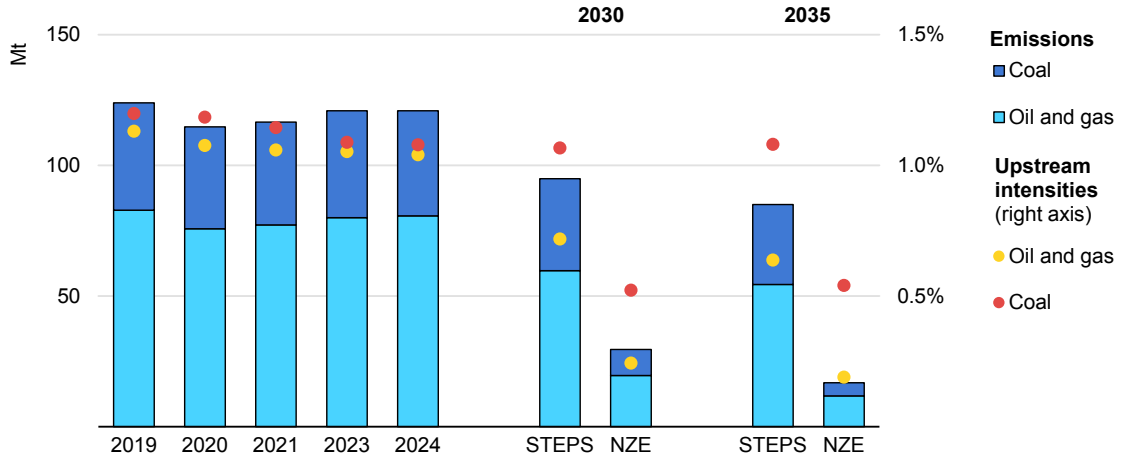
Based on 2024 energy prices, we estimate that around 30% of methane emissions from the fossil fuel sector could have been avoided at no net cost. This share is higher for the oil and gas sector than in the coal sector. Many measures can save money because the outlays required to deploy them are less than the market value of the methane that can be captured and sold. The value of 30% is slightly lower than the 40% estimated by the Global Methane Tracker 2024 because natural gas prices in 2023 were higher in most countries. The inclusion of emissions from abandoned facilities in our calculations also resulted in a smaller share of abatement measures that can be deployed at no net cost.

In the oil and gas sector, abatement measures are concentrated in the upstream segment, whereas in the coal sector, mitigation measures are mostly linked to underground coal mines. The most cost-effective options for reducing methane emissions are in leaky oil and gas facilities that already have access to gas markets and in gassy underground mines.

Methane emissions reductions depend on targeted action

In the IEA's Net Zero Emissions by 2050 (NZE) Scenario, methane emissions from fossil fuels fall by around 75% by 2030, and by around 85% by 2035 compared with current levels. Most of this decline stems from the explicit deployment of methane abatement technologies, and all fossil fuel producers in 2030 achieve an emissions intensity close to that of the best performers today. The global average upstream methane emissions intensity of oil and natural gas production falls from around 1% in 2024 to 0.2% in 2030 and the intensity of coal operations falls from just over 1% to 0.5% over the same time period.

Methane emissions and intensities in the STEPS and NZE Scenario, 2030 and 2035



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Notes: STEPS = Stated Policies Scenario. NZE = Net Zero Emissions by 2050 Scenario. Methane intensity is calculated here in energy terms as total methane emissions from upstream operations divided by marketed fuel production, assuming methane has an energy density of 55 megajoules per kilogramme (MJ/kg).

Gas is almost always better than coal on a lifecycle basis, but "beating coal" on emissions is not enough to make an environmental case for gas

When considering the full lifecycle emissions intensity of gas and coal, some have argued that emissions from the production, processing and transport of natural gas mean that sometimes it is more emissions-intensive than coal. Methane leaks along the natural gas and coal value chains are the critical element in this calculation.

There is a very wide variation in the emissions intensity associated with the production, processing and transport of different sources of gas and coal (i.e. all

emissions apart from the CO_2 released during combustion). Still, on a full lifecycle basis, we find that more than 95% of the natural gas consumed today has a lower emissions intensity than coal.

Globally, on average, natural gas results in 35% fewer greenhouse gas emissions than coal. Coal only outperforms natural gas when methane emissions from gas extraction, processing and transport are very high and when the warming impact of methane is considered over a shorter timeframe (e.g. when using the 20-year GWP rather than the 100-year GWP). The lifecycle emissions intensity of LNG tends to be higher than for natural gas, given the energy intensity of the liquefaction process – but in general, LNG still has lower emissions than coal. The IEA is conducting an in-depth analysis of the greenhouse gas emissions intensity of LNG and the options available for reducing these emissions, which will be released in June 2025.

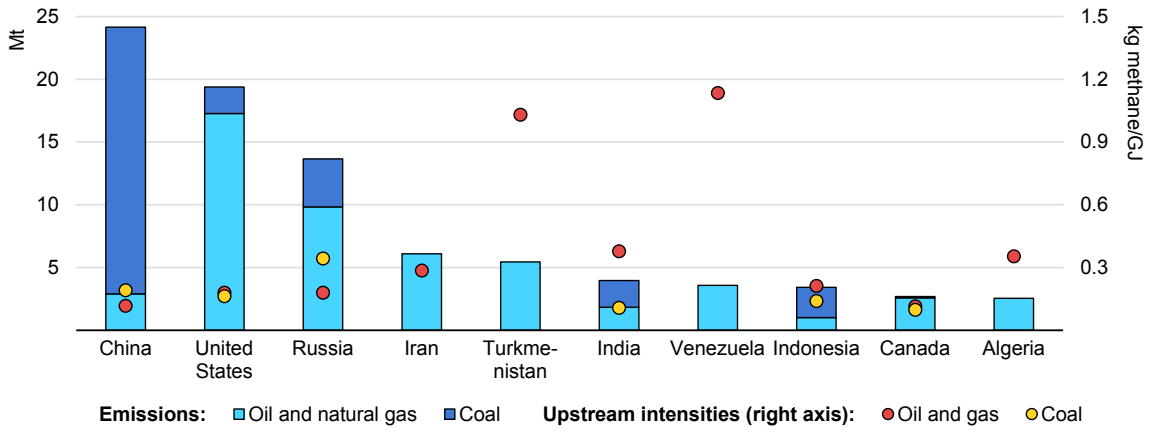
Nonetheless, “beating” coal on environmental grounds sets a low bar for natural gas, especially since there are lower-emissions – and often lower-cost – alternatives to both fuels. The declining cost of renewable technologies in the power sector is the clearest case in point. In many power markets, wind and solar photovoltaic (PV) are already among the cheapest options for new generation. Lifecycle emissions from bioenergy are also considerably lower, on average, than from natural gas.

The Global Methane Tracker provides a coherent set of estimates for the energy sector based on the best available data

The IEA produces and publishes country-level estimates for energy-related methane emissions and abatement options as part of our Global Methane Tracker. It also includes emissions estimates from non-energy sectors – waste and agriculture – based on publicly available data to provide a fuller picture of methane sources from human activity. Analysis of how different policy options could reduce methane emissions is also available, as well as comparisons of commitments and plans to reduce methane emissions across countries and regions.

Our estimates are regularly updated using the best available data on fossil fuel operations, country- and production-specific emissions intensities, the latest scientific studies and measurement campaigns as well as large emissions events detected by satellites. Over time, these estimates can be influenced by several factors, including measurement studies, ageing of facilities, shifts in flaring intensities, types of operators and satellite-detected large emissions, as well as evolutions to governance indicators, methane policies and regulations.

Methane emissions from the fossil fuel sector and upstream methane intensity for selected producers, 2024



Note: Methane intensity is calculated here as total methane emissions from upstream operations divided by marketed fuel production.

The IEA works closely with UNEP's International Methane Emissions Observatory (IMEO) and other partners to ensure our estimates reflect the latest findings from measurement-based, peer-reviewed studies. In addition to the Global Methane Budget, a number of publications released in 2024 used innovative techniques to estimate sectoral emissions for top-emitting regions and countries. These studies demonstrate efforts to compare and reconcile measurement-based and inventory-based methodologies.

Emissions from downstream operations have been revised upwards in this year's edition of the Global Methane Tracker (to around 13 Mt globally, compared with 8 Mt in last year's edition). This is based on new data on operating pipelines, measurement studies, and analysis undertaken by Kayrros on the distribution of emissions detected by satellites.

We include emissions from the end use of coal, oil products and natural gas in the Global Methane Tracker. These estimates are based on the emissions factors published by the Intergovernmental Panel on Climate Change (IPCC). Some measurement campaigns have suggested that these emissions factors could significantly underestimate actual emissions across different end-use environments, including in industry, cities and households. These are areas with very high levels of uncertainty and our estimates will continue to be updated as the evidence base grows.

Emissions estimates from bioenergy are another area of high uncertainty. For solid bioenergy, the Global Methane Tracker relies on emission factors reported by the IPCC in 2006. This year, we conducted a more detailed analysis of solid bioenergy use, refining our estimates of emissions from traditional use of wood for cooking

and heating. We also include a specific assessment of methane emissions from biogas supply. This is based on an assessment of emissions from biodigesters, biogas upgrading facilities and emissions from digestate storage.

For the first time, emissions from abandoned coal mines and oil and gas wells are included in the Global Methane Tracker 2025. To estimate these emissions, we first generate country-specific and production type-specific emissions intensities. These are then applied to estimates of abandoned wells and mine capacity on a country-by-country basis, assuming older facilities emit less than recently abandoned ones. Existing measurements of these sources cover a very limited number of facilities and regions, and reliable data (e.g. year of closure, condition of the facility) are not available for most countries. This is an area with very high levels of uncertainty and our estimates will continue to be updated as the evidence base grows.

Hydropower facilities can also emit significant amounts of methane (estimated in one study to be up to 14 Mt annually). Methane sources from these operations include degassing at turbine outlets as well as diffusive, ebullitive emissions from reservoirs. We do not yet include these emissions in the Global Methane Tracker due to the limited information available on the extent and characteristics of these sources. Nonetheless, they may represent significant levels of emissions.

In 2024, we published the IEA's Methane Abatement Model, which allows users to estimate oil and gas methane abatement potential and the associated cost of abatement by country, segment and reduction technology. This report and the information presented in the Methane Tracker Data Explorer represent our best attempt to reconcile existing information and produce a consistent set of country-level estimates. Further details on the methods used can be found in the Global Methane Tracker Documentation. We recognise these estimates do not represent the last word and welcome all feedback based on measurements and robust data sources that can further refine our estimates.

Relevant reports, scientific studies or information can be shared with IEA analysts by email at methanetracker@iea.org.

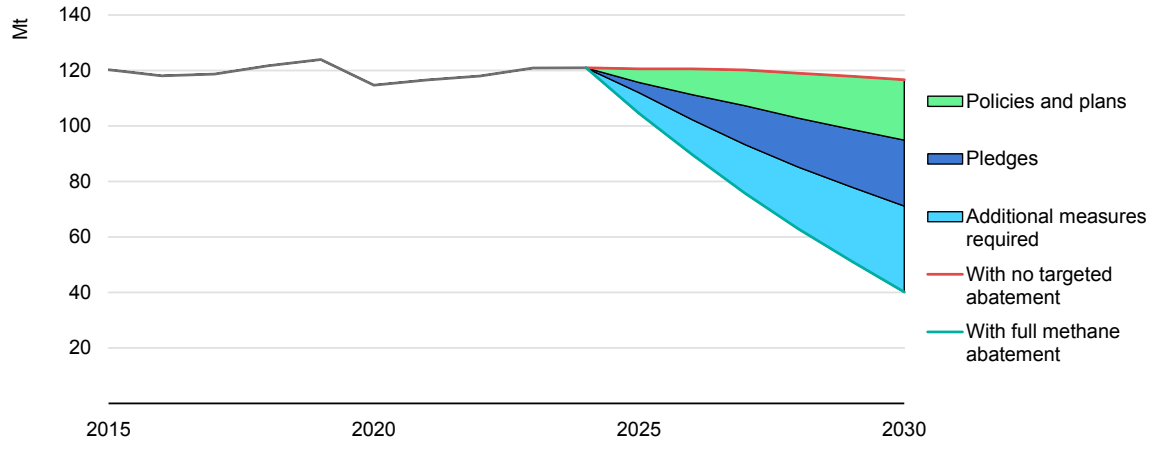
Policies

Existing pledges would cut fossil-fuel methane emissions by 40% by 2030, but only half are backed by detailed policies and regulations

Methane pledges cover 80% of global fossil fuel production, with the largest initiative being the Global Methane Pledge (GMP). Countries that participate in the GMP commit to work together to collectively reduce global methane emissions from human activity (across all sources, not limited to energy) by at least 30% below 2020 levels by 2030. Cutting the world's methane emissions by 30% over the next decade would have the same impact on global warming by mid-century as immediately shifting the global transport sector to net zero CO_2 emissions.

In 2024, Azerbaijan, Tajikistan, Guatemala and Madagascar joined the GMP, bringing the total number of participating countries to 159 (plus the European Union). The GMP now covers more than 50% of global methane emissions from human activity. Yet while membership in the GMP continues to grow, most signatories have yet to take concrete action.

Methane emissions reductions in the fossil fuel sector from current policies, plans and pledges to 2030



Notes: Pledges include whether countries participate in the Global Methane Pledge or have a high-level pledge to reduce methane. Policies and plans include detailed national action plans, policies or a specific methane-related target as of end-March 2025.

Existing high-level pledges on methane would suggest a reduction of approximately 55% in oil and gas methane emissions by 2030. However,

implementation is still lacking: detailed methane policies and regulations would cut emissions by only around 25% by 2030.

Commitments to cut methane emissions from the coal sector are more limited, with an even larger implementation gap. High-level pledges would lead to a 30% reduction in coal mine methane emissions by 2030, while policies and regulations currently in place would only lower emissions by just under 15% by 2030.

Recent changes in methane policies and regulations

A number of countries have recently introduced new measures on methane emissions:

- **Canada** issued draft regulations to establish a national cap-and-trade system for greenhouse gas emissions from the oil and gas sector. These regulations are expected to further incentivise Canadian oil and gas operators to cut their methane emissions.
- **China** established a new air pollution standard for coalbed methane, requiring coal mine operators to capture gas that has a methane concentration of 8% or higher and a flow rate of 10 m^3/min or more. This gas must be utilised or stored in gas tanks. If the gas cannot be utilised or stored, it must be destroyed.
- **Brazil** issued guidelines through its National Energy Policy Council that promote the decarbonisation of oil and gas activities, including minimising flaring and eliminating routine flaring. The guidelines also call for measures to reduce methane leaks from oil and gas operations.
- **Kazakhstan** is developing regulations to reduce methane emissions from the fossil fuel sector, including by eliminating non-emergency methane venting, requiring leak detection and repair (LDAR), and establishing a measurement, monitoring, reporting and verification (MMRV) framework.
- The **European Union** adopted its Methane Regulation on emissions reduction in the energy sector, which includes mandatory MMRV requirements for emissions at the source level, both for operated assets as well as non-operated assets.

In the United States, a reconsideration of methane rules issued under the previous administration has been announced. Congress has also overturned a rule issued by the Environmental Protection Agency (EPA) that implemented the “Waste Emissions Charge” mandated by the Inflation Reduction Act.

Nearly 100 countries have completed or are developing national methane action plans. This includes 37 countries that are being supported by the Climate and Clean Air Coalition (CCAC) through participation in the CCAC’s Methane Roadmap Action Programme.

The IEA has prepared two detailed “how-to” guides for countries looking to develop new methane policies and regulations: one for oil and gas emissions and another for coal mine emissions.

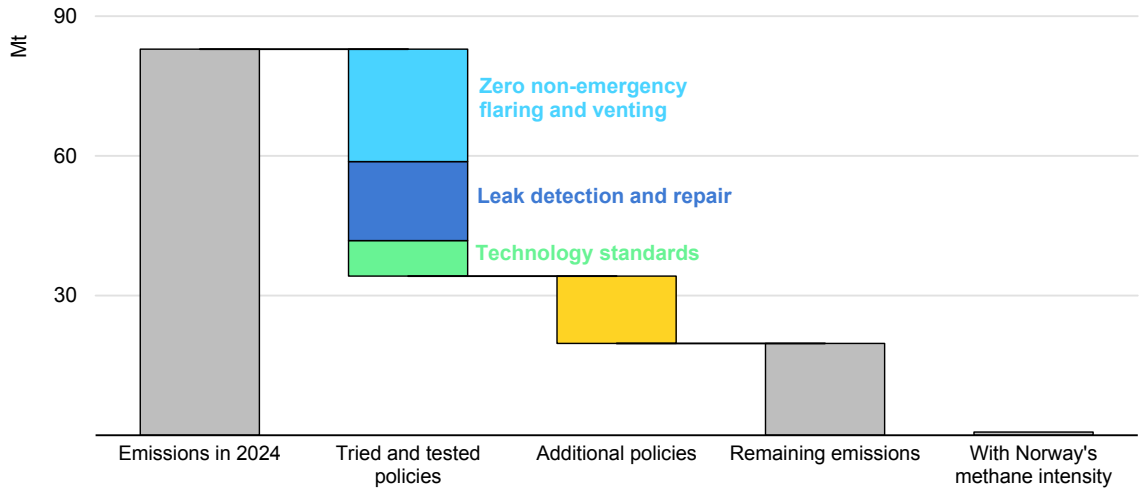
Implementing tried-and-tested policies globally would lower oil and gas methane emissions by more than half by 2030

A number of tried-and-tested policies for reducing methane emissions have been successfully applied in various countries and contexts worldwide. These policies include limiting flaring and venting, requiring LDAR programmes, and introducing technology standards. They do not require extensive systems for measuring methane emissions and can serve as an effective first step to methane mitigation.

Were every country to implement these tried-and-tested policies, we estimate that global methane emissions from oil and gas operations would shrink by more than half. If additional policies (such as emissions pricing, financing instruments, and performance standards) were also adopted globally, this would lead to a 75% reduction in methane emissions from oil and gas operations.

Certain countries have already implemented these policies successfully, providing a model for other countries aiming to reduce their methane emissions. For example, Norway banned non-emergency flaring in 1971 and imposed a tax on natural gas venting and flaring in 2015. Thanks to these measures, Norway has driven methane emissions from fossil fuel operations to very low levels – and it now has the lowest emissions intensity of any country. If all countries managed to match Norway’s emissions intensity, global methane emissions from oil and gas operations would fall by more than 90%. Meanwhile, Nigeria and Colombia have also recently enacted regulations that introduce tried-and-tested policies, including restrictions on cold venting and LDAR requirements.

Global oil and gas methane emissions, emissions reduction from tried-and-tested policies, and estimated emissions with Norway's performance level, 2024

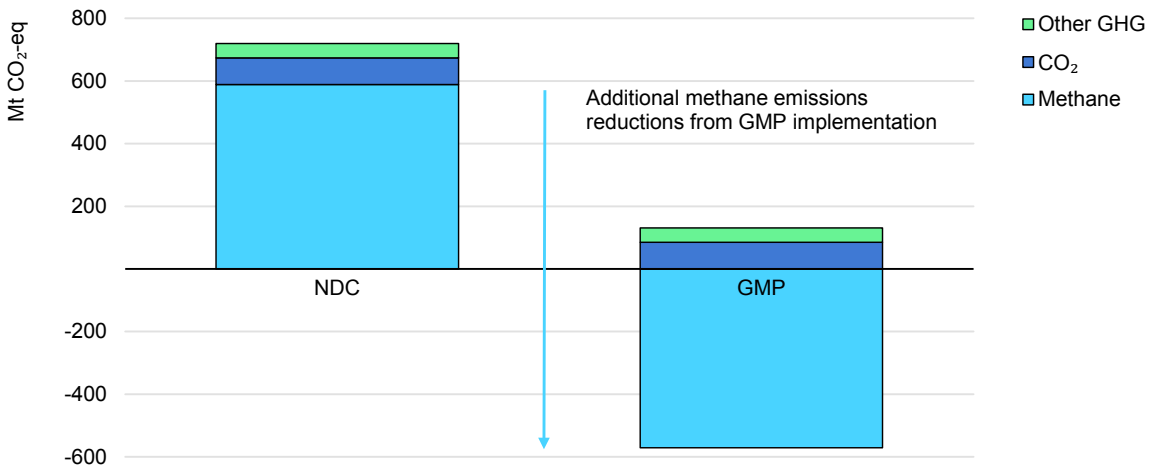


The ongoing round of Nationally Determined Contributions is an opportunity for countries to strengthen methane commitments

The current round of Nationally Determined Contributions (NDCs) due in 2025 represents an opportunity for countries to indicate how they will move from pledges to action on methane abatement. In 2024, only about 30 NDCs mentioned specific measures for reducing energy-related methane emissions, while just nine included quantitative targets for these reductions. With the 2025 NDC update, countries have a chance to set specific quantitative targets for methane reduction, including sector-specific targets for energy.

We have identified 65 GMP signatories for whom cutting domestic methane emissions by 30% would represent a greater reduction in greenhouse gas emissions than what is included in their pre-2025 NDCs. Many of these NDCs indicate methane emissions would follow a "business as usual" scenario. Economy-wide greenhouse gas emissions in these 65 countries would rise in aggregate by a little over 10% between 2020 and 2030. However, if these countries achieved a 30% reduction in domestic methane emissions through national policies and regulations, their total greenhouse gas emissions would instead decline by 10% during this period, resulting in the elimination of 1.2 gigatonnes of carbon dioxide-equivalent (CO_2-eq) emissions by 2030. This would be broadly equivalent to eliminating all emissions from international aviation and shipping.

Change in greenhouse gas emissions between 2020-2030 for selected countries under pre-2025 NDCs and through domestic implementation of the Global Methane Pledge



Notes: GHG = greenhouse gas. Includes emissions for 65 GMP countries whose pre-2025 NDCs can be enhanced by incorporating the GMP target as a 30% reduction in domestic methane emissions. NDC estimates are based on the contributions set out by each country, according to their target type (i.e. relative, absolute, "business as usual", intensity). One tonne of methane is considered to be equivalent to 30 tonnes of CO_2 based on the 100-year global warming potential (IPCC, 2021).

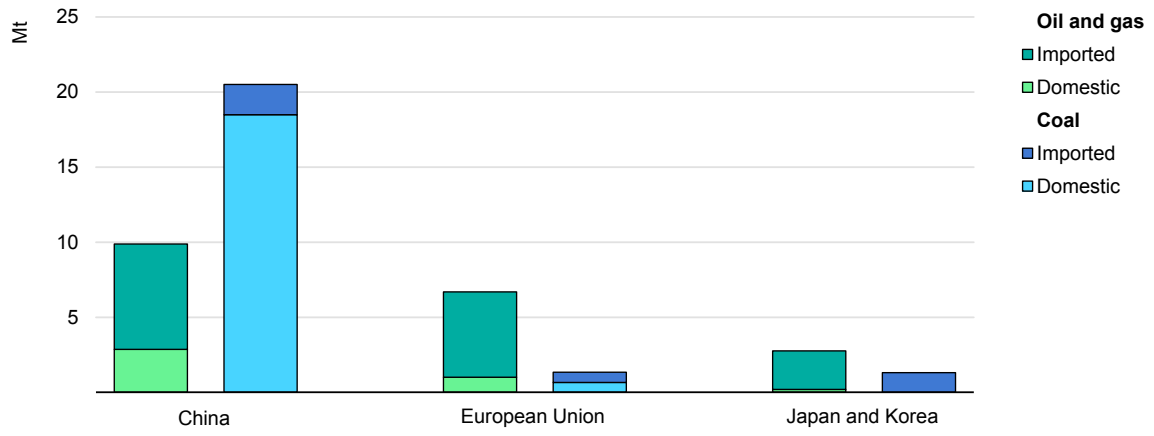
Sources: Data for 2020 are economy-wide GHG emissions in 2020 using IEA data for energy-related methane emissions and EDGAR data for other GHG emissions.

Some countries have already released their updated NDCs for the period up to 2035. New NDCs from Brazil, Canada, the United Arab Emirates and the United Kingdom all include measures for reducing methane emissions from the energy sector. To measure progress on these targets, countries can report on their methane emissions in a consistent and transparent manner as part of their Biennial Transparency Reports.

Action by importing countries can help drive significant methane emissions reductions in exporting countries

Many high-emitting countries have yet to commit to reducing their methane emissions. To date, Algeria, China, India, Iran, Russia, Syria, Thailand and Venezuela have not joined the GMP. Together, these eight countries account for nearly 45% of global energy-related methane emissions. Many of these countries export oil and gas to GMP participants.

Methane emissions from fossil fuel consumption in selected countries and regions, 2024



Note: Domestic emissions are from domestic fossil fuel operations that satisfy consumption within that country or region.

Trade and diplomatic action by importing countries has the potential to drive significant reductions in methane emissions in exporting countries. Importing countries have several tools at their disposal to incentivise methane abatement in exporting countries:

- **Trade measures:** Importing countries can set performance standards for imported oil and gas products, requiring these products to fall below a specified methane-intensity threshold. For example, starting in 2030, the EU Methane Regulation will require oil, gas and coal placed on the EU market to comply with a specified methane intensity threshold. Another option is to impose import taxes or fees on products with high emissions, for example through a carbon border adjustment mechanism.
- **Economic incentives:** Importing countries can commit to purchasing gas that would have otherwise been vented or flared. They can also create preferential marketplaces or related price premiums for fossil fuels with low methane emissions. This can be supported by providing funding that is conditional on the implementation of measures to capture and commercialise methane.
- **Technical and institutional support:** Importing countries can support the development and implementation of methane policies, regulations and technologies in exporting countries. For example, the Japan Organization for Metals and Energy Security (JOGMEC) has signed arrangements with PETRONAS (Malaysia's national oil company, or NOC) and Pertamina (Indonesia's NOC) to advance collaboration on methane emissions measurement and reduction.
- **Measurement, monitoring, reporting and verification (MMRV) standards:** Countries can develop common MMRV standards for methane emissions. This would help avoid loopholes and reduce the regulatory burden for companies. In

2023, 12 countries and the European Commission created a Working Group to develop an international framework for measuring, monitoring, reporting and verifying greenhouse gas emissions along international natural gas supply chains. Similarly, in July 2023, Japan and Korea (alongside partners) launched the Coalition for LNG Emission Abatement Toward Net-Zero (CLEAN) initiative, a public-private project under which LNG buyers from Japan and Korea collect information from suppliers on the status of methane reduction efforts.

- **Diplomatic action:** Importing countries can use diplomatic means to encourage exporting countries to abate methane emissions, including through joint work programmes and other forms of collaboration.

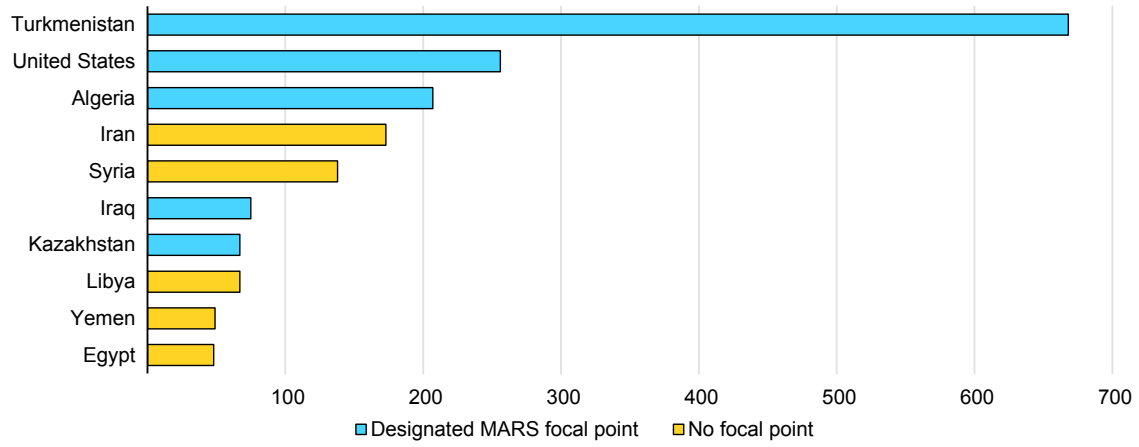
Technology is available to detect super-emitting events, but policy responses are lacking

Advances in monitoring technologies – notably satellites – have been key to enabling the detection of large emission events. While satellite technology is not perfect (with readings being more difficult offshore or in mountainous, snowy, icy, overcast and high-latitude regions), current satellites and data processing techniques can detect and measure a range of emissions events – from major leaks over large areas down to small leaks at the facility level. Analysis from Carbon Mapper, which looked at more than 2 000 plumes globally, indicates that these sources are often recurrent. In the oil and gas sector, it is estimated that around one quarter of leaks are recurrent (i.e. a leak was detected on multiple occasions at the same location).

Data from the European Space Agency's satellite Sentinel-5P, processed by the analytics firm Kayrros, identified 906 super-emitter events at oil and gas facilities across 47 countries in 2024. When accounting for the level of satellite coverage, we estimate that these events led to the release of around 4.6 Mt of methane into the atmosphere. The five countries with the highest number of satellite-detected events in 2024 were Turkmenistan (287 events); the United States (190 events); Russia (154 events); Algeria (39 events); and Iran (38 events). In Russia, the number of observed events almost doubled compared with 2023. The highest single emitting event was detected at a facility in Texas (United States) in October 2024, followed by two events in Turkmenistan.

Preventing and swiftly addressing major leaks or releases is a key opportunity to rapidly reduce methane emissions. In 2022, the UNEP's International Methane Emissions Observatory (IMEO) launched the Methane Alert and Response System (MARS), which uses satellite data to identify large methane emissions. When a large emitting event is detected and validated, IMEO notifies the relevant country's government. If the facility in question is determined to belong to a member of UNEP's Oil and Gas Methane Partnership 2.0, IMEO will also notify the relevant operator.

Actionable Methane Alert and Response System notifications for the oil and gas sector



Notes: Includes the 10 countries with the highest number of notifications. Satellite detection capabilities depend on surface conditions, cloud coverage and environmental conditions, among other factors that vary from country to country. Satellite coverage is sufficient in all the countries presented here except from Yemen, where coverage is low.

Source: IEA analysis based on UNEP's IMEO data as of mid-March 2025.

Since its launch, MARS has detected more than 7 000 methane plumes and has issued around 2 000 notifications to governments and operators. But while IMEO has sent multiple notifications, fewer than half have been acknowledged by recipients, and IMEO received an explanation on the event's source in only 15 cases, a response rate of just 1%.

Addressing and resolving super-emitting events requires action from both governments and operators. Governments and OGMP 2.0 operators can designate a MARS focal point to receive notifications from IMEO. To date, 20 countries have done so. Governments can help by ensuring that focal points are well supported to respond quickly upon notification and have the appropriate legal authority to mitigate the event. Prompt reaction to MARS notifications has delivered methane reductions in Algeria, Argentina, Azerbaijan, Nigeria and the United States.

Governments can also establish emergency response plans for responding to notifications. Emergency response plans may include procedures for determining which operator is involved based on the event's location, as well as obligations for operators to investigate the event's source, mitigate the event, and avoid similar events in the future. Plans may also establish mitigation timelines and reporting obligations.

Emergency response mechanisms can also rely on other sources to identify super-emitting events. For example, the U.S. Super Emitter Program currently requires a facility's owner or operator to initiate an investigation within five days of

receiving a notification from the EPA, based on remote sensing technologies operated by certified third-party entities. The owner or operator must report the results of this investigation to the EPA within 15 days of receiving the notification, including an explanation of the event's source (if the owner or operator was able to identify it).

Emissions from abandoned facilities can be significant, but are often overlooked in policies and regulations

Abandoned wells and mines can be significant sources of methane emissions. While emissions may diminish after production stops, they do not disappear entirely and can persist at a steady rate for a prolonged period of time. Methane can leak through cracks, fissures and gaps, particularly when a well or mine has not been properly plugged or sealed. Governments can play a critical role in curbing methane emissions from these sources, which often increase in the absence of regulatory safeguards, including by incorporating methane requirements in closure and decommissioning plans.

Tackling methane emissions from abandoned wells and mines requires developing clear mitigation strategies that distinguish between different classes of facilities. One key distinction lies between wells and mines for which an operator is accountable and those for which no operator can be identified – for example because the operator has become insolvent or has ceased to exist (referred to as "orphaned" facilities).

In cases where **an identified operator is responsible**, governments can require operators to perform closure activities for assets being decommissioned. In the case of oil and gas wells, this can take the form of plugging and well integrity monitoring. For coal mines, mine flooding is an effective way to reduce methane emissions as it stabilises the hydrostatic pressure on the coal seams. In cases where flooding is not safe or technically feasible, mines can be sealed and drainage systems put in place to capture the emerging gas.

To help finance decommissioning activities for abandoned wells and mines, governments can require operators to set aside funds throughout the asset's life. Governments can also follow Alberta's model of establishing an annual industry-wide minimum spending requirement, which is then divided between each oil and gas operator.

Regulators can also promote the capture and utilisation of methane from abandoned coal mines. An important element of methane recovery is establishing clear ownership and transfer rights to the resource. In Germany, ownership and transfer procedures for abandoned mines were established in the 1990s and the country is now home to the most active abandoned mine methane industry in

Europe. Incentives for capturing abandoned mine methane can take the form of grants or subsidies for project implementation, feed-in tariffs for the electricity produced, or the inclusion of projects in carbon offset crediting schemes. The German Renewable Energy Sources Act provides a guaranteed fixed payback tariff for 20 years through feed-in tariffs or fees paid for electricity produced from approved abandoned mine methane projects.

In the case of **orphaned wells and mines**, governments can inventory these facilities to identify which ones emit the largest amounts of methane. For example, the United States established a programme to identify and inventory orphaned wells on federal lands, including measuring and tracking their methane emissions. Canada, New York and Western Australia have undertaken similar inventories. Similarly, under the EU Methane Regulation, Member states have until August 2025 to establish inventories of non-producing wells and mines, identify responsible parties, and take mitigation steps where emissions exist.

To reduce methane emissions from orphaned wells and mines, governments can provide public funding for plugging, flooding or sealing. For example, in 2021, the United States allocated USD 4.7 billion for plugging orphaned wells on federal, state, tribal and private lands. Pennsylvania has used this funding to set up its own grant programme, while the Texas Railroad Commission has used it to issue solicitations for contracts under its existing State Managed Plugging Program. Closure projects could also be made eligible for carbon credits, allowing project operators to trade these credits on carbon markets.

To help finance public funding for closure activities, one option is to rely on fees collected from operational assets. Alberta imposes an annual Orphan Well Levy on companies operating oil and gas assets within the province, which is then transferred to the Orphan Well Association to offset closure costs. Western Australia has set up a Mining Rehabilitation Fund for abandoned mines across its territory, which is financed in part through annual levies collected from active mine operators.

Accelerating industry action

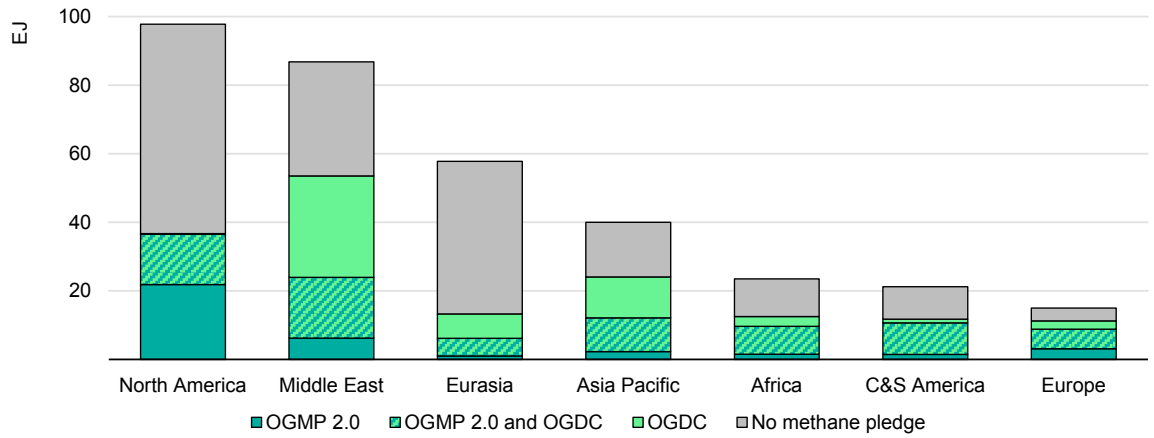
Current oil and gas industry initiatives on methane

A growing number of oil and gas companies have set methane targets, joining initiatives such as the Oil and Gas Methane Partnership 2.0 (OGMP 2.0), the Oil and Gas Climate Initiative (OGCI), the Oil and Gas Decarbonization Charter (OGDC), and the Methane Guiding Principles.

OGMP 2.0 is the flagship oil and gas reporting and mitigation initiative of the United Nations Environment Programme (UNEP). Since 2023, around 20 new companies joined OGMP 2.0, bringing coverage to just over 40% of global oil and gas production.

OGCI's Aiming for Zero Methane Emissions Initiative aims to eliminate all methane emissions from the oil and gas sector by 2030. OGCI also facilitates peer-to-peer learning through its role as the secretariat of the OGDC, which includes knowledge-sharing and collaboration programmes to disseminate solutions. With the recent inclusion of PetroChina, the OGDC's membership now accounts for around 40% of global oil and gas production. Several companies in China, including PetroChina, Sinopec and CNOOC, as well as pipeline operators and utilities, have also recently established the China Oil and Gas Methane Alliance to promote best practices.

Oil and gas production covered by methane pledges in 2024



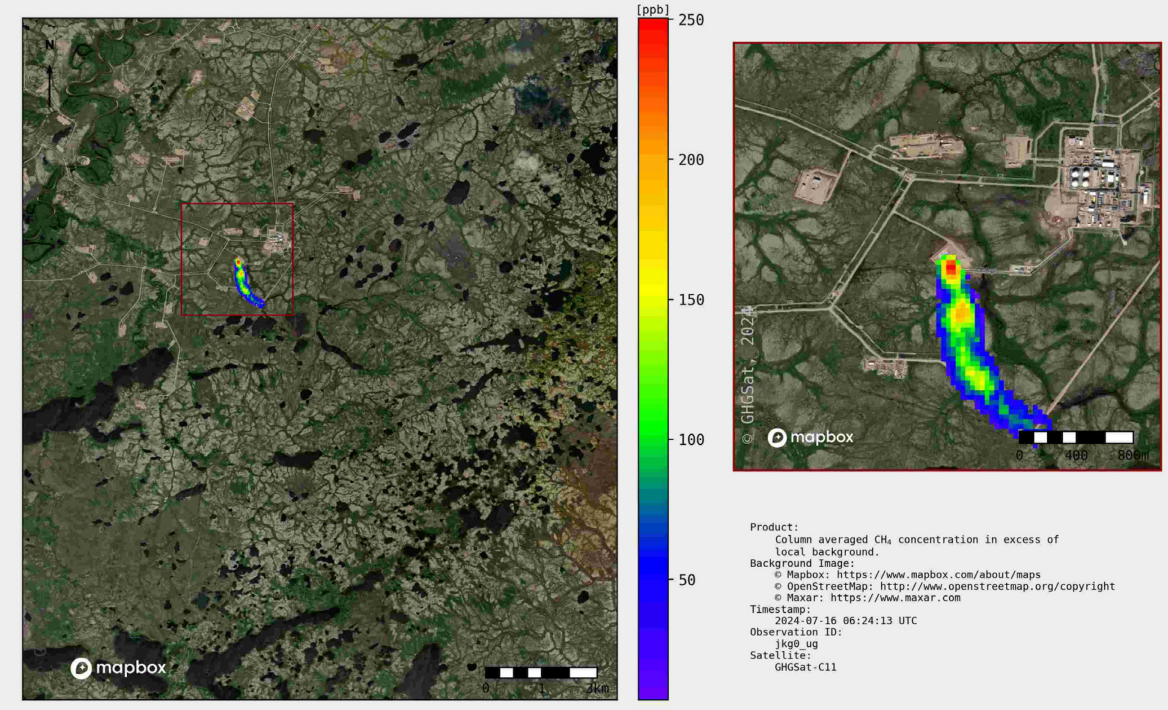
Notes: OGMP 2.0 = Oil and Gas Methane Partnership 2.0. OGDC = Oil and Gas Decarbonization Charter. C&S America = Central and South America. Considers global equity production by company. OGMP 2.0 is the share of production under reduction targets.

While this momentum is positive and some operators have taken demonstrable steps forward, globally the industry has yet to demonstrate consistent progress in methane reductions. Reducing methane is the single-most effective and cost-efficient way for the industry to minimise overall emissions. The gains are not solely environmental: fossil fuel operations with lower emissions intensity are likely to have an increasing commercial advantage over higher-emitting sources.

Upstream operators can improve their emissions performance through cost-effective abatement programmes

Credibly reducing emissions from upstream assets should be a top priority. Upstream operations are not just the main source of emissions in the oil and gas industry – they hold the greatest potential for cost-effective abatement. We estimate that around 25 Mt of methane emissions from upstream operations (40% of all upstream oil and gas methane emissions worldwide) could have been avoided at no net cost in 2024. Well over 15 Mt of emissions could have been avoided through measures with internal rates of return exceeding 25% – well above the thresholds that oil and gas companies typically require for capital investment.

Methane plume from a flare in Russia, 2024



Source: GHGSat.

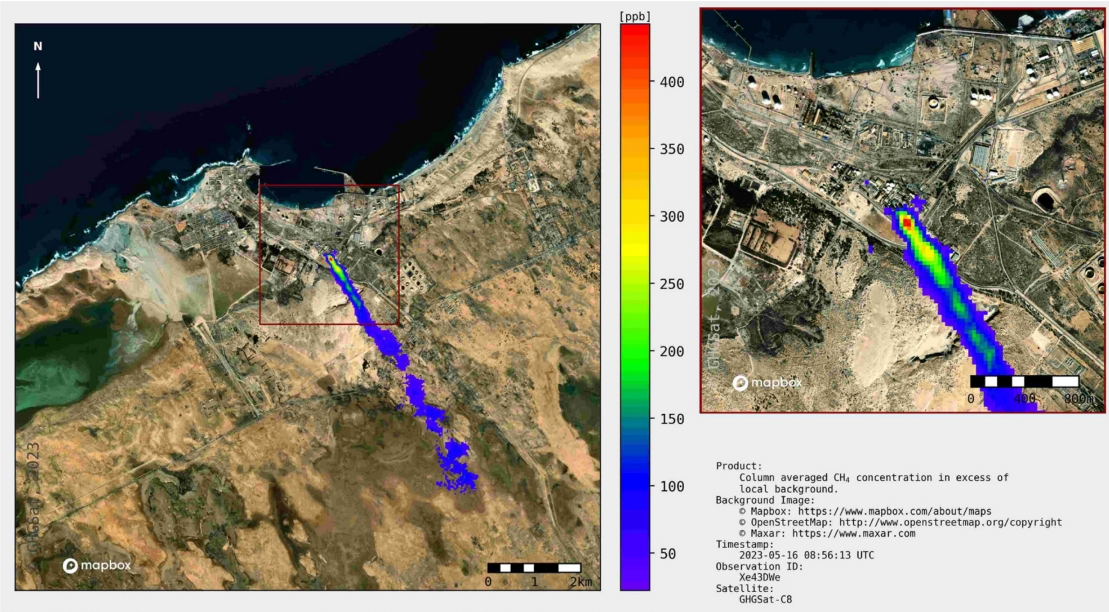
The global average methane intensity of upstream oil and gas has fallen by around 10% since 2019. Yet despite this progress, emissions intensities still vary more than 100-fold between the best and worst performers – and recent increases in production mean that emissions remain at record levels. The most cost-effective options available today for reducing emissions include: leak detection and repair (LDAR); replacing pumps and other methane-emitting equipment with electric devices; using vapour recovery units to capture vented gas; and employing associated gas utilisation technologies such as microturbines for power generation.

The IEA's methane abatement model – which was recently released as an open-source tool – can be used by companies to explore abatement costs and technologies in detail and help them identify appropriate and cost-effective solutions for methane abatement.

Solutions also exist for reducing methane emissions from downstream operations to near zero

Downstream operations – defined here to include refining and shipping as well as natural gas transmission, distribution and storage – resulted in nearly 13 Mt of methane emissions in 2024 (an upward revision from our 2023 estimate given new data from measurement studies and satellites). This represents around 15% of total methane emissions from oil and natural gas operations – with almost all of that coming from natural gas value chains. In the European Union, downstream operations are responsible for nearly 75% of methane emissions from domestic oil and gas supply chains.

Methane plume from an LNG facility in Libya, 2023



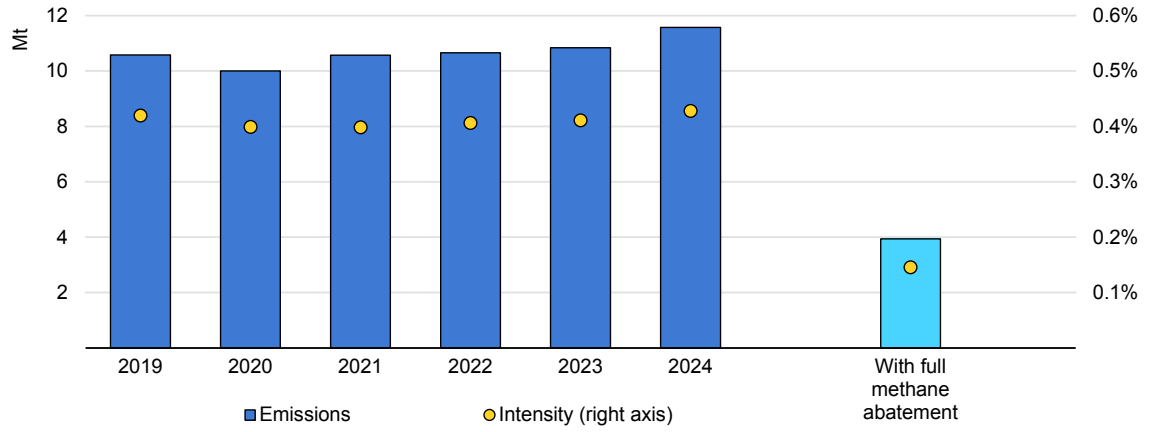
IEA. CC BY 4.0.

Source: GHGSat.

Several solutions exist for reducing emissions in the downstream segment, and many companies are working to improve methane monitoring and reduce emissions. In 2024, for example, Cheniere Energy completed measurement studies and set a target for annual methane emissions intensity of 0.03% per tonne of LNG produced. Terega, which manages more than 5 000 km of pipelines in France, reported a 36% reduction in methane emissions from 2017 levels.

If all the abatement technologies available today were to be deployed at natural gas processing and transport facilities, the global average methane intensity of downstream natural gas operations would fall from more than 0.4% to below 0.2%.

Global methane emissions and intensities from downstream natural gas



Notes: Methane intensity is calculated here as methane emissions from downstream natural gas divided by global marketed natural gas (149 EJ in 2024), assuming methane has an energy density of 55 MJ/kg.

The coal industry is lagging behind

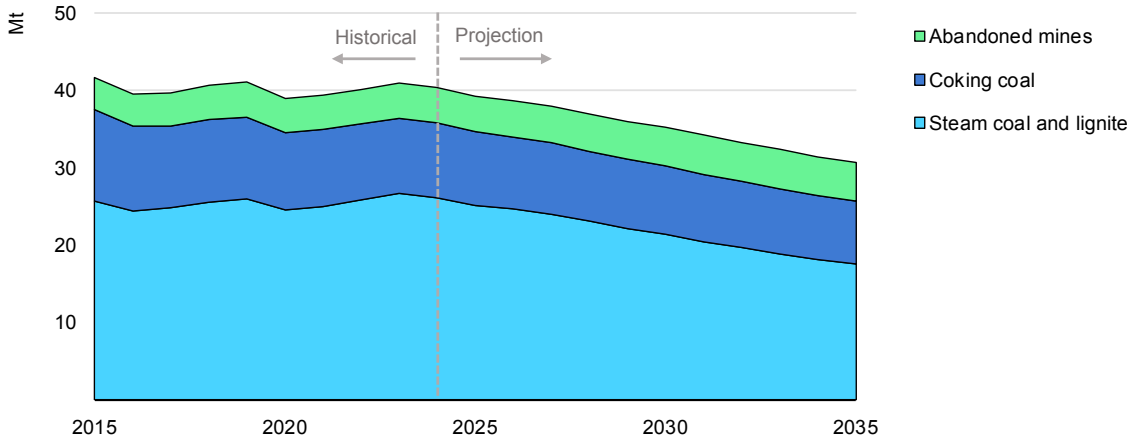
The coal sector released around 40 Mt of methane emissions in 2024. While there are some instances where methane capture and use is economically viable for coal operators, most would not generate enough revenue from the sale or use of captured gas to pay for it themselves. Widespread deployment of abatement measures should remain a priority, however, especially for coking coal, which is generally harder to replace than steam coal, and which is often sourced from underground mines where abatement is more feasible.

Most of the coal industry has not committed to reducing its methane emissions. Some companies engage in initiatives like the United Nations Economic Commission for Europe Group of Experts on Coal Mine Methane and Just Transition, or the Global Methane Initiative, while others choose to address methane in their climate or sustainability strategies. For example, BHP has committed to "minimise fugitive methane emissions to the greatest extent technically and commercially viable, through enhanced application of existing or

emerging technology." Anglo American reports its investments in methane pre-drainage infrastructure at underground steelmaking coal operations. Coal producers that can credibly demonstrate lower methane emissions could gain a commercial edge with customers: Many steel producers, for example, are looking for ways to reduce the lifecycle emissions intensity of their products.

Annual emissions from steam coal and lignite production have remained around 30 Mt for the past decade. They fall under the Stated Policies Scenario (STEPS) largely because of a reduction in demand. The STEPS also sees emissions from coking coal mines fall around 15% to 2035, slightly outpacing decreases in production, thanks to pledges by certain countries to tackle coal mine methane (e.g. China's Methane Action Plan).

Coal-related methane emissions under the Stated Policies Scenario, 2025-2035



To bolster the environmental case for biogas, producers need to do more to minimise their own emissions

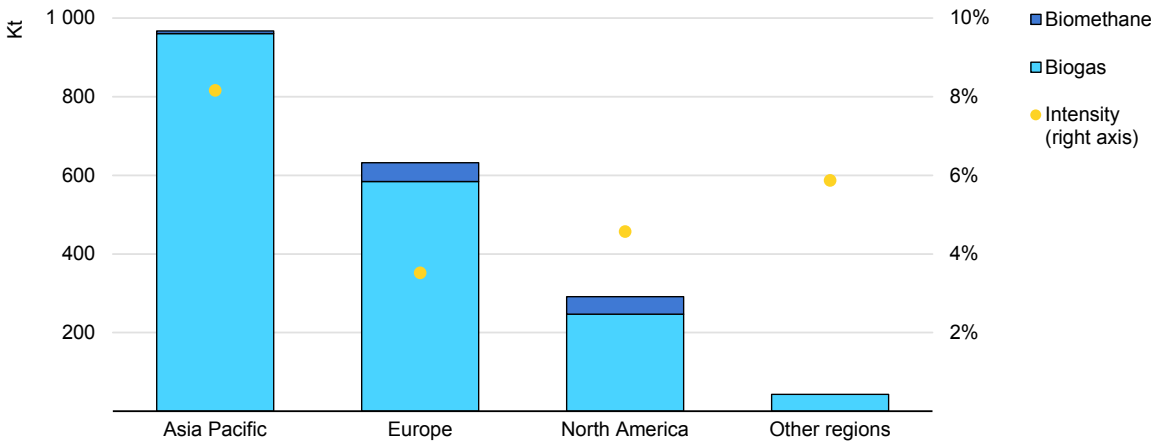
Use of biogas and biomethane – both of which are considered to be low-emissions gases – has notably increased in recent years. Biogas can be used for heat and electricity generation and biomethane (an upgraded form of biogas) can be a direct substitute for natural gas. Biogas feedstocks include crop residues, animal manure, solid waste from municipalities or landfills and sewage sludge. For some of these feedstocks – mostly notably waste and manure – biogas production using anaerobic digestors can prevent methane emissions that would have otherwise occurred during natural decomposition. Quantifying and recognising the value of these avoided emissions is crucial for assessing the environmental credentials of

biogases. Without careful handling, methane leaks along biogas and biomethane supply chains can undermine – or eliminate entirely – the benefits of switching from natural gas to biogases.

Methane leaks can occur during transport, storage and processing of feedstock, during the biogas production and upgrading processes or from the handling and storage of the residual fluids and fibrous materials (often called "digestate"). Emission factors for each of these stages vary widely: from around 2% to 10% for digestate composting or storage and from 0.2% to 3% for upgrading units that produce biomethane.

There are several measures available for minimising methane emissions in each of these stages. These include LDAR programmes, the use of thermal oxidisers to reduce methane emissions from low-concentration flows, the application of best available technologies (e.g. gastight digestate storage at biogas plants), and the optimisation of production processes. The IEA will release a report on the outlook for biogases in May 2025 that will provide further detail on strategies to minimise emissions from biogases.

Methane emissions and related intensities for biogas and biomethane supply, 2023



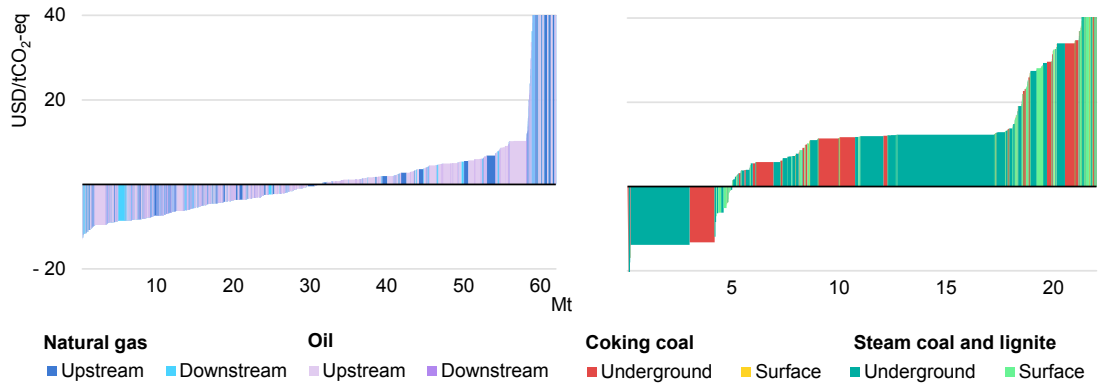
Note: The methane intensity is calculated here as total methane emissions from biogas and biomethane supply divided by production (2 EJ in 2023), assuming methane has an energy density of 55 MJ/kg.

Overcoming barriers to abatement

There are gaps in financing, data and capacity

Tackling methane emissions from fossil fuel operations represents one of the fastest and lowest-cost opportunities to reduce greenhouse emissions globally. Almost all the available methane abatement measures across the energy sector would be cost-effective to deploy in the presence of a greenhouse gas emissions price of about USD 20/tCO_2-eq.

Marginal abatement cost curves for methane from the fossil fuel sector, 2024



Note: One tonne of methane is considered to be equivalent to 30 tonnes CO_2 based on the 100-year global warming potential (IPCC, 2021). Abandoned oil and gas wells here are included in the upstream segment.

Several factors explain why methane emission reduction measures have not been deployed more widely. For example, companies could be unaware of the scale of the problem or the available solutions. There may be higher-profile opportunities competing for investment resources, or leadership may perceive methane abatement as more costly than it is. There may be split incentives, whereby equipment owners do not directly benefit from reducing methane leaks, the contractual terms prevent methane savings from affecting revenue, or the owner of the gas does not see its full value. Securing capital for required upfront investments can be difficult, especially in developing economies. Companies may struggle to muster sufficient staff or secure the necessary services to tackle the problem. Or they may not have identified an effective pathway or business case for bringing captured gas to productive use.

Overcoming these barriers requires co-operation between governments, industry, the finance community, international organisations and civil society. Investors and financiers can play an important role by incorporating information on methane in

their activities, as well as collaborating with companies to set targets and ensure accountability. Public and philanthropic actors can serve as catalysts by supporting project identification, building capacity and unlocking additional private finance.

New initiatives are emerging to facilitate the implementation of methane emissions pledges

While the need to tackle methane emissions is generally well-understood, actors often lack the technical expertise or resources to implement reduction strategies. This includes governments that want to introduce or refine regulations targeting methane emissions and strengthen implementation efforts but do not yet have the capacity to do so. Similarly, companies may lack the technical expertise to develop viable emissions-reduction projects or struggle to access the necessary technology.

Several initiatives have emerged to help bridge these gaps. They support methane cuts through the sharing of best practices, building capacity or providing financial support and other forms of assistance. The IEA is engaged or affiliated with many of these efforts, which include:

- UNEP's International Methane Emissions Observatory (IMEO), which delivers training and technical guidance to governments and companies looking to reduce methane emissions from the oil and gas sector. The IMEO also conducts scientific studies and analysis with data provided through an online portal.
- OGMP 2.0, which provides a reporting framework for methane emissions in the oil and gas sector, fosters best-practice sharing and supports companies and governments in adopting robust measurement and verification standards to drive emissions reductions.
- The Fossil Fuel Regulatory Programme (FFRP), initiated by the Climate and Clean Air Coalition (CCAC) and the Clean Air Task Force. This will support up to 20 developing country governments over the next three years with tailored support for building capacity, regulatory development and enforcement. The IEA co-implements the FFRP in Kazakhstan and Iraq.
- The World Bank's Global Flaring and Methane Reduction Partnership (GFMR), which focuses on providing grant funding and mobilising financing to help governments and state-owned operators deploy flaring and methane reduction solutions in the oil and gas sector.
- The Global Methane Hub, which supports methane reduction efforts through grant-making and partnerships.
- The CCAC's Methane Roadmap Action Programme (MRAP), which supports Global Methane Pledge countries eligible for official development assistance in developing national methane roadmaps and action plans. MRAP establishes

priorities for action and advocates for methane's inclusion in governments' Nationally Determined Contributions (NDCs).

- Tools and resources from the Oil and Gas Climate Initiative, the Global Methane Initiative and the Methane Guiding Principles.

The IEA provides support to governments looking to reduce methane emissions from the energy sector. Through its Methane Tracker Database, the IEA provides information and data on methane emissions, abatement, costs and policies – at both the regional and individual country level. In addition, through its Policies Database, the IEA has compiled a catalogue of more than 600 existing and announced policies and regulations related to methane emissions.

The IEA also leverages its convening power and its network of national regulators to support the development of regulatory frameworks for curtailing methane emissions in the fossil fuel sector. In September 2024, the IEA hosted a high-level event on Turning Methane Pledges into Action. This was followed by the launch of a series of regional roundtables on methane focused on the challenges and opportunities for emissions control and abatement in specific regions.

In most cases, the fossil fuel industry is in a position to cover the financing gap, but additional external support will be needed

We estimate that around USD 260 billion in spending is needed through to 2030 to implement all of the methane abatement measures required to reach a 75% reduction in methane emissions. This includes USD 175 billion from the oil and gas sector and USD 85 billion from the coal sector. Roughly USD 215 billion would take the form of new capital expenditure, while USD 45 billion represents operational expenditures. A significant share of this investment is linked to properly closing abandoned facilities, with just over USD 100 billion needed to monitor and plug abandoned wells with significant levels of emissions.

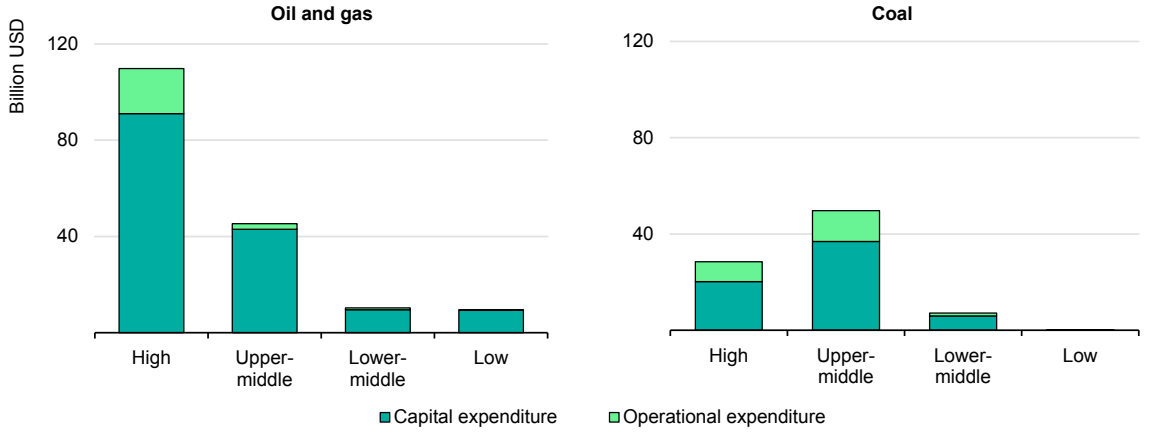
Fossil fuel companies should carry the primary responsibility for abating methane emissions, as the average annual spending required represents less than 2% of the net income the industry generates annually. To encourage methane abatement, companies could integrate methane-specific performance indicators into their financial and operational strategies (such as tying them to employee and executive compensation). They might also consider establishing an internal price for methane when making capital investment decisions related to both new and existing projects.

In some cases, external support may be needed – particularly when the available abatement options have net positive costs and access to capital is limited. Natural

gas subsidies present another potential barrier. National oil companies (NOCs) are often constrained by competing priorities for domestic spending, especially within low- and middle-income countries, and may require tailored approaches to drive investment in methane abatement. Projects involving high upfront capital costs could require dedicated financing, while those facing high operational costs may need continuous support.

We estimate the financing gap for fossil fuel methane abatement in low- and middle-income countries to be around USD 60 billion (roughly USD 40 billion for active operations and USD 20 billion for abandoned facilities). Some resources, such as the World Bank's Global Methane and Flaring Reduction (GFMR) trust fund, are available, but new sources of financing are needed. To date, external financing aimed at reducing methane in the fossil fuel industry totals less than USD 1 billion, although this could catalyse much larger financial commitments.

Required spending in the fossil fuel sector to fully deploy all methane abatement measures, by country-level income category, to 2030



Note: Country-level income category is based on the 2025 categorisation provided by the World Bank.

By helping to bridge this financing gap, investors can help drive reductions in methane emissions from fossil fuels. Financiers have a number of levers at their disposal: they can promote strict performance standards and push for verifiable methane reductions as well as transparent and comparable disclosures on measured emissions. Financial instruments, including sustainability-linked bonds or loans, use-of-proceeds bonds and conventional instruments can all be linked to progress on methane abatement. Insurers, too, can develop policies and financial products that incentivise methane abatement.

Financial mechanisms for accelerating action on methane emissions reductions

Financial mechanism	Description	Key players
Revenue reinvestment	Using the profits or cost savings from captured methane or operational efficiencies to fund methane abatement projects	Oil and gas companies
Sustainability-linked bonds	Bonds that link financial outcomes to achieving methane targets	Institutional investors, commercial banks, multilateral development banks
Sustainability-linked loans	Loans tied to specific methane-related Key Performance Indicators, offering lower interest rates or penalties based on performance	Institutional investors, commercial banks, multilateral development banks
Use-of-proceeds bonds	Funds are explicitly allocated to methane reduction projects	Institutional investors, commercial banks, multilateral development banks
Grants and subsidies	Non-repayable funding or financial incentives provided for methane abatement	Governments, climate funds, philanthropic foundations, multilateral development banks
Project finance	Project cash flows fund methane abatement rather than company balance sheets	Multilateral development banks, export-import banks, independent project developers, infrastructure funds
Insurance and underwriting	Policies and financial products require methane-specific criteria as a condition of coverage	Insurance companies, export-import banks

The Methane Abatement Financing Taskforce, an initiative launched in 2023 during the UNFCCC's COP28 conference in Dubai, aims to increase investment in methane emissions reductions projects through these market mechanisms. It is developing voluntary methane-specific guidance for oil and gas companies and financiers, in line with the International Capital Market Association guidelines for green, sustainability and sustainability-linked bonds and with the Climate Transition Finance Handbook. The guidance accommodates the governance, technical capacity and capital structure of capital seekers and counterparties, with a particular focus on emerging markets and national oil companies.

Some actors have already incorporated methane abatement goals into their engagement with the fossil fuel industry. The world's 14 largest financial companies – including JPMorgan Chase, HSBC and Barclays – have produced methane management guidelines for their oil and gas sector clients. Leading multilateral development banks, such as the World Bank and the Asia Development Bank, have also issued similar guidelines. The World Bank's GFMR provides catalytic grant funding and technical assistance, while also helping mobilise financing to support flaring and methane reduction projects in state-owned oil and gas operations.

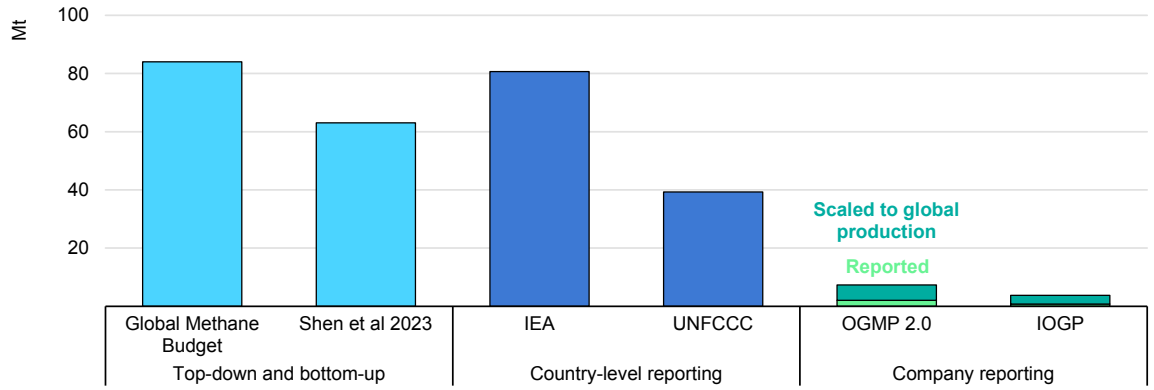
A methane data revolution is underway – but only a few actors measure and report emissions in a robust way

Accurate data is not a prerequisite for tackling methane emissions, but it is extremely helpful. It allows a jurisdiction or company to effectively target methane emissions by identifying major sources, abatement opportunities, costs and potential savings, while tracking progress over time.

Currently, most company and country methane inventories are based on multiplying activity data (e.g. the number of facilities or the extent of operations) by standardised emission factors (e.g. default values or leak rates for particular types of equipment). Measurements from satellites and airborne observations suggest that actual emissions levels are often much higher (e.g. in Europe and South America). Efforts are underway to reconcile these two approaches to estimating emissions, and these suggest that existing inventories often fail to capture certain sources of emissions, particularly accidental and high-emitting leaks.

Globally, we estimate that methane emissions from the energy sector are about 80% higher than the total reported by national governments. The quality of reporting also varies widely – with many oil and gas companies failing to report emissions at all. Were the oil and gas companies that report their emissions fully representative of the entire industry, it would imply that methane emissions are more than 90% below our estimates.

Reported methane emissions from oil and gas operations



Note: UNFCCC = United Nations Framework Convention on Climate Change. OGMP 2.0 = Oil & Gas Methane Partnership 2.0. IOGP = International Association of Oil and Gas Producers. IEA estimates are for 2024, other estimates are for the latest year available. The Global Methane Budget refers to the top-down estimate. Emissions from company reporting are scaled to the global level based on the reporting companies' share of production and assuming non-reporting companies have the same average emissions intensity.

Source: IEA analysis based on data from Global Methane Budget (2024); Shen et al.(2023); UNFCCC (2023), IMEO, 2023; IOGP (2024).

There are many possible reasons for these differences. For example, many official greenhouse gas submissions to the UNFCCC have not been updated for years. It is likely that the companies that report emissions are among the better performers or more motivated to address methane – meaning that they may not fully represent the broader industry. Companies that are reporting emissions may be relying on inventory data that does not consider methane measurements. Recent UNEP analysis suggests that emissions reported by OGMP 2.0 companies will continue to increase as companies improve the quality of their data.

Another major cause of uncertainty is the lack of data transparency and disclosure. Companies that are part of OGMP 2.0 have committed to detailed emissions reporting for all operated and non-operated assets within a set timeframe. But not all companies have joined transparency initiatives. Some companies have cited commercial sensitivities as a reason for not detailing their methane emissions, but they could do more to explain these concerns and help to advance solutions that enable greater scrutiny of reported data. This is essential for building regulatory and public confidence in the actions being taken, and it is particularly important for companies looking to demonstrate that they have already achieved a very low methane emissions intensity.

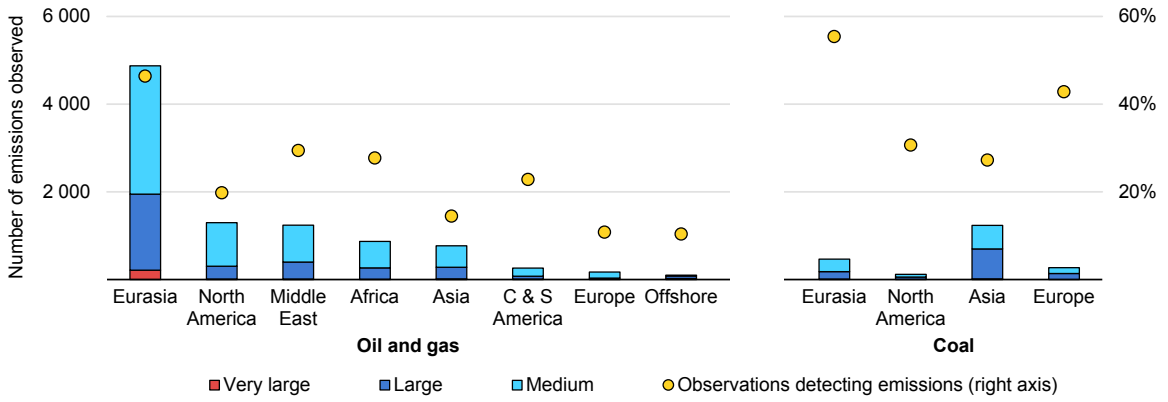
Technologies for monitoring methane emissions, notably from satellites, are advancing rapidly

New satellites and data processing techniques now enable detection and quantification of a range of emissions, from major leaks over a large area to small

leaks at the facility level. New satellites have recently been launched, including MethaneSAT, Tanager-1, EMIT, and EnMap, which provide publicly available data with high resolution and sensitive detection thresholds. These have already started to improve methane quantification capabilities, raise public awareness and support regulatory oversight. UNEP's Methane Alert and Response System compiles data from several of these satellites – including EMIT, EnMAP, Landsat, PRISMA and Sentinel 2 – and has released data on more than 7 000 leaks in the fossil fuel sector. Satellites excel at detecting persistent leaks, and advancements in data processing have enhanced capabilities for monitoring offshore sources.

Unlike satellites with large detection areas for spotting emissions, certain satellites have a much finer resolution and can target specific locations. For example, data provided to the IEA by GHGSat indicated that in 2024, GHGSat's satellites conducted 16 400 observations at oil, gas and coal facilities around the world. Of these, around 4 100 detected emissions and just under 11 700 leaks were identified (multiple leaks were often seen during a single observation). Around 9 600 of the leaks were associated with oil and gas operations, while just over 2 100 were observed at coal operations. The share of observations that detect emissions varies widely by region: only around 10% of observations conducted at oil and gas facilities in Europe saw any emissions, while almost half of the observations conducted in Eurasia detected at least one methane leak.

Methane leaks at fossil fuel sites detected by GHGSat satellites, 2024



Note: Very large = more than 10 tonnes per hour (t/h). Large = 1-10 t/h. Medium = less than 1 t/h. GHGSat satellites have a methane detection threshold of 0.1 t/h.

Source: IEA analysis based on data provided by GHGSat.

Satellite technologies and data processing techniques are not perfect. They can struggle to provide readings in many environments such as offshore areas, mountain ranges, snowy or ice-covered regions, and at high latitudes. Although there have been recent improvements, satellite observations can still be impaired

by cloud cover, limiting the number of days when detection is possible. This makes observation more difficult in countries with dense forests or in equatorial regions, such as Nigeria or Venezuela.

Other detection and measurement campaigns will remain essential, not least because most satellites are best at detecting large and persistent leaks. The optimal system will combine satellite measurements with drone-based and other aerial surveys, ground-based sensors and surveys, and continuous monitoring devices that are geographically and temporally representative.

Buyers can use data to target emissions from international trade

More than 40% of global oil supply and close to 20% of natural gas and coal supply is traded internationally. This presents a major opportunity for buyers to work with suppliers to reduce methane emissions along international fossil fuel supply chains with little to no impact on fuel prices.

Wholesale fossil fuel prices in selected import markets at varying methane prices, 2023

	Methane price (USD/tCO_2-eq)		
	0	10	20
	Crude oil (USD/barrel)		
Global	81.8	81.9	82.0
	Natural gas (USD/Mbtu)		
European Union	12.10	12.14	12.17
China	11.52	11.57	11.62
Japan	12.99	13.01	13.04
	Steam coal (USD/tonne)		
European Union	128.9	131.5	134.1
China	150.4	152.1	153.9
Japan	173.7	175.4	177.1

Note: Analysis does not assume a price impact from the additional capture and sale of natural gas that results from methane abatement. Considers methane emissions from the production and transport of fuels placed in these markets.

Harmonised measurement, monitoring, reporting and verification standards are an important enabler for markets to act on emissions. Several ongoing initiatives serve as examples, including: UNEP's OGMP 2.0, the Coalition for LNG Emission

Abatement toward Net Zero (CLEAN), and the MMRV Working Group launched by 12 countries and the European Union in 2023.

So far, the market for fossil fuels with certified methane emissions remains limited, but better access to data might help change this. For example, there are options to certify LNG, but currently these involve small gas volumes and can lack strong incentives for emissions reduction. New services are tapping into the growing availability of satellite-data to guide market choices and potentially open new avenues for cutting emissions.

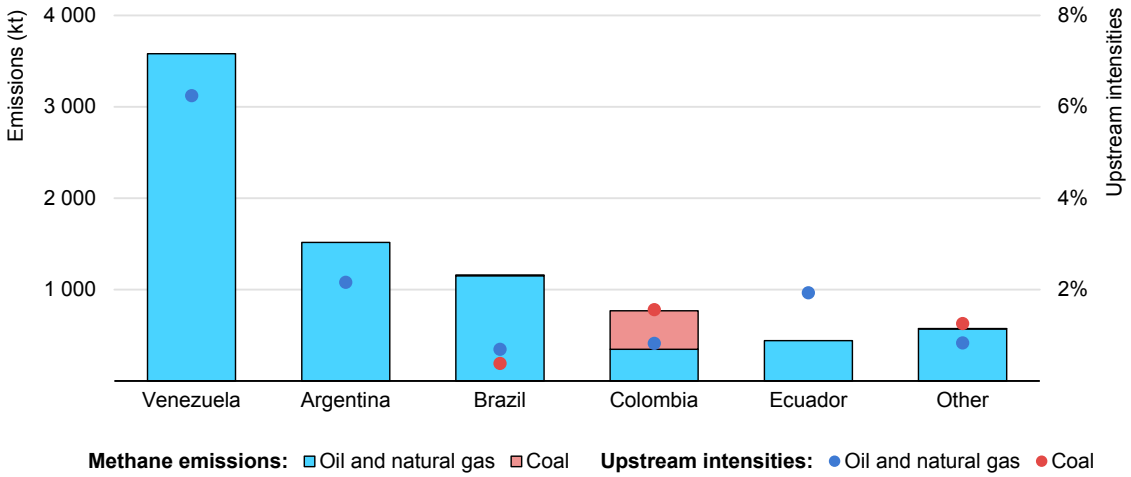
Regional insights

Central and South America

The fossil fuel sector in Central and South America emitted around 8 Mt of methane in 2024, about 45% of which were from oil and gas facilities in Venezuela. Oil and gas facilities are the main sources of methane emissions in Venezuela, Argentina and Brazil, and coal mines are the largest source in Colombia.

The upstream methane emissions intensity of oil and gas operations in Venezuela is six times the global average, and its flaring intensity is ten times the global average. Operations in Argentina and Ecuador are around twice the global average, while Brazil and Colombia perform slightly below the global average. Little measurement data is available across countries in Central and South America, with large parts of its oil and gas production in offshore or cloud-covered regions, where satellites struggle to make regular observations. UNEP's IMEO is currently conducting a study on the sources of methane emissions in Colombia and the CCAC is supporting efforts to strengthen monitoring, reporting and verification in its mining sector.

Methane emissions from the fossil fuel sector in Central and South America, 2024



Notes: Other countries include Bolivia, Chile, Cuba, Guyana, Peru, Trinidad and Tobago and other countries in the region. Methane intensity calculated in energy terms as emissions from upstream operations divided by marketed fuel production, assuming methane has an energy density of 55 MJ/kg.

Apart from Venezuela, all major producers in the region have signed the Global Methane Pledge. Yet Colombia is the only country with an explicit strategy for reducing methane emissions and regulations in place to limit methane emissions

from oil and gas operations (including restrictions on flaring and venting, requiring biannual LDAR and setting technology standards). Argentina, Brazil and Ecuador have policies to restrict flaring, although these have had mixed success. From 2013 to 2023, flared volumes fell by 10% in Brazil, but they increased by around 60% in Argentina and nearly doubled in Ecuador.

Stopping all non-emergency flaring and venting is the single-most effective policy measure for reducing methane emissions in the oil and gas sector. Many use cases exist for the natural gas that is currently flared, including delivering it to consumers via gas networks or as CNG or LNG; using it to generate electricity near oil and gas sites; or reinjecting it to help maintain reservoir pressure.

Under the Stated Policies Scenario, fossil fuel methane emissions in the region fall by around 15% by 2030 and by 25% by 2035. In the Announced Pledges Scenario, these emissions fall by about 45% by 2030 and by 60% by 2035, reflecting additional measures taken by countries and companies to deliver on existing pledges such as the World Bank Zero Routine Flaring by 2030 Initiative or the Global Methane Pledge, and near zero upstream methane targets set as part of the OGDC or the OGMP 2.0. In the NZE Scenario, fossil fuel methane emissions in the region fall by around 75% by 2030 and by 85% by 2035, with comprehensive action to deploy all methane abatement measures in the industry.

China

China is the world's largest emitter of methane and coal mines are its main source of energy-sector methane emissions. China produces and consumes more than half the global supply of coal. Emissions have risen in tandem with growing energy demand and fossil fuel production. In 2024, the fossil fuel sector in China emitted nearly 25 Mt of methane, of which around 20 Mt came from coal mines (including abandoned underground mines that can continue emitting methane for years after closure).

Oil and gas operations in China have a lower upstream methane intensity than the global average, while the country's coal mines perform close to the average. Deep mines that produce coking coal are linked to higher intensities and present key opportunities for abatement.

China is also the world's largest importer of oil, gas and coal and annual methane emissions from its fossil fuel imports are estimated to be around 10 Mt. Most of these emissions are associated with imports of crude oil from Russia and the Middle East.

China does not participate in the Global Methane Pledge but it has an action plan to cut methane emissions. This includes a target of 6 billion cubic metres (bcm) of coal mine gas use annually and prioritises methane recovery in the oil and gas

sector through measures such as leak detection and repair requirements (LDAR), and limits on flaring. China's action plan also highlights methane monitoring, reporting and verification systems.

China has introduced several policies and regulations for controlling fossil fuel methane emissions. In the coal sector, there is an emissions standard requiring gas utilisation in mines with methane concentrations and volumes above defined thresholds. Oil and gas operators are subject to limits on flaring and venting.

PetroChina participates in the OGDC, and China Gas Holdings Limited is a member of OGMP 2.0. Several Chinese oil and gas companies have also set up a Methane Control Alliance to promote the sharing of technology and expertise to reduce emissions.

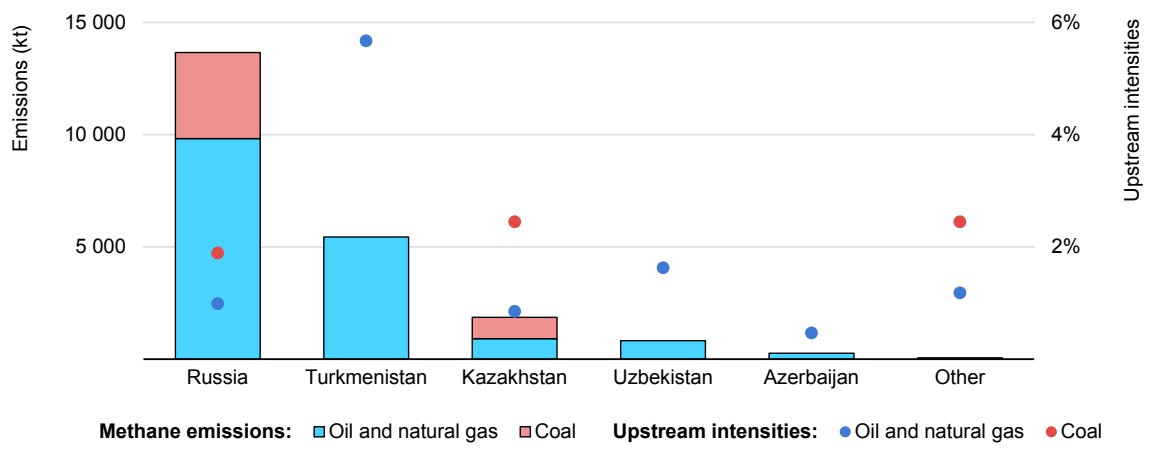
Under the Stated Policies Scenario, fossil fuel methane emissions in China fall by nearly 15% by 2030 and by around 30% by 2035 due to a peak in fossil fuel production and the deployment of abatement measures. In the Announced Pledges Scenario, emissions fall by close to 30% by 2030 and by nearly 60% by 2035, resulting from the implementation of the national methane action plan and from actions by companies to meet their own emissions targets. In the NZE Scenario, fossil fuel methane emissions in China fall by 80% by 2030 and by 90% by 2035.

Eurasia

The fossil fuel sector in the Eurasian region was responsible for 22 Mt of methane emissions in 2024. More than 60% of these emissions originated in Russia, where the oil and gas sector released nearly 10 Mt and coal mines 4 Mt of methane.

Oil and gas upstream methane intensities are high in most countries, with Turkmenistan having the second highest intensity in the world. Azerbaijan is the only producer in the region that has a lower intensity than the global average. Emissions events large enough to be detected by satellites are common in Turkmenistan, representing around one-third of all observations from the Methane Alert and Response System. While satellite coverage is very limited in Russia – due to ice and snow and prolonged periods of limited daylight – around 90 plumes were observed over Russian territory in 2024.

Methane emissions from the fossil fuel sector in Eurasia, 2024



Notes: Other countries include Armenia, Georgia, Kyrgyzstan and Tajikistan. Methane intensity calculated in energy terms as emissions from upstream operations divided by marketed fuel production, assuming methane has an energy density of 55 MJ/kg.

All major emitters in Eurasia participate in the Zero Routine Flaring by 2030 Initiative. Russia is the only producer that is not part of the Global Methane Pledge. None of the Eurasian countries have established methane reduction targets or published action plans to cut fossil fuel methane emissions. However, as part of their Nationally Determined Contributions (NDCs) under the Paris Agreement, Azerbaijan mentions the prevention of losses in the energy sector and Turkmenistan mentions the prevention of methane leaks in the oil and gas sector. Uzbekistan's NDC attributes its declining greenhouse gas emissions between 2010 and 2017 to reductions in fugitive methane from oil and gas activity.

Few countries in Eurasia directly regulate methane emissions from the fossil fuel industry. Russia and Kazakhstan impose financial penalties on methane emitters, but these are quite low and exemptions apply. Monitoring is also not based on reliable measurements, further limiting their effectiveness. So far, there is no evidence that these charges have led to measurable methane reductions.

Many national oil companies from the region participate in the OGDC, including SOCAR (Azerbaijan), KazMunayGas (Kazakhstan) and Uzbekneftegaz (Uzbekistan).

Around 45% of the Eurasian oil and gas methane emissions in 2024 could have been avoided through measures that would have ultimately paid for themselves. Leak detection and repair (LDAR) is the single-most effective measure for reducing fossil fuel methane in the region and it is highly cost-effective: 95% of the emissions savings from LDAR would have come at no net cost to operators. This includes abatement related to rapid-response systems for addressing large emissions events detected by satellite.

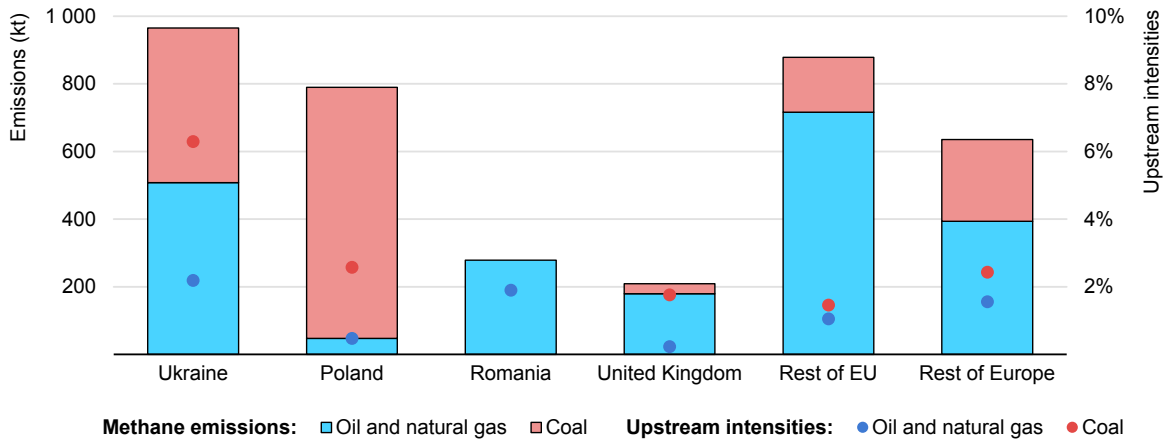
Under the Stated Policies Scenario, Eurasian fossil fuel methane emissions fall by 15% by 2030 and by 20% by 2035. In the Announced Pledges Scenario, emissions fall by 40% by 2030 and by 50% by 2035, a result of increased efforts to meet the Zero Routine Flaring by 2030 Initiative and the Global Methane Pledge as well as actions taken by signatories of the OGDC. In the NZE Scenario, fossil fuel methane emissions in the region fall by 75% by 2030 and by 85% by 2035.

Europe

Most of the methane emissions from fossil fuels used in Europe are tied to imports. In 2024, methane emissions from the supply chain for oil, gas and coal imports are estimated to be around 6 Mt, nearly four times the emissions that occur within Europe from its fossil fuel sector.

Around 55% of the fossil fuel methane emissions that occur within Europe come from the oil and gas sector, mostly from downstream operations, and 45% come from coal mines, mainly in Poland and Ukraine. Upstream oil and gas operations are responsible for the majority of emissions in Romania and the United Kingdom. Norway and the Netherlands have the lowest upstream intensities in the world, while most other countries in the region perform near the global average.

Methane emissions from the fossil fuel sector in Europe, 2024



Notes: Rest of EU includes Czechia, Denmark, Germany, Italy, The Netherlands and other EU Members. Rest of Europe includes Norway, Türkiye and other European countries that are not EU Members. Methane intensity calculated in energy terms as emissions from upstream operations divided by marketed fuel production, assuming methane has an energy density of 55 MJ/kg.

All major producers in Europe have signed the Global Methane Pledge. The European Union Methane Regulation, adopted in 2024, sets a series of measures for the fossil fuel sector. This includes measurement, reporting and verification requirements, a ban on routine flaring and venting, leak detection and repair (LDAR) mandates for all oil and gas facilities and limits to venting in thermal coal mines. It also calls for mitigation plans for abandoned facilities.

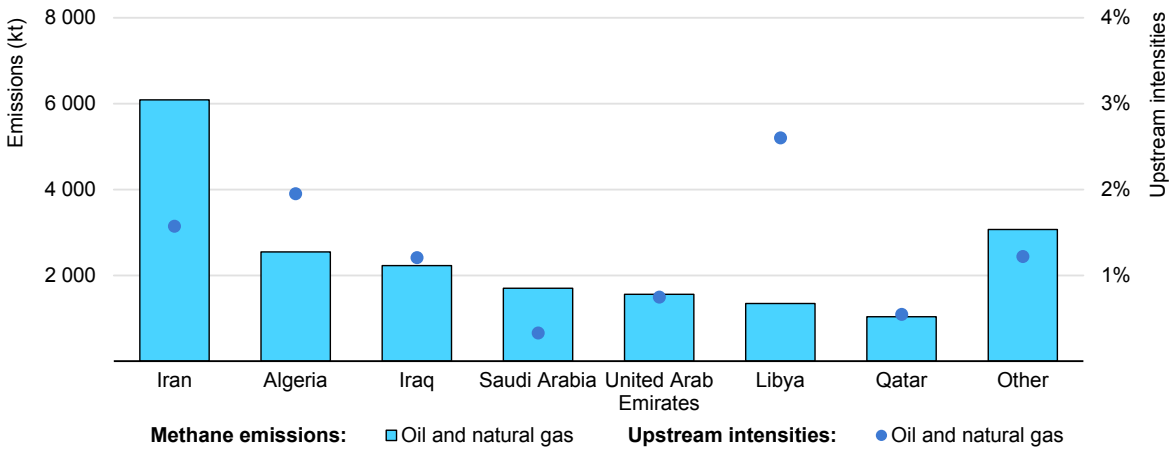
The regulation also requires that natural gas, oil and coal imported into the European Union under contracts concluded after January 2027 meet reporting requirements equivalent to those for domestic sources. It further references a methane intensity standard for new contracts from 2030. In 2024, the European Union also announced a Methane Abatement Partnership Roadmap, with a blueprint for cooperation between fossil fuel importing and exporting countries to reduce methane emissions.

Under the Stated Policies Scenario, domestic fossil fuel methane emissions fall by 35% by 2030 and by 45% by 2035. In the Announced Pledges Scenario, they fall by around 60% by 2030 and by more than 70% by 2035, reflecting additional measures to meet climate targets. In the NZE Scenario, fossil fuel methane emissions in the region fall by 75% by 2030 and by nearly 90% by 2035, with comprehensive action to deploy all methane abatement measures in the industry alongside large reductions in consumption.

Middle East and North Africa

Fossil fuel operations in the Middle East and North Africa emitted around 20 Mt of methane in 2024, nearly all which came from oil and gas activity. Flaring is a leading source of emissions, accounting for around 25% of the total. Performance varies widely, with Libya, Algeria and Iran having upstream methane intensities that are two- to six-times higher than Saudi Arabia, Qatar and the United Arab Emirates – all of which perform better than the global industry average.

Methane emissions from the oil and gas sector in the Middle East and North Africa, 2024



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Notes: Other countries include Bahrain, Egypt, Kuwait, Oman, Syria, Yemen and other countries in the region. Methane intensity is calculated in energy terms as emissions from upstream operations divided by marketed fuel production, assuming methane has an energy density of 55 MJ/kg.

Emissions events large enough to be detectable by satellite are common in the Middle East and North Africa, representing around 30% of all observations from the Methane Alert and Response System. The region's geography, with minimal cloud cover and open landscapes, ensures good satellite coverage. Satellites made more than 800 methane emission observations over Algeria, 400 in Iran, and 165 in Iraq. A satellite campaign supported by the Oil and Gas Climate Initiative with data from GHGSat studied 12 facilities and identified incomplete combustion from burning pits as the leading source of emissions in Algeria and Egypt, followed by gas lift system vents and equipment venting. A previous campaign in Iraq found flaring and direct venting as major sources.

All countries in the region participate in the Global Methane Pledge except for Algeria, Iran and Syria. Many also take part in the Zero Routine Flaring by 2030 Initiative. However fewer countries have developed regulations focused on limiting oil and gas methane emissions. Qatar has technology standards, as does Kuwait, which also requires leak detection and repair in the upstream sector. Egypt and Iraq have announced that they are currently working on developing new regulations. The IEA is working alongside the Clean Air Task Force and CCAC to support Iraq's oil and gas mitigation efforts.

Flaring and venting restrictions are common in most countries, but flared volumes have increased by over 50% since 2010. Many of the region's national oil companies have joined the OGDC or OGMP 2.0, including ADNOC (United Arab Emirates), the National Oil Corporation (NOC) of Libya, Saudi Aramco (Saudi Arabia), Bapco Energies (Bahrain) and Petroleum Development Oman.

Three countries – Iraq, Iran and Algeria – that together produce around 10% of the world's oil account for more than 30% of the flared volumes and related methane emissions. Most flares in these countries operate on a continuous basis and many are located within 20 km of existing gas pipelines.

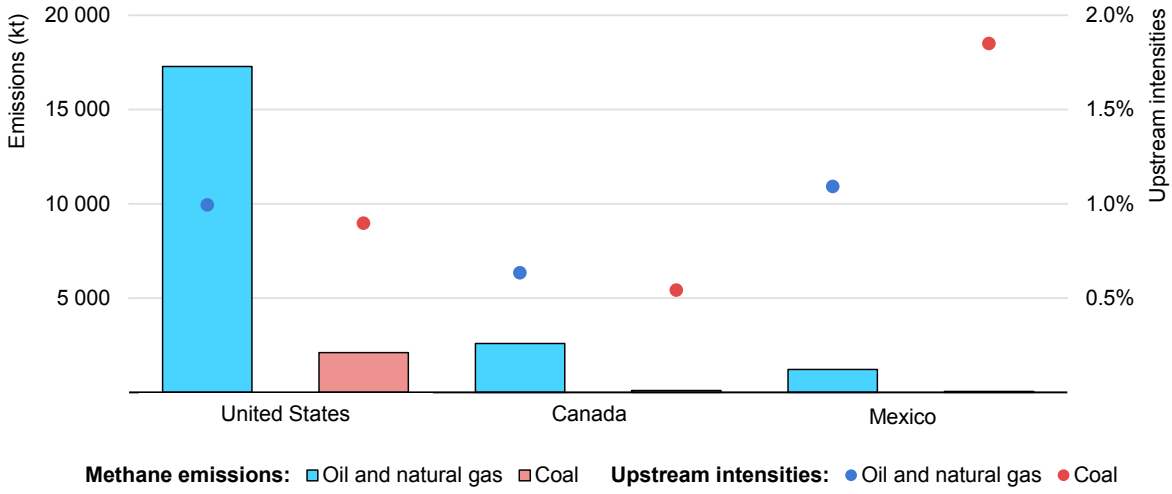
Under the Stated Policies Scenario, fossil fuel methane emissions in the Middle East and North Africa fall by 20% by 2030 and by 30% by 2035. In the Announced Pledges Scenario, emissions fall by 50% by 2030 and by 60% by 2035, as a result of stronger regulations to meet methane pledges and company action to achieve their near-zero upstream targets (around 60% of the oil and gas production in the region is covered by such targets). In the NZE Scenario, fossil fuel methane emissions in the region fall by 80% by 2030 and by 90% by 2035.

North America

North America's fossil fuel sector emitted more than 23 Mt of methane in 2024, of which roughly 85% came from the United States. Unconventional oil and gas production alone accounted for 12 Mt. Major sources of emissions include tanks that vent to the atmosphere, leaks and natural gas-driven pneumatic devices that release methane during normal operations.

Canada has the lowest upstream methane intensity in the region, while the United States and Mexico perform close to the global average. Airborne measurements indicate that intensities in the United States can vary by an order of magnitude between producing basins. The Methane Alert and Response System has to date tracked more than 700 super-emitting events in the United States – representing almost 10% of the world's total – with around 260 events classified as "actionable" (i.e. an emissions source was identified and could still be emitting).

Methane emissions from the fossil fuel sector in North America, 2024



Note: Methane intensity calculated in energy terms as emissions from upstream operations divided by marketed fuel production, assuming methane has an energy density of 55 MJ/kg.

While the United States has recently removed some of its regulations on methane, some policies and support for emissions reduction remain at the federal- (e.g. funding for research and development) and state-level (e.g. flaring restrictions). Canada has set venting limits and LDAR requirements, as well as an ambitious methane strategy that aims for a 75% reduction in emissions by 2030. Mexico introduced standards for the use of associated natural gas and established comprehensive guidelines for controlling methane emissions.

In the Stated Policies Scenario, methane emissions from the North American fossil fuel sector fall by around 40% by 2030 and then plateau to 2035. In the Announced Pledges Scenario, emissions fall by 70% by 2030 and by 80% by 2035, mainly as

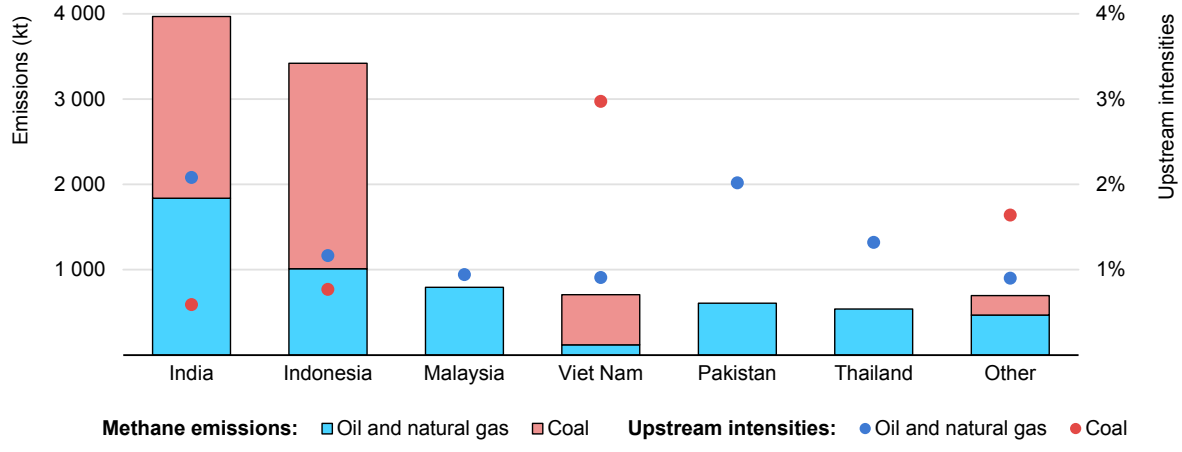
a result of national methane commitments and additional measures assumed to be taken by companies to deliver on pledges made as part of the OGDC and OGMP 2.0. Most of the major companies active in North America, as well as a number of smaller independent operators, participate in these initiatives. In the Net Zero Emissions by 2050 (NZE) Scenario, methane emissions from fossil fuel operations in the region fall by 75% by 2030 and by 85% by 2035.

South and Southeast Asia

The fossil fuel sector in South and Southeast Asia was responsible for around 10 Mt of methane emissions in 2024, half of which came from coal mines and half from the oil and gas sector. India and Indonesia were the largest emitters. Methane emissions in the region have been increasing in recent years, alongside rising energy demand and production of fossil fuels. India plans to double its coal output by 2030.

Oil and gas upstream methane intensities are high in most South and Southeast Asian countries, with the exception of Malaysia and Viet Nam, where operations are concentrated offshore and there is growing attention to curbing methane. In India and Pakistan, intensities are roughly double the global industry average. Most of the coal production in India and Indonesia comes from surface mines, where abatement options are more limited.

Methane emissions from the fossil fuel sector in South and Southeast Asia, 2024



Notes: Other countries include Bangladesh, Brunei, the Philippines and other countries in the region. Methane intensity is calculated in energy terms as emissions from upstream operations divided by marketed fuel production, assuming methane has an energy density of 55 MJ/kg.

All major emitters in the region participate in the Global Methane Pledge except for India and Thailand – though Thailand has identified some opportunities for lowering methane emissions, such as minimising fugitive emissions from oil and gas activity.

Bangladesh and Viet Nam have developed action plans to tackle methane emissions with quantified reduction targets. Viet Nam's plan encourages the collection of associated gas from oil operations, investment in leak detection and repair (LDAR), and methane drainage and recovery before and during underground coal mining. Viet Nam also has a policy that includes provisions on emissions monitoring and reporting. Bangladesh's methane emissions reduction plan refers to reducing leaks and recovering vented associated gas. Indonesia has a rule to increase the utilisation of associated gas. Many national oil companies from the region participate in the OGDC, including ONGC (India), PETRONAS (Malaysia), Pertamina (Indonesia), PPL (Pakistan) and PTTEP (Thailand).

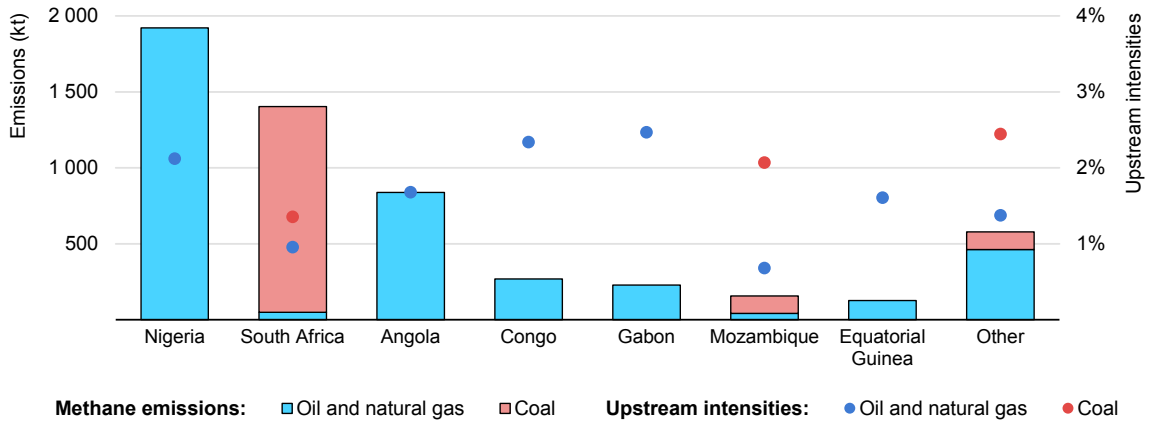
Under the Stated Policies Scenario, fossil fuel methane emissions in South and Southeast Asia fall by nearly 15% by 2030 and by just over 20% by 2035. In the Announced Pledges Scenario, emissions fall by around 35% by 2030 and by more than 45% by 2035, resulting from greater efforts to meet the Global Methane Pledge and from company action to reach near-zero upstream targets (around 65% of oil and gas production in the region is covered by these targets). In the NZE Scenario, fossil fuel methane emissions in the region fall by 65% by 2030 and by 85% by 2035.

Sub-Saharan Africa

In 2024, fossil fuel operations within sub-Saharan African countries emitted around 6 Mt of methane, of which around 70% came from oil and gas operations and the remainder from coal mines (mainly from South Africa). Fossil fuel methane emissions in the region have been falling in recent years, following decreases in oil and gas activity in Nigeria, which is the top emitter in the region. Emissions from the traditional use of biomass account for around 20% of energy-related methane in the region.

Oil and gas upstream methane intensities are high in many major producers. In Nigeria, Congo and Gabon, intensities are about double the global industry average. Several countries have the potential to increase production significantly in the coming years, including Mozambique and Senegal.

Methane emissions from the fossil fuel sector in sub-Saharan Africa, 2024



Notes: Other countries include Côte d'Ivoire, Equatorial Guinea, Ghana, Niger, Senegal, South Sudan, Sudan, Tanzania and other countries in the region. Methane intensity is calculated in energy terms as emissions from upstream operations divided by marketed fuel production, assuming methane has an energy density of 55 MJ/kg.

With the exception of South Africa, all major emitters in the region participate in the Global Methane Pledge. Many also take part in the Zero Routine Flaring by 2030 Initiative, including Angola, Nigeria and Gabon, and some countries have developed action plans to tackle methane emissions, including Côte d'Ivoire, Ghana, Nigeria and Togo. Côte d'Ivoire, Ghana and Nigeria have also established targets for methane emissions reduction.

Nigeria is the only country in the region that has developed a set of methane regulations specifically for the oil and gas sector. These include emissions and equipment standards, LDAR requirements, a tax on flaring and measurement and reporting obligations. Its current NDC commits to reducing fugitive methane emissions from oil and gas operations by 60% by 2031. Several other countries in the region also limit flaring, including Gabon and Equatorial Guinea. Many national oil companies (NOCs) participate in the OGDC, including NNPC (Nigeria), Sonangol (Angola), NILEPET (South Sudan) and NAMCOR (Namibia).

Under the Stated Policies Scenario, fossil fuel methane emissions in the region fall by 35% by 2030 and by 45% by 2035, mainly due to regulations in Nigeria and voluntary action from operators taking advantage of cost-effective abatement options. In the Announced Pledges Scenario, emissions fall by around 65% by 2030 and by nearly 75% by 2035, due to increased efforts to meet the Global Methane Pledge and from company action to reach near-zero upstream targets. In the NZE Scenario, fossil fuel methane emissions in the region fall by 80% by 2030 and by 90% by 2035, due to comprehensive action to deploy all methane abatement measures and a drop in steam coal production in South Africa.

Annex

Abbreviations

CCAC	Climate and Clean Air Coalition
CLEAN	Coalition for LNG Emission Abatement toward Net
EPA	Environmental Protection Agency
FFRP	Fossil Fuel Regulatory Programme
GFMR	Global Flaring and Methane Reduction
GMP	Global Methane Pledge
GWP	Global warming potential
IEA	International Energy Agency
IMEO	International Methane Emissions Observatory
IPCC	Intergovernmental Panel on Climate Change
LDAR	Leak detection and repair
LNG	Liquefied natural gas
MARS	Methane Alert and Response System
MMRV	Measurement, monitoring, reporting and verification
MRAP	Methane Roadmap Action Programme
NDC	Nationally Determined Contributions
NOC	National oil companies
OGCI	Oil and Gas Climate Initiative
OGDC	Oil and Gas Decarbonization Charter
UNEP	United Nations Environmental Programme
UNFCCC	UN Framework Convention on Climate Change

See the IEA glossary for a further explanation of many of the terms used in this report.

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