Advancing Methane Emissions Reductions by National Oil Companies

International Energy Agency

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Abstract

National oil companies (NOCs) are responsible for around half of all global oil and gas production today and their actions strongly influence methane abatement prospects. More than 30 NOCs have joined the Oil and Gas Decarbonization Charter (OGDC) and are engaging in initiatives to tackle methane emissions and flaring. There is a major opportunity for NOCs looking to implement best practices in methane management to learn from the experience of peers in order to deploy strategies that are adapted and tailored to their circumstances. Best practices include adopting measures to limit flaring and venting, implementing leak detection and repair programmes, and deploying low-emissions equipment. This report explores these opportunities in view of NOCs' distinctive characteristics, including their ties to national policy priorities.

Executive summary

NOCs have a crucial role to play in shaping the outlook for methane emissions. Rapid and cost-effective measures to tackle methane emissions by NOCs could deliver an annual reduction of up to 30 million tonnes (Mt) of methane by 2030, an impact comparable to eliminating all CO_2 emissions from the global aviation industry. This report aims to support NOCs on their methane reduction journey.

Around half of the oil and gas produced by NOCs is covered by pledges to achieve near-zero methane emissions by 2030. NOCs are tackling methane emissions in line with policy goals, to improve their sustainability credentials, and to attract financing. Key opportunities to accelerate action include:

- **Integrating methane management into operations.** Dedicated resources and plans are key to support effective capital and operational spending on methane abatement. Half of the options to reduce emissions in the oil and gas industry could be deployed with positive rates of return, improving natural gas resource use and cash flows.
- **Working with host governments and partner companies to unlock synergies and align goals.** NOCs can play a major role in supporting policy objectives. In over 30 countries where NOCs are responsible for more than half of oil and gas production, methane is already included in the scope of their Nationally Determined Contributions (NDCs).
- **Implementing best practices.** This includes adopting measures to limit flaring and venting, implementing leak detection and repair programmes, and deploying low-emissions equipment. Many of these mitigation options do not require measured emissions data or large investments. Flaring reductions by NOCs could make 60 billion cubic metres of natural gas available for domestic consumption or for export.
- **Develop a methane monitoring, reporting, and verification system based on emissions measurements.** This would enable a better assessment of abatement options and a credible way to track progress over time. It would also help meet market and regulatory requirements such as those of the European Union's (EU) methane regulation.
- **Make the most of supporting initiatives**. Many initiatives support oil and gas methane reductions, offering technical resources, capacity building and financing. These can help NOCs overcome existing barriers and take action that is tailored to their national contexts.

NOCs and methane management

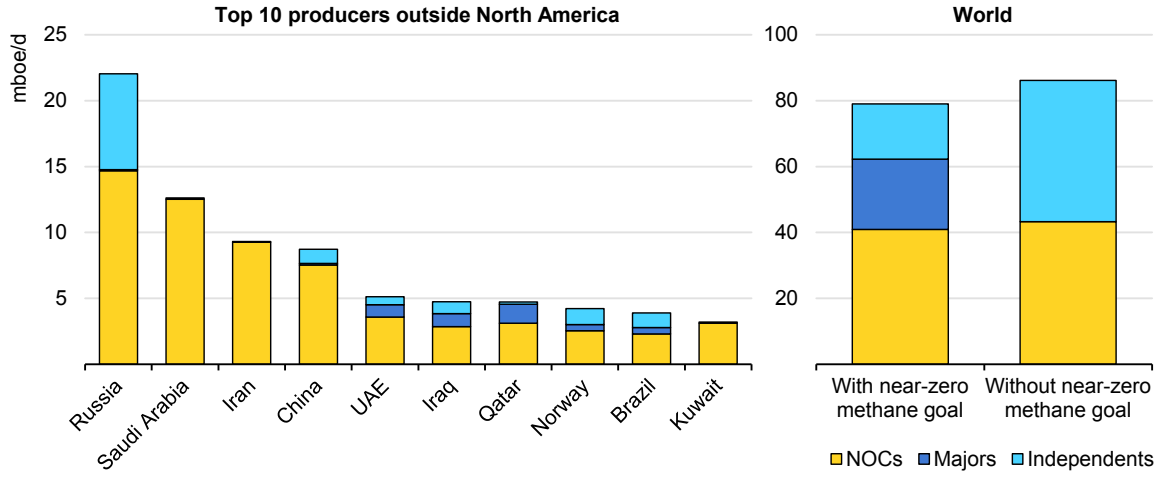
NOCs are established to manage, produce, and oversee a country's oil and gas resources. They play a central role in advancing government objectives, including generating state revenue, promoting resource efficiency, securing energy supply, boosting investment and supporting employment. Some NOCs also have regulatory roles and a mandate to promote sustainable practices.

NOCs have ample opportunities and reasons to lead rapid and low-cost reductions in methane emissions. Curtailing methane emissions enhances health, safety, and environmental performance. Methane abatement can also increase resource efficiency and boost gas sales, leading to additional revenue. NOCs can tackle methane emissions to support policy goals, meet market and investor requirements, or attract sustainable financing. Several NOCs have already embraced methane reduction efforts and are among top performers, while others are only now turning to this strategic opportunity.

NOCs can unlock major methane emission reductions

NOCs control close to 60% of global oil and gas reserves and accounted for half of global oil and gas production in 2024. In the Middle East, NOCs produce around 85% of all oil and natural gas, led by Saudi Arabia's Aramco and the National Iranian Oil Company. These two companies produce roughly as much oil and gas as all the majors (BP, ConocoPhillips, Chevron, Eni, ExxonMobil, Shell, and TotalEnergies) combined.

Oil and gas production in selected countries and production covered by methane goals, 2024



Notes: mboe/d = million barrels of oil equivalent per day. UAE = United Arab Emirates. Considers global equity production by company.
Source: IEA analysis based on data from the IEA and Rystad Energy (2025).

NOCs are responsible for around 35 Mt of upstream methane emissions annually (assuming that NOCs perform at the same level as the average of the oil and gas industry in countries in which they operate).

Around half of the oil and gas produced by NOCs comes from companies that have signed the OGDC or are members of the Oil and Gas Methane Partnership 2.0 (OGMP 2.0). We estimate that if these NOCs achieved their near-zero methane targets, it would lower methane emissions globally by close to 10 Mt. If all NOCs were to achieve near-zero methane emissions,[1] this would represent an annual reduction of around 30 Mt. On a 100-year timeframe, this is roughly equivalent to immediately eliminating all CO_2 emissions from domestic and international aviation.

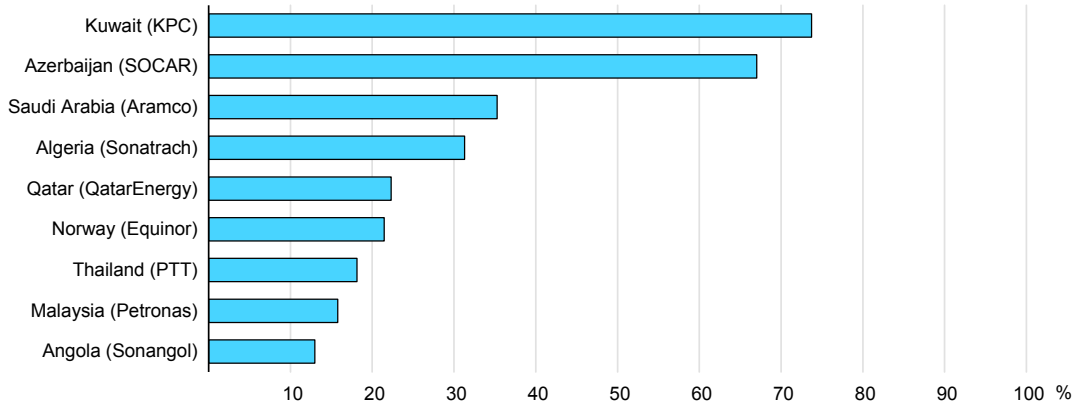
While countries and companies around the world are growing commitments to tackle emissions, the most recent annual data suggests that flaring and methane emissions from oil and gas operations remain near record levels. Achieving emissions reductions will require concrete plans and accountability, especially over the crucial period to 2030.

[1] Defined as a methane intensity of no greater than 0.2% (the methane intensity here is taken as methane emissions divided by total oil and gas supply, all in energy terms, assuming that methane has an energy density of 55 MJ/kg).

Navigating methane management amid competing priorities

National priorities assigned to NOCs set them apart from other oil and gas companies. These priorities can pose both additional challenges and opportunities for methane mitigation. NOCs can account for a substantial share of public revenue, supporting spending on social programs and infrastructure. In Azerbaijan, Kuwait and Saudi Arabia, revenue from NOCs accounts for more than one third of Gross Domestic Product (GDP).

National oil companies' revenue as share of GDP for selected countries



Note: Countries and NOCs shown are those that disclose their annual reports publicly and whose annual revenues account for more than 10% of nominal GDP. Data is for the 2024 calendar year, except for Algeria (Sonatrach) where the data is for 2023.

Sources: IEA analysis based on data from World Bank and annual reports from Aramco, Equinor, KPC, Petronas, PTT, QatarEnergy, SOCAR, Sonangol, and Sonatrach.

A methane agenda can support several government goals, such as ensuring energy supply, creating jobs, or providing incentives to domestic industries. For example, methane and flaring reduction efforts might support infrastructure development and help improve energy security by bringing additional natural gas to markets. It can also support national climate pledges or sustainability goals.

NOCs often face unique limitations in accessing commercial financing. Some NOCs carry high levels of debt. For example, Mexico's Pemex has more than USD 100 billion in debt and has had to receive financial support from the state on a number of occasions over the past decade. The debt ratio (total liabilities to total assets) exceeds 50% for NOCs in Angola, Indonesia, Nigeria, Thailand and a few other countries. We estimate the financing gap for deploying all oil and gas methane abatement options in low- and middle-income countries to be around USD 40 billion, which is well beyond available funding. In some contexts, this is compounded by subsidised gas prices that lower potential revenue from methane abatement

projects. Yet methane mitigation can offer a path to lower spending (e.g. by reducing natural gas imports) and improved access to financing or insurance.

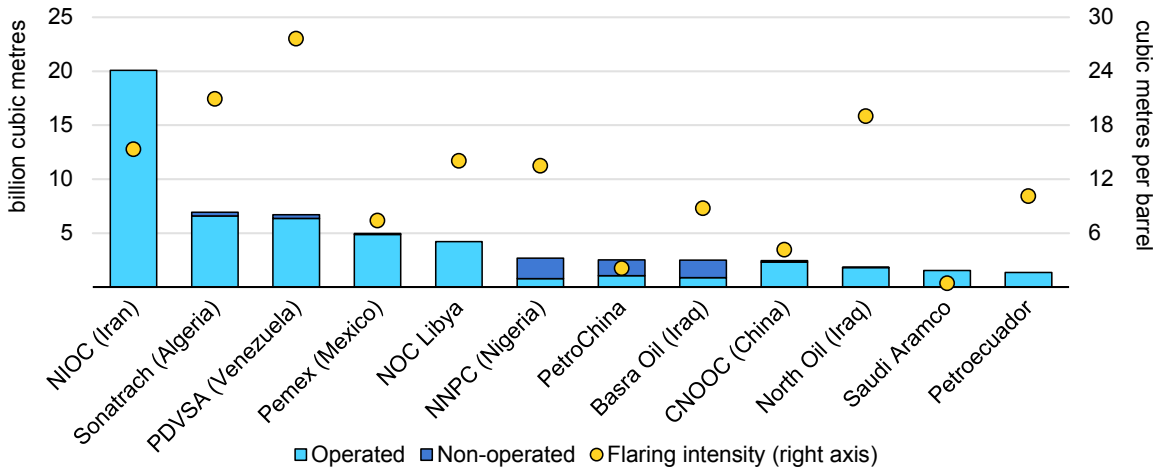
Many NOCs face similar demands as privately owned companies, such as pressure from stakeholders for investment returns or capital discipline, and buyers that are looking for clear information on emissions levels. The Coalition for LNG Emission Abatement toward Net-zero (CLEAN), for example, collects information on the status of methane emissions management and reduction efforts from LNG producers.

Governments and NOCs can work together to speed up methane abatement

NOCs can work with governments to help in the roll-out of methane abatement technologies, paving the way towards their broad adoption by other oil and gas operators. They can collaborate with universities and research institutions on training and innovation. Governmental job programs can feature methane-related employment opportunities and have links to NOCs. Major finance and investment decisions can be made in coordination with government ministries, and benefit from political backing to address funding needs. These companies can also make use of their regulatory competences or connections with host governments to help establish industry standards and set a level playing field for all operators in the country. Some countries have designated focal points from NOCs to receive and coordinate responses to alerts from the Methane Alert and Response System (MARS).

Current performance among NOCs on methane emissions and flaring varies significantly, highlighting that quick improvements are often possible. If all NOCs were to perform as well as Saudi Aramco, which reduced flaring through a master gas system that captures and processes a wide range of gas streams, flaring volumes would be around 60 billion cubic metres (roughly 90%) lower. Enhancing performance is not only feasible but essential to meet growing market and policy expectations around emissions reductions. It can also help align NOC operations with national and global climate targets.

Flaring volumes and flaring intensity of selected national oil companies, 2023



Notes: The top 12 NOCs with the largest flaring volumes outside Russia. Flaring intensity is calculated here as the volume of natural gas flared, divided by the volume of produced oil.

Source: IEA analysis based on data from the Clean Air Task Force (2024).

Many companies are showing that progress is possible. Around ten NOCs reached the OGMP 2.0 gold standard in 2025, including ADNOC, Ecopetrol, Petroleum Development Oman and Petronas. These companies have progressed on measuring methane emissions and some of them now provide data based on the highest levels of reporting. They are also setting their operations on a path to comply with the import requirements of the EU's methane regulation.

Brazil's Petrobras offers an example of how an NOC can support and progress national climate pledges. Petrobras has reported a series of measures to tackle its methane emissions within its operations and reach near-zero methane emissions by 2030. In 2018, the firm joined the Oil and Gas Climate Initiative; in 2022 it joined the OGMP 2.0; in 2023 it signed the OGDC; and in 2024 the company said its work on methane helped to strengthen Brazil's position vis-a-vis the Global Methane Pledge (GMP).

In more than 35 countries, over half of national oil and gas production is produced by NOCs. Most of these countries (32) include methane within the scope of their NDCs, but in 15, NOCs have neither signed the OGDC nor are they members of OGMP 2.0; there are also 13 countries that are participants of the GMP yet their NOCs do not participate in either the OGDC or the OGMP 2.0.

Government methane pledges and NOC methane commitments in selected countries

Country	GMP participant	Methane in scope of NDC	NOC has signed the OGDC	NOC is an OGMP 2.0 member
Algeria		✓		
Azerbaijan	✓	✓	SOCAR	SOCAR
Brazil	✓	✓	Petrobras	Petrobras
Cameroon	✓	✓		
Chad	✓	✓		
China		✓	PetroChina, Zhenhua Oil	
Colombia	✓	✓	Ecopetrol	Ecopetrol
Cuba	✓	✓		
Ecuador	✓	✓		Petroecuador
India			Oil India, ONGC	
Iraq	✓	✓		
Kuwait	✓	✓		
Libya	✓		National Oil Corporation	
Malaysia	✓	✓	Petronas	Petronas
Mexico	✓	✓		
Morocco	✓	✓		
Niger	✓	✓		
Norway	✓	✓	Equinor, Petoro	Equinor
Oman	✓	✓	PDO	PDO, Oman LNG
Pakistan	✓	✓	GHPL, OGDCL, PPL, MariEnergies	
Qatar	✓	✓		QatarEnergy
Romania	✓	✓		Romgaz
Russia		✓		
Saudi Arabia	✓	✓	Aramco	
South Sudan		✓	Nilepet	
Sudan	✓	✓		
Thailand		✓	PTTEP	PTTEP
Tunisia	✓	✓		
Turkmenistan	✓	✓		
United Arab Emirates	✓	✓	ADNOC, Dragon Oil, SNOC	ADNOC
Ukraine	✓	✓		Naftogaz
Uzbekistan	✓	✓	Uzbekneftegaz	
Venezuela		✓		
Viet Nam	✓	✓		
Yemen	✓			

Notes: Shows countries where methane pledges are in place and NOCs account for over 50% of national oil and gas production.

Advancing best practices

This section explores four key areas where rapid progress on methane emissions management by NOCs is possible: tackling flaring and venting; implementing leak detection and repair programmes; deploying no- or low-emissions equipment; and developing methane monitoring, reporting, and verification systems based on emissions measurements.

NOCs can accelerate progress in these areas by learning from their peers, both from other state-owned enterprises and across the broader oil and gas industry. Peer exchanges can help NOCs navigate competing priorities and identify the technologies, operational practices, and regulatory frameworks best suited to their context. Partner companies can offer insights into deployment strategies, cost-effectiveness of abatement measures, and workforce training.

Regional partnerships among NOCs create synergies and foster collaboration for methane mitigation, enabling joint development of technologies, pooled training resources, and coordinated engagement with relevant stakeholders. In Southeast Asia, Malaysia's Petronas launched the ASEAN Energy Sector Methane Leadership Program 2.0 in collaboration with fellow NOCs, government agencies, international organisations, and other partners to understand, discuss, and implement best practices on methane emissions abatement in the region. The initiative builds upon the ASEAN Energy Sector Methane Roundtables and Methane Leadership Program.

By sharing performance data, lessons learned, and implementation challenges, NOCs can benchmark industry practices and develop better strategies. International initiatives such as the OGDC and the OGMP 2.0 provide frameworks for such collaboration. Joint ventures also provide opportunities for sharing best practices on methane management, as seen in agreements between Chevron and KMG in Kazakhstan and ADNOC and Eni in the United Arab Emirates. NOCs account for an average of 30% of the majors' non-operated production, highlighting the potential for collaboration.

Tackle flaring and venting to improve national resource use and reduce emissions

Stopping all non-emergency flaring and venting is the single-most effective measure for reducing methane emissions in the oil and gas sector. It also leads to better resource use and often to additional revenue or cost savings. The IEA has estimated that around two thirds of volumes flared globally could be avoided at no

net cost because the value of the captured methane is sufficient to cover the cost of the abatement measure. For methane, the use of vapour recovery units to capture vented gas and associated gas utilisation technologies presents some of the best options available to reduce emissions.

Nearly 95% of emissions from flaring are abatable with existing technologies. There are many options to use the natural gas that is currently flared, including by delivering it to consumers via a new or existing gas network, reinjecting it to support reservoir pressure, or converting it to LNG, compressed natural gas, methanol, fertilisers or power. Mobile equipment can reduce the need for flaring and venting during well testing and other short-term operations.

The IEA estimates that flares have a global average combustion efficiency of around 90%,[2] which is significantly lower than the standard assumption of 98%. There should be minimal methane emissions if a flare is designed, maintained and operated correctly. However, that is not always the case, and higher emissions can occur due to factors such as weather patterns or changes in production rates. Occasionally, an active flare may be totally extinguished, resulting in the direct venting of methane gas into the atmosphere.

Technologies and maintenance practices can improve the efficiency of existing flares. For example, using flare tips with modern designs that improve fuel and air mixing, or adopting flare stacks that ensure adequate fuel-air mixing to consistently achieve high combustion efficiencies can significantly reduce emissions resulting from poor combustion efficiency. Flares can now be monitored every day on a near real-time basis, helping companies to identify bottlenecks and opportunities in operated and non-operated assets.

Flaring and venting reduction projects face many barriers, including lack of infrastructure, contractual terms that prevent natural gas savings from affecting revenue, or information gaps on gas volumes and characteristics (e.g. the level of routine flaring). There may be higher-profile opportunities competing for investment resources, ownership challenges, or risks in the phase of project development. Small volumes can make it costly to recover investment through developing new infrastructure or by gas transport. It is also challenging to reduce flaring and venting in some assets, such as offshore facilities, due to space and weight constraints, as well as higher investment needs.

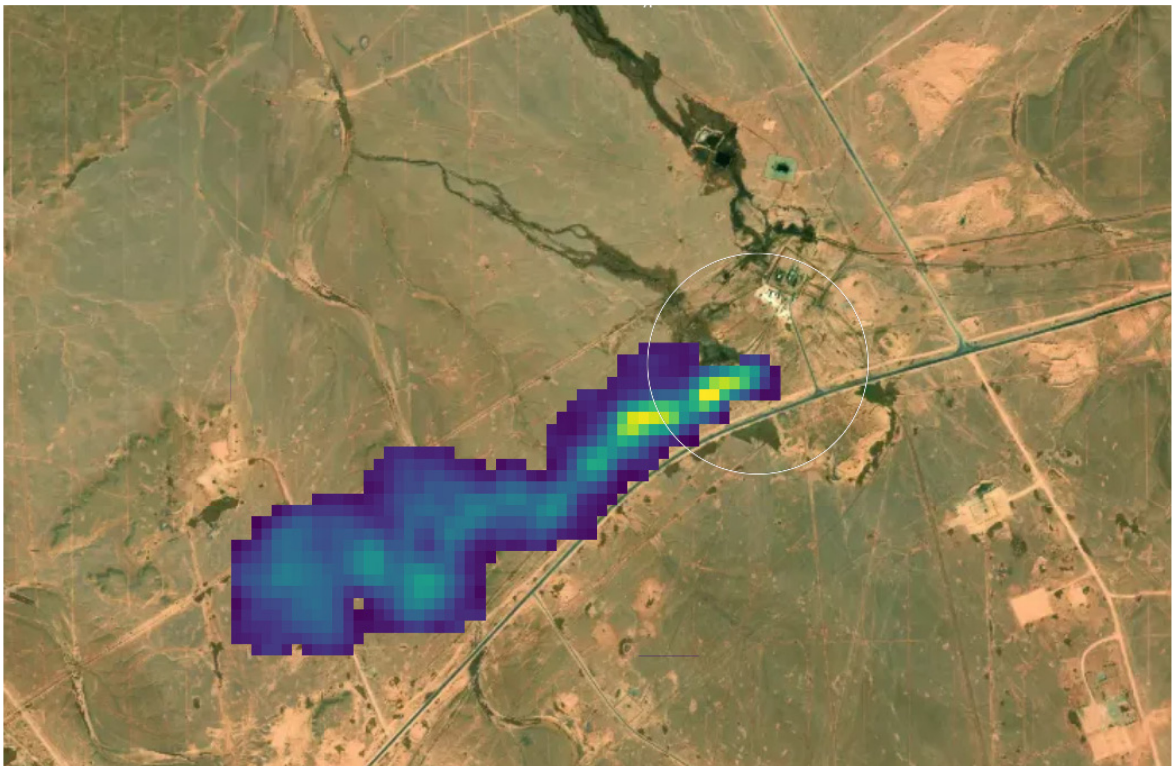
Nevertheless, there are measures available to reduce flaring and venting that require little investment and which are often cost-effective. These include better planning of commissioning and maintenance activities to avoid flaring and venting

[2] Based on a detailed bottom-up assessment of production types; facility and flare design practices; operators; changes in produced volumes over field lifetime; local crosswind variability; and the strength of regulation, oversight and enforcement in flaring sites.

during facility startups, optimising operations and building redundancy to minimise upsets and equipment failure linked to gas flaring and venting.

NOCs are often well positioned to address flaring and venting. Their ability to coordinate with government initiatives offers potential synergies for infrastructure development and connections to natural gas demand centres. Their mandate may include elements of sustainability and be part of national pledges, such as the Zero Routine Flaring by 2030 (ZRF) initiative launched by the World Bank. Some NOCs have a regulatory role and can lead the domestic industry by example or through standards. NOCs are also usually tasked with stewardship of national oil and gas resources, providing an added incentive to avoid energy waste and invest in measures that increase energy security.

Methane plume from a flare in Algeria, 2024



Source: Kayrros SAS, processed L1B image from the German Aerospace Center's EnMAP.

NOCs may also face particular challenges, such as financial constraints or aging infrastructure. Many NOCs face budgetary pressures or limited access to financing, especially in lower-income countries. Tax structures or production-sharing agreements may not reward gas capture, making flaring the path of least resistance. Integrating gas recovery systems into existing operations can be technically challenging and costly, especially in mature or remote fields.

Several initiatives have emerged to help bridge these gaps. The World Bank's Global Flaring and Methane Reduction Partnership (GFMR) 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 Methane Guiding Principles developed a series of best practice guides for methane management, including how to tackle flaring and venting, as well as a toolkit to assist in assessing, measuring and monitoring methane emissions from flaring. Partnerships with other operators, as in Iraq, or with financiers can also help overcome these challenges.

Petronas's path to zero routine flaring and venting

In 2025, Malaysia's NOC and upstream oil and gas regulator, Petronas, reported a 62% reduction in methane emissions from groupwide natural gas value chain from the 2019 baseline to 2024, mostly due to the implementation of flaring and venting reduction projects. These efforts were part of its commitments to Net Zero Carbon Emissions by 2050, the ZRF and OGMP 2.0, which support Malaysia's participation in the Global Methane Pledge.

Petronas changed operating procedures to reduce routine venting and implemented projects to use gas that was being vented or flared. Reported emissions from cold venting (to dispose of unwanted gases) upstream declined by around 80% from 2020 to 2024. Upstream assets met their target of zero routine venting by 2024 in all its operated assets in Malaysia. Key recent initiatives include a flare gas recovery project in the Terengganu Gas Terminal, curbing flaring associated with well unloading at Erb West and minimising venting at Miri Crude Oil Terminal. Some of these projects strengthened cash flows through reduced operational expenditure and increased sales.

Petronas is working with other companies to reduce methane emissions and flaring. In its capacity as regulator, the NOC has annual flaring and venting limits for operators that have a license from Petronas to participate in oil and gas exploration or production. Flaring and venting volumes must be reported to Petronas monthly. If the flaring and venting limits are exceeded, these operators must notify the NOC and provide a mitigation plan.

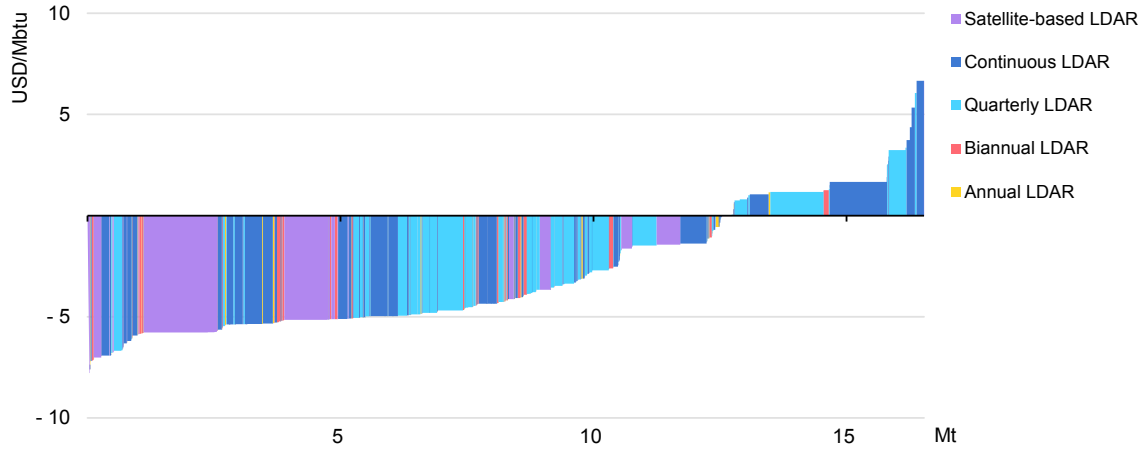
Petronas also announced plans to establish the Southeast Asia Methane Emissions Technology Evaluation Centre in collaboration with the Japan Organization for Metals and Energy Security. The centre will support measurement, monitoring, reporting and verification, as well as capacity building, research and development initiatives.

Leak detection and repair programmes offer a cost-effective path to reduce methane leaks

Leak detection and repair (LDAR) programmes are the main tool for addressing emissions from leaking components and malfunctioning equipment, which account for around 20% of methane emissions in the upstream segment and more than 40% in downstream facilities.

LDAR programmes are often cost-effective and require only modest investment. We estimate that around 75% of emissions reductions that could be achieved by LDAR would come at no net cost, with upfront spending being offset over time by additional revenue from captured gas. Most spending is related to operational costs, including personnel and logistics, and can synergise with job programmes. Capital expenditure is also required, for example, to obtain specialised detection equipment and training, which can be done in partnership with public research agencies or regulators. Net costs usually increase with LDAR frequency, but that relationship depends on gas prices and leak prevalence. Higher costs are also often associated with remote or offshore facilities and long-distance pipelines.

Methane marginal abatement cost curve for fugitive oil and gas emissions, 2024



The reduction potential of LDAR programmes depends on their scope as well as the frequency of inspections and the inspection methods used. The more frequently inspections take place, the sooner leaks can be detected and abated. Traditionally, LDAR was limited to on-the-ground inspections with optical gas imaging cameras, but new and emerging technologies, including continuous monitoring sensors, along with aircraft, drone and satellite observations, are improving leak detection capability.

Facility characteristics and company objectives will determine what type of LDAR and equipment is most suitable to each operational context. Leak detection frequency can also vary over time, according to how often significant emissions are being detected. The optimal system would build on a range of complementary technologies, such as satellite measurements, drone-based and other aerial surveys, ground-based sensors and surveys, and continuous monitoring devices. For example, satellites or overflights can be used to identify large leaks and activate on-site inspections. Complex facilities with multiple potential sources of emissions may be good targets for continuous monitoring systems.

Tackling fugitive emissions might be of special interest to NOCs since it aligns with several government priorities. These include the safety of operations, minimising health impacts to nearby communities and reducing energy waste and emissions. To do so, NOCs may develop in-house capability to favour local employment and expertise, especially if they have extensive operations. Alternatively, they can rely on service companies, potentially through an umbrella contract that serves multiple facilities, minimising contractual burdens. NOCs with a regulatory role can set minimum LDAR requirements according to asset characteristics (e.g. for onshore or offshore, upstream or downstream). There are guidelines and tools to help operators choose detection and quantification technologies and structure an LDAR programme according to best practices. These cover detection capabilities, repair timelines, and re-survey procedures to confirm leak resolution.

The use of leak detection and repair by Ecopetrol

In 2021, Colombia's Ecopetrol became the first NOC in Latin America to announce a commitment to achieve net zero scope 1 and 2 emissions by 2050. The announcement included an interim target of a 25% reduction in emissions from 2019 to 2030. Also in 2021, the NOC carried out the first major methane measurement campaign in all its upstream production assets, with the support of the Canadian government. In 2023, the company announced a methane-specific target: to reduce methane emissions from its production segment by 45% by 2025 and by 55% by 2030 compared to the 2019 baseline.

Measures to tackle fugitive emissions are a key component of Ecopetrol's efforts to achieve its methane targets. Ecopetrol has implemented an LDAR programme in line with national regulations and OGMP 2.0, investing in technologies such as infrared cameras, flow meters, satellite imagery and aerial surveys. Between 2021 and 2024, the company carried out surveys over an area of 1 200 km², covering 95% of its operated production assets and six non-operated assets, and performed source-level methane measurements across many facilities. As a result, Ecopetrol reported the detection and repair of nearly 2 000 leaks.

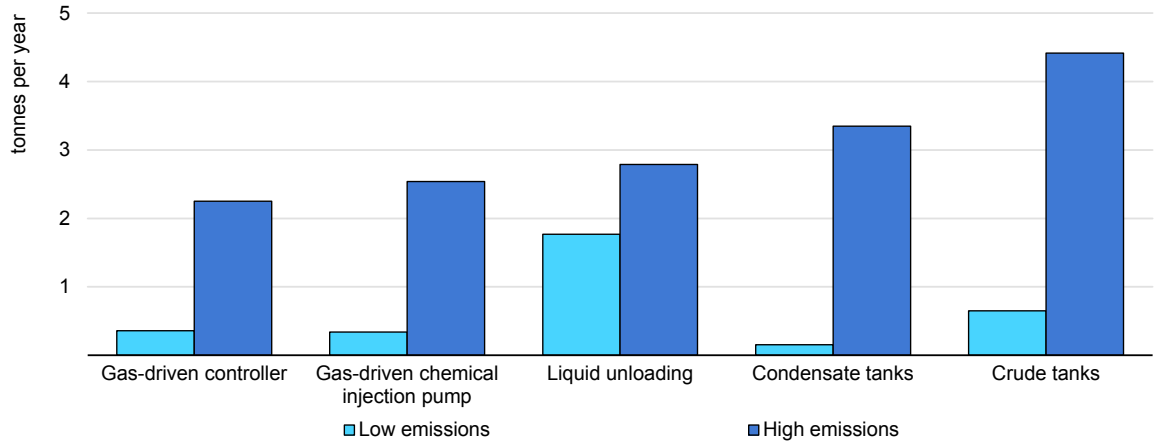
Ecopetrol reports that it reduced around 17 000 tonnes of methane between 2020 and 2024 based on LDAR, gathering of vents from wells and tanks, and other emissions reduction measures. This is part of the company's strategy to achieve near-zero methane emissions and zero routine flaring by 2030. Ecopetrol has also developed a greenhouse gas marginal abatement cost curve to identify cost-effective levers for emissions mitigation.

Ecopetrol indicates that it is working on methane emission measurements to improve emissions estimates, their assessment of abatement opportunities and to verify the closure of previously repaired leaks. It is participating in a scientific effort that includes airborne methane measurements across more than 150 facilities and is set to include source-level measurements at priority assets in 2025.

Deploy no- or low-emissions equipment to kick-start emissions reductions even if emissions data is lacking

Progress on abatement is possible even with an imperfect understanding of emissions levels. Equipment choices can help reduce methane emissions and offer a no-regrets option for companies looking to start reducing emissions quickly. We estimate that more than 15 Mt of methane can be avoided globally by replacing pumps, controllers, compressors, and other equipment with low- or no-emissions alternatives.

Illustrative methane emissions factors for selected oil and gas production equipment



Notes: Gas-driven controller shows values for high- and low-bleed pneumatics. Gas-driven chemical injection pump shows values for piston and diaphragm pumps. Liquid loading shows values with and without plungers. Condensate and crude tanks show values for large tanks with and without vapour recovery units, assuming 10 cubic metres of production per day.

Source: IEA analysis based on data from the American Petroleum Institute's Compendium of Greenhouse Gas Emissions Methodologies for the Natural Gas and Oil Industry.

There are some types of equipment that emit by design under normal operational conditions. While emissions volumes vary depending on asset characteristics and the local context, significant levels of emissions are often associated with gas-driven controllers and pumps, compressors, tanks and separators. Planned processes and operations, such as well unloading or pipeline blowdowns, can also lead to significant emissions.

Many technologies are available to reduce these emissions. Gas-driven controllers and pumps can be switched to no-emissions alternatives, such as instrument air systems and electric devices. Gas engines can be swapped by electric motors. Dry-seal centrifugal compressors can replace ones with wet-seals, which emit significantly more. Proper maintenance and early replacement of rod-packings can minimise emissions from reciprocating compressors. Tanks, separators and compressors can route their vents to flares or vapour recovery units. Plungers can

be installed to avoid venting during well unloading. Further information on such technologies is available in best practice guides and online platforms.

NOCs can use several strategies to deploy these technologies. They can integrate equipment upgrades in plans to revitalise assets and aging infrastructure, coordinating with government plans for resource development. Planned equipment upgrades can be pooled to lower transaction costs and make projects more attractive. Maintenance programs and planned shutdowns offer another opportunity to deploy these solutions systematically across operations, building onto company logistics. NOCs with regulatory authority can mandate the use of best available technologies in new developments, licenses or contracts.

Sinopec strengthens methane management

China Petroleum and Chemical Corporation (Sinopec) is one of the largest integrated energy and chemical companies in China. It has a target to reduce its methane emission intensity by 50% from 2020 to 2025.

Sinopec indicates that it has implemented a series of measures to meet this target. This includes deploying technologies for casing gas recovery, comprehensive utilisation of flare gas, recovery of vented natural gas – including at remote wells – and improving transportation processes. In 2023, it reported a 4.8% year-on-year increase in methane gas recovery, reusing approximately 0.9 billion cubic metres of methane.

In the Shengli Oilfield, the methane emission management system imposes a fee on methane emissions for sources related to oil extraction, storage, and treatment. All oil and gas subsidiaries must file a monthly management plan and progress report for each controlled source. Some sources are exempted, such as wellheads or oil unloading points, as well as equipment that complies with applicable operational and emissions requirements. Shengli Oilfield indicates it carries on-site monitoring and verification based on the reported information. Controlled sources exempted from fees are subject to random testing, and those that fail to meet emission requirements lose their exemption and are subject to rectification.

The company reported that field subsidiaries treated 545 emission sources in 2023, reducing 4.3 million cubic metres of methane emissions, a year-on-year reduction of more than 15%.

Monitoring, reporting and verification systems are key for credible and effective methane emissions reductions

Monitoring, reporting and verification (MRV) systems are a key element of methane management. They allow a company to effectively target methane emissions by identifying major sources and abatement opportunities, unlocking investments by clarifying potential costs and savings. They also help to track progress over time and meet market and regulatory requirements, such as the ones set in the European Union's methane regulation.

Currently, most company methane inventories are based on multiplying activity data (e.g. the number of large oil tanks) by standardised emission factors (e.g. default emissions rates for large oil tanks). Measurements from satellites and airborne observations suggest that actual emissions levels are often much higher than estimated (e.g. in the United States). Source-level and facility-level measurements with representative temporal and geographical coverage are needed for robust emissions estimates that reflect all main sources of emissions, including accidental leaks. While detection is sufficient to verify the need for action (e.g. repairs), quantification is needed for a better understanding of emissions and to establish baselines and related goals.

There is a wide range of quantification technologies for methane emissions, including systems that combine LDAR and MRV needs. Advances in direct measurement techniques by land and air, notably from satellites and drones, are allowing for more – and more reliable – information on methane emissions. Continuous monitoring systems are also becoming increasingly reliable and economical. Companies can refer to best practice guides and further resources on the technologies available.

Reporting and verification are also essential elements. The OGMP 2.0 offers a measurement-based international reporting framework for the oil and gas sector that can support transparent publication of emissions data. Independent third-party verification can improve credibility and support market change.

NOCs can be national leaders in testing methane monitoring technologies and supporting regulatory innovations, working ahead of broader sectoral adoption. They can coordinate with government plans to align on potential MRV elements and upcoming requirements. In some cases, NOCs may include model clauses in contracts with other operators to cover MRV of methane emissions. Related MRV data can then support national greenhouse gas inventories. This may be of particular interest to NOCs that sell products to markets that are increasingly looking at methane credentials, such as the European Union, Japan and Korea.

Equinor champions methane measurements

Norway's Equinor is an international energy company that is majority state-owned. In 2024, their reported methane intensity was 0.01% (volume of methane emissions per volume of marketed gas), improving from 0.02% in 2023 and 0.06% in 2015.

This reporting is based on a robust monitoring system. Equinor indicates that it carries out source-level quantification at all operated assets and started to roll out site-level measurements across operations in 2024. In 2019, the company was relying on aircraft surveys and collaborating with academia to gather information on its methane emissions. Equinor has been awarded the OGMP 2.0 Gold Standard every year since the initiative was established in 2020. The company reports its methane emissions on a yearly basis for all of its assets, both on an operational and equity basis.

Equinor also invests in methane mitigation measures. It reports that LDAR is performed in all operated assets and requested at assets operated by partners. In 2024, the company invested around USD 30 million to deploy a recovery unit at the Peregrino field in Brazil and to shut down an amine unit at Åsgard B in Norway. In project assessments, Equinor considers a price of USD 5 700 per tonne of methane emissions for sensitivity analysis during evaluation of abatement opportunities.

Equinor contributes to the GFMR and has signed agreements with partner NOCs to support their decarbonisation initiatives, including Petrobras, Sonangol, Sonatrach, and YPF.

Overcoming barriers to action

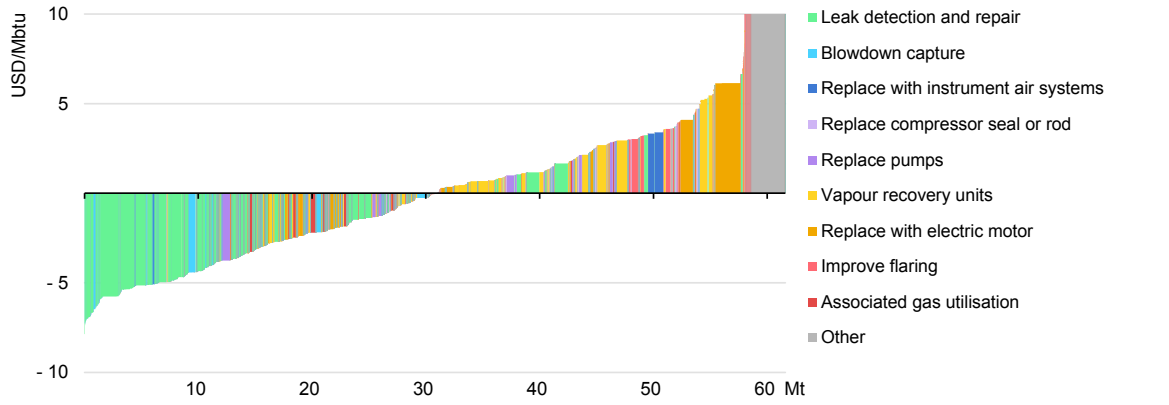
This section explores strategies to tackle the many challenges NOCs face when approaching methane abatement. Some are unaware of the scale of the problem or the available solutions. Some face competing opportunities for investment or split incentives, whereby they do not directly benefit from reducing methane leaks. Securing capital for required investments can be difficult, especially in developing economies. Companies may also struggle to find sufficient staff or secure the services to tackle the problem.

Adjust to gaps in data, capacity and finance to start tackling emissions

NOCs need to consider how to best match methane management to their circumstances, including existing regulatory frameworks, market context and their knowledge of emissions. Identifying key barriers helps to decide on areas for future work. For example, companies with a shortage of technical capacity can focus on developing training programmes. If access to capital is a limitation, they can explore financial instruments, including sustainability-linked bonds or loans, use-of-proceeds bonds and other financing options.

There is a lot that NOCs can do to start tackling methane in the face of barriers, such as a lack of emissions data. Operational data, like inventories of equipment or records of hydrocarbon flows, can help map potential cost-effective or low-capex abatement options. This may start with the identification of facilities with higher gas losses or high-emission equipment. NOCs can also review operational procedures to minimise wasteful practices and revise contracts with service companies to add methane-related provisions.

Methane marginal abatement cost curve for oil and gas emissions, 2024



Note: 'Other' includes monitoring and plugging abandoned wells, reduced-emission completion, among other abatement options.

Around half of the options to reduce methane emissions in the oil and gas industry could be deployed with positive rates of return. In some cases, revenue does not directly impact investment decisions of NOCs due to their institutional set up, but there are ways to overcome this by working with the board, setting corporate goals for abatement and coordinating with the government. Debt issuances could help allocate specific resources to methane abatement. Companies can use free tools to build the case for methane abatement. Carbon Limits developed a free methane inventory software that can run on few inputs and be improved over time to help prioritise mitigation. It has already been used by NOCs to better understand the economic benefits of abatement projects. The IEA's open methane abatement model can be used to develop tailored abatement cost curves.

Uzbekneftegaz's partnership for emissions reduction

Uzbekneftegaz, Uzbekistan's NOC, has set a target to reduce its greenhouse gas emissions by 25% by 2030 and is tackling methane emissions as part of this pledge. In 2023, the company partnered with ICA-Finance and Vema Carbon, both private sector specialists in emissions reduction, to implement an advanced LDAR programme across four of its oil production units. The project comprised the detection and measurement of methane emissions and leaks in operated natural gas pipelines and oil treatment plants, followed by repair works. A monitoring programme was put in place to ensure timely detection and repair of equipment leaks. The project has an expected annual impact exceeding 300 000 tonnes of CO_2-equivalent emissions reduced. These reductions have generated Upstream Emission Reduction credits under the German Upstream Emission Reduction Ordinance, thereby providing a lever for project financing.

Collaborate with other companies and regulators to improve abatement prospects

Strategic collaboration with private partners, regulators and other stakeholders facilitates methane emissions reductions. Joint ventures offer an opportunity for technology-sharing and the pooling of resources and expertise, reducing costs and enhancing operational efficiency. NOCs can also work with service providers and equipment manufacturers to spread best practices across assets and tackle local challenges and innovation needs.

In parallel, NOCs can play a proactive role in supporting and complying with regulatory frameworks. By working with national regulators, they can support policies that are both ambitious and achievable in view of industry characteristics. For example, performance-based standards can be aligned for new operations, considering available technologies and corporate targets. Where abatement is not cost-effective, financial incentives for emissions reductions can be negotiated. Transparent data sharing and third-party verification mechanisms can further build trust, collaboration and accountability.

NOCs can also work with host governments to align internal goals with national energy and environmental priorities by participating in policy development and regulatory consultations. This collaboration can help ensure a level playing field across the sector, foster transparency and enable NOCs to integrate national objectives, such as emissions reductions or energy security, into their strategic planning and operational frameworks.

TotalEnergies partners with NOCs to monitor methane emissions

TotalEnergies has made its Airborne Ultralight Spectrometer for Environmental Applications (AUSEA) technology available to several NOCs, enabling them to carry out drone surveys of their own assets. The drone-mounted AUSEA gas analyser consists of a dual sensor capable of identifying and quantifying methane and CO_2 emissions. The technology enables access to hard-to-reach emission points and features a high accuracy sensor (> 1 kg/h).

After deploying its AUSEA drones at all its upstream operated sites, TotalEnergies performed the first AUSEA flights on non-operated assets in 2023 and announced the signing of five cooperation agreements with NOCs: NNPC in Nigeria, ONGC in India, Petrobras in Brazil, SOCAR in Azerbaijan, and Sonangol in Angola. In 2024, TotalEnergies signed a similar cooperation agreement with Oil India Limited, an NOC that had recently joined the OGDC.

TotalEnergies' long-term objective is to develop an unmanned drone navigation system with data automatically streamed to the servers, as well as continuous data processing and reporting capabilities.

New initiatives are emerging to facilitate the implementation of methane reduction plans

Many organisations and initiatives offer support for methane reductions in the oil and gas industry and can help NOCs in their journey:

- The Oil and Gas Climate Initiative hosts a methane library with resources focused on helping oil and gas companies accelerate methane emissions reductions. They also work with the OGDC to support operators directly, including through satellite monitoring campaigns.
- The World Bank's GFMR focuses on providing catalytic grant funding, technical assistance, and mobilising financing to help governments and state-owned operators deploy flaring and methane reduction solutions in the oil and gas sector.
- The UN Environment Programme's (UNEP) International Methane Emissions Observatory (IMEO) provides 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.
- The Methane Finance Working Group aims to drive capital toward methane abatement by integrating methane performance into debt structuring. In 2025, the group published voluntary guidance for the issuance of methane-related finance instruments, including use-of-proceeds bonds and key performance indicators-linked instruments.

SEPOC acts on the UNEP's Methane Alert and Response System

UNEP launched the MARS initiative in 2022 to mobilise methane emissions reductions. MARS is a global satellite detection and notification system, managed by IMEO, that provides actionable data on very large methane emissions around the world. It alerts companies that are members of UNEP's OGMP 2.0 and country focal points of leak detections under their administration.

In September 2024, MARS detected a leak coming from a well in Yemen's Kamil Field. Analysis of historical satellite data indicated it was ongoing since at least January 2022 and releasing an estimated 19 000 tonnes of methane per year. MARS notified Yemen's national oil and gas company, SAFER Exploration and Production Operations Company (SEPOC), which is responsible for the asset and the government-nominated focal point for MARS. In response, SEPOC investigated the well and found that the leak was caused by a deep casing failure. The NOC attempted to repair the well, but satellite images indicated the repair was not successful. SEPOC then decided to shut down the well indefinitely on 13 April 2025. That same day, IMEO confirmed via imagery from multiple satellites that no further emissions were detected.

Another large source of methane emissions was detected in Yemen between January and May 2025 in Al-Shura, where an upstream production facility was located. SEPOC found that the emissions were due to a restriction at the tip of the pilot gas line, which prevented the flare from properly lighting and led to methane being sporadically vented into the atmosphere. The NOC increased the pilot gas rate and pressure to restore the flare function and plans to extend the pilot line to prevent future obstructions. IMEO analysed satellite images in May and confirmed that no further emissions were detected at the site.

Acknowledgements, contributors and credits

This report was prepared by the World Energy Outlook team in co-operation with the Office of Legal Counsel under the guidance of Tim Gould, Chief Energy Economist, and Christophe McGlade, Head of the Energy Supply Unit. The lead author was Tomás de Oliveira Bredariol. Félix Gagnon, Sadhika Gulati, Courtney Turich, K.C. Michaels, Natalie StClair and Maria Elena Hernandez Sanchez provided valuable inputs.

Thanks go to the IEA Communications and Digital Office (CDO), particularly to Clara Vallois, Liv Gaunt and Astrid Dumond.

Valuable comments and feedback were received from external experts, including from Jonathan Stern (Oxford Institute for Energy Studies), Justine Roure (the Oil and Gas Climate Initiative), Sara Castellanos (Ecopetrol), Sara Lopez (Petroecuador), the Clean Air Task Force, the Environmental Defense Fund and the World Bank's Global Flaring & Methane Reduction team.

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Typeset in France by IEA - November 2025
Cover design: IEA
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