WHITE PAPER

Six Steps for Oil and Gas Companies to Achieve Near-Zero Methane Emissions

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Executive summary

Situation: Methane emissions from oil and gas (O&G) operations need to decline by more than 75%, from 82 Mt CH4 to 17.3 Mt CH4 (2.3 to 0.5Gt of CO2e), by 2030 to stay within a 1.5C global temperature rise. Methane abatement is among the most viable decarbonization levers available to the industry today, and some companies are already approaching near zero methane emissions.

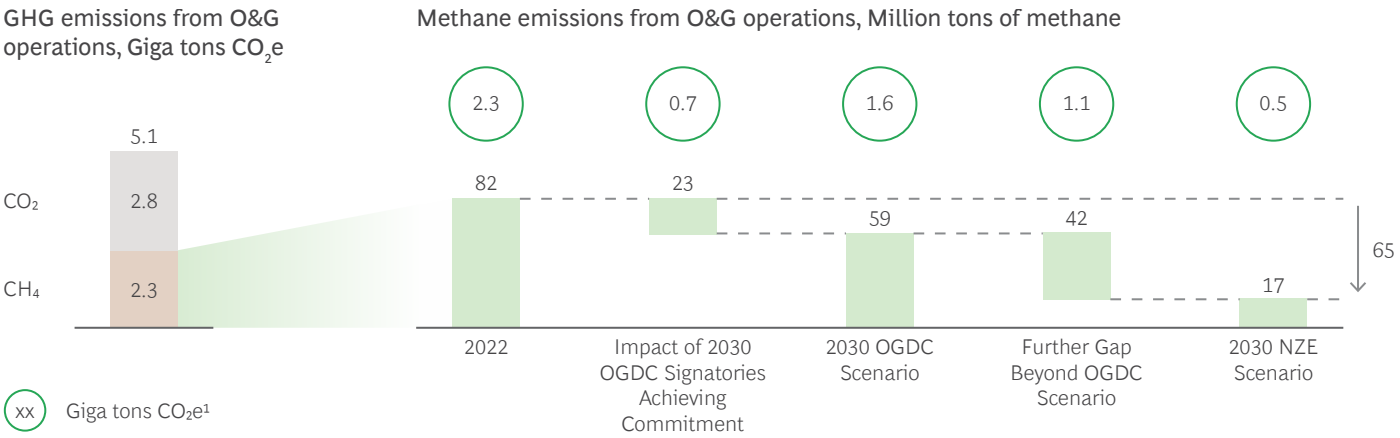
What is changing: More than 50 O&G companies have committed to near-zero methane emissions by 2030. Achieving this commitment could cut methane emissions by up to 23 Mt CH4 (0.7 Gt CO2e), helping to reach the industry's 2030 milestone (Exhibit 1). Some key jurisdictions are introducing new or strengthening existing policies and regulation, including new measurement, reporting and verification requirements, penalties, and funds to incentivize methane emissions abatement. Methane's global warming potential (GWP) index value is likely to further increase, as are measurement and public scrutiny. Collectively, these shifts are forcing urgency for action.

So what: These changes have the potential to significantly increase O&G companies' financial liabilities. They pose new threats to the credibility and viability of gas as a transition fuel, and to near-zero methane emissions products and services such as blue hydrogen and direct air capture. There is also the very real risk of being cut off from access to markets. Meanwhile, they also create "carbon out, cost out" and new revenue opportunities for those able to demonstrate improved performance. More fundamentally, the industry urgently needs to accelerate its methane emissions reduction – the pace of methane abatement is too slow; potential costs of inaction are too high; and the 42 Mt CH4 (1.1 Gt CO2e) gap remaining even after the 50+ commitments noted above is far too large.

How to get started and accelerate abatement: BCG's experience based on extensive client work across geographies and asset classes indicates that regardless of its starting point and context, any company can shape a realistic and effective pathway towards near-zero methane emissions operations. Companies can get started and accelerate progress at the right cost by following six steps: set your aspiration; develop a practical emissions baseline; deploy a solution to integrate across data, actions and reporting; secure funds for the journey; measure progress and get recognition; kick-off abatement now; and transform for near-zero methane emissions operations.

However, corporate efforts alone won't solve the issue: To cut methane emissions this fast will also require supportive policy and regulation in the highest emitting jurisdictions; rapid supply chain evolution for practical detection, measurement and abatement; and improved collaboration, awareness and leadership.

Exhibit 1 - Methane emissions from O&G operations need to decline 65 Mt CH4 (1.8Gt) in the next 5 years



1. Global warming potential of 28
Source: IEA, Rystad Energy, BCG O&G Decarbonization

> **These changes have the potential to significantly increase O&G companies' financial liabilities ... There is also the very real risk of being cut off from access to markets. Meanwhile, they also create "carbon out, cost out" and new revenue opportunities ...**

Situation overview: the urgent need to cut methane emissions

According to the IEA's Net Zero by 2050 Roadmap and our own analysis, methane emissions from O&G operations need to decline by more than 75%, from 82 to 17 Mt CH4 (2.3 to 0.5Gt CO2e), by 2030 to stay within the +1.5C global temperature target. Methane emissions contribute ~45% of total GHG emissions from O&G operations (2.3 out of 5.1Gt CO2e) and ~60% of total methane emissions from the energy industry.

Fortunately, methane abatement is among the most viable decarbonization levers available today, alongside flaring reduction and energy efficiency. According to the IEA, ~75% of O&G methane emissions can be abated with solutions that are already available – and up to 80% of these at zero net cost (at 2022 gas prices, considering the gas saved). In fact, estimates suggest that it would require only ~$100B between now and 2030 to fully abate all methane emissions in the O&G sector

For an offshore platform emitting 4kt CH4 (110kt CO2e), the capex needed to achieve near-zero methane emissions can be approximately $10M to $15M, depending on facility design, conditions, and company practices. Compare this relatively modest cost to the ~$150+M capex required for an offshore power-from-shore electrification project, or the ~$250+M capex for an onshore post-combustion CCS project.

A few O&G companies are already near to zero in their methane emissions, or making bold moves in that direction. These leaders are setting the precedent for what the O&G industry needs to do. In 2022, Oil & Gas Climate Initiative (OGCI) members reported an aggregate upstream operated methane intensity (methane emissions volume as a percentage of gas produced and marketed) of 0.15%, 10 times lower than the global industry average. The largest natural gas producer in USA has completed a full-scale program replacing over 9,000 natural gas-powered pneumatic devices for a relatively low cost of $30 million. This reduced methane emissions intensity by ~70% and abated over 12 ktCH4 (300ktCO2e) of absolute emissions. The company's methane emissions intensity is now below 0.05%, earning an A grade certification for methane emissions from MiQ.

What is changing: increasing industry will and support as well as government and public pressure

More than 50 O&G companies have committed to near-zero methane emissions by 2030 and meeting this commitment could cut methane emissions by at least 23 Mt CH4 (0.7 Gt CO2e), helping close the gap to our 2030 milestone

More than 50 O&G companies, representing over 40% of global oil and 30% of global gas production, have joined the Oil & Gas Decarbonization Charter (OGDC), committing to near-zero methane emissions by 2030. National oil companies (NOCs) constitute over 60 percent of signatories. Meeting this commitment could cut methane emissions by at least 23 Mt CH4 (0.7Gt CO2e) based on estimates by IEA's Methane Tracker, shrinking the gap to the industry's 2030 milestone. Based on industry and our direct experience, these companies' reported methane emissions are likely to increase when measurements start. Before the OGDC, 24 O&G producers had joined OGCI's Aiming for Zero Methane Emissions Initiative, committing to near-zero methane emissions from operated assets by 2030. Meanwhile, more than 100 companies representing 35% of O&G production have joined the UN's Oil & Gas Methane Partnership 2.0 (OGMP 2.0), committing to reporting annually their methane emissions using the OGMP 2.0 measurement-based reporting framework. This year, many of these companies could achieve Gold Standard for their operated assets. Finally, asset certification by third parties, such as MiQ, is rapidly emerging as the performance standard.

Key countries are strengthening policies and regulation including new measurement, reporting and verification requirements, penalties and funds to incentivize emissions abatement

Some key countries and jurisdictions are strengthening their methane abatement policies and regulation. We are seeing more stringent reporting requirements, new penalties, and funds allocated to incentivize emissions abatement. Consider four examples: the USA, the EU, Australia, and Japan/South Korea.

The USA has introduced new policy, regulation, reporting requirements, penalties and funds. In 2021, the Environmental Protection Agency (EPA) proposed new regulation to monitor and report on methane emissions abatement in O&G operations. In 2022, the US Senate approved the Inflation Reduction Act (IRA) which introduces a charge on methane emitted by O&G companies, starting at $900 per metric ton of methane in 2024 and increasing to $1,500 from 2026 onwards. The country also signed into law the Infrastructure Investment and Jobs Act, which aims to inject $1.5B into methane emissions abatement in O&G operations. Finally, SEC issued a rule requiring public companies to provide climate-related disclosures, including of scopes 1 and 2 emissions, in their annual reports and statements. SEC's rule broadens the number of facilities beyond EPA's scope.

The EU's 'Fit for 55' legislation introduces new requirements and bans, and doubles the decline rate of carbon credits. Beginning in 2024, O&G companies must measure, monitor,

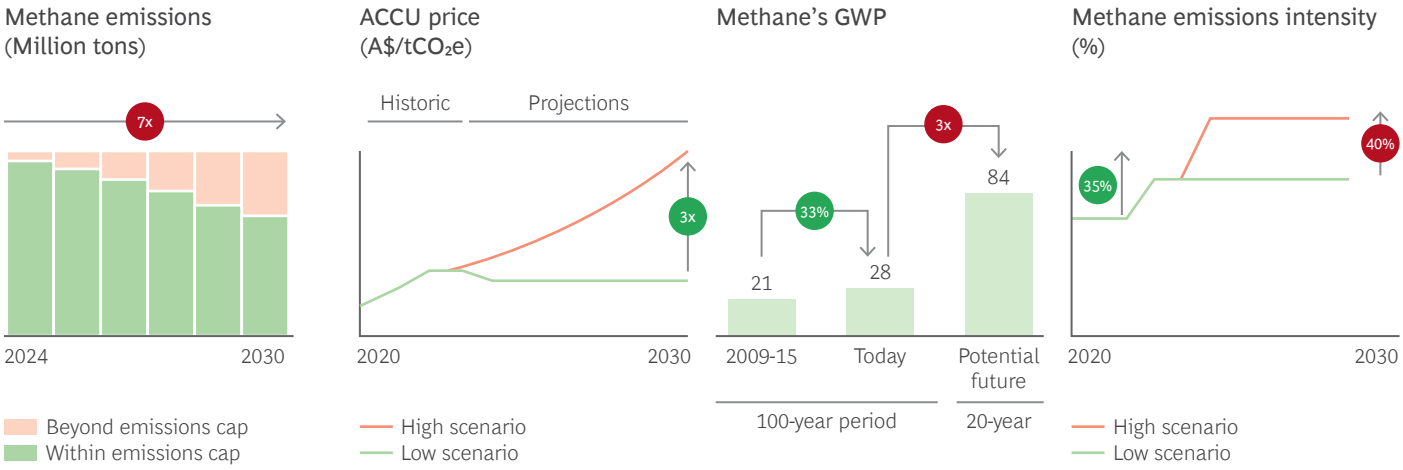
report and verify methane emissions. By 2027, there is a ban on routine flaring and venting. As soon as the European Parliament and Council approve it, the emissions cap for each O&G facility will decline at 4.2% p.a. vs. 2.2% p.a. – in line with a net zero goal by 2040. This change intensifies the risk of EU ETS prices doubling by 2040. Finally, as of January 2027, new import contracts for oil, gas and coal can be only concluded if the same monitoring, reporting and verification obligations are applied by exporters as for EU producers.

Australia has revised its emissions reduction policy called the Safeguard Mechanism, and introduced new regulation, reporting requirements, and a ~5% p.a. decline rate of carbon credits. Beginning in July 2023, the emissions cap for each Safeguard facility, previously static, will decline at ~5% p.a. until 2030 – in line with a 34% emissions reduction target by 2030. If a facility's emissions remain below its cap, it can generate Safeguard Mechanism credits. However, if emissions exceed its cap, it will need to acquire and retire credits. This change intensifies the risk of Australian Carbon Credit Units' prices tripling by 2030, creating a potential liability of up to $1.2B p.a. for Australia's LNG industry (Exhibit 2).

Japan and South Korea launched the Coalition for LNG Emissions Abatement toward Net-zero ("CLEAN") in July 2023. CLEAN is an initiative taken by the two largest LNG buyers (JERA - largest power producer in Japan, and KOGAS - largest natural gas provider in South Korea), together with LNG producers, to reduce methane emissions in the LNG value chain.

Exhibit 2 - O&G companies' financial liabilities associated with methane emissions could increase drastically to 2030[2]

AUSTRALIA CASE STUDY



7x

Increase in methane emissions exposed to carbon credits market

3x

Potential increase in price of Australian Credit Units (ACCUs)

3x

Potential increase in methane's Global Warming Potential (GWP)

40%

Potential increase in methane emissions intensity

5%

Annual decline in methane emissions cap for each Safeguard facility

2x

Actual increase in price of ACCUs between 2020 and 2023

33%

Actual increase in methane's GWP between 2016 and 2020

35%

Actual increase in methane emissions intensity in Australia mines

2. Source: Clean Energy Regulator; BCG Decarbonization Team

Methane's global warming potential could further increase and potentially triple, if IPCC and governments were to change methodology

Methane has shown an 84x greater warming effect than carbon dioxide over a 20-year period (and 28x greater effect over a 100-year period). IPCC's Assessment Report shows that the global warming potential (GWP) index value for methane has increased 33% since 2015, as its effects on the earth's temperatures are increasingly acknowledged. The Environmental Defense Fund's recent research also demonstrates that the standard 100-year-timescale calculation undervalues the role of methane-dominated sectors in warming by half. As such, as more data comes in, methane's GWP could further increase – and potentially triple, if IPCC and governments were to change their methodology. Current methodology uses a GWP to convert methane to CO2 equivalent units, with the GWP extending out over the next 100 years. If regulators and agencies, mostly at the country level, choose to shorten the assumed GWP to a 20 year view, then the calculated CO2-e that methane contributes would rise.

Measurement and public scrutiny are increasing

At COP28, the International Methane Emissions Observatory (IMEO) launched its Methane Alert and Response System (MARS), the first global system that connects satellite-detected methane emissions with a trackable notification process. During its pilot phase, from January to December 2023, MARS detected over 1,000 energy sector methane plumes globally, linked 400 of the plumes to specific facilities, and notified six national governments and relevant OGMP 2.0 member companies of 127 events.

In March 2024, the Environmental Defense Fund launched MethaneSAT, with the goal to determine the magnitude of methane emissions, attribute the emissions back to the emitters, and track progress toward reducing methane emissions over time. MethaneSAT, a satellite, will orbit the Earth 15 times a day, monitoring emissions from oil and gas operations. It will regularly monitor 50 major regions accounting for more than 80% of global oil and gas production. MethaneSAT data will be public and free of charge.

These changes have the potential to significantly increase O&G companies' financial liabilities and pose new threats to the credibility and viability of gas as a transition fuel, and to near-zero methane emissions products and services such as blue hydrogen and direct air capture. They also create "carbon out, cost out" and new revenue opportunities for those able to demonstrate improved performance. More fundamentally, the industry urgently needs to accelerate its methane emissions reduction – the pace of methane abatement is too slow; potential costs of inaction are too high; and the 42 Mt CH4 (1.1 Gt CO2e) gap remaining even after the 50+ commitments noted above is far too large.

How to get started and accelerate abatement: six steps

Over the past five years, BCG has worked with O&G companies across jurisdictions and asset classes, spanning the end to end process for methane emissions abatement – from creating an emissions baseline and the most cost effective measurement strategy to preparing their assets for third party certification. We also collaborate with governments to develop their policies and regulation, and with technology companies and investors to adapt their portfolios to a rapidly evolving context. Our experience indicates that regardless of starting point and context, any company can shape a realistic and effective pathway towards near-zero methane emissions operations. The following six steps will help companies get started and accelerate progress at the right cost (Exhibit 3).

Exhibit 3 - Six steps for companies to accelerate methane abatement at the right cost[3]

Set your aspiration

Develop a practical emissions baseline

Deploy a solution to integrate across data, actions, and reporting

Secure funds for the journey

Measure progress and get recognition

Kick-off abatement now and transform for near-zero methane emissions operations

Only possible with...
Supportive policy and regulation; a fit for purpose supply chain; improved collaboration, awareness and leadership

Step 1: Set your aspiration

There are different ways to frame this aspiration, as well as varying levels of ambition. Possible examples include: more efficient regulatory compliance and reporting; a corporate target to achieve near-zero methane operations (0.2% intensity or less) by 2030; joining OGMP 2.0 or

3. Source: BCG O&G Decarbonization Team

earning third party asset certification to facilitate selling near-zero methane emissions products. At a minimum, the target should comply with both local requirements and your corporate strategy. The target informs standards to adhere to and pace of measurement and abatement. With more than 50 O&G companies across multiple policy and regulatory regimes, including 30 NOCs, committing to near-zero methane emissions operations by 2030, this is quickly emerging as the industry's 'expected goal'. Moreover, some O&G companies have already demonstrated that it is achievable. In jurisdictions with a carbon credits market, a few companies have started to explore the business of providing near-zero methane emissions products. While currently less common, this approach will gain traction as companies mature their decarbonization and energy transition strategy, and seek ways to reap full benefit from emerging government incentives and funds, and gas buyers become more focused on methane emissions associated with their energy supplies.

Don't: Delay commitment until you have completed your measurement. There is nothing like a public commitment to mobilize people including employees, investors and customers. Given the existing tools and precedents, there is no good reason to be timid or slow in setting an aspiration.

Step 2: Develop a practical emissions baseline

Select a pilot asset, representative of your portfolio, and inventory its largest emitting pieces of equipment and practices, using a risk-based approach. Then design and conduct a practical detection and measurement campaign at a statistically relevant sample of assets. This can be challenging because actual measured methane emissions can be much higher than estimates using emissions factors, and there is no single source measurement solution. Fortunately, emissions are often concentrated in a handful of the largest sources such as pneumatic controllers, well venting, storage tanks, open ended lines, compressors, pressure relief valves, and unlit and inefficient flares. Venting can be a significant source of emissions where there is no flaring, and pipelines' fugitive emissions can account for more than 80% of the total operational emissions. To ensure the most effective detection and measurement, deploy a mix of site level (e.g., satellites, drones, planes, vehicles) and source level (e.g., handheld sensors, fixed sensors) tools, reflecting desired granularity and frequency. You will need to weigh the pros and cons of each to determine the optimal approach for your specific assets. There are several vendor categories (hardware, software, service providers) for each of these technology solutions, and metrics for their evaluation and comparison (e.g., capability coverage, price, service-level). Third party certification programs can be helpful as they have pre-determined the ideal combination of measurement technologies. The team leading this effort should be empowered to decide on technologies, vendors, and deployment.

Don't: Spend months and lots of resources building a comprehensive baseline, before kicking-off physical abatement actions. You will need to be practical and agile and bring together enough expertise across various rapidly evolving technologies and suppliers, pieces of equipment (tanks, compressors, valves, flares), asset classes (onshore and offshore; wells, plants and pipelines), standards, and requirements – and assess pros and cons within weeks.

Step 3: Deploy a solution to integrate across data, actions, and reporting

Generating insights from complex emissions and operational data requires a solution that can integrate across data sets, actions, standards, and reporting methods. It is important to develop a scalable, robust interface that can ingest, integrate, and reconcile data, and transform it into information that feeds operational and structural choices, and accurate reporting. Several challenges are common during this stage: site and equipment data is often incomplete or non-existent; there is no single, streamlined interface to display and action data; voluntary standards and more stringent regulation continue to evolve; and standards can differ and conflict. At a minimum, you need a mechanism that allows you to scale up your pilot approach in an efficient way. This includes being able to: capture information from several inconsistent data formats across a mix of detection technologies, internal IT and operational systems; aggregate and contextualize what you measure in order to pinpoint the source of a leak; differentiate actual leak events from operational events or false detects; trigger remedial action by field operators; feed into reports; monitor progress against your goal; and calculate the value of your abatement program. Note that reports may be jurisdiction-specific, or related to group

commitments like OGMP 2.0. Some companies have gone further, developing digital solutions that can also identify the root cause of the methane release and, by integrating operational data, suggest both immediate repair actions and broader structural changes to operations, maintenance, or equipment designs. Finally, some ambitious O&G players are going all-in and designing solutions that enable third party asset-level certification to participate in carbon credit markets and sale of near zero methane emissions products.

Don't: Just buy a methane abatement software package. To be effective, the solution must go beyond digital capabilities. It requires integrating digital, emissions, operational, organizational, reporting, and carbon credit market intelligence to underpin tangible action that prevents methane release.

Step 4: Secure funds for the journey

You need upfront investment to develop and fund the methane emissions abatement journey. Many O&G companies have been able to build an effective capital deployment program, as they generally would to operationalize a strategic priority. Many initiatives can be implemented at no net cost, and policy incentives can drastically increase the attractiveness of a business case. However, it may be challenging for O&G companies in jurisdictions without a supportive policy and regulatory framework to fund their own methane abatement at the right pace. What we have learned is countries and companies are often willing to contribute in-kind and collaborate to bring down costs. For example, Canada lent Colombia detection and measurement equipment for their first campaign. One IOC recently lent its cameras to the NOC with assets nearby. Onshore companies in the USA are coordinating their campaigns and sharing equipment. There are several international initiatives and organisations that can provide external funding and blended finance. For example, the World Bank recently launched the Global Flaring and Methane Reduction (GFMR) Partnership. The GFMR will provide more than $250 million and mobilize billions from the private sector to help developing countries cut carbon dioxide and methane emissions generated by the oil and gas industry. Methane abatement-specific funds also exist and continue to emerge. For example, ICA-Finance is an investment company that partners with NOCs and independent oil and gas companies on emissions reduction projects such as LDAR programs, flared gas recovery, and vapor gas recovery units.

Don't: Wait to get started only when you have the big money approved by the corporation. Speak up quickly, and explore the possibilities – people out there have the mission to invest in these types of projects.

Step 5: Measure progress and get recognition

Be sure to reap the benefits that accrue with measurable methane abatement progress. Again, at a minimum you will need to comply with reporting requirements of your jurisdiction and demonstrate progress against your own target, be it OGDC's near zero methane emissions by 2030 or OGMP 2.0. Traditional bottom-up estimation now falls short for reporting purposes, with the introduction of new laws that mandate direct measurement of emissions. Reconciliation of bottom-up and top-down emissions data becomes crucial, requiring standardized rules and methodologies. This creates the urgent need for a digital solution to centralize data inputs, facilitate reconciliation, and ensure standardized reporting, data traceability, transparency. Note that if you are in the business of near-zero methane emissions products, you will also need third-party certification from a company like MiQ. Beyond required reporting, measuring progress will be at the heart of the transformation effort that drives your abatement program at pace. Think of visual management in plants and executive dashboards that bring both awareness and praise.

Don't: Leave measurement until the end. Navigating policy, regulation, reporting, and certification requirements can be complex. The effort calls for expertise and strategic thinking to build practical, effective solutions so begin thinking ahead to measurement during the early planning stages of your journey.

Step 6: Kick off abatement now and transform for near-zero methane emissions operations

Sustained progress requires a structured approach run by a central emissions control center that manages the methane abatement ecosystem, including: day-to-day leak tracking and repairs; reporting and certifications; audit coordination and facilitation; and an internal knowledge database of practices and training for field teams. Use all the digital emissions-related data by equipment, facility or site to identify the structural changes needed in the operations, and make decisions on capital allocation (MACC based, target emissions reduction). Ultimately, the whole company will need to adapt if you are to reach and maintain near-zero methane, from accountabilities and talent to workflows and culture. Start by getting people excited about this journey. Launch initial projects that can generate quick wins, while following a structured program to embed methane abatement across the organization. Quick wins may include replacing wet with dry seals and high bleed with low bleed valves, repairing vapor recovery units and flares, or modifying a well's start-up routine to minimize venting. But as important as the immediate results are, you will need to run the program until it is engrained in the company's DNA and becomes business as usual. This kind of long-term success includes four ingredients: accountability, talent, workflows and culture. See The New Decarbonization Paradigm for Oil and Gas.

Don't: Implement company-wide transformation too late, partially, or not at all. Clear accountability comes first, followed by a structured program that increases employee awareness and adapts the organizational context to incentivize no methane releases.

The need for O&G companies to decarbonize their operations has never been more urgent. And methane abatement offers substantial emissions reduction for manageable cost, leveraging existing tools and technologies. With leadership from the 50+ OGDC signatories, more companies are achieving near-zero methane emissions – while government and societal expectations are placing increasing pressure on slower movers. More and faster methane abatement is within the reach of any company, and the six steps described here provide your roadmap. However, company-specific efforts alone won't solve the problem. To cut methane emissions fast will also require systemic changes. These include: supportive policies and regulation in the highest-emitting jurisdictions; rapid supply chain evolution for practical detection, measurement and abatement; and improved collaboration, awareness and leadership.

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