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CLIMATE GROUP

Reducing methane emissions from oil and gas operations

State and regional solutions

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Contents

Executive summary

One of the essential steps for reducing global warming in the near term is reducing the emission of short-lived climate pollutants (SLCPs)[1]. Only by quickly reducing methane and other SLCPs, along with fast reductions of carbon dioxide, can we have a chance of keeping global warming to 1.5°C.

Over the next 20 years, methane is more than 80 times more potent as a climate pollutant than carbon dioxide (CO_2). Reducing methane emissions also yields immediate economic and health benefits.

While methane emissions come from a variety of sources, including agriculture and waste decomposition, methane emissions from the oil and gas sector present both a growing risk as well as an opportunity for immediate action. There is converging agreement in industry and around the world that reducing methane emissions from oil and gas operations represents one of the most viable and immediately implementable climate strategies available to us.

There are a range of cost-effective solutions readily available to reduce methane emissions from oil and gas operations – including increased regular maintenance of equipment, upgrades to new technologies, and leak detection and repair – and in many cases these can be implemented at no net cost. Despite this, implementation of these solutions is only required in a small number of jurisdictions, and methane emissions consequently continue to rise. Governments at all levels, national, subnational, and local, need to act so that mitigation solutions are implemented quickly and on a wide scale, ensuring climate goals are met and health and economic benefits are realized.

Through the peer-learning forums in the Under2 Coalition Methane Project, state and regional governments in Canada and the United States (US) have been sharing their experiences in tracking and reducing methane emissions in the oil and gas sector and using the Under2 Coalition platform to showcase climate leadership. This report draws on insights from the project and other expertise to present an overview of state and regional government action in Canada and the United States to reduce methane emissions from oil and gas. In particular, it identifies a key set of actions governments can take to reduce emissions, provides leading state and regional government policy examples, and highlights elements of best practice.

1 Short-lived climate pollutants include methane, black carbon, tropospheric ozone and hydrofluorocarbons. They are referred to as "short-lived" because they do not persist in the atmosphere for long, although they have a dramatic effect on global surface temperatures so long as they are there. As such, curbing the emissions of these pollutants can have immediate mitigative effect on climate change.

Leading state and regional governments are paving the way for subnational action

Governments such as British Columbia in Canada, and Colorado and California in the United States, are leading the way with innovative policies targeting methane emissions from oil and gas. The policy examples and insights from these governments and others throughout this report provide a basis for understanding the role that subnational jurisdictions can play to set targets, develop policies, and implement programs to achieve methane emissions reductions. Jurisdictions looking to take action can look to the examples set by states and regions for guidance in developing and implementing a methane reduction strategy.

There is an opportunity for many more governments to increase action and maximize benefits

A large number of states and regions are taking only minimal and indirect action on methane. If more jurisdictions implement methane mitigation policies, we can scale action at the pace needed to reduce emissions and maximize benefits. Reducing oil and gas methane emissions benefits the climate, improves local air quality, promotes greater resource efficiency, and builds momentum needed to address other major sources of methane, such as agriculture and landfills.

Leading governments can strengthen existing regulations

Governments with existing best practice regulations can increase their effectiveness through critical analysis of their regulations, evaluation of new science and data, and addressing any gaps in their regulations as well as connecting with interregional forums to access additional resources and expertise.

Implementing regulations is one of the most effective ways that governments can bring about swift emissions reductions

Regulations that include mandatory standards and enforcement provisions for technology are a highly effective method for achieving methane emissions reductions and climate change mitigation overall because they promote the adoption of cost-effective practices to reduce venting and leaks.

Governments can take advantage of new technology developments

New technologies and methodologies for detecting and measuring methane emissions are constantly emerging. Governments with a regulatory framework in place that can take advantage of the latest technologies to quickly identify and reduce emissions will maximize the benefits of these reductions and achieve their targets.

Regulations can be complemented by a range of policies and initiatives

Beyond direct regulations, methane mitigation plans also benefit from creative policymaking that can achieve multiple goals and co-benefits, such as local capacity-building and the development of new technology. These approaches include investments in research and innovation programs, advocacy and stakeholder engagement, and technical training.

Collective action by state and regional governments can help drive progress

There is an untapped opportunity to maximize the impact of methane emissions reduction actions through collective subnational action. State and regional governments can make faster progress by working together to develop policies that are cutting-edge, complement existing policies at both the national and local levels, and fill in gaps in action.

Governments can adopt the following actions to drive reductions in methane emissions from oil and gas

The following page outlines actions that can act as a framework for developing an effective methane mitigation strategy or improving existing strategies.

To reap the benefits of reducing methane emissions, it is critical that governments implement solutions fast. There are opportunities for governments to act now and see immediate results and these actions should be prioritized. Other actions may take longer to fully implement but will contribute to a comprehensive strategy. For example, leak detection and repair (LDAR) or requirements to replace outdated equipment are an effective way to cut emissions quickly.

There are a range of solutions available to reduce methane emissions from oil and gas - many of these are cost-effective for both companies and for the economy overall.

Key actions governments can take to reduce methane emissions from oil and gas

Action	Why is it important?	What does best practice look like?
Create an inventory of oil and gas facilities and equipment	**Facilitates the implementation of regulations by identifying the full scope of existing technologies, and opportunities for introducing cleaner technologies.**	• Identification of all oil and gas facilities/ operations and equipment and components at those facilities/operations. • Includes information on equipment types, locations, oil/gas ratios, and production and flow/use rates at facilities. • Identification of ideal technology upgrades and changeouts to maximize emissions reductions.
Require regular/ ongoing measurement of methane emissions and develop an emissions baseline	**Allows regulators to track progress towards reduction goals and promotes transparency.** **Allows for identification of major emissions sources.**	• Quantification of methane emissions from equipment/components at all facilities. • Specification of primary measurement methods and technology with flexibility to include the best available measurement technology. • Where estimations are calculated, current data and statistically representative measurement of significant sources are used. • Regular reviews and updates to reflect actual reductions and technological developments.
Set requirements for leak detection and repair (LDAR)	**Identifies leaks and leads to immediate emissions reductions by repairing unintentional oil and gas equipment leaks that can occur at any time in the system.**	• Frequent inspections (e.g., quarterly or monthly) of facilities and equipment using instruments such as optical gas imaging and/or continuous monitoring of sources with the potential to leak. • Identified leaks are repaired within a specified timeframe. • Allowance of a pathway to compliance for robust alternative methods with equivalent efficacies. • Reduction over time of key source emission points.
Set technology or performance standards	**Provides clear parameters and guidance for the industry to adopt technology options for components, equipment and processes in oil and gas operations.**	• Standards are applied to all major methane emissions sources. • Reporting and enforcement provisions to ensure compliance. • Encourage adoption of innovative and emerging technologies. • Requirements for oil and gas operators to use reduced emissions completions (RECs) during well completions and well workovers. • Aspects such as vapor collection and control requirements, venting and flaring restrictions, equipment retrofit and replacement requirements, and monitoring and management plans are included.
Require comprehensive reporting and record keeping	**Promotes transparency by tracking compliance with regulations and improves emissions mitigation by providing information about when and where problems in the system often occur.**	• Requirements for regular reporting for operators to demonstrate compliance with each of the mandatory methane reduction measures. • Specifies the amount of time that detailed records should be kept by operators.
Set a jurisdiction-wide methane emissions reduction target	**Supports effective action by providing a mandate for policy development and providing industry with a target for long-term direction of change.**	• Ambitious targets that are technologically and economically feasible and are structured as a percentage reduction based on a current or historical baseline, as a total mass-based emission level, or against an absolute target, such as net zero. • The law setting the target directs jurisdiction regulators to adopt rules or regulations to meet the goal, with regulatory flexibility and enforcement authority.
Participate in information and technology sharing forums	**Enables governments to stay up to date with the latest developments, share policy solutions, and benefit from the experiences of others.**	• Development of relationships with other governments to learn about each other's experiences and drive collective action. • Knowledge exchange of progress and barriers, and connecting with technical experts to craft solutions.

Why governments should take action on methane from oil and gas

Globally, levels of methane emissions across all sources hit a record high in 2017, the most recent year for which a full budget is available, and atmospheric concentrations of methane continued to increase in 2019 and 2020. The share of methane emissions from the oil and gas sector has been rapidly accelerating and is expected to continue increasing with the growing demand for natural gas.

About 80% of recent growth in methane pollution in North America comes from the fossil fuel sector and recent studies have shown that the problem of methane emissions in the US is approximately 60% higher than previously thought. While agriculture and landfills are also significant sources of methane emissions, the availability of cost-effective solutions for the oil and gas sector presents a unique opportunity for fast action.[2]

Because the climate warming impact of methane is more than 80 times that of carbon dioxide over a 20-year timespan, scaling action quickly to reduce emissions is crucial for avoiding near-term warming. Projected oil and gas system pollution over the next three decades could result in as much near-term warming as 2,000 coal plants – pollution that can be avoided at very low cost.

This underscores the need to focus on reducing methane from the oil and gas sector and implement solutions that are not only readily available, but also yield economic, health, and climate benefits for all. The 2020s—the Climate Decade—are crucial for reducing short-lived climate pollutants, such as methane, and avoiding the worst impacts of global temperature rises. The Global Methane Alliance is calling for a 60-75% global reduction in methane by 2030.

Policy action and regulations at the national and subnational levels are critical for achieving these goals and state and regional governments can contribute to the solution by responding quickly to the opportunity to tackle methane emissions. They are uniquely positioned to implement fast, effective, and tailored responses that address the needs of their communities. Subnational action can also serve as the testing ground for innovative approaches that can then be scaled up and replicated by other governments. Furthermore, state and regional governments are eager to learn from each other's experiences and some are already paving the way and can support those looking to do more.

80%

of recent growth in methane pollution in North America comes from the fossil fuel sector

2 The agriculture, energy, and waste sectors are responsible for approximately 42%, 39%, and 20% of anthropogenic methane emissions, respectively.

Cost-effective solutions are readily available. According to the IEA, 75% of methane emissions reductions can be achieved with existing technology, and around 40% of methane reductions can be achieved at no net cost, based on existing inventories. The IEA's methane tracker shows that Canada has the potential to abate 19% of its methane emissions while the US has the potential to abate 15% of its emissions, at no net cost.

Methane emissions from the oil and gas sector occur primarily from upstream operations but can occur throughout the system - from production through to end-use distribution, and from both unintentional leaks (e.g. equipment malfunction, human error) and from technology that is intentionally designed to vent methane and other gases. Jurisdictions with lower levels of oil and gas production are also indirectly responsible for methane emissions from oil and gas production in the countries from which they import gas. Moreover, the risk of super-emitters— high-emitting sources that account for a disproportionate share of methane emissions—throughout the oil and gas system highlights the need for jurisdictions to be prepared with a strategy for addressing and preventing methane emissions.

Strong regulations that limit methane emissions from the oil and gas sector, particularly those that are easily addressed, allow governments to realize the full scope of benefits of methane emission reductions, including:

- **economic** – measures to reduce methane emissions can promote the economic efficiency of the oil and natural gas system by capturing and using gas that would otherwise be vented or leaked.
- **health** – reducing methane also reduces the release of associated hazardous air pollutants, like volatile organic compounds (VOCs) and other pollutants, which have been linked to serious negative health impacts, are potentially carcinogenic and can accumulate in communities surrounding oil and gas operations.[3]
- **climate change** – reducing methane by 50% globally has the potential to mitigate global warming by 0.18°C.[4]

At the same time, leading governments can inspire innovation and support the development of more comprehensive climate solutions that more quickly and more effectively reduce emissions. By working together, states and regions can develop policies that are cutting-edge, complement existing policies at both the national and local levels, and fill in gaps in action.

Jurisdictional powers of state and regional governments in Canada and the United States

State and regional governments can take direct action to reduce emissions in their regions by implementing regulations and through indirect action that incentivizes other stakeholders to act, including the private sector and the federal government. In fact, in both Canada and the United States, these subnational governments are the primary energy regulators.

The scope of actions available to states and regions is often shaped by the federal context, which can facilitate action at the subnational level by removing barriers to the implementation of more ambitious targets. This section provides background on the jurisdictional powers held by states and regions in Canada and the United States.

3 In addition to methane emissions, oil and gas operations also release volatile organic compounds (VOCs) and other pollutants such as benzene, formaldehyde and acetaldehyde. VOCs are recognized as hazardous air pollutants, are potentially carcinogenic and are known to cause other serious negative health impacts. VOCs are also precursors to the formation of ground-level ozone, a dangerous air pollutant that causes harm to the respiratory system.

4 Methane is also a precursor to tropospheric ozone, which is itself a short-lived climate pollutant and directly related to negative impacts on human health and agriculture.

By working together, states and regions can develop policies that are cutting-edge, complement existing policies at both the national and local levels, and fill in gaps in action.

The Canadian context

The federal government has the authority to regulate methane emissions under the Canadian Environmental Protection Act, 1999 (CEPA). The provinces can introduce their own regulations if they achieve equivalent emissions reductions to the federal ones.

Canada's three major oil and gas provinces — Alberta, Saskatchewan and British Columbia — have all written their own rules and signed equivalency agreements with the federal government in 2020. This means that the provincial rules apply in these three provinces, while the federal rules are in place across the rest of Canada.

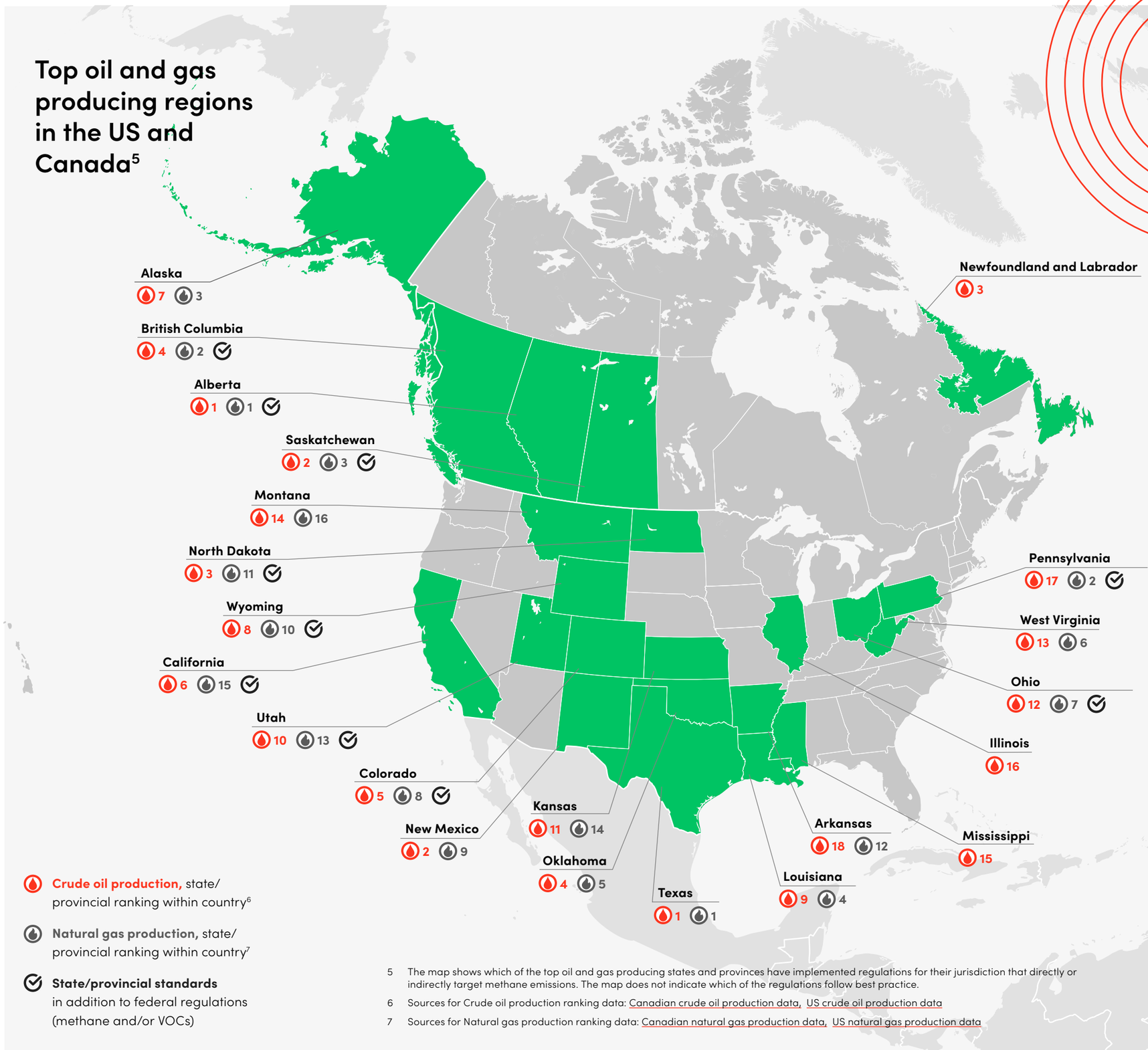
The United States context

At present, US states have full legal authority to implement standards for oil and gas methane emissions for both new and existing facilities that are at least as stringent as federal standards. Future federal regulation could create additional baseline requirements for either or both categories, which states would generally be free to supplement with more stringent standards.

In the US, the federal and state governments share jurisdiction over air emissions from stationary sources, including emissions from oil and gas operations. Under the Clean Air Act, the US Environmental Protection Agency (EPA) is responsible for setting nationwide air quality and emissions standards for stationary sources (which states implement), but states retain the authority to apply their own standards so long as they are at least as stringent as federal equivalents. This federal floor-setting authority encompasses GHG emissions.

The EPA has set regulations for upstream VOC emissions, including rules for swapping out high-emitting components, conducting reduced emissions completions (RECs) at wells, and semi-annual leak detection and repair (LDAR) inspections. However, in 2020, a ruling removed the EPA's obligation to develop methane-specific emissions guidelines for new and existing sources.

Top oil and gas producing regions in the US and Canada[5]



Crude oil production, state/provincial ranking within country[6]

Natural gas production, state/provincial ranking within country[7]

State/provincial standards in addition to federal regulations (methane and/or VOCs)

5 The map shows which of the top oil and gas producing states and provinces have implemented regulations for their jurisdiction that directly or indirectly target methane emissions. The map does not indicate which of the regulations follow best practice.

6 Sources for Crude oil production ranking data: Canadian crude oil production data, US crude oil production data

7 Sources for Natural gas production ranking data: Canadian natural gas production data, US natural gas production data

Key actions to reduce methane emissions

This section provides details on actions that governments can take to reduce methane emissions from oil and gas. It highlights state and regional government examples and compares them to federal government regulations in Canada and the United States, where relevant.

Setting of regulations underpins these actions, as regulations are one of the most effective ways that governments can bring about swift and effective change.

We have highlighted some elements of best practice, drawing on examples of leading governments and other expert advice, but these are not exhaustive.

There are a range of detailed and technical resources available that provide comprehensive information on mitigating methane emissions, including:

- **The IEA's Regulatory Roadmap and Toolkit**
- **The UNECE Best Practice Guidance**.

1 Create an inventory of oil and gas facilities and equipment

Governments should develop a comprehensive understanding of the oil and gas operations in their jurisdiction. This facilitates the implementation of regulations by identifying the full scope of existing technologies and opportunities for introducing cleaner technologies. Both Canada and the US inventory facilities at a federal level, but these inventories are not complete.

What does best practice look like?

States and regions should require oil and gas operators to report their facilities and equipment. The inventory should include equipment types, locations, oil/gas ratios, production and flow/use rates at facilities. Identification of ideal technology upgrades and changeouts to maximize emissions reductions can form part of the inventory process.

2 Require measurement of emissions and develop a baseline

Measuring and estimating methane emissions from equipment/components at facilities and operations included in the facility/operations inventory allows regulators to understand the emissions sources in their jurisdiction.

Where it is not feasible to measure all sources of leaks or venting, governments can estimate the size of emissions using representative emissions factors. Emissions factors are predictions based on placing an estimation on what identified equipment and components are presumed to emit. The most useful estimations are robust and specific, using real-time reported data and up-to-date equipment counts. Measurement and estimations data can be combined with calculation-based approaches to develop an overall emissions inventory and baseline.

There are a variety of approaches for quantifying methane emissions, and it is important to choose a method appropriate for the purpose. Having detailed measurement data, as well as jurisdictional level emissions inventories enables governments to design policies which target the most significant emissions sources, track progress towards reduction goals, and promote transparency.

What does best practice look like?

Best practice involves the quantification of methane emissions from equipment/components at all facilities, based on reported data and actual measurement of emissions. The primary measurement methods should be specified, but also maintain flexibility to include the best available measurement technology. They should require a statistically representative measurement of significant sources of methane emissions and should not rely on outdated emissions factors. Emissions inventories should be updated regularly to reflect actual reductions and technological developments.

Governments should always strive for better measurement data, but where cost of improved measurement methods are prohibitive, short-term action to reduce emissions should be prioritized over the need for perfect data.

3 Set requirements for leak detection and repair

Leak detection and repair (LDAR) refers to finding and repairing leaks and is an essential part of the solution for addressing oil and gas methane emissions.

Unintentional oil and gas equipment leaks (distinct from emissions from equipment designed with intentional venting to release pressure buildup) can occur at facilities in components such as valves, connectors and flanges, and vessel or pipe walls due to age, corrosion, wear, damage, human error, or structural/installation flaws.

Leaks can occur at any time and at any place in the system, and in some cases can constitute super-emitters - high-emitting sources that account for a disproportionate share of methane emissions. It is commonly the case that a small percentage of facilities account for a large percentage of emissions and, in many cases, actual emissions have been found to be much greater than estimated emissions. Because of the uncertainty of where and when leaks occur, particularly super-emitters, and the gaps in existing emissions data, LDAR is critical to identifying super-emitters and effectively reducing overall emissions.

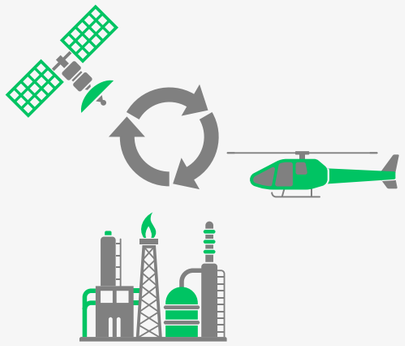
LDAR programs can be implemented immediately by both operators and regulatory agencies, as leaks can be found and repaired even before an emissions baseline has been developed. Regulations for LDAR specify aspects such as methods for finding leaks, mandatory frequencies for leak detection by equipment type, timeframes for repairing any detected leaks, and requirements for record-keeping.

What does best practice look like?

Instrument-based leak detection and repair inspections by oil and gas operators should be carried out frequently (e.g. quarterly or monthly). The inspections should be comprehensive and cover all potential sources, including component leaks, abnormal operating conditions, and excessive venting from equipment designed to vent, well sites, gas processing plants, compressor stations, and tank batteries. They should include requirements for detected leaks to be repaired.

At the same time, regulatory agencies can conduct inspections using remote-sensing technology to complement inspections done by operators and identify the highest polluting areas and facilities.

LDAR programs should be subject to public input and regulatory review and include robust alternative compliance pathways that allow for the use of emerging technologies that are as effective in reducing emissions as allowable instruments.



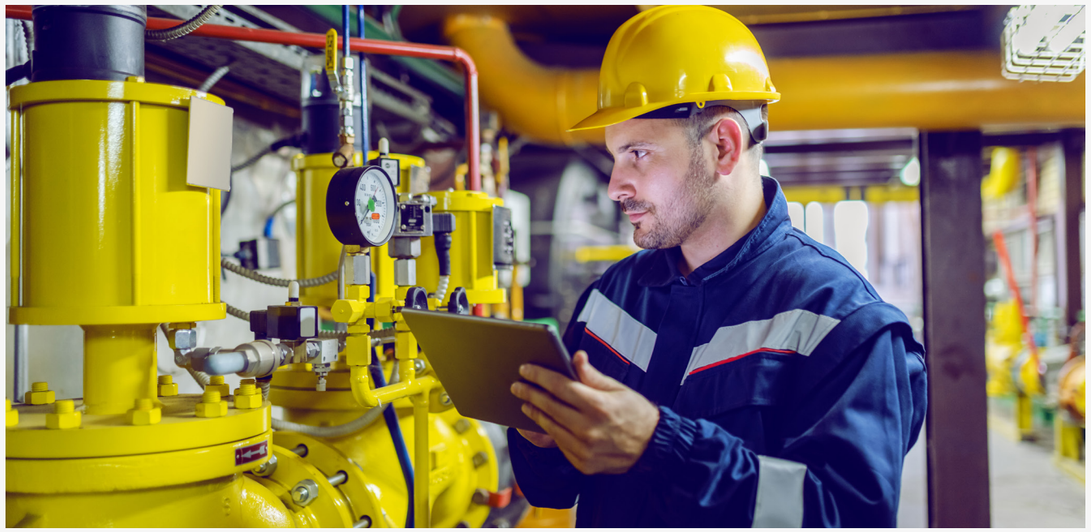
Detection and measurement technologies fall into three main categories:

- **Satellite**
- **Aerial**
- **Ground-level**

Comprehensive detection and measurement of methane emissions includes a combination of bottom-up methods using ground-level technology (e.g. optical gas imaging, real-time sensors) at both the facility-level and the component/equipment-level and top-down methods through satellites or aerial technology. Each method can be implemented at varying frequencies and has its own benefits and drawbacks, but together can lead to effective and efficient methane emissions reductions.

Remote-sensing and satellites: Emerging aerial and satellite detection technology has the potential to provide more information for identifying and quantifying methane emission sources. Together with bottom-up technologies for testing equipment, satellite and aerial technologies contribute to comprehensive inspections of areas and facilities to identify key source points.

The Carbon Mapper program is leading the research effort to make this data available to governments and other stakeholders looking to make immediate emissions reductions. In collaboration, California has led the way for governments by demonstrating how remote-sensing measurements can be utilized to improve a jurisdiction's understanding of emissions sources. Regulators and other stakeholders should keep a close eye on how this technology evolves so that they can be best positioned to use the new information for immediate action.



4 Set technology or performance standards

Setting mandatory standards for low emissions technology is a highly effective method for addressing oil and gas methane emissions. It provides the industry with clear parameters for identifying outdated equipment and processes and planning for technology changeouts. Another approach is to set performance standards, which specify a level of performance for a piece of equipment or a facility, but do not specify the methods for achieving this.

What does best practice look like?

Standards should be applied to all major methane emissions sources, covering aspects such as vapor collection and control requirements, venting and flaring restrictions, equipment retrofit and replacement requirements, and monitoring and management plans. They should include requirements for retrofitting existing facilities and for new installations.

To maximize the effectiveness of standards, regulatory reviews should be conducted routinely to ensure that the regulations are on track to meet committed reduction targets.

Additionally, reporting and enforcement provisions should be included to ensure compliance, as well as identification of a pathway to compliance to encourage adoption of innovative and emerging technologies.

In the US and Canada, federal regulations include reduced emissions completions (REC) requirements during well completions and well workovers following hydraulic fracturing. For governments outside of North America, RECs should be included in regulations as they are essential for preventing future emissions, particularly from jurisdictions with shale gas operations.

Setting technology standards to regulate methane emissions

The following sections provide an overview of standards used to regulate the major sources of methane emissions in the sector. These sources are drawn from the nine core emissions sources outlined by the Climate and Clean Air Coalition's Oil and Gas Methane Partnership (OGMP). An effective methane mitigation strategy will also include these sources within the jurisdiction's LDAR program.

For some emissions sources, there are noticeable differences in the approaches used in Canada compared with those used in the United States. Where this occurs, we have highlighted the leading practices in each country to demonstrate the approaches available to states and regions, but have not commented on whether one approach is more effective than the other.

Each source can be addressed individually or through regulations that encompass multiple sources. For example, regulations addressing venting, such as venting bans or facility-wide limits, can apply to storage tanks, well venting, and casinghead gas venting.

In Canada, regulations take a flexible approach, setting overall emissions limits at the facility level and allowing companies to choose the solutions that works best for them. The Canadian federal government has set ambitious facility-level venting limits. Provinces have catered their limits to target the largest sources of provincial emissions, but the venting limits are not as ambitious.

In the US, the state approach involves specifying methods for the mitigation of VOC emissions, which also leads to the reduction of methane emissions, or regulating methane directly, as is the case in California. Mitigation options include vapor recovery units (VRUs), which enable the gas to be used productively elsewhere, stabilization towers, and flaring/combustion.

Emissions source	Description	Elements of best practice
Storage tanks 	**Storage tanks hold liquids such as crude oil, condensate, and produced water. Emissions arise from methane and other volatile organic compounds (VOCs) which vaporize from the liquids stored in the tanks. Many tanks are designed to vent excess gases directly into the atmosphere.**	• Set ambitious facility-level limits on venting from major sources including storage tanks. • Require vapor collection to route gas for sale or to a disposal system or vapor control with a control efficiency of at least 95%. • Require flares or other combustion devices have no visible emissions. Flares used to control flash emissions from storage vessels must achieve a destruction efficiency of at least 98%. • Require that a professional engineer certify the adequacy of control systems for tanks.
Gas compressors 	**Reciprocating and centrifugal compressors emit gas both from seals and rod packing during operation and through leaks. They are found in a variety of operations throughout the oil and gas industry.**	• Set ambitious limits on emissions from centrifugal and reciprocating compressors. • Require vapor collection to capture emissions from compressor rod packing and seals. • Vapor collection and control methods should also be engineered to meet the best practices (e.g. achieve 95% or 98% destruction efficiency). • Regular replacement of rod packing (at least every 36 months) as an alternative to emission rate limits.

Emissions source	Description	Elements of best practice
Pneumatic devices and pumps 	**Outdated pneumatic devices and pumps were designed to emit excess gas pressure as part of their usual operations and all pneumatic devices and pumps are susceptible to leaking due to malfunctions or maintenance issues.**	• The use of zero emissions pneumatic devices should be required in new installs. • Existing pneumatic devices and pumps should be retrofitted for zero emissions. • Pneumatic devices and pumps should be subject to LDAR controls to ensure they are operating correctly.
Well venting from liquids unloading 	**The amount of gas produced in non-associated gas wells naturally decreases over time. As a result, liquid droplets that were once removed due to the gas flow start to accumulate in the wells. As these liquids inhibit gas production, they then need to be removed or 'unloaded'.**	• Implement vapor collection methods, if possible. • Ensure that venting is limited to the maximum extent by having an operator present on site during planned liquids unloading events. • Require direct measurement and recording of the venting event.
Casinghead gas venting 	**Casingheads are installed at the top of an oil well and manage the flow of oil. Many oil wells also produce significant amounts of gas, which is routinely vented into the atmosphere. It can readily be captured and used on-site or fed in the gas gathering system.**	• Include casingheads in sources covered under facility level venting limits or vapor control and collection requirements. • Operators can report emission flow rates from open well casing vents to improve understanding of emissions sources.

i. Storage tanks

Storage tanks are used in the oil and natural gas sector to hold liquids such as crude oil, condensate, and produced water. Emissions from tanks occur when methane and other volatile organic compounds (VOCs) vaporize from the liquids stored in the tanks and are intentionally vented into the atmosphere to alleviate pressure build-up inside the tank.

What does best practice look like?

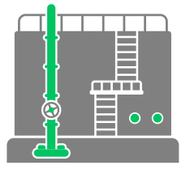
- Ambitious facility-level limits on venting from major sources including storage tanks.
- Requiring vapor control with a control efficiency of at least 95% or vapor collection to route the gas for sale, reuse on site, or to a disposal system.
- Requiring that flares or other combustion devices have no visible emissions. Flares used to control flash emissions from storage vessels must achieve a destruction efficiency of at least 98%.
- Require that a professional engineer certify the adequacy of control systems for tanks.

For example, operators in Colorado are required to implement vapor control with an efficiency of 95%. This is complemented by weekly monitoring and regular inspections depending on the VOC emissions level.

The Climate and Clean Air Coalition's Oil and Gas Methane Partnership (OGMP)

This is a voluntary, public-private initiative that aims to minimize methane emissions from global oil and gas upstream operations. The OGMP's Technical Guidance Documents for each of the nine core emissions sources provides methodologies for quantifying methane emissions and detailed mitigation options for each source.

ii. Gas compressors (reciprocating and centrifugal)



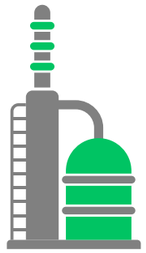
Reciprocating and centrifugal compressors emit gas both from seals and rod packing during operation and through leaks. They are found in a variety of operations throughout the oil and gas industry.

Within Canada, the Government of Alberta and the Canadian federal government have the strongest limits on compressor emissions. In the US, Colorado is the leading best practice example for gas compressor regulations with an emissions reduction target of 95% from 2015 for wet seal centrifugal compressors.

What does best practice look like?

In Canada, best practices have included setting ambitious limits on emissions from reciprocating and centrifugal compressors and targeting compressors with the highest emissions. In the US, leading governments require emission flow rate limits, vapor control and collection methods that achieve at least 95% or 98% destruction efficiency, and/or regular replacement of rod packing (at least every 36 months) as an alternative to emission rate limits.

iii. Pneumatic devices and pumps



In the past, pneumatic devices and pumps were designed to emit gas as part of their usual operations. Newer technology is available to eliminate gas release into the atmosphere. Additionally, all pneumatic devices and pumps are susceptible to leaking due to malfunctions or maintenance issues. These emissions can be mitigated by setting standards to eliminate outdated technology and requiring new pumps and devices to be zero emitting.

What does best practice look like?

- The use of zero emissions pneumatic devices should be required in new installs.
- Existing pneumatic devices and pumps should be retrofitted for zero emissions.
- Pneumatic devices and pumps should be subject to LDAR controls to ensure they are operating correctly.

In Canada, best practice examples draw from multiple jurisdictions. British Columbia has the strongest regulations for pneumatic devices, followed by Alberta, while the Canadian federal government has the strongest regulations for pneumatic pumps. In the US, California and Colorado lead the way with zero- and low-emitting requirements for pneumatic devices and pumps.

iv. Well venting from liquids unloading

The amount of gas produced in non-associated gas wells naturally decreases over time. As a result, liquid droplets that were once removed due to the gas flow start to accumulate in the wells. As these liquids inhibit gas production, they eventually need to be removed or 'unloaded'. There are a variety of methods that can be used to remove these liquids, some of which result in gas venting to the atmosphere.

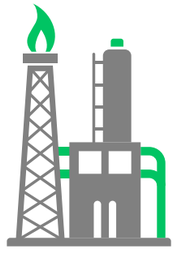
In Canada, this source isn't included in regulations because it is not considered to be a major source of emissions.

In the US, the EPA Natural Gas Star Program advocates for the use of plunger lifts to reduce the need for liquids unloading. California addresses this source by specifying vapor collection or direct measurement and reporting of vented gas. Colorado permits venting during liquids unloading only if other best management practices to avoid venting are unsuccessful. Most other states do not address well venting from liquids unloading in their regulations.

What does best practice look like?

- Vapor collection methods are implemented, if possible.
- Operator is present on site during any planned liquids unloading event to ensure that venting is limited to the maximum extent.
- Direct measurement and recording of the venting event.

v. Casinghead gas venting



Many oil wells also produce significant amounts of gas. This gas (known as associated or solution gas) is routinely vented into the atmosphere. It can readily be captured and used on-site or fed into the gas gathering system. Casingheads are installed at the top of an oil well and manage the flow of oil.

This source is covered under facility-level venting limits by the Canadian federal government as well as the provincial governments of Alberta and Saskatchewan.

At the federal level in the US, the Bureau of Land Management Venting and Flaring Rule limiting the amount of methane leaked, flared, or vented was removed in 2018, but there is still a policy for assessing royalties on flared and vented gas that didn't have to be flared and vented. At the state level, the approach is varying. In Colorado, venting is addressed through vapor control and collection requirements. In California, the current requirement is to have operators report emission flow rates from open well casing vents; however, some local air districts in the state prohibit venting from wells altogether.

In Texas, operators must request a permit from the state's regulatory agency to conduct flaring operations—the majority of the requests submitted are for flaring of casinghead gas from oil wells. North Dakota bans the venting of natural gas and requires flaring of all oil well gas and the volume flared to be measured and reported.

5 Require reporting and record keeping

Reporting and record-keeping contribute to the comprehensiveness of LDAR programs and technology standards by providing information about when leaks and malfunctioning equipment were detected and addressed, keeping track of where problems in the system often occur, and improving inventories. In states and regions, oil and gas operators can be required to maintain records and regularly report emissions by source type, including details such as venting and flaring events, fugitive emissions, inspections, and detection and repair activity.

What does best practice look like?

An effective reporting and record-keeping process will require annual public reporting for operators to the regulatory agency. It will include detailed and site-specific record-keeping provisions, demonstrating compliance with each of the mandatory methane reduction measures by source type. Policymakers can request a minimum set of data across oil and gas companies for consistency in comparison and data evaluation and determine a time period for maintaining records (e.g. 5 years). The method of calculation and key metrics that are to be used for the calculation should be specified (e.g. methane composition, volume, time etc.). Reporting requirements should also be designed in a way that enables the information collected to be used to improve inventories.

6 Set methane emissions reduction targets

Setting statewide or regional targets and reporting against them helps to drive effective action. Targets provide a mandate for government agencies to develop policies that reduce emissions and can influence federal governments to take stronger action. They drive inventory development and innovation and provide industry with a long-term direction of change.

Some governments have stand-alone methane strategies to achieve their targets; others have incorporated them into their overall climate change strategies. For example, British Columbia's Clean BC strategy includes methane from the oil and gas industry, referencing their methane target and providing an overview of upcoming plans to address these emissions. California has a Short-Lived Climate Pollutant Reduction Strategy and also includes methane in their Climate Change Scoping Plan.

To drive meaningful reductions and achieve climate goals, targets need to be set at an ambitious level. The Global Methane Alliance is calling for a 45% reduction in oil and gas methane by 2025 and a 60–75% reduction by 2030. These targets are realistic and achievable, and greater reductions can be achieved through innovation.

What does best practice look like?

Targets should be ambitious as well as technologically and economically feasible. In setting targets, governments will also need to take into account their specific circumstances and level of existing action, and the ambition of the target is dependent on the baseline or starting year. The targets can be structured as a percentage reduction based on a current or historical baseline, as a total mass-based emission level, or against an absolute target, such as net zero.

The law setting the target should direct jurisdiction regulators to adopt rules or regulations to meet the goal, with regulatory flexibility and enforcement authority.

New modeling of the Canadian federal methane regulations showed that federal regulations were not on track to achieve the committed target, only achieving a 29% reduction by 2025 as opposed to the committed 40–45% target. The federal government has reaffirmed their commitment to the target by committing to public reporting on progress to achieve the 2025 reduction targets in 2021 and to strengthening the regulations if needed. In late 2020, the federal government committed to more ambitious methane reduction targets for 2030 and 2035 to align with global best practices.

US & Canadian emissions reduction targets

Government	Emissions reduction target for methane from oil and gas	Greenhouse gas emissions reduction target
United States	40%–45% by 2025	26–28% reduction from 2005 levels by 2025, 80% by 2050
California	40% below 2013 levels by 2030, for methane from all sectors	40% below 1990 levels by 2030, 80% below 1990 levels by 2050, net zero by 2045
Colorado	*Tentative: 30% reduction in total emissions by 2025 and 50% by 2030*	26% reduction by 2025, 50% by 2030 and 90% by 2050 from 2005 levels
Canada	40%–45% below 2012 levels by 2025	30% reduction from 2005 levels by 2030, net zero by 2050
Alberta	45% below 2014 levels by 2025	None
British Columbia	45% below 2014 levels by 2025	At least 40% below 2007 levels by 2030, 60% by 2040, and 80% by 2050
Saskatchewan	40%–45% below 2015 levels by 2025	None

In the US, states leading with ambitious methane reduction targets, such as California and Colorado, make it possible for other states to follow suit and states with a GHG reduction target can build on them with a methane-specific commitment.

Although establishing a methane reduction target is not a prerequisite to taking action and making immediate reductions, doing so does contribute to an effective mitigation strategy by providing a goalpost to track progress against, signalling methane as a long-term priority, and informing overall GHG emissions reduction plans.

7 Participate in information and technology sharing forums

Through participation in information sharing forums governments can stay up to date with the latest policy and technology developments, share policy solutions, and benefit from the experiences of others.

The Under2 Coalition Methane Project is an example of such a forum, with governments sharing their experiences in tracking and reducing methane emissions in the oil and gas sector and using the platform to showcase climate leadership.

As governments scale up action on methane emissions, connecting with their peers will accelerate the implementation of mitigation strategies and elevate best practice to standard practice. Through peer learning and engagement, subnational governments will also be able to leverage the power of collective action to expand their impact globally and influence key actors, like national governments and the private sector.

There are a number of global and regional initiatives that are working to reduce methane emissions. These initiatives play an important role by sharing knowledge on emissions reduction technologies and global best practice, driving innovation and research, convening stakeholders, and monitoring methane emissions. Governments can draw on the resources, expertise and networks of these initiatives and use them in the policy making process.

> “As governments scale up action on methane emissions, connecting with their peers will accelerate the implementation of mitigation strategies and elevate best practice to standard practice.

Further ways governments can drive methane emissions reductions

In addition to the key actions identified in the previous section, a variety of other policies and approaches are available to states and regions that may be included in their methane mitigation strategy.

8 Engage with stakeholders

Incorporating a formal process for engaging both external and internal stakeholders is an important element of a methane mitigation strategy.

It facilitates industry buy-in and paves the way for long-term compliance. Especially as more states move to benefit from reducing methane emissions by significantly improving their existing strategies or taking action for the first time, stakeholder engagement will ensure that the actions being taken are comprehensive and tailored to the local context. In addition to oil and gas companies, key stakeholders include vulnerable and fenceline communities, health agencies, and NGOs.

9 Provide funding for fast action

To support emissions reductions, governments can create funding programs that facilitate immediate action by supporting the uptake of new technologies and promoting long-term action. Especially as a result of the COVID-19 pandemic, public investments in the form of green recovery programs can serve multiple goals, including creating jobs, achieving emissions reduction goals, and strengthening resiliency.

For example, the Canadian federal government announced the Emissions Reduction Fund aimed at helping companies reduce methane emissions. $675 million will be available to onshore oil and gas companies to lower or eliminate routine venting of methane-rich natural gas from onshore conventional, tight, and shale oil and gas operations. The remaining $75 million will focus on reducing emissions and improving environmental performance, as well as research and development. The onshore fund will provide loans for actions that lower methane emissions and partially refundable loans for actions that eliminate methane. The portion of the loan that is refundable scales with the cost per tonne of CO_2 equivalent (CO_2e) mitigated, creating incentives for companies to pursue low cost projects. This program is well-designed to create incentives for going beyond the current regulations.

In 2020, Alberta announced more than $100 million of funding towards the implementation of the latest technologies in greenfield and brownfield operations, including efforts to reduce methane emissions, in order to support economic recovery and environmental resiliency. These programs focus on reducing costs for companies to comply with regulations and provide support for research and development, emissions inventories, and opportunity assessments. While this funding will provide support to industry and contribute to reducing costs, it is not linked to action beyond the current regulations.

10 Invest in research programs

Governments can implement research programs to better understand and incorporate new technologies into their policy response.

British Columbia's Oil and Gas Methane Emissions Research Collaborative (MERC) is a multi-stakeholder initiative between the province, environmental non-profits, industry, and research organizations. It was established to ensure research efforts improve the province's understanding of methane emissions from the oil and gas sector and ensure new technologies are achieving the outcomes expected from the provincial regulations.

Alberta has several ongoing research programs focusing on methane technology and innovation approaches across the oil and gas sector. These include testing and deploying alternative detection technologies and assessing the effectiveness of leak detection programs among other work. The work is conducted through the Petroleum Technology Alliance of Canada (PTAC) and involves industry and government.

11 Facilitate education and outreach

Governments can provide industry and the public with education, outreach and public awareness programs highlighting the importance of taking action on methane as well as opportunities for mitigation. Including information about the role of methane in climate change or public health awareness campaigns helps citizens understand its impact and how the government is addressing it. For industry, these programs can have important benefits for compliance and offers opportunities to build government-industry relationships.

Colorado's Small Business Assistance Program provides free education, support, outreach, and advocacy to help small businesses comply with environmental regulations, including air quality regulations such as the oil and gas emissions rules. To qualify, a business must have fewer than 100 employees and release less than 50 tons per year of any one regulated pollutant and less than 75 tons per year of any combination of regulated pollutants. While the program is not a subsidy, the provision of free regulatory advice could be considered financial support for smaller operations.

12 Apply economic or market-based instruments

Implementing economic instruments such as a price on carbon and other GHG emissions can be part of a government's approach to methane mitigation, and a few governments have included methane in their carbon pricing programs. However, a robust baseline and emissions measurement and reporting program is needed to effectively tax methane. Additionally, carbon pricing overall is shown to be an effective revenue raiser for investing in low emission efforts.

Alberta has an output-based pricing system for industry, called the Technology Innovation and Emissions Reduction (TIER) Regulation, which includes methane emissions in its scope. The policy applies to large industrial emitters and sets the amount of emissions allowed for each unit of production for each sector (e.g., for crude oil, the intensity limit would be in units of tonnes of carbon dioxide equivalent per barrel of oil). Producers must pay a price on emissions that exceed the limit, but not on emissions below the limit. Combustion, process, and methane emissions are all priced and companies may either reduce emissions at each facility to comply with the limit or pay the price on carbon. While the majority of methane emissions are at small sites that are not included in the program, companies can reduce methane emissions to comply with the regulation through the offset system.

California's Cap-and-Trade Program establishes a declining limit on major sources of GHG emissions, including methane emissions, throughout the state. The program covers approximately 80% of statewide GHG emissions, and it creates an economic incentive for investment in cleaner, more efficient technologies. The program covers petroleum and natural gas systems (including natural gas production, processing, transmission compression, and underground storage facilities over a minimum annual emissions threshold), refineries, and natural gas suppliers (including suppliers of compressed and liquefied natural gas), in addition to other sectors. Certain sources of emissions from the oil and gas sector are exempt, including vented and fugitive emissions from a variety of storage tanks and from produced water, vented and fugitive emissions from intermittent-bleed pneumatic devices; and vented emissions from certain qualifying well-site compressors.

13 Support business innovation

As methane mitigation is closely linked to improvements in technology and processes, business innovation and leadership is an important factor in the success of these outcomes.

Governments should consider ways in which they can support and enable business innovation. For example, governments can support and collaborate on pilot projects in their region and promote success stories through leadership award programs.

Looking ahead

States and regions can lead the way in scaling up the action, ambition, and collaboration needed to realize the full benefits of methane reduction and achieve our climate goals.

The next few years are critical for making progress on methane and leading state and regional governments have demonstrated the opportunities to make immediate methane emissions reductions. Driving action forward will involve leveraging best practices for key methane emissions sources, utilizing latest technologies, and verifying compliance against regulations.

As major oil and gas producing nations, there remains an opportunity for Canada and the US to further reduce emissions from both the oil and gas sector at the national and subnational level. In Canada, further regulation is needed to achieve the methane reduction goals set out by the federal government. In the US, many of the top oil producing states have significant potential to reap climate and cost gains through ambitious actions to reduce methane emissions.

The Climate Group is also exploring the potential for action on short-lived climate pollutants more broadly, and how future programs can support state and regional governments to make progress and achieve their goals.

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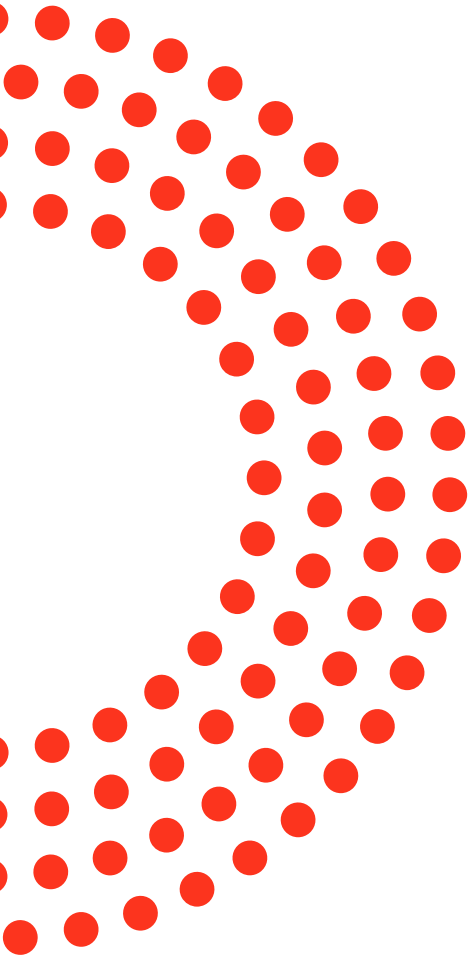
PEMBINA institute



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