Policy Approaches for Reducing Methane Emissions

Comparing regulations, carbon pricing, and subsidies

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Addressing methane from the oil and gas sector has become increasingly popular as a way to reduce emissions of greenhouse gases (GHGs). Methane is a large and complex problem that can be challenging to understand because it comes from many sources. Despite its complexity, methane can be managed effectively and inexpensively, making it one of the most cost-effective ways to address climate change. Methane is also a short-lived GHG, surviving in the atmosphere for less than a decade. This means we will see the positive impact of reducing methane emissions now.

The current policy landscape for methane is advancing very quickly. In the last year, Canada finalized their methane regulations, while Alberta and British Columbia released draft regulations. Internationally Mexico released regulations on methane in 2018 and U.S. states including California, Colorado, and Wyoming have regulations in place.

But is regulation the best way to reduce methane emissions? In this report, we compare three policy approaches to addressing methane: regulations, pricing, and subsidies. In comparing and evaluating the approaches, the coverage, innovation potential, enforcement issues, fairness to other sectors, and overall effectiveness are considered. While each policy has its strengths and weaknesses, we recommend applying a combination of all three. The following steps will achieve the greatest reductions now, while improving measurement systems and continuing to drive reductions in the future.

1. Implement methane regulations now.
2. Improve measurement, monitoring, and reporting.
3. Implement effective compliance and enforcement regimes.
4. Invest in developing better measurement and monitoring.
5. Put a price on methane emissions.

1. Introduction

1.1 Methane as a greenhouse gas

Methane has become a hot topic in recent years as countries realize that addressing methane is an extremely effective way to cut overall greenhouse gas emissions (GHGs). The Government of Canada finalized their methane regulation in early 2018, and Alberta, Saskatchewan and British Columbia have followed suit to release at least a draft version of their regulations. Internationally, Mexico came out with a set of regulations on methane in 2018, and the number of U.S. states with regulations in place is growing.

Reducing methane emissions is an effective and inexpensive way to combat climate change. While methane stays in the atmosphere for less than a decade, it is almost 100 times as potent a greenhouse gas as carbon dioxide.[1] This means that reducing methane emission will have an immediate positive impact. And getting rid of methane is cheap. The Government of Canada's regulations aim to reduce methane emissions by 40–45%, at a cost of less than $20 per tonne of carbon dioxide equivalent (CO_2e).[2] Compared to a carbon price of $35/t CO_2e in British Columbia, $30/t in Alberta and the federal plan to increase the price nationwide to $50/t by 2022, methane emissions reductions are a bargain.

Methane is responsible for 14% of Canada's greenhouse gas emissions, and close to half of that is emitted by the oil and gas sector.[3] It is also the main component of natural gas, which makes it a valuable asset worth conserving.

[1] The global warming potential of methane is 96 times larger than carbon dioxide on a 20-year time scale. https://core.ac.uk/download/pdf/132092586.pdf

[2] Government of Canada, *Regulations Respecting Reduction in the Release of Methane and Certain Volatile Organic Compounds (Upstream Oil and Gas Sector)* SOR/2018-66. http://gazette.gc.ca/rp-pr/p2/2018/2018-04-26-x1/html/sor-dors66-eng.html

[3] Based on National Inventory data from Environment and Climate Change Canada, *National Inventory Report 1990-2016: Greenhouse Gas Sources and Sinks in Canada, Part 3* (2018), Table A9-3, 2014 GHG Emissions Summary for Canada. https://unfccc.int/process-and-meetings/transparency-and-reporting/reporting-and-review-under-the-convention/greenhouse-gas-inventories-annex-i-parties/national-inventory-submissions-2018

1.2 Sources of methane emissions

The majority of methane emitted from the oil and gas sector is from the production and processing of natural gas and crude oil, as shown in Figure 1. To a lesser extent, natural gas transmission and distribution, crude oil refining, and oilsands operations also contribute to methane emissions. Most of the methane is emitted in provinces that produce oil and gas — Alberta, Saskatchewan and British Columbia.

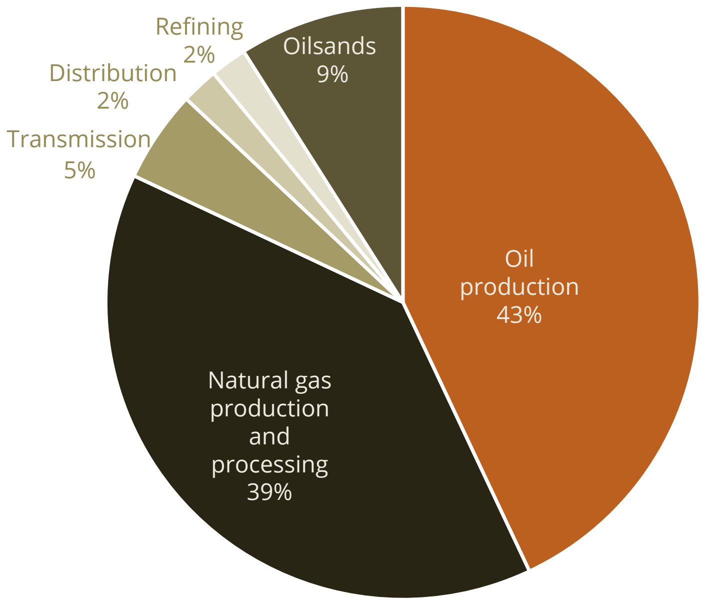

Figure 1. Methane emissions from the oil and gas sector, 2014

Data source: Environment and Climate Change Canada[4]

Methane emissions sources in the oil and gas sector are diverse and numerous, can change over time, and vary by facility and type of operation — conventional oil, natural gas production, oilsands mining, natural gas processing, etc. Sources of methane can be unpredictable and difficult to measure, but they can be grouped into several categories (see Figure 2).

[4] *National Inventory Report 1990-2016,* Table A9-3.

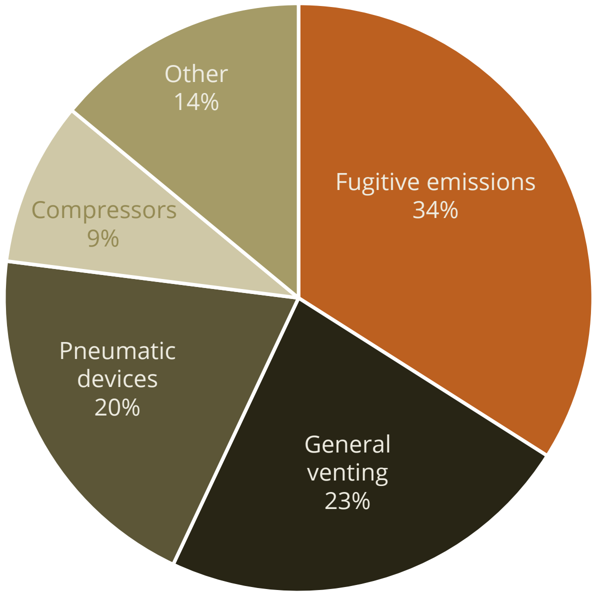

Figure 2. Methane emissions by category

Data source: Environment and Climate Change Canada[5]

Fugitive emissions

Fugitives are unintended emissions leaking from components such as piping connections, flanges, and valves. They result from component wear and tear or maintenance issues.

Venting

Venting is a broad category that capture many sources. Examples are gas emitted from storage tank vents, intentional releases of natural gas dissolved in crude oil (solution gas) and gas discharged during process upsets/emergencies.

Pneumatic controllers and pumps

Pneumatic controllers are devices used to measure or control process conditions such as temperature, pressure, flow rate, or liquid level. Pneumatic pumps are used to pump chemicals on site. The majority of controllers and pumps in use in the oil and gas sector are driven by natural gas. Both controllers and pumps are designed to vent natural gas

[5] Based on best available estimates. Shown in Environment and Climate Change Canada, "Proposed Methane Regulations: A Significant Step in Addressing Climate Change in Canada," presentation, June 2017.

during operation, while malfunctions can cause them to release even more gas than intended.

Compressors

Natural gas is transported through pipelines at high pressures. It is pressurized using compressors which are stationed at regular intervals along the pipeline. Most compressors are powered by natural gas, although electric alternative do exist. The seals and other internal components of compressors emit natural gas under normal operating conditions. As these seals wear out over time they emit more and more gas.

Others

Other sources include methane emitted during hydraulic fracturing of natural gas wells (well completions), biogenic methane generated from oilsands tailings ponds, and methane emitted during the incomplete combustion of natural gas in flaring.

1.3 The measurement problem

Recent studies in B.C., Alberta, and the U.S. have shown that methane emissions are much higher than what is currently being reported.[6, 7, 8] In Alberta, methane emissions were found to be as much as 50% higher than current government estimates, and over five times higher than what oil and gas companies are currently reporting.[9]

Why are our estimates of methane emissions so poor? In Canada, companies have not historically had to report all of their methane emissions. Even those emissions that are reported may not be accurate. For example in Alberta, oil and gas companies are only required to report flaring and venting emissions. Methane emissions from pneumatic devices, compressor seals, fugitives, and many other sources are not reported.

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[6] Ramon Alvarez et al, "Assessment of methane emissions from the U.S. oil and gas supply chain," *Science* (2018), DOI: 10.1126/science.aar7204

[7] Emmaline Atherton et al., "Mobile measurement of methane emissions from natural gas developments in Northeastern British Columbia, Canada," *Atmospheric Chemistry and Physics Discussions*, 17 (2017), 12405, http://www.atmos-chem-phys-discuss.net/acp-2017-109/acp-2017-109.pdf

[8] Matthew Johnson et al, "Comparisons of Airborne Measurements and Inventory Estimates of Methane Emissions in the Alberta Upstream Oil and Gas Sector," *Environmental Science and Technology*, 51, no. 21 (2017), 13008, DOI: 10.1021/acs.est.7b03525

[9] Ibid.

Our understanding of these other sources is based on national inventories compiled using estimates and averages from various industry and academic studies. National inventory estimates are based on total facility counts, average equipment and component counts (how much equipment does each have and how many component does each piece of equipment have), production accounting (how much oil and gas is produced at each facility) and average emission factors (how much methane is leaking out of each piece of equipment). While incoming methane regulations will improve measurement and reporting, the quality of data is currently limited by inadequate measurement and reporting requirements, poor accuracy of reported data, and a lack of accurate and affordable measurement techniques.

Methane emissions are also highly skewed, with a small number of emission sources ("super-emitters") responsible for a large portion of emissions. While this creates a challenge when attempting to estimate total methane emissions based on limited data, it is an advantage when trying to reduce emissions: you only need to focus on a small portion of the emissions to get big reductions.

With this in mind, we will evaluate and compare different policy approaches for reducing methane emissions.

2. Evaluating policy approaches

This report will consider three policy approaches: regulations, carbon pricing and subsidies. Each approach will be evaluated and discussed individually before considering the best policy or combination of policies. In evaluating and comparing the policies, the following questions will be considered:

- What percentage of methane emissions can be covered?
- Will the policy drive innovation?
- Can the policy be enforced properly?
- How fair is the policy to other sectors of the economy?
- How effective at reducing emissions is the policy likely to be?

2.1 Regulations

Increasingly, countries, provinces, and states are choosing to address methane emissions via regulation. This has been shown by the overwhelming movement to implement regulations on methane in Canada, Mexico, and many U.S. states. The Ecofiscal Commission calls methane regulations a "gap-filling policy" that applies to GHG emissions that have challenges like measurement which make them difficult to include in a carbon price.[10]

Regulations can be implemented in many different ways. In addressing methane, they typically require operators to take specific actions such as conducting surveys to detect and fix leaks or adopt specific technologies that reduce emissions such as replacing pneumatic devices which are designed to vent gas with ones powered by air or electricity, which do not vent gas. In this case they work by applying known solutions that industry has been slow to adopt. They may also set limits on emissions from specific sources while providing the operator with flexibility on where and how to reduce the emissions.

Coverage: Well-designed regulations can provide good coverage by addressing emissions sources that cannot be accurately measured. Many sources of methane emissions cannot be measured accurately, or accurate measurement is expensive (see

[10] Canada's Ecofiscal Commission, *Supporting Carbon Pricing: How to identify policies that genuinely complement an economy-wide carbon price* (2017), III. http://ecofiscal.ca/wp-content/uploads/2017/06/Ecofiscal-Commission-Report-Supporting-Carbon-Pricing-June-2017.pdf

Section 1.3). An example is fugitive emissions — it is easy and feasible to detect and fix leaks, but methods that are typically used to measure leaks can be inaccurate and time consuming. Regulations can specify available solutions to sources of methane emissions.

Innovation: Balancing certainty of action with innovation can be a challenge with regulations. Regulations that are specific and inflexible don't encourage innovation, but this is not always bad. Sometimes there is one feasible and readily available solution that will solve the problem without the need for innovation. An example for methane is pneumatic devices, where the clear and feasible solution is to replace pneumatics that vent gas with ones powered by air or electricity that do not vent gas. On the other hand, conventional heavy oil facilities that vent gas have more than one solution, and require flexibility in regulation. The best regulatory approach is to set an ambitious limit on how much gas a facility is allowed to vent and give operators flexibility in how to use the gas. In this case, there is room for new innovative solutions to be applied in the future.

Enforcement: Regulations require verification to ensure that the specific actions, technologies, and limits have been implemented. Strong enforcement is needed so that the public can be assured that companies are complying with the regulations. The reporting and enforcement of these actions needs to be transparent and available to the public.

Fairness: Applying regulations is inherently not a fair solution because not all sectors have the same regulations on emissions. However regulations are not meant to be fair — they are meant to target large sources of emissions that have readily available solutions which would otherwise not be addressed. They are useful at addressing emissions sources that are not covered by a broad policy such as a carbon price due to obstacles such as measurement.

Effectiveness: Overall, regulations can be effective when they require specific actions, technologies or limits to address known emission sources with clear, readily available solutions. However their effectiveness depends on the level of stringency. Weak regulations will result in weak outcomes. For example, in leak detection and repair, strong regulations require leaks to be surveyed and repaired at four times a year, while a weak regulation would only require one annual survey. Reluctance to implement stronger regulations can mean that relatively low-cost abatement options are not captured. In order to drive future improvements, regulations must clearly outline how stringency will increase over time.

Best practices in methane regulation

The three largest sources of methane emissions — fugitive emissions (leaks), pneumatic devices, and general venting — each have different challenges and require different regulatory solutions.

With fugitive emissions, the biggest obstacle is that measurement and detection of leaks has not been required historically, although recent regulations in Canada are changing this. Leaks are generally easy to fix, but no one knows where they are. This lack of data must be addressed; the solution is to require operators to conduct frequent leak surveys (four times per year) to find and fix leaks.

Pneumatics are mechanical devices that are powered by natural gas. They are designed to release gas regularly during operation. The best solution is to require specific technology: operators should replace the old gas-releasing devices with air- or electricity-powered alternatives that emit no gas, and to use only these alternatives for new facilities.

In general venting, operators release gas into the atmosphere when it isn't economic to conserve or destroy it by flaring or other means. However conserving, flaring, or using the gas in other ways is feasible and can save a valuable commodity from being wasted. The best solution is to set an ambitious limit on how much gas a facility is allowed to vent and give operators flexibility in how to use the gas. The gas could be tied into a pipeline, used for on-site heating, or if nothing else is possible, completely flared (burned off). Conservation should be prioritized over flaring. A recent study has shown that methane emissions from reported venting in Alberta can be reduced by 77% at an average cost of less than \$6/t CO_2e.[11]

2.2 Pricing

A pricing system (e.g. carbon pricing) requires companies and citizens to pay a price for the greenhouse gases that they emit. This provides incentive to reduce emissions when the cost of achieving the reduction is cheaper than paying the price. Companies have full flexibility on where and how to achieve these reductions and will pursue the most

[11] David R. Tyner and Matthew R. Johnson, "A Techno-Economic Analysis of Methane Mitigation Potential from Reported Venting at Oil Production Sites in Alberta," *Environmental Science and Technology,* 52 no. 21 (2018). https://pubs.acs.org/doi/10.1021/acs.est.8b01345#

cost-effective route. A pricing system can take several forms and while there are differences in these approaches, each aims to achieve reductions at the lowest possible cost.

Pricing is mainly applied to carbon dioxide. Most jurisdiction don't include other GHGs in their pricing systems. When pricing methane or GHGs other than carbon dioxide, typically the emissions are multiplied by a factor based on their global warming potential. The global warming potential of other GHGs relative to carbon dioxide varies based on the timeline that is considered. Since methane is a short-lived pollutant that remains in the atmosphere for less than a decade, the timeline has a big influence on its climate impact and the cost of mitigation. Typically a 100-year timeline is used for methane, meaning that 1 kg of methane has the same impact on the climate as 34 kg of carbon dioxide released. If the timeline is reduced to 20 years, however, 1 kg of methane has the same impact as 96 kg of carbon dioxide.[12]

Coverage: Only emissions that can be accurately measured would be effectively covered in a pricing system. The current uncertainty and inaccuracy of measurement would make it difficult to price methane and allocate emissions. Venting and fugitive emissions can be unpredictable and difficult to detect and measure. Uncertainty in the quantity and location of emissions would create risk and act as a barrier to action based on current pricing levels.

Innovation: A price on methane would create incentive for companies to pursue innovative solutions because it doesn't dictate specific technologies or solutions. A clear signal of an increasing price over time would provide further motivation for companies to develop low-carbon solutions.

Enforcement: Under a pricing system, parties must submit detailed emissions inventories that have been verified by a third party. The lack of accurate measurement of methane emissions would be an obstacle to accurate reporting. Reporting systems would have to rely on best available estimates of methane emissions for sources where accurate measurement capabilities don't currently exist.

Fairness: Pricing methane would be fair because all sectors of the economy would be subject to the same system and the same price. This is why a pricing system is the ultimate end goal for addressing emission sources such as methane which have some of the most inexpensive mitigation options.

[12] Thomas Gasser et al., "Accounting for the climate–carbon feedback in emission metrics," *Earth System Dynamics* 8 (2017). https://core.ac.uk/download/pdf/132092586.pdf

Effectiveness: In the current landscape, a pricing system would not be effective at reducing methane emissions at current pricing levels because of the lack of measurement, monitoring reporting of accurate data — the real amount of reductions that would be achieved is unknown. This may act as a barrier to action for companies, because if they don't understand their real emissions they won't be able to evaluate whether mitigating emissions is more cost effective than paying the price. However, adding accurate measurement and reporting would transform pricing into an effective tool because it can drive reductions up to the cost of carbon. The Canadian government estimates that the cost to achieve its target of reducing methane emissions by 40% to 45% is less than $20/tonne CO_2e.[13] With the federal carbon price slated to reach $50/t by 2022[14], a price on methane would drive much greater reductions than the currently proposed regulations.

If the carbon pricing system is an output-based allocation or cap-and-trade program (see box below for an explanation of each), a price on methane emissions would drive reductions similar to a carbon levy, but through different mechanisms. These systems both typically include tradable permits, meaning that an operator who can reduce emissions at a cost less than the price can sell them to other operators with in the same sector, or even in other industry sectors. This would achieve significant reductions because methane emissions are some of the lowest cost reductions across the economy. As an example, a coal plant operator may look to buy credits from methane reduction projects to reduce their emissions if it's cheaper than physically reducing emissions from their plant.

Carbon pricing regimes

Carbon levy (ex. British Columbia)

Fuel purchases are taxed based on the emissions generated by burning that fuel. The price on carbon increases over time, providing a strong signal and advance notice that pollution will get more expensive.

[13] *Regulations Respecting Reduction in the Release of Methane.*

[14] Environment and Climate Change Canada, *Technical Paper on Federal Carbon Pricing Backstop* (2017) https://www.canada.ca/en/services/environment/weather/climatechange/technical-paper-federal-carbon-pricing-backstop.html

Output-based allocation (ex. Alberta)

Typically applied to large industrial emitters, output-based allocations set a specific target for each industry on the emissions allowed for each unit of production (e.g. for crude oil, the intensity limit would be in units of tonnes CO_2e per barrel of oil). Producers must pay a price on emissions that exceed the limit, but not on emissions below the limit. As with a carbon levy, the price increases over time.

Cap-and-trade (ex. Quebec, California)

A cap is set on how much greenhouse gas can be emitted in a year. Companies are allowed to buy and sell credits that allow them to emit a specific amount. The price of credits is determined by the market. Continuous improvement is created by decreasing the cap over time, allowing fewer and fewer emissions.

2.3 Subsidies

A subsidy can be a tax credit or money given to provide incentive for reducing emissions or conducting research on new measurement and mitigation technologies.

Coverage: Subsidies are limited in that they only cover the sources that are subsidized and only to the extent and duration of the funding level.

Innovation: Subsidies can drive technology innovation when applied to research and development of new technologies. Creating new measurement and mitigation technologies will be critical to minimizing methane emissions in the coming decades due to the current challenge in affordably and accurately measuring many sources of methane.

Enforcement: When subsidies are provided to companies for reducing methane emissions, proper enforcement is needed to ensure that these reductions have actually taken place.

Fairness: Subsidies for methane in oil and gas are not fair to other sectors that don’t receive similar subsidies for reducing GHG emissions.

Effectiveness: Subsidies can be an effective way to motivate early action and stimulate development of new technologies. However use of subsidies should be limited because it is not sustainable long-term solution. As an example, the Government of Alberta is providing close to $300 million to tackle methane starting in 2017. This includes rewards for early action through offsets, rebates and support for retrofits and leak detection and repair, and grants for development of measurement and reduction technology.[15]

[15] Government of Alberta, "Protecting Alberta jobs, cutting methane pollution," media release, April 24, 2018. https://www.alberta.ca/release.cfm?xID=55828C212C369-BDCB-0802-F1B7D21F8054EE6C

3. Recommendations

Based on the evaluation above, we recommend adopting complementary policies by pairing regulations with pricing system, along with strategic use of subsidies to drive innovation and help smaller companies.

However, measurement issues remain a significant barrier to reducing methane emissions using a pricing system. These need to be addressed before implementing a price on methane. Pricing methane is a market solution, and market solutions require good data.

Implement methane regulations now

Regulations are the most effective and quickest approach to reduce methane emissions given the lack of accurate and feasible measurement options for many methane sources. Proven abatement technologies are commercially available and economically feasible. There is no reason to delay the implementation of regulations — the sooner they are in place, the sooner emitters will begin to act to reduce methane emissions.

Improve measurement, monitoring, and reporting

In parallel with regulations, measures are needed immediately to improve the measurement and reporting of methane by implementing the on best available technology. More work is needed to advance measurement technology to the point where methane emissions can be accurately measured continuously and in real time.

a) To improve the accuracy of methane emissions data, operators should be required to measure the emissions wherever possible. Where measurement isn't an option, due to technology limitations, estimation methods should be improved as much as possible. As an example, leak detection and repair (LDAR) programs should include all sources of methane emissions, especially pneumatics, compressors, and surface casing vents.

b) Companies should be required to report their emissions in detail by source. This is especially true for venting, which includes many sources of emissions that are typically lumped into one category. The U.S. EPA GHG Reporting Rule (Subpart W) is a good model system to follow.[16]

c) Methods are needed to identify and report super-emitters. These large emissions sources have been shown to account for the majority of emissions. If we are to truly know where methane emissions are coming from and how much they are being reduced with mitigation efforts, identification of super-emitters is critical.

d) In the short term, while we work towards accurate measurement, we should continue to conduct field studies to build on the current inventory of emissions factors and equipment counts to ensure that the data we use is accurate and representative.

Implement effective compliance and enforcement regimes

The policy tools evaluated are only as good as the ability of government and the public to know with certainty that action is being taken. It's not clear that regulators are doing the checks to ensure that companies are complying with current regulations. As well, the enforcement that is being conducted is not being reported to the public in a clear and transparent manner. Strong enforcement is essential to ensuring accountability and so the public can observe which companies are in compliance. This is achieved by doing regular compliance checks and publishing the results so they are available to everyone. Public trust can only be earned if regulations are being properly enforced and if this is communicated to the public.

An example of a jurisdiction with effective compliance enforcement is Colorado, where the regulator conducts regular independent LDAR surveys and issues regular fines for non-compliance.

Invest in developing better measurement and monitoring

Governments should continue to invest in the development of innovative methane measurement and mitigation technology. The Methane Challenge funded by Emission Reduction Alberta is an example of effective investment in new technology. There are several areas that are in particular need of improvements in measurement technology:

[16] United States Environmental Protection Agency, Greenhouse Gas Reporting Program (GHGRP): Subpart W – Petroleum and Natural Gas Systems. https://www.epa.gov/ghgreporting/subpart-w-petroleum-and-natural-gas-systems

Fugitive emissions

Infrared cameras are being used to detect leaks, but current methods of measuring the leak rate take more time and are inaccurate. Affordable, accurate, and portable technology is needed for measuring leak rates, not just detecting leaks. Another potential solution is to combine large-scale vehicle, drone, or satellite mounted systems to detect large leaks with on-the-ground measurement methods.

Solution gas venting from conventional heavy oil

Conventional heavy oil production in Alberta produces significant amounts of gas along with the oil. This solution gas is dissolved in the oil and is vented in large quantities. Solution gas venting is currently measured based on estimates of the gas-to-oil ratio from each reservoir. These estimates are unreliable because of the variability of gas-to-oil ratios over time. More accurate and affordable methods of continuous measurement are needed.

Storage tanks

Measuring venting from storage tanks is either inaccurate but fast, or accurate but takes a long time. Part of the problem is that tank vents are high above the ground and not easily accessed. Faster and more accurate measurement techniques are needed to reliably measure storage tank venting.

More precise measurement will overcome the serious limitations of the current estimation approach. It will provide more accurate understanding of emissions sources, creating a robust and accurate system that can generate auditable results for compliance purposes within a pricing system. Looking forward, we need to work towards developing real-time facility-level monitoring of methane as this approach is the most efficient, accurate, robust and accountable.

Put a price on methane emissions

A pricing system is the ultimate outcome-based approach — it is completely agnostic on solutions and steps taken by emitters as they will make decisions based on financial feasibility and minimized costs, and will ultimately drive the lowest cost emissions reductions.

After regulations and a proper measurement and reporting system are in place, a pricing mechanism should be implemented. A price on methane provides a long-term signal to address emissions reductions which may not be feasible immediately. A price can be easily raised, increasing the stringency of the policy and driving more reductions, while remaining consistent across all sectors of the economy. Pricing methane will not only affect decisions that operators make now but it will also affect how they plan for the future.

Several options exist for pricing methane – a fuel levy, output based allocations, or cap-and-trade. Each system has its advantages and disadvantages. The most efficient solution for pricing methane is to integrate methane emissions from oil and gas into the carbon pricing scheme already in place in each province. A reference carbon price of \$50/tonne of CO_2e should be implemented to align with the federal backstop. For fairness and effectiveness, it's critical that all sources of methane emissions, especially venting and flaring, are covered under a carbon price.